Welcome to The 360 Modena Workshop Manual at Ferrari

Publication Date: 03/09/2018

Disclaimer: Whilst every effort has been made to ensure the accuracy of this Workshop Manual, the manufacturer （Ferrari) shall not in any circumstances be held responsible for any inaccuracy or the consequences thereof. The manufacturer (Ferrari) reserves the right to vary specifications without notice in accordance with its policy of continual product improvement.

Note:We will upgrade the manual,when the Ferrari has a new upgrade for 360 Modena

Download workshop Manual as **PDF**

01.01 CONSULTING THE MANUAL

The manual is subdivided into **sections**, each one of which is identified by a **letter**.
Each section is subdivided into **chapters**, each one of which is identified by the **letter** of the section in which it is grouped, followed by a **consecutive number**.
Each chapter is, in turn, broken down into **paragraphs** that are identifiable by the section **letter**, the chapter number and by a **consecutive number** separated by a **period**.
Any references to chapters or paragraphs in other sections will be defined in this manner.
It is possible to locate the chapter and paragraph that include notes on a specific topic by consulting the table of contents found at the beginning of each section.
The text is backed up with illustrations highlighting or listing the parts described with numerical references in order to provide an improved description of the topic being dealt with.

01.02 UPDATING – PRINTING

Updating

The manual will be updated periodically, on the basis of the modifications made on the car and on the production of new versions.
ALWAYS consult the Technical Circulars as they could list adjustments and work procedure methods that are more current than those found in this manual.

Printing

The manual will no longer be in distributed in paper form, but it will be possible to get a printout of each subject viewed by simply pressing the PRINT key.

01.03 SYMBOLS

The Safety symbols presented below shall be utilized to attract the attention of the User regarding Personal safety hazards and risks, to signal operating conditions that could damage the vehicle or to supply useful information on the procedure being performed.
Meanings of the symbols used in the manual:

CAUTION
Failure to comply with the instructions found under this heading, can give rise to dangerous situations and cause severe injury to the Operator and/or persons working in the immediate vicinity.

IMPORTANT
Failure to comply with the instructions found under this heading, can give rise to damage, including irreparable damage, to the vehicle and/or vehicle parts.

NOTE
The instructions found under this general heading supply the Operator with useful information on the procedure being performed.

Reference to a paragraph or chapter dealing with the procedure mentioned.

01.04 ABBREVIATIONS AND TERMS WITH PARTICULAR MEANINGS

ABS
Anti **B**locking **S**ystem

A.C.
Air **C**onditioning

ASR
Anti **S**kid **R**egulator

CAN
Controller **A**rea **N**etwork

PTC
Positive **T**emperature **C**oefficient

NTC
Negative **T**emperature **C**oefficient

CO
Carbon monoxide

CO_2
Carbon dioxide

EBD
Electronic **B**rake-force **D**istribution

ECU
Electronic **C**ontrol **U**nit

HC
Hydro**c**arbons

MSR
Motor Breaking-torque **R**egulator

N_2
Nitrogen

NOx
Nitric oxide

Standard
Indicates the reference value

Servicing limit
Indicates the cutoff beyond which intervention is required in order to bring a component or a coupling within the prescribed range of tolerance.

NO
Normally open (referring to the valves)

NC
Normally closed (referring to the valves)

Euro 2
Directive 96/69/EC, regarding polluting emissions, valid until 31/12/2000

Euro 3
Directive 1999/102/CE, regarding polluting emissions, in force from 01/01/2001

EGAS
Electronic **GAS** pedal (Engine controlling system where every situation is interpreted as a torque request. The main torque request element is the acceleration pedal).

OBD II
On **B**oard **D**etection and **D**iagnostic system (System for detecting any operating malfunction in the engine control system, in compliance with the regulations for emission control)

RLFS
Return **L**ess **F**uel **S**ystem (Fuel supply system which prevents fuel from flowing back to the tank)

Right-hand and/or left-hand
The words right-hand and/or left-hand refer to the right-hand and/or left-hand side with respect to the car's

02.01 MANUAL USERS

-

This publication has been compiled by the Ferrari Technical Service Department as informative back-up support to help the Operator in the performance of any work to be done on Ferrari cars.
This manual is addressed to expert operators who have sufficient knowledge and skills to perform all maintenance and repair procedures for Ferrari cars correctly and safely.
Besides damaging the vehicle, the performance of said procedures without such knowledge and skills, can give rise to hazardous situations for the Operator and for the User of the vehicle.

02.02 REPAIRS AND MAINTENANCE PROCEDURES

-

The operator must abide by the descriptions and warnings thereof, avoiding repair and maintenance methods or equipment that are unsuitable, which can be risky for personal safety and for the vehicle itself.
In addition to the guided diagnosis system, which can be performed with the SD-2 Ferrari tester, there are diagnostic procedures listed in every section of the manual and they make it possible to identify malfunctioning problems with the various car parts.
In any case, it is of essential importance to evaluate the User's impressions, formulating the questions most suited to obtaining clarification of the symptoms underlying the problem.
Once the cause has been identified, plan out the work to be done by consulting the informative notes concerning the equipment required, the reference data for the overhaul and the disassembly and re-assembly procedures outlined in the manual.
Following the methods outlined in this manual for each individual intervention, guarantees User safety and vehicle reliability and quality.

02.03 USE OF ORIGINAL FERRARI EQUIPMENT AND SPARE PARTS

-

Ferrari makes specific equipment available to garages authorised for repairing Ferrari cars. Such equipment makes it possible to perform repairs correctly and safely.

The performance of procedures without using specific Ferrari equipment, or adopting alternative tools, can damage components and/or systems, and shall nullify the terms of the warranty.

Always use original Ferrari spare parts for replacing parts and refer to the spare parts catalogue.

In addition to nullifying the warranty, the utilisation of non-Ferrari components can damage the vehicle and create dangerous situations for the User.

02.04 REPAIRS UNDER WARRANTY

-

Ferrari warrants Ferrari cars for a period of 2 years from the date of delivery.
During this period, all repairs under the warranty must be performed by completing the special form and consulting the repair times table in order to note the time assigned by Ferrari for that procedure.

02.05 TIGHTENING TORQUES

As to the tightening of main components in the vehicle, Ferrari has defined three tolerance categories for the torque rated value:

Category A	± 5%
Category B	± 10%
Category C	± 20%

The torque category is shown in the summary paragraphs concerning tightening torques, at the beginning of each section and/or at the beginning of each paragraph.

03.01 PREVENTIVE MEASURES AND PROTECTION DEVICES

-

When performing particular maintenance or repair procedures, the operator must take every precaution to prevent personal injury and damage to the vehicle.

Always wear protective gloves when working on parts that are hot or sharp, or when using dangerous parts. In this latter case, suitable goggles should be worn to protect your eyes.

Avoid creating sparks or flames when working on the vehicle's fuel system as the fuel or the fumes emitted can easily catch fire.

The following paragraphs describe several specific situations in which the conditions of the car or the handling of some parts can create hazardous situations.

03.02 DANGEROUS PARTS EXHAUST SYSTEM AND ENGINE

-

When the car is utilised, the exhaust system components and the engine itself, reach very high temperatures and remain hot for a long time after the engine is turned off.

Always use insulated gloves to handle these components or wait as long as necessary for them to cool.

Battery

When the battery is being charged, gases are released and they can become explosive in contact with sparks or flames.

Always charge the battery in a well-ventilated area.

Furthermore, the battery contains sulfuric acid in the form of electrolyte, which upon contact, can cause skin irritation.

Always wear suitable protective clothing and a mask when handling the electrolyte.

Electric cooling fans

When the vehicle is stopped and the engine still warm, the electric fans for the cooling system may start up suddenly. Be very careful when working near these parts.

03.03 DANGEROUS EMISSIONS AND PRODUCTS EXHAUST GASES

-

The performance of some maintenance procedures require that the engine be kept running. The exhaust gases contain carbon monoxide, a highly poisonous gas which if inhaled for a lengthy period, can also be lethal.

Avoid running the engine in closed areas. If possible, work outdoors or utilise an exhaust gas removal system.

The devices used for monitoring and controlling the emission of exhaust gases have made it possible for the vehicle to attain type-approval for circulating freely on roadways, in accordance with pollution control regulations and regarding noise levels. Removal or tampering with these devices **is prohibited** by law.

Under any and all circumstances, avoid perforating the exhaust silencers or eliminating internal parts.

Avoid utilising the vehicle if any one of these devices is missing.

The type-approval number is marked or present on a plate on each one of these devices.

Avoid replacing the original devices with others that are not type-approved.

Furthermore, said devices must be kept in good condition by carrying out all of the procedures found in the programmed maintenance plan.

Fuel

The fuel contained in the fuel tank and throughout the engine's entire fuel system engine, is highly flammable and under certain conditions, it is also explosive.

Do not smoke or create sparks or flames near the workplace or in the immediate vicinity.

Always work in a well-ventilated area.

Keep out of reach of children!

Do not pollute the environment with fuel!

Used oil

Prolonged contact of the skin with the used oil can cause severe skin diseases. To avoid all risks, always wear protective gloves and/or thoroughly wash the part that has come into contact with it, using soap and water.

Keep out of reach of children!

Do not pollute the environment with used oil!

Fluid for the hydraulic systems

Besides damaging parts made of plastic and rubber, as well as painted parts, the oil contained in the brake, clutch and hydraulic steering systems is very dangerous if it comes into contact with eyes or skin.

In the event of contact, thoroughly rinse the body area involved with running water. To avoid all risks, always wear goggles and protective gloves.

Keep out of reach of children!

Do not pollute the environment with used fluid!

Coolant

The cooling system contains a fluid that reaches a high temperature and it is under pressure. Under these conditions, contact with the fluid can cause severe burns.

Furthermore, contact with the coolant can cause irritation to the skin and the coolant is poisonous if swallowed.

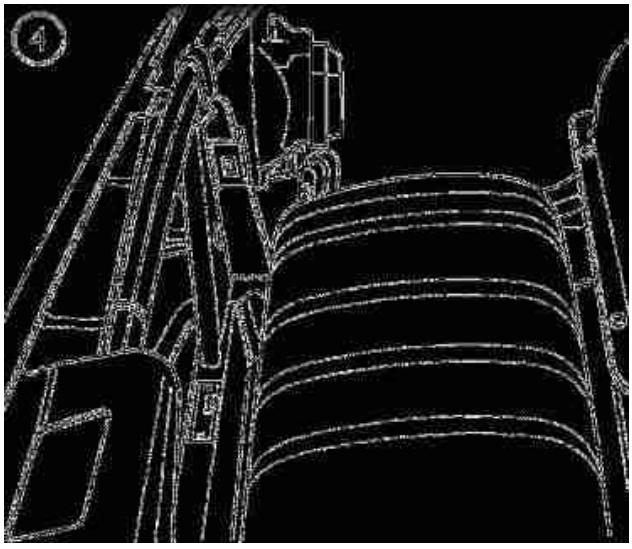
Keep out of reach of children!

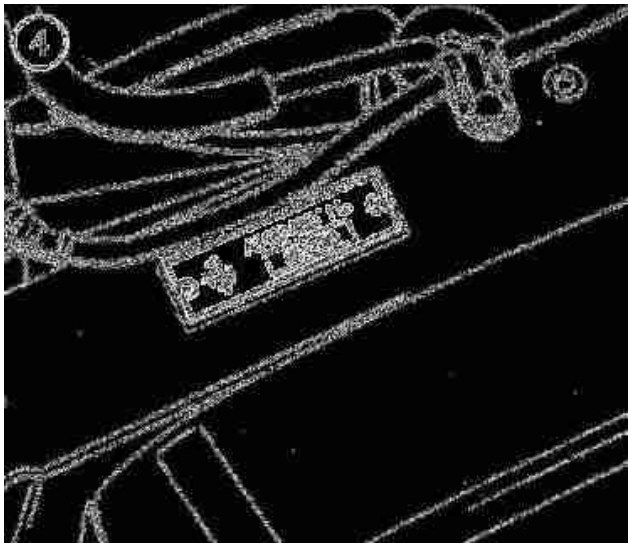
Do not pollute the environment with used coolant!

04.01 IDENTIFICATION PLATES

-

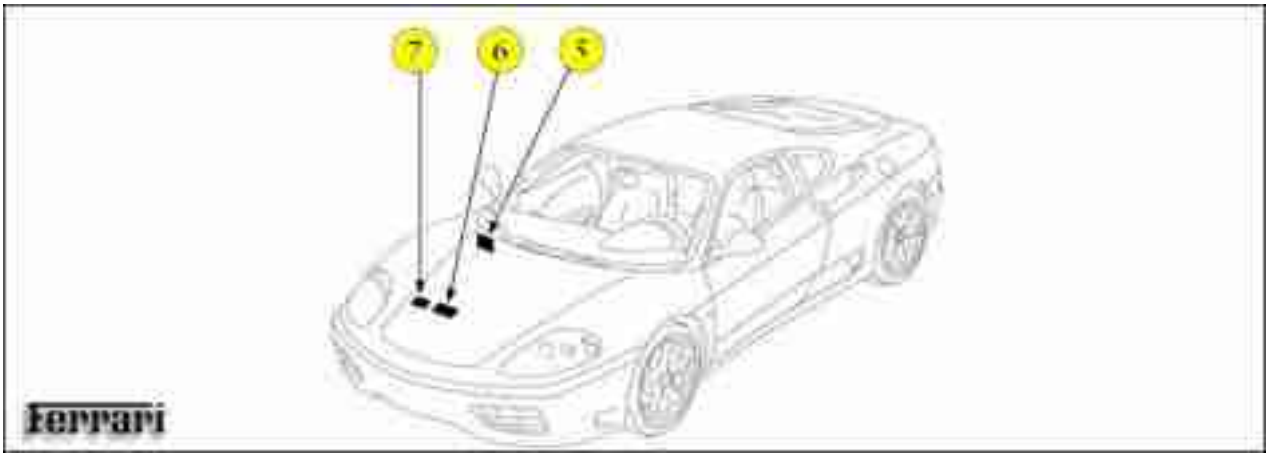
1 - Punched **chassis** number.
2 - **Chassis** type and number plate.
3 - Punched **engine** type and number.
4 - **Assembly number** plate.


4

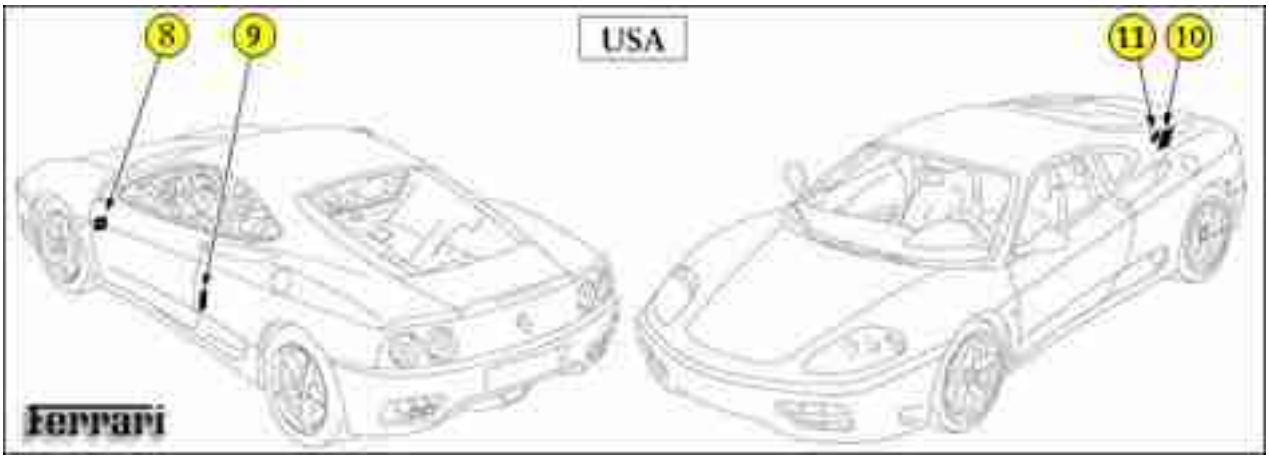

4

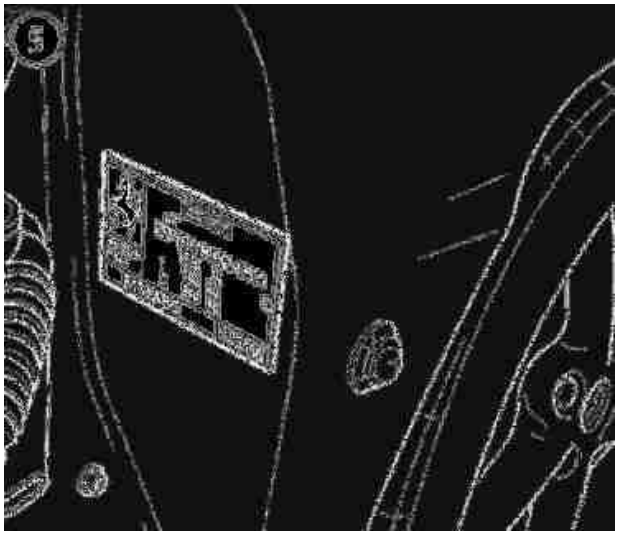
04.02 HOMOLOGATION PLATES

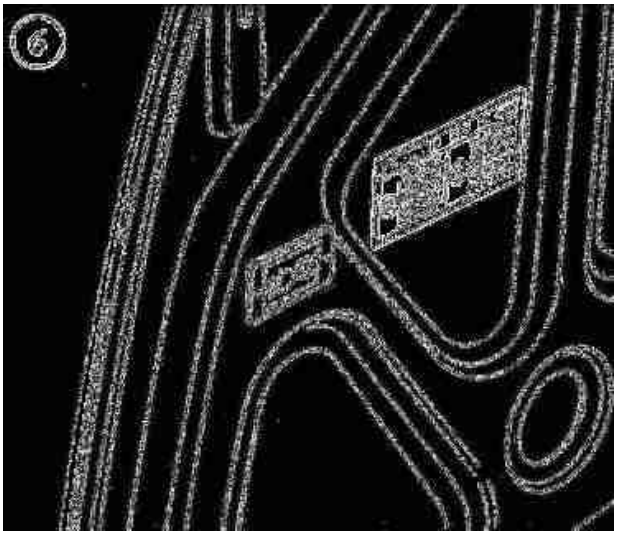
5 - Car identification.
6 - ECE approval.
7 - High beam-type approval.

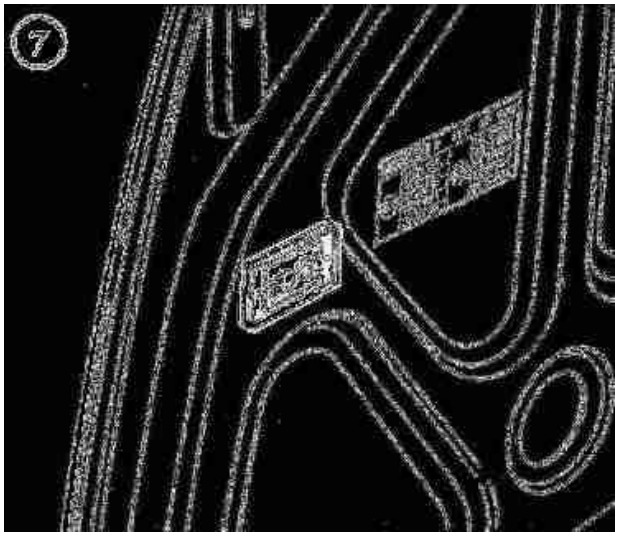


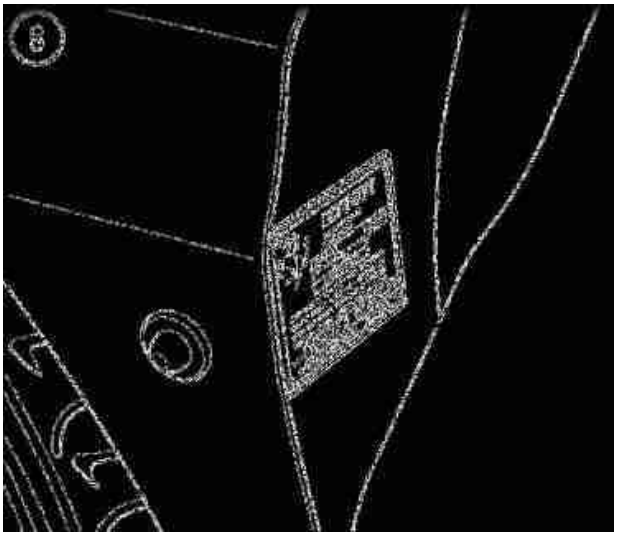
***US** version*
8 - Plate in **compliance with safety standards**.
9 - **V.I.N.** plate **(car identification)**.
10 - **V.E.C.** plate **(no longer used starting from M.Y. 2003).**
11 - **Emission control data** plate.

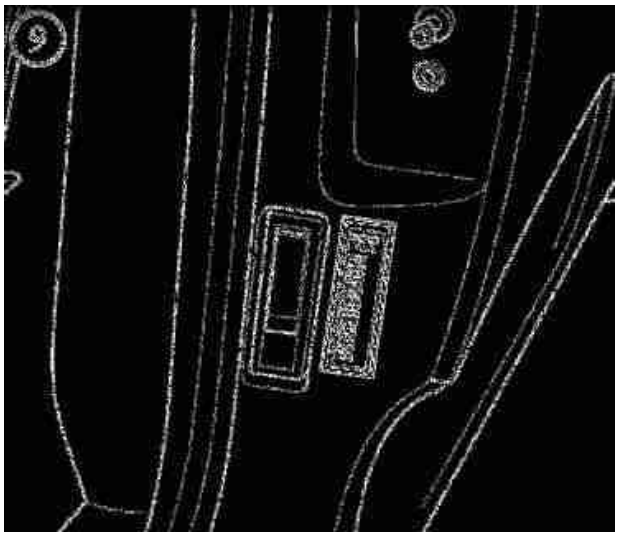


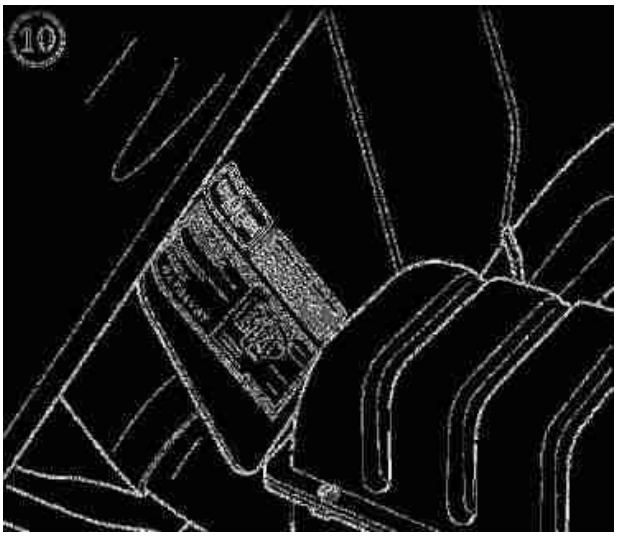

5

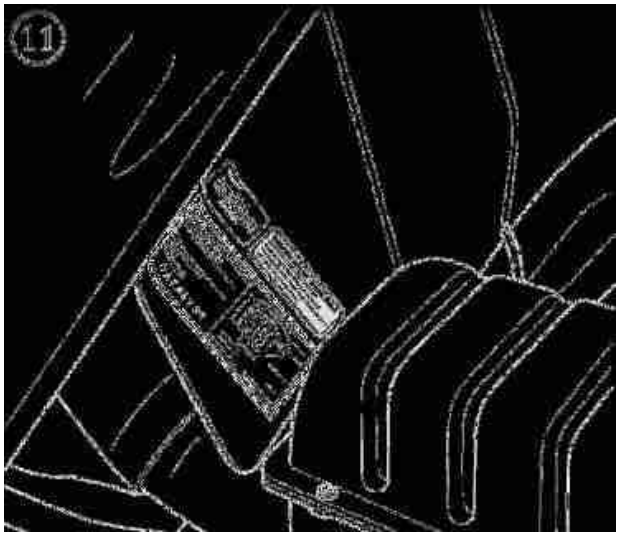

6


7


8

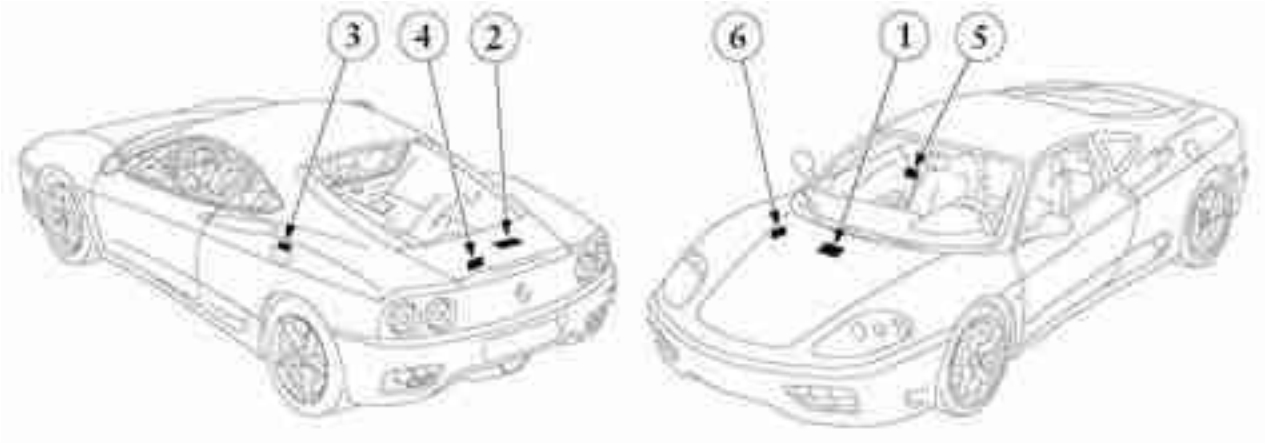

9

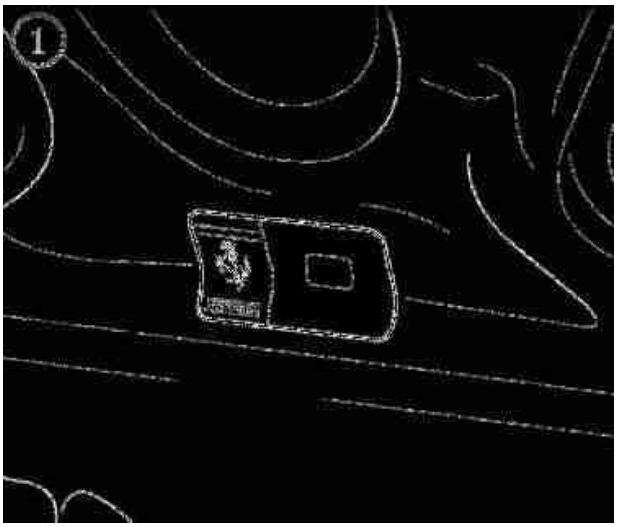

10

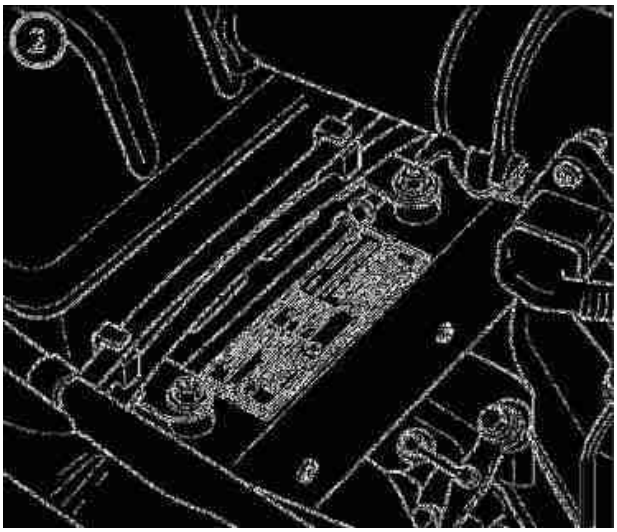

11

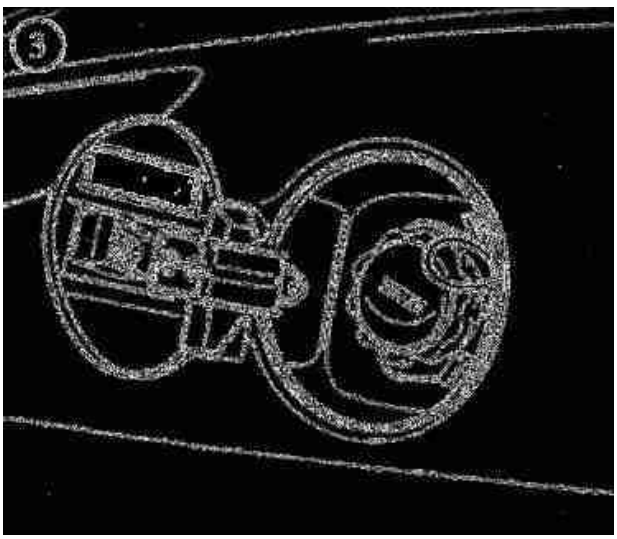
04.03 INSTRUCTION PLATES

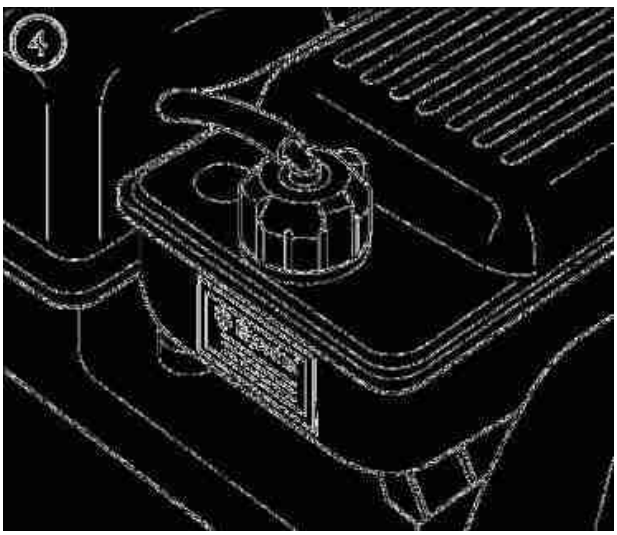
1 - **Paint** plate.
2 - **Lubricant** plate.
3 - **Fuel** plate.
4 - **Anti-freeze** plate.
5 - Tyre pressure plate.
6 - **"Battery master switch use"** instruction plate.



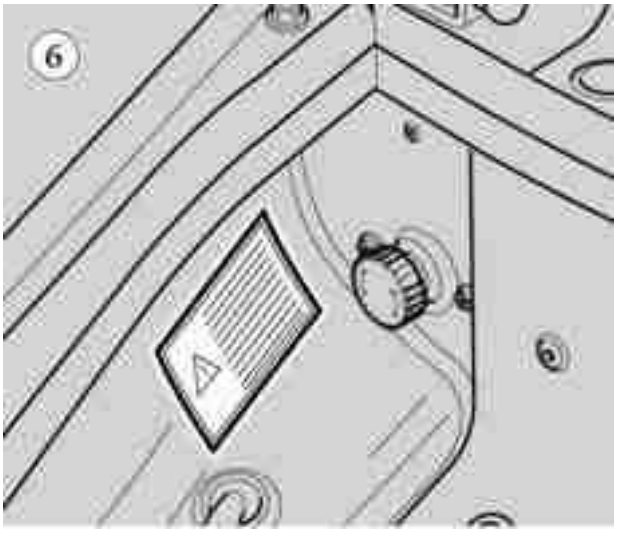








5

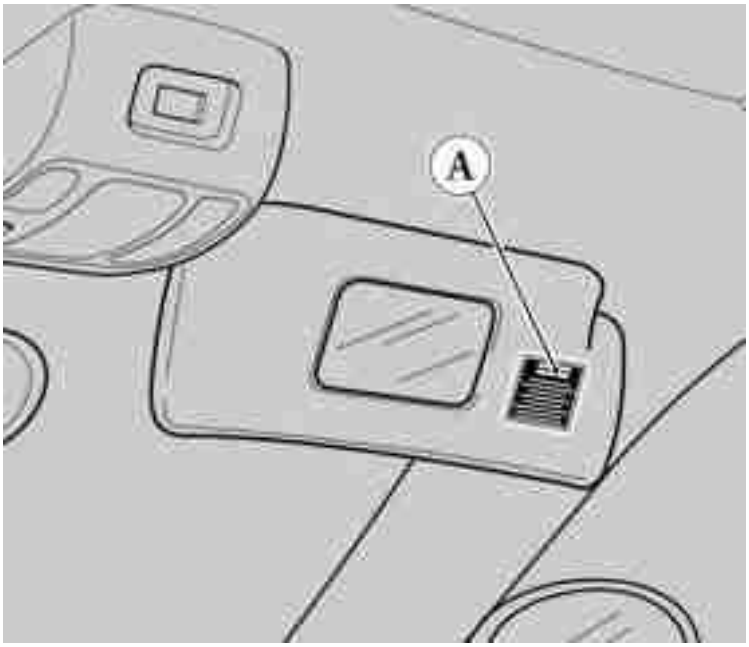

6

04.04 CHILD AIRBAG-SAFETY SYSTEM PLATES

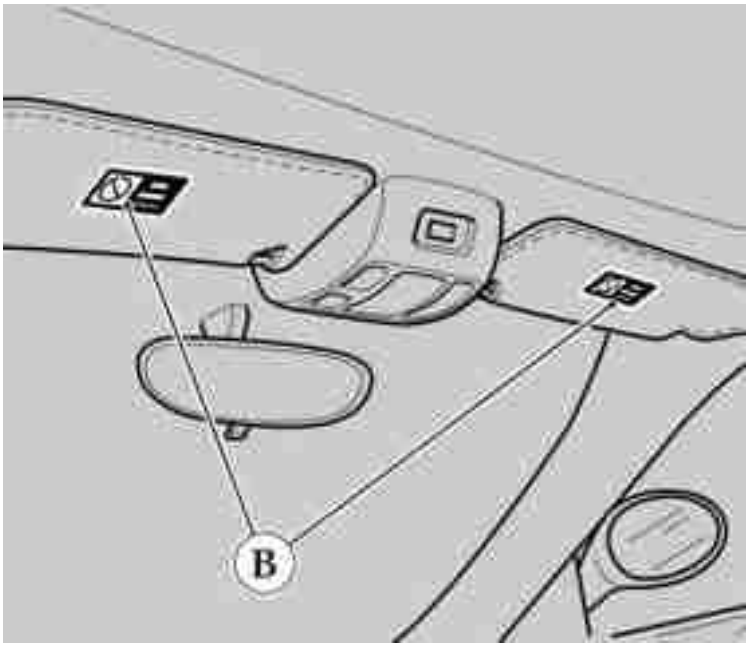
-

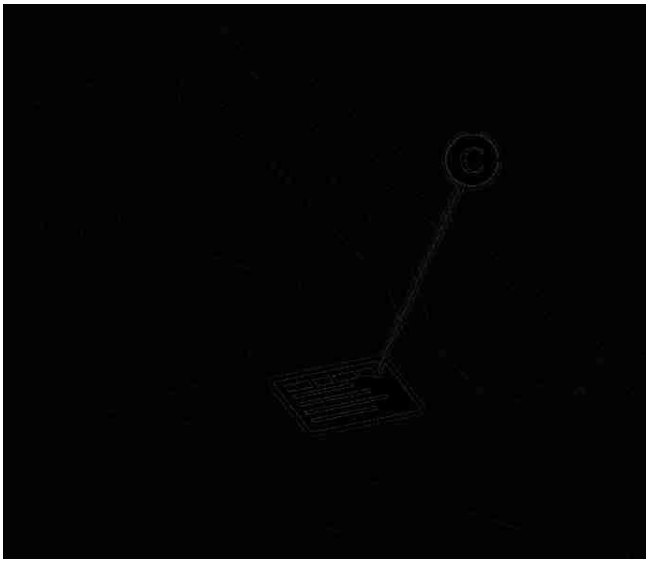
Airbag:

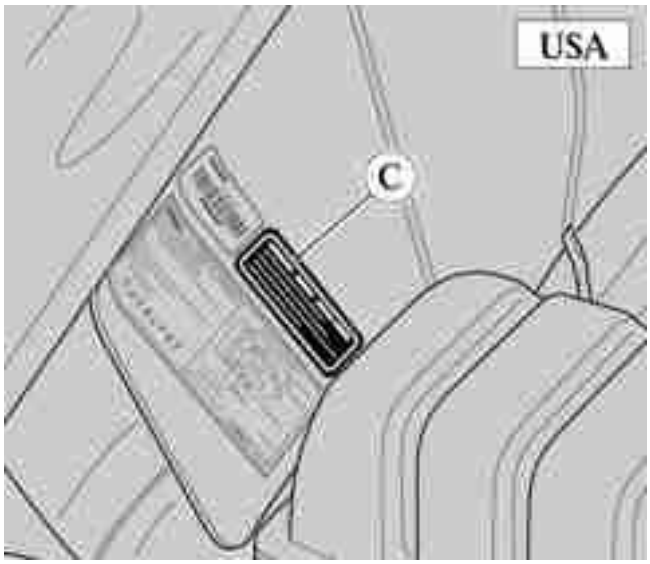
A – Plate displaying the Airbag system expiry date.



B/C – Plate displaying the presence of an Airbag system

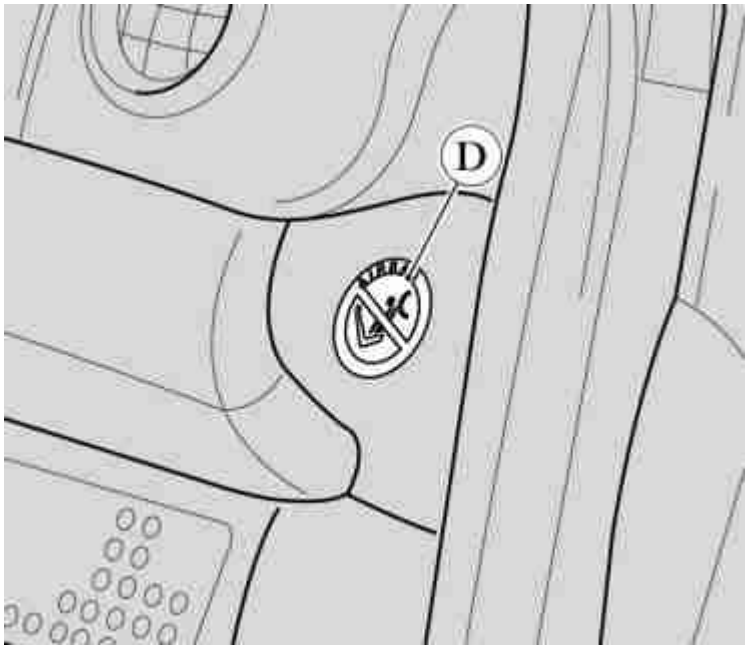


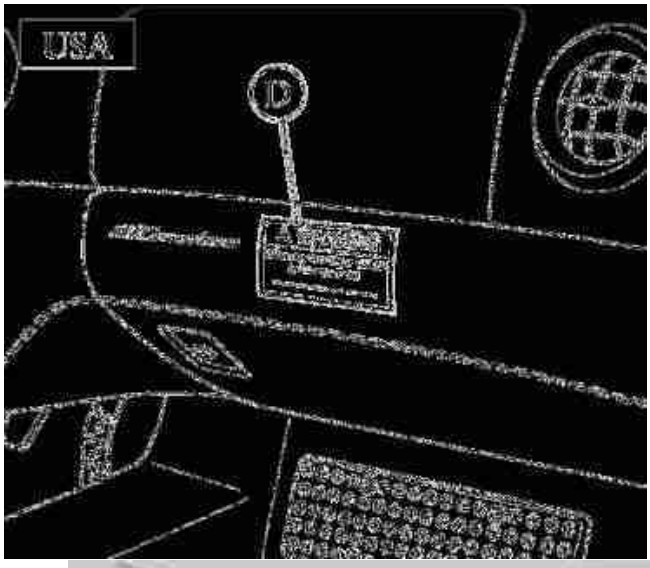


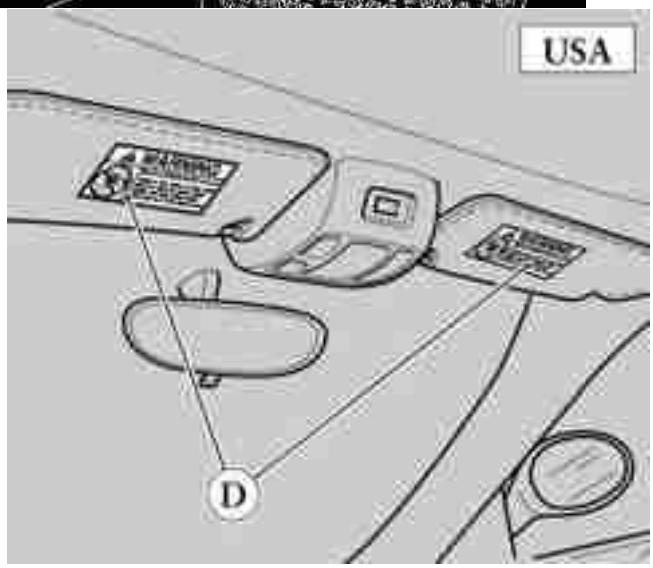


Child safety:

D – Plate reporting that the child's safety seat must not be placed on the passenger seat facing backwards.







05.01 PERFORMANCE AND CONSUMPTION

Performance

0 to 100 km/h	**4.5** sec.
0 to 400 m	**12.6** sec.
0 to 1000 m	**22.9** sec.

Maximum speed **296** km/h (**184** mph)

NOTES
These estimates are based on tests of vehicles equipped with frequently purchased optional equipment.

Consumption and CO_2 emissions (Dir. 1999/100/EC)

	Urban cycle	*Out-of-town cycle*	*Combined cycle*
Liters per 100 km (lt/km)	**30.2**	**12.9**	**19.3**
Grammes per km (gr/km)	**685**	**297**	**440**

NOTES
The actual fuel economy of this car may vary depending upon your particular driving habits, the conditions of the car, the optional equipment installed, the road and weather conditions during testing.

To obtain highway fuel economy values similar to those indicated above, it is advisable to shift from **fourth** to **fifth** gear at about **75** km/h (**47** mph).
For best fuel economy results, it is advisable to shift gears at the following speeds:

1st to **2nd**	**25** km/h (**15** mph)
2nd to **3rd**	**40** km/h (**25** mph)
3rd to **4th**	**65** km/h (**40** mph)
4th to **5th**	**75** km/h (**47** mph)
5th to **6th**	**90** km/h (**56.5** mph)

05.02 DIMENSIONS AND WEIGHTS

Dimensions

Wheelbase	**2600** mm (**102.36** in.)
Max. length	**4477** mm (**176.26** in.)
Front track	**1073** mm (**42.24** in.)
Rear track	**804** mm (**31.65** in.)
Max. height (with car empty)	**1215** mm (**47.83** in.)

Max. width	**1925** mm (**75.79** in.)
Projection from front wheel axle	**1669** mm (**65.71** in.)
Projection from rear wheel axle	**1617** mm (**63.66** in.)

Weight:

Under running conditions	**1470** kg (**3240** lb.)
• on the front axle	**566** kg (**1247** lb.)
• on the rear axle	**834** k **1838** lb.)

A1.01 CHARACTERISTICS OF THE FLUIDS USED

Cooling System

Protective coolant with antifreeze action for monoethylene glycol-based cooling systems.
Must be mixed with 50% water.

Windscreen and headlight washer system

Use a mixture of water and denatured isopropyl alcohol (50 %).
For cleaning the windscreen, use one phial of **"windscreen washer additive"** in the summer and two phials in the winter.

Fuel

Only use **“Unleaded fuel”** with an octane level of at least **95 RON.**
In the US market, the **AKI** (**A**nti **K**nock **I**ndex) is used for octane level classification; in these countries, use “Premium” unleaded fuel with a minimum **AKI** of 91.

A1.02 REFILL SERVICING TABLESERVICING TABLE

Parts to be serviced	Product	Quantity
Engine (1)	HELIX ULTRA 5W-40	**2.63 USgallon / 9,95 lt** **3.02 USgallon / 11,45 lt (5)**
	HELIX ULTRA AF 10W-60 (4)	**.26 USgallon / 1 lt (2)**
Gearbox and differential (1)	TRANSAXLE OIL 75W-90	**.92 USgallon / 3,5 lt**
F1 transmission system	DONAX TX	**.26 USgallon / 1 lt**
Steering box	RETINAX CS00	**.39 lb. / 180 gr**
Hydraulic steering system (1)	DONAX TA	**.48 USgallon / 1,8 lt**
Air-conditioning compressor	HARRISON-DIAVIA ISO 135 RL 150	**16.16 cu.in. / 265 cc**
Air temperature control system	R 134 A	**1.65 lb. / 750 gr ±25**
Cooling system (1)		**4.86 USgallon / 18,4 lt**
Fuel tank	Unleaded gasoline 95 N.O.	**24.7 USgallon / 95 lt**
- reserve		**5.3 USgallon / 20 lt**
Brake-clutch system	DONAX UB	**.39 USgallon / 1,5 lt**
F1 brake system		**.34 USgallon / 1,3 lt**
Window-washer system	AREXONS DP1	**.92 USgallon / 3,5 lt**
Window-washer system and Headlight-washer system (3)	AREXONS DP1	**1.98 USgallon / 7,5 lt**

(1) When dry
(2) Between "MIN" and "MAX"
(3) Optional
(4) For hot climate conditions and during heavy driving on racing tracks
(5) FROM Ass.ly No. 51487

A2.01 PROGRAMMED MAINTENANCE PLAN

Covered km							***Operations***
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓	✓	**1** - Change engine oil and filter (_____)

Covered km							***Operations***
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓		**2** - Change the gearbox/differential oil and clean the oil filter (A 3.02)

Every two years

Covered km							***Operations***
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	

Every 50.000 km and not over 3 years

3 - Change the timing belts (A 3.03)

Covered km							***Operations***
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓	✓	**4** - Check tension and wear conditions of auxiliary part belts (water pump, alternator, air temperature control system compressor, power steering pump); change if necessary (A 3.04)

Not over 3 years

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		

Every 30.000 km

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
	✓			✓			

5 - Replace the spark plugs (A 3.05)

6 - Blow-by connection integrity check (A 3.07)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
✓	✓	✓	✓	✓	✓		

7 - Check cooling system connections and hoses (A 3.08)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
✓	✓	✓	✓	✓	✓		

8 - Check injection/ignition system connections and piping (_____)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
		✓			✓		

9 - Replace the activated charcoal filter (A 3.10)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
			✓				

10 - Replace oxygen sensors (A 3.12)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
✓	✓	✓	✓	✓	✓		

11 - Check air cleaner elements (replace if required) (A 3.13)

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
✓	✓	✓	✓	✓	✓	✓	

12 - Replace the cleaner on air temperature control system external air intake (A 3.14)

Every 12 month

Covered km						Yearly Maintenance	Operations
10.000	30.000	50.000	70.000	90.000	110.000		
✓	✓	✓	✓	✓	✓		

13 - Tighten screws, nuts and bolts (including those on the exhaust system), connections, clips and strips in general (A 3.15)(A 3.17)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓		**14** - Check carburation and emission concentration (A 3.16)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓	✓	**15** - Check level of brake/clutch fluid (possible bleeding) (A 3.18)

Replace every year

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓	✓	**16** - Check "F1 Gearbox" system oil level (_____)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓	✓	**17** - Check level of fluid for power steering (possible bleeding) (A 3.19)

Replace every two years

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓	✓	**18** - Inspect brake system: pipes/hoses, calipers, connections. Check efficiency of warning lights on the dashboard (A 3.20)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓	✓	**19** - Inspect state of wear of braking surfaces (discs, pads). Change if necessary (A 3.21)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓		**20** - Check brake pedal free play and the operation of the handbrake (A 3.22)

Covered km							Operations
10.000	30.000	50.000	70.000	90.000	110.000	*Yearly Maintenance*	
✓	✓	✓	✓	✓	✓		**21** - Check suspension part tightening (A 3.23)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**22** - Check steering components, joint protection and boots on the steering rack, steering levers and on the axle-shafts (A 3.24)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**23** - Check car geometry (adjust if necessary) (A 3.24)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**24** - Inspect air temperature control system (refrigerant and filter change every 2 years and check of oil quantity in the compressor) (A 3.25)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**25** - Check and lubricate controls and adjusters in general, hinges, doors, bonnet and bonnet boot (A 3.26)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**26** - Check correct operation and securing of the seats and seat belts (A 3.27)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	✓ **27** - Battery: check connections, charge and absorption (A 3.28)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
	✓			✓		**28** - Check generator absorption and charge (A 3.29)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
✓	✓	✓	✓	✓	✓	**29** - Check headlight aiming (L3.04)

Covered km						Operations
10.000	30.000	50.000	70.000	90.000	110.000	Yearly Maintenance
Every 2 years						**30 -** Visually check that chassis and protected areas are intact (_____)

Covered km							*Operations*
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	

Every 10 years

31 - Replace the Airbags (H 3.02)

Covered km							*Operations*
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓	✓	**32** - Treatment of the leather interiors

Covered km							*Operations*
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓	✓	**33** - After these operations, check the tyres' pressure and their conditions, check the wheel rims (for scratches), the indicators on the dashboard, the lights and stop lights and then road test the car (_____)

Covered km							*Operations*
10.000	**30.000**	**50.000**	**70.000**	**90.000**	**110.000**	***Yearly Maintenance***	
✓	✓	✓	✓	✓	✓	✓	**34** - After the road test make sure that the wheels are tightened

-
-

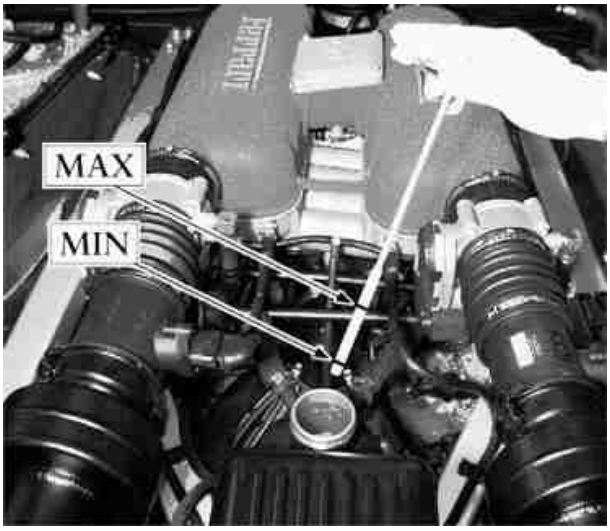
A3.01 CHECKING, CHANGING OR REPLACING ENGINE OIL AND FILTERS

Tightening torques	Nm	Category	Product
Pipe union on radiator	**78**	**B**	
Engine oil drain caps	**75**	**B**	
Oil filter cartridge	**25**	**B**	**Engine oil**

Checking the oil level

IMPORTANT
The oil level must be checked with the engine warm.

- Run the engine at about **4500 min^{-1}** until reaching a temperature of **80÷90 °C**.
- Keep the engine idling.
- Slide out the retainer **(A)** (B 4.03) unscrew the oil separator cap found on the gearbox housing and check the oil level. The latter should be between the "**MIN**" and "**MAX**" notches marked on the oil dipstick.



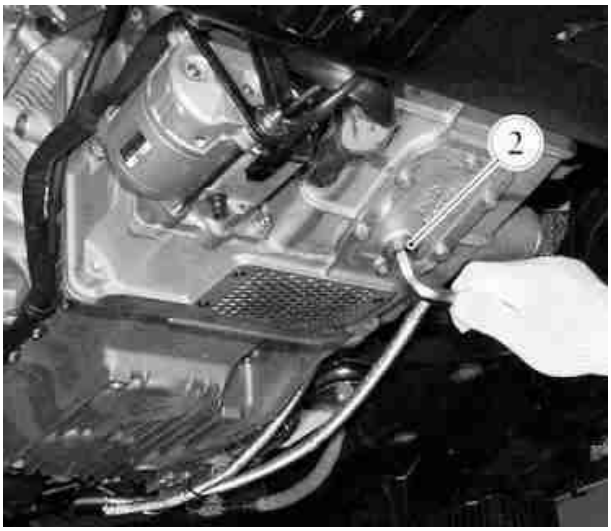
IMPORTANT
The cap with the oil dipstick must be resting on the oil separator filler neck.
In the event that the oil level is too low, before proceeding further, check for the causes that may have brought about excessive oil consumption.

- If needed, proceed by topping up with the oil prescribed (A 1.02) to the "**MAX**" level.
- Tighten the oil separator cap and fit the retainer **(A)** (B 4.03).

Changing the engine oil and replacing filters

The engine oil must be changed at regular intervals, as prescribed in the Programmed Maintenance Plan, and with the engine warm.

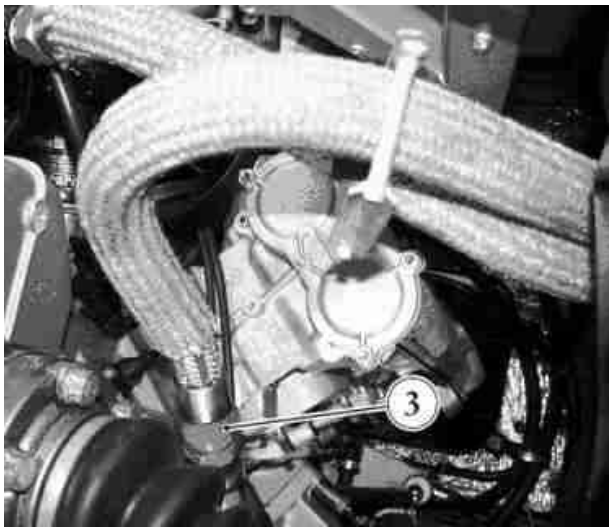
- Unscrew the cap **(1)** on the engine sump and the cap **(2)** underneath the gearbox housing.
- Allow the oil to drain out completely.



CAUTION

Do not pollute the environment with the used oil.

- In order to allow the oil backed up in the pipes and in the cooling system radiator to drain out, it is advisable to remove the rear part of the underfloor (M 2.12).
- Detach the union **(3)** on the pipe delivering oil to the radiator and deliver compressed air to the hose.



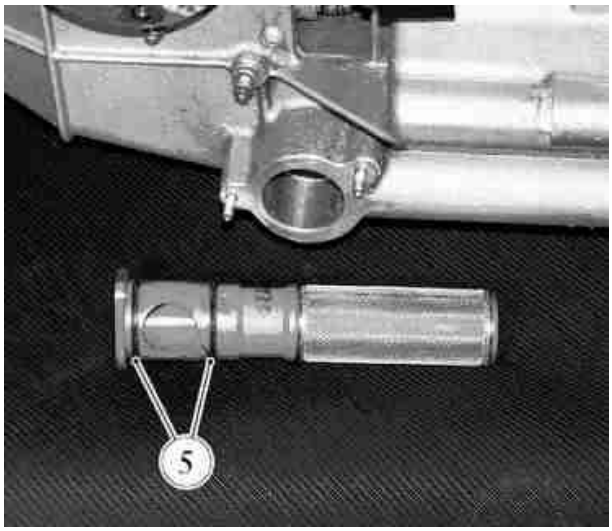
Clean the mesh filter in accordance with the intervals established in the Programmed Maintenance Plan. It is found on the right-hand side of the gearbox housing, underneath the differential attachment flange.

NOTES

For the sake of clarity, the figure shows the gearbox removed from the car.

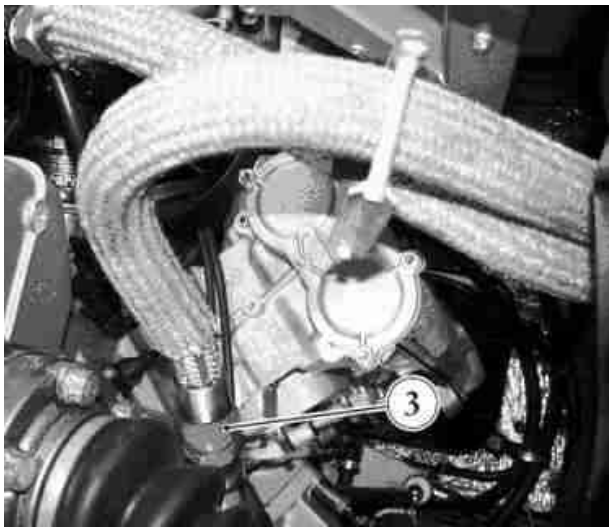
- Unscrew the two fastening nuts **(4)**.

- Rotate the outer flange slightly and using a flat screwdriver as a lever, slide out the mesh filter.
- Remove the O-Rings **(5)** and proceed with cleaning procedures by immersing the filter in a degreasing solution and then drying it with compressed air. Special care must be taken to avoid damaging the mesh. If any tears are found on the filtering part, the entire filter must be replaced.

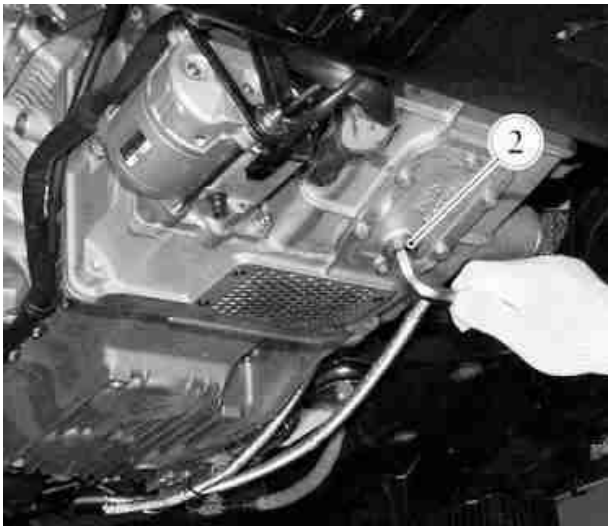


Reassembly

- Insert the O-Rings **(5)** in the mesh filter seats and lubricate them with **MOLYKOTE** grease.
- Assemble the mesh filter on the gearbox housing and lock the fastening nuts **(4)**.
- Lock the union **(3)** on the pipe delivering oil to the radiator to the prescribed torque.



- Carefully clean the caps and replace the gaskets.
- Re-assemble them and tighten them to the prescribed torque.



- Apply the **USAG D156** tool, cod. **95971560** on the filter cartridge, positioned in front of the oil separator, and unscrew the cartridge out of its seat.

- Use **PURFLUX LS 538** filter cartridges only and lubricate the rubber gasket with engine oil before reassembling.
- Assemble the cartridge in its seat, screwing it to the prescribed tightening torque.
- Proceed with refilling, using oil of the type indicated and the quantity listed in the "Refill servicing table" (A 1.02).

NOTES

The quantity of oil to be added may differ slightly from the amount prescribed when dry. This is due to unavoidable build-up inside the system. We advise you to refill gradually, in accordance with the dipstick reference marks.

- Re-start the engine and check the level, as described above.
- Ensure that there is no leakage from the drain caps **(1)** and **(2)**, from the filter cartridge and from the union **(3)**.

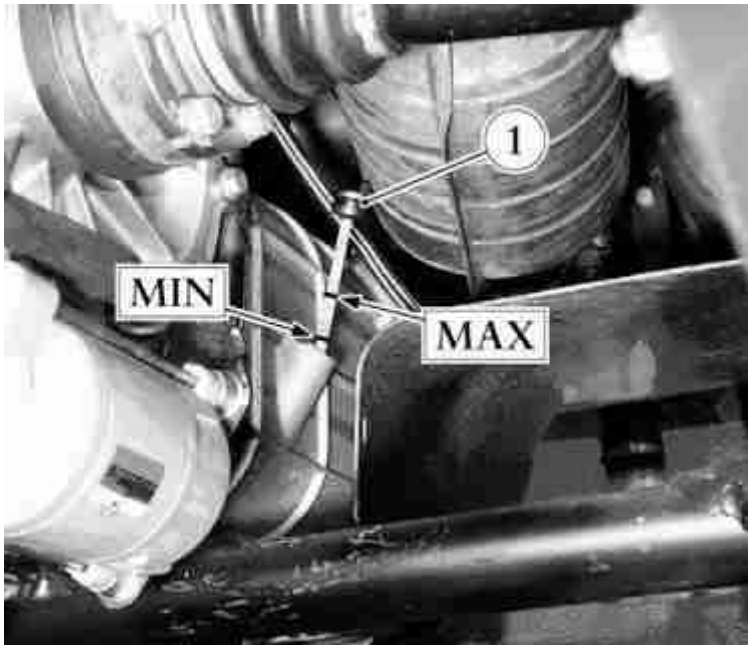
A3.02 CHECKING AND CHANGING GEARBOX-DIFFERENTIAL OIL

Tightening Torques

Union on delivery pipe	**49 Nm**
Gearbox oil drain plug	**75 Nm**

Checking the Oil Level

- Detach the rear part on the underfloor (M 2.12).
- Idle the engine for about two minutes and wait five minutes after stopping.
- Unscrew the oil filler plug **(1)** found on the left-hand side of the gearbox housing and check the oil level. The latter should be between the **"MIN"** and **"MAX"** notches marked on the oil dipstick.



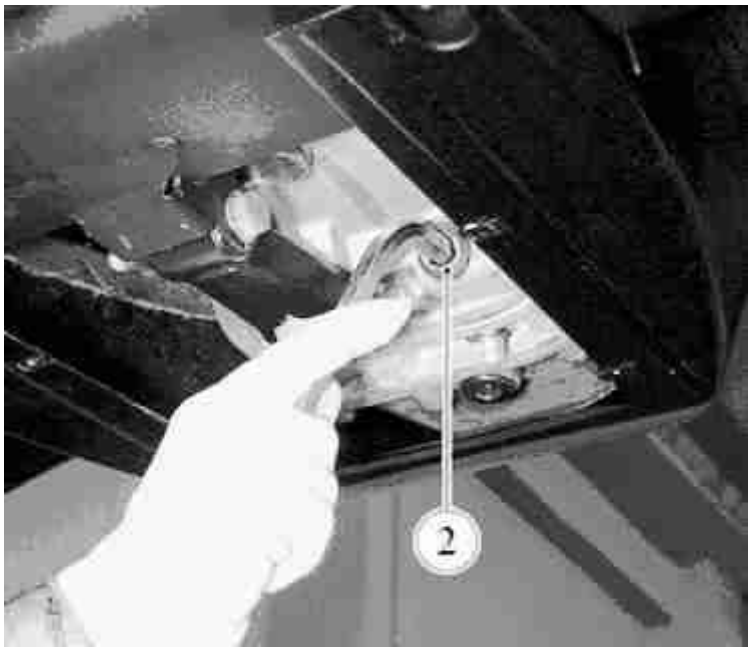
IMPORTANT
The oil level check should be performed with the dipstick resting on the seat.
In the event that the oil level is too low, before proceeding further, check for the causes that may have brought about excessive oil consumption.

- If needed, proceed by topping up with the oil prescribed (A 1.02) to the **"MAX"** level.
- Tighten the plug with gasket.

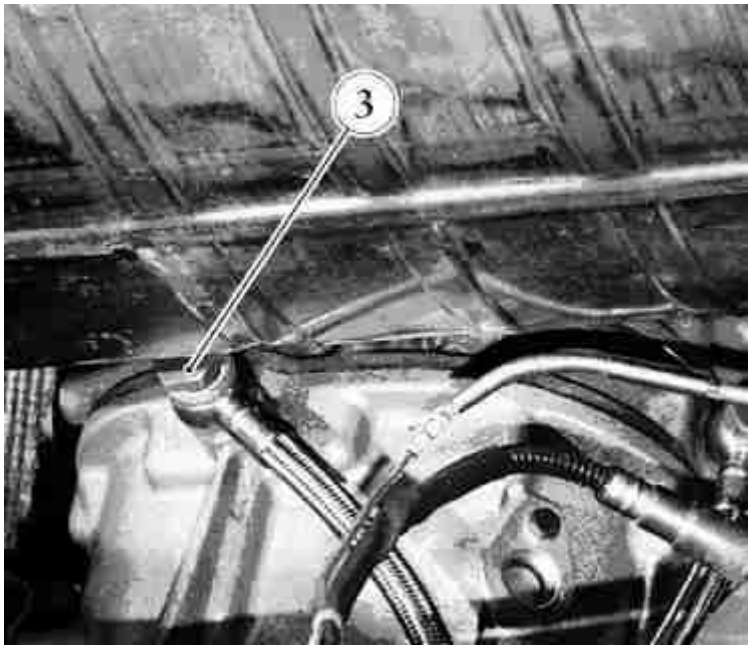
Changing the Gearbox-Differential Oil

The gearbox-differential oil must be changed at regular intervals, as prescribed in the PROGRAMMED MAINTENANCE PLAN.

- Run the engine propulsion system until it reaches its operating temperature.
- Unscrew and remove the oil drain cap **(2)** with gasket, found underneath the rear part of the gearbox housing.



- In order to allow the oil backed up in the cooling system to drain out, it is advisable to detach the union **(3)** on the pipe delivering oil to the exchanger, from the side part of the gearbox housing, and use compressed air in the pipe.



- Allow the oil to drain out completely.

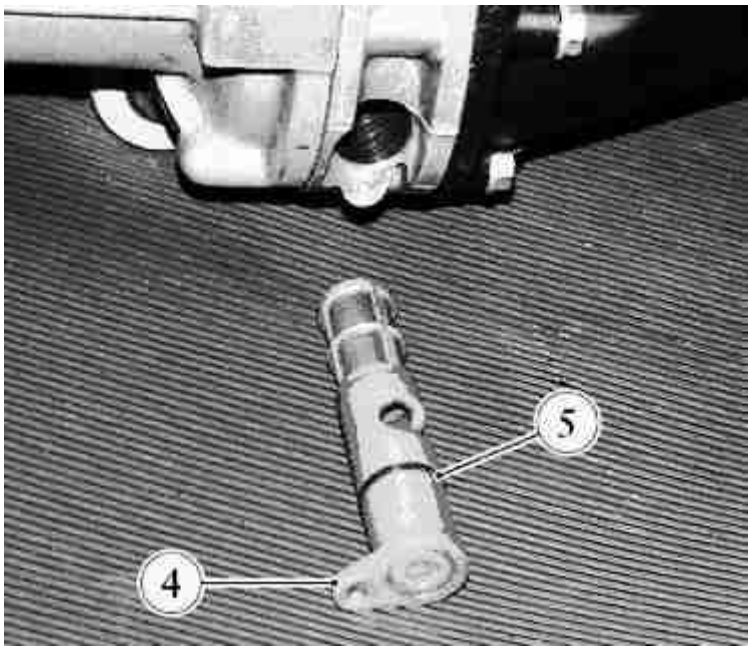
CAUTION
Do not pollute the environment with the used oil.

It is advisable to clean the mesh filter each time the oil is changed. The mesh filter is found in the left rear part

of the gearbox housing.
- Remove the rear bumper (M 2.04).

NOTES
For the sake of clarity, the figure shows the gearbox removed from the car.

- Unscrew the fastening screw and rotate the outer flange **(4)** slightly.
- Use a flat screwdriver as a lever and slide out the mesh filter.
- Remove the O-Ring **(5)** and proceed with cleaning procedures by immersing the filter in a degreasing solution and then drying it with compressed air. Special care must be taken to avoid damaging the mesh. If any tears are found on the filtering part, the entire filter must be replaced.



Re-Assembly

- Insert the O-Ring **(5)** in the mesh filter seat and lubricate it with **MOLYKOTE** grease.
- Assemble the mesh filter on the gearbox housing and lock the fastening screw.
- Re-assemble the delivery pipe and lock the filler neck to the prescribed torque.

Carefully clean the caps removed and replace the gaskets.

- Re-assemble the drain cap with gasket, tightening it to the prescribed torque.
- Proceed with refilling through the oil filler plug seat, using oil of the type indicated and the quantity listed in the "Refill servicing table" (A 1.02).
- Fill with half of the amount indicated and wait several minutes to allow for distribution of the oil. Then finish filling gradually until reaching the **"MAX"** reference mark on the dipstick.

NOTES

The quantity of oil to be added may differ slightly from the amount prescribed when dry. This is due to unavoidable build-up inside the system and to the film adhering to the mechanism. We advise you to refill gradually, in accordance with the dipstick reference marks .

- Check the oil level, as described above.
- Ensure that there is no leakage from the caps **(1)** and **(2** , from the union **(3)** and from the mesh filter.

A3.03 REPLACING AND CHECKING TIMING SYSTEM BELT TENSION

Tension Check Value **190÷220 Hz** (Sum of the tension on the two branches)

Specific Equipment

SEEM tensiometer **TYPE Diapaz cod. 95978151**

-

Clutch crown lock tool	**AV 3207**
Belt tensioner tool	**AV 2938**
Dial gauge tool	**AV 737**

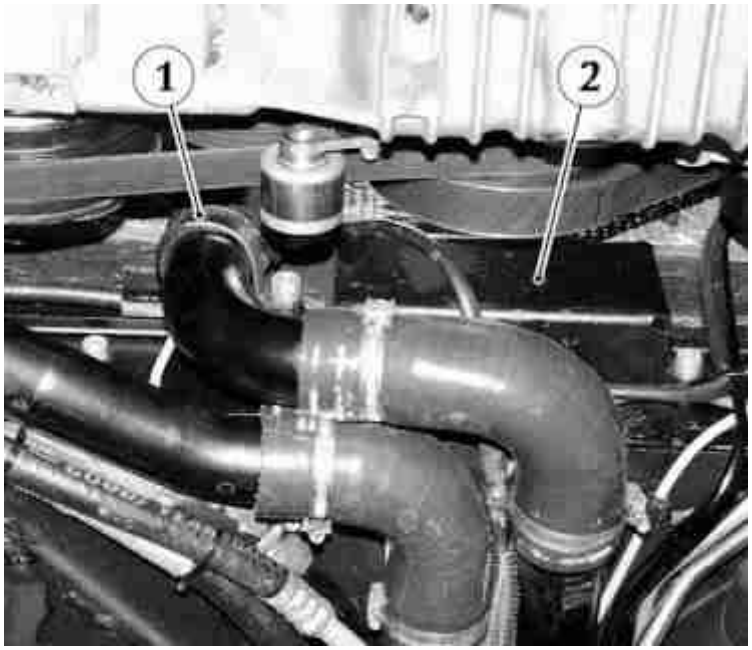
Tightening Torques		**Product**
Timing case fastening screw	**9,8 Nm**	
Accessories control pulley fastening screw	**196 Nm**	AREXONS 4706 SYSTEM 52A42
Belt tensioner pulley fastening screw	**49 Nm**	

The timing system belts must be changed at regular intervals, as prescribed in the PROGRAMMED MAINTENANCE PLAN.

Preliminary Procedures

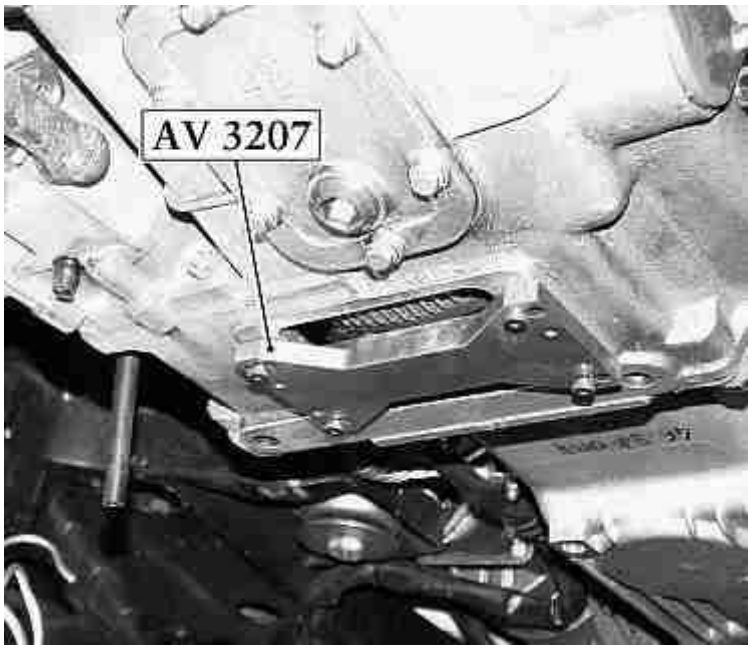
Belt replacement and checks on the timing system belt tension are also possible with the engine installed in the car, through the opening found in the dividing panel between the passenger and engine compartments.

- Some passenger compartment components and the engine inspection door must be removed in order to gain access to said opening (M 3.05).
- Remove the water pump-generator control belt and the A.C. compressor control belt (A 3.04).
- It is necessary to remove the rear part of the underfloor in order to work on the accessories' control pulley (M 2.12).
- The first vertical component of the pump's water return pipe, can obstruct the removal of the left-hand side distribution sump (B 5.04). Remove the pipe's support bracket **(1)** from the chassis in order to facilitate the procedure.
- Remove the striking energy absorber box **(2)** found between the chassis and the engine.

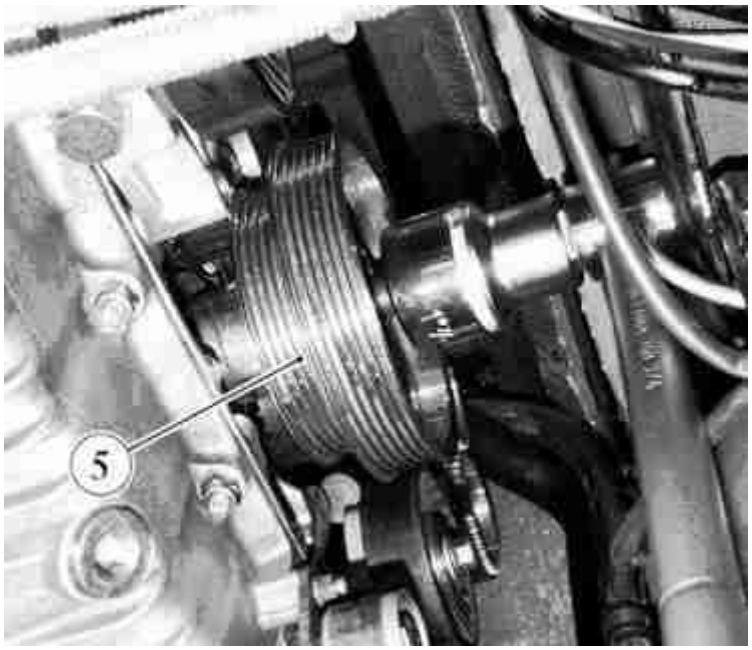


Replacing the Timing System Belts

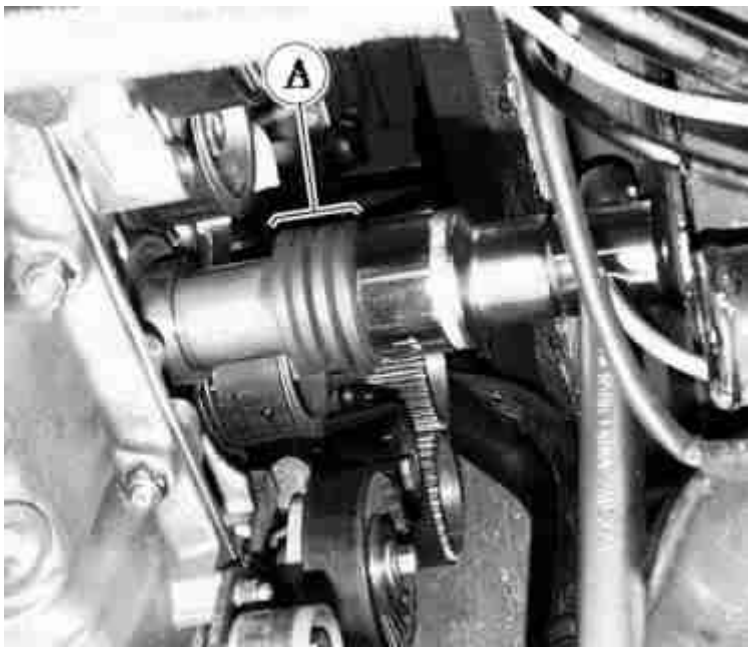
- Remove the inspection cover found underneath the gearbox housing.
- Install the **AV 3207** locking tool to block rotation of the crankshaft.



- Loosen the fastening screw for the pulley **(5)** on the crankshaft.



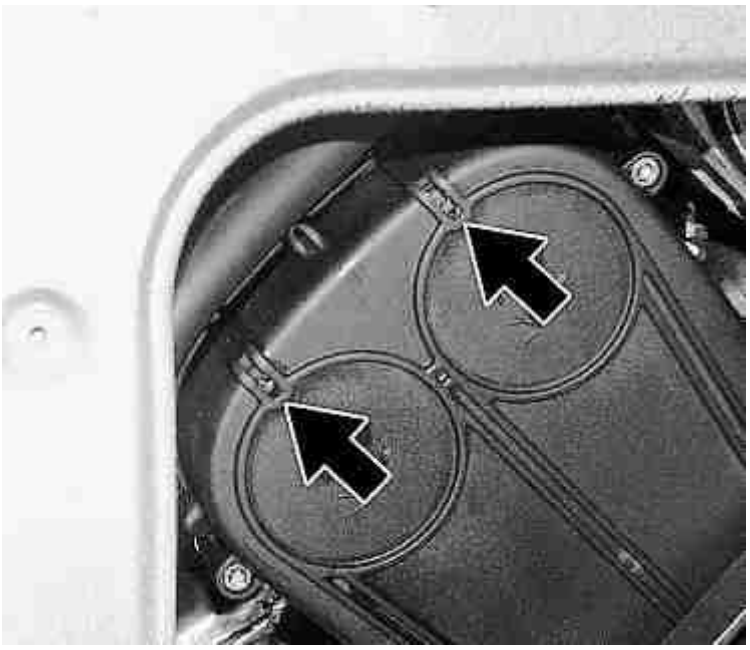
- Slide the pulley out and replace it temporarily with a spacer **(A)** of suitable size.



- Lock the fastening screw and remove the engine rotation lock device.

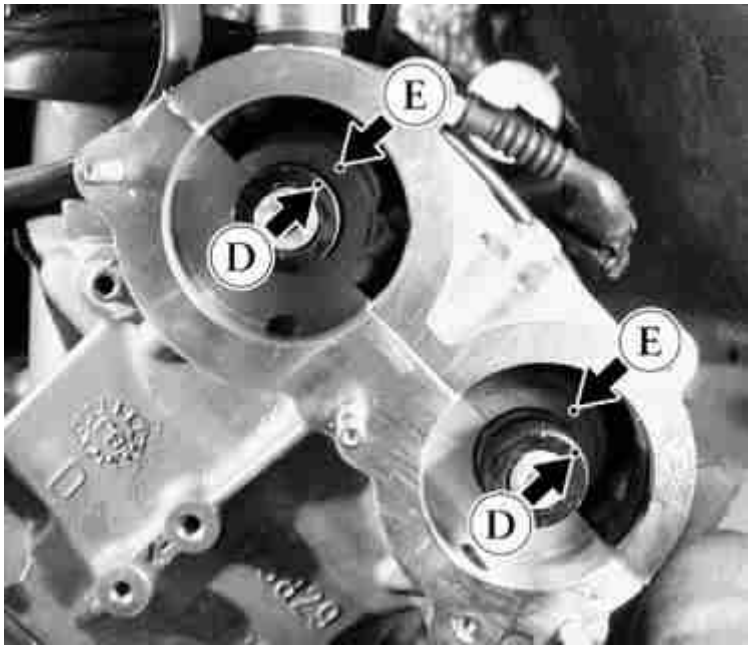
- Remove the coils and spark plugs for each cylinder (A 3.05).
- Install the **CS 104488** dial gauge tool **(B)** in cylinder no.**1** spark plug hole, for bank **1-4**, and in the spark plug no. **5** hole, for bank **5-8**.

- Rotate the engine (clockwise, working in the front part (in front of the timing system) until cylinder no. **1** piston is brought to the **T.D.C.**, in the explosion phase.
- At this point the reference marks on the driven pulleys must be aligned with the openings on the upper part of the distribution covers.



- It is possible to carry-out a further timing check by removing the rear cover **(6)** from each head along with the relative gasket.

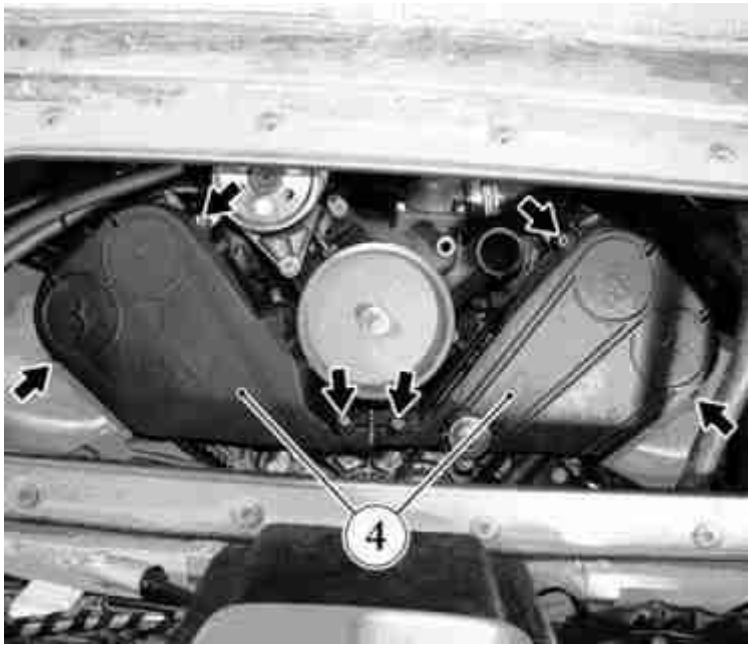
- The reference mark **(D)** located on the end of camshaft must be aligned with the corresponding mark **(E)** on the support cap.



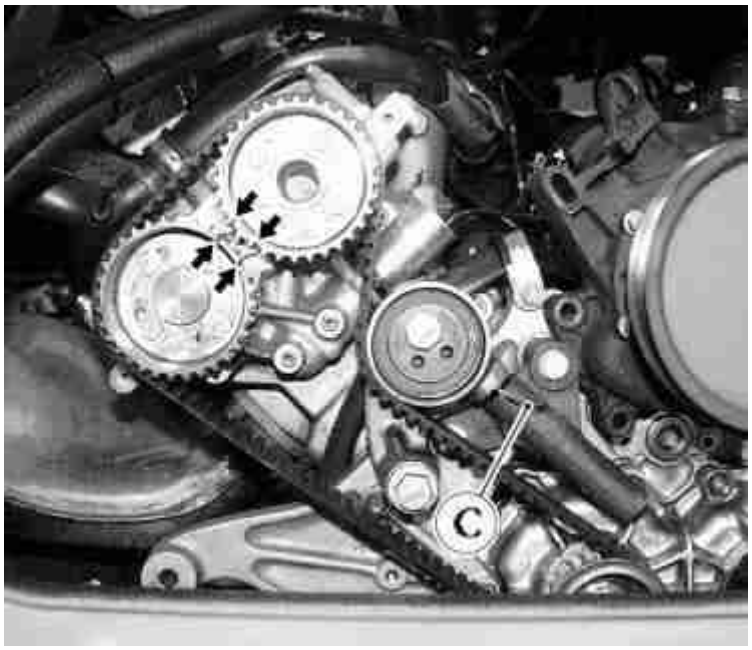
IMPORTANT
If the above conditions are not met, the engine timing must be checked (B 3.02).

- Detach the support along with the bearing for the water-generator pump belt and remove the stumps **(4)** from the distribution by unscrewing the three fastening screws..

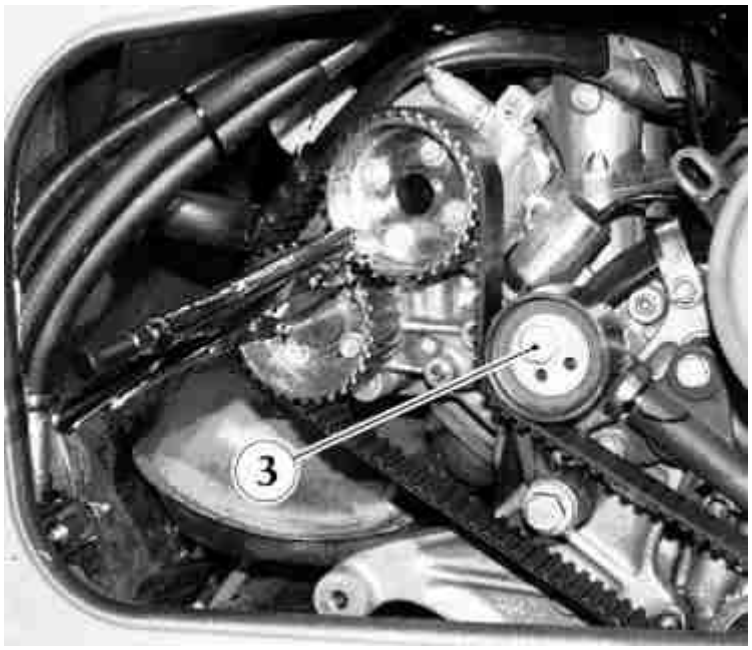
NOTES
Pay attention to the spacers positioned under the LH distribution cover and head.



- Insert a lock device **(C)** into the hydraulic tensioner.
- Mar the two driven pulleys and the driving pulley with respect to the front cover, in order to identify any shifting when the belt is being inserted.



- Use a self-locking collet to lock together the two driven pulleys.
- Loosen the belt-tensioner pulley by unscrewing the screw **(3)** and remove the belt.



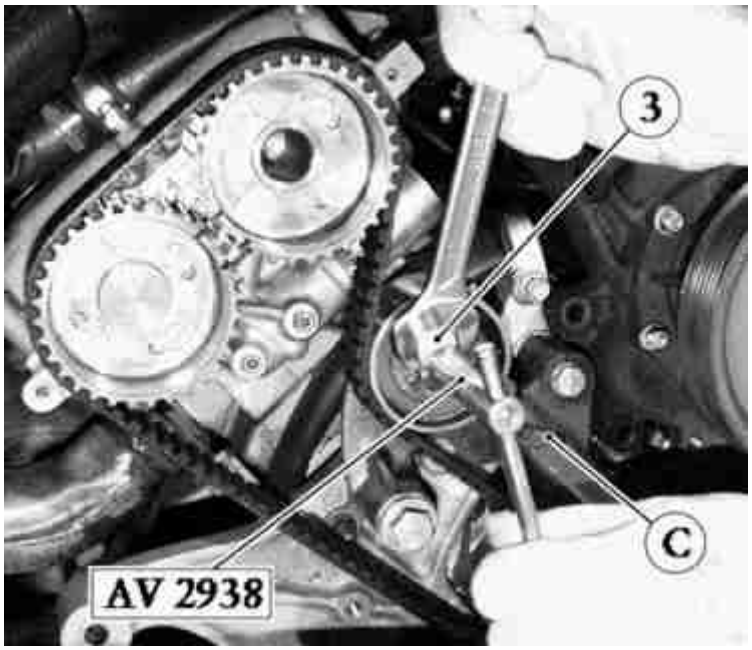
- Install the new belt and carefully avoid any shifting of the pulleys.

IMPORTANT

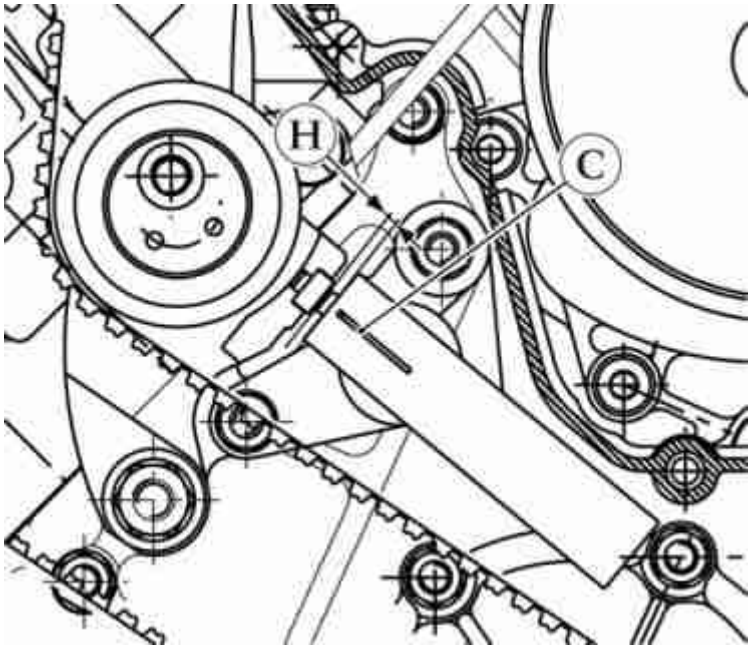
Under all circumstances, avoid sharp bending of the belts. Also avoid any contact between the belt and oil or gasoline.

Checking Tension

- Install the **AV 2938** belt tensioner tool in the pulley holes.
- Rotate the pulley with the tool toward the internal part of the engine until the lock **(C)** is free to slide into the seat of the hydraulic tensioner.
- Ensure that the distance **(H)** between the tensioner and the pulley-holder arm is equal to **1.9÷2.3 mm**.
- Lock the screw **(3)** in this position.



- Have the crankshaft complete two revolutions, solely in the direction of operating rotation, and once again, check to ensure that the lock is free and that the distance **(H)** remains as specified.

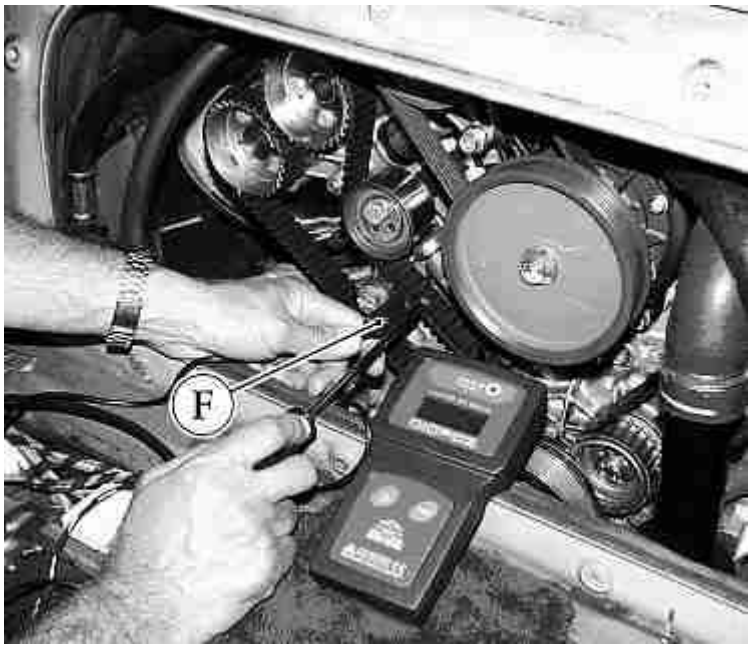


- Lock the screw **(3)** to the prescribed tightening torque.

NOTES

Following this procedure, you must wait at least two minutes to allow the tensioner to settle into the proper position.

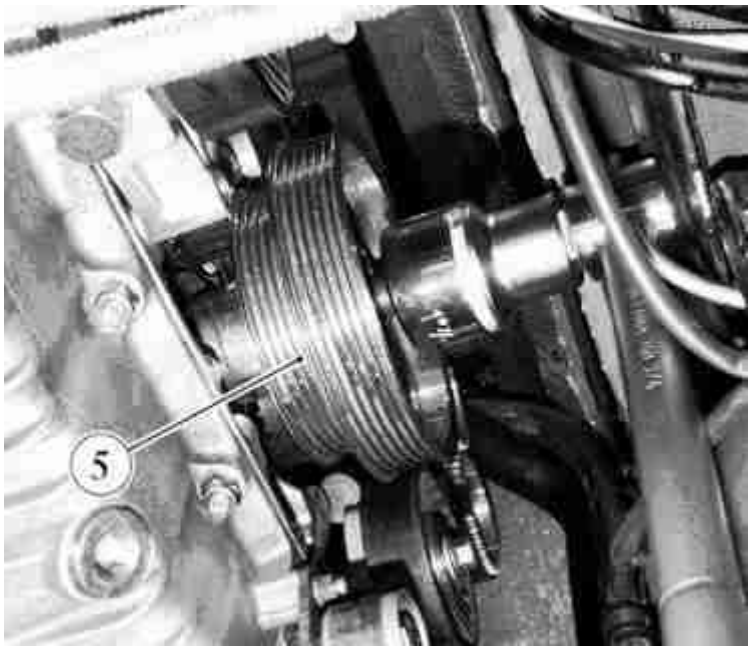
- Apply the frequency detector for the tension measuring tool to the midpoint of the longest belt branch, avoiding any contact.
- Strike the belt with a screwdriver, near the detector **(F)** and record the value on the tool.



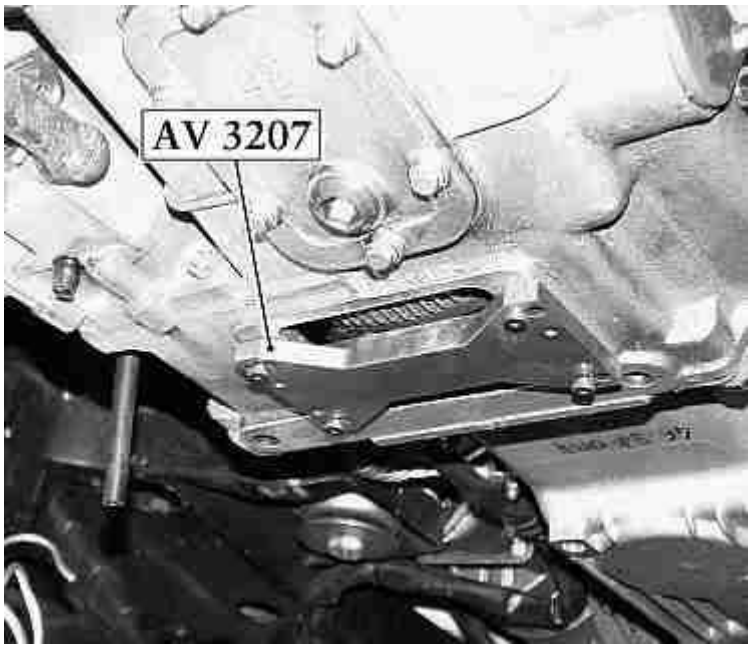
- Perform the same procedure applying the tool detector on the belt branch included between the tensioner roller and the driving pulley and find the sum of the two values detected.
- Should the values prove to be beyond the tolerance limits, adjust the position of the belt-tensioner pulley until the correct tension is observed.

Re-assembly

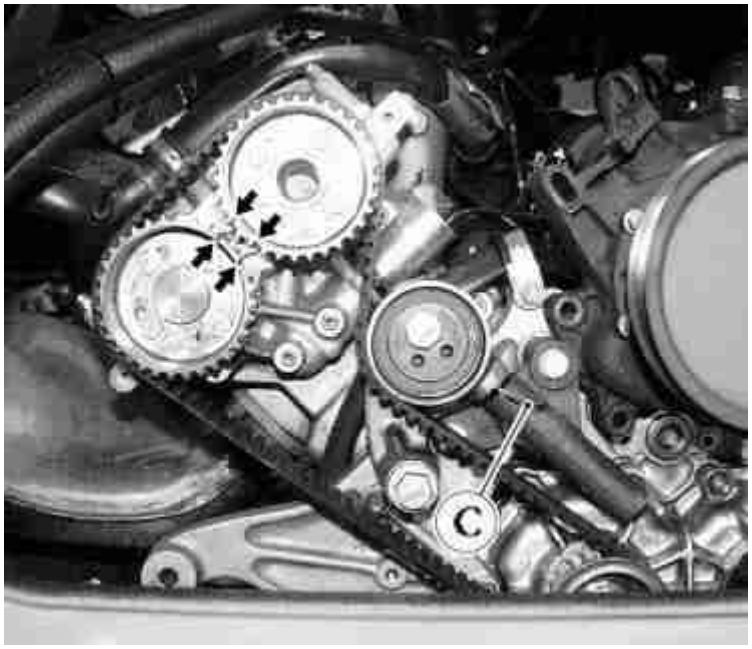
- Proceed by re-assembling the pulley **(5)** on the crankshaft, locking it with the washer and the original screw.

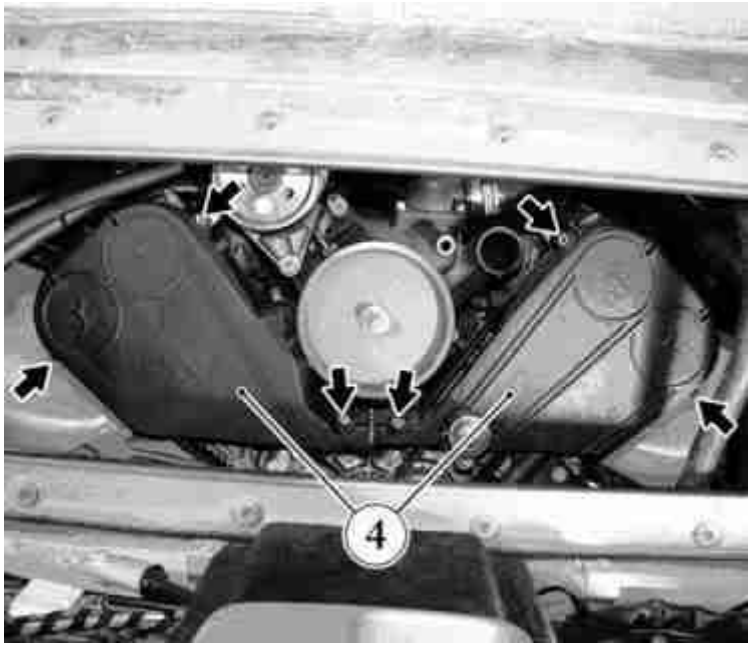


- Re-assemble the **AV 3207** tool to stop rotation of the crankshaft and tighten the screw to the prescribed torque.



- Slide off the lock **(C)** on the hydraulic tensioner and re-assemble the timing system cases **(4)**, with special care as to the spacers to be installed under the left-hand cover, where the two upper screws are found.





- Proceed by re-assembling the water pump-alternator control belts and the air-conditioning compressor control belt (A 3.04).
- Re-assemble all the parts that have been disassembled.

A3.04 CHECKING TENSION AND REPLACING AUXILIARY MEMBER BELTS

Specific Equipment

SEEM tensiometer **Type Diapaz cod. 95978151**

Tension Check Values

Belt	Rated	Acceptable minimum after use
• generator-water pump	**100 Hz**	**90 Hz**
• A.C. compressor	**145 Hz**	**131 Hz**
• hydraulic steering pump	**216 Hz**	**195 Hz**

Tightening Torques

Belt-tensioner pulley nut **50 Nm**

The engine auxiliary member belts must be replaced at regular intervals, as prescribed in the PROGRAMMED MAINTENANCE PLAN.

IMPORTANT
Check belt tension when the engine is cool.
Should the values observed prove to be lower than the minimum acceptable value, do not re-tension to the rated value more than twice.
Do not tension belts excessively in order to avoid irregular stress on the support bearings.

Generator-Water Pump Belt

To check the generator-water pump belt tension and to replace the belt, you must gain access from the lower part of the car, after having removed the rear part of the underfloor (M 2.12).

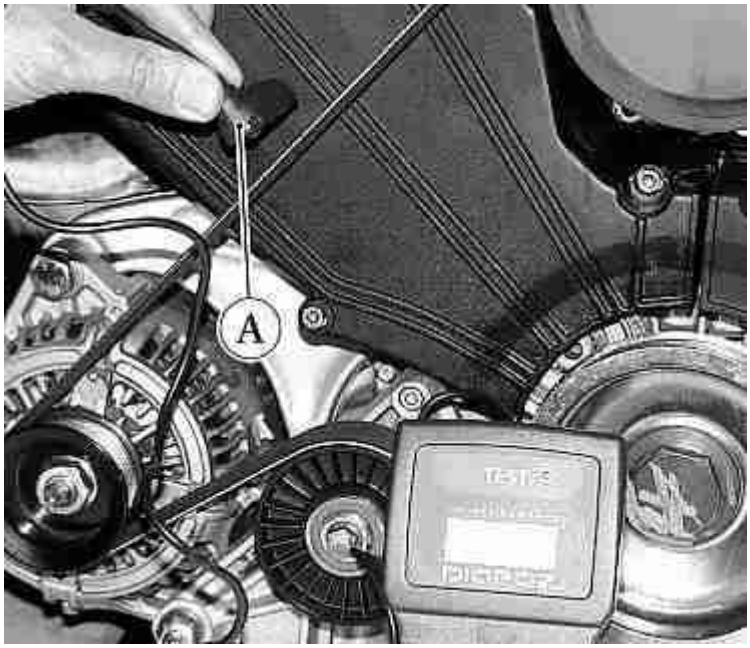
Checking Tension

- Apply the frequency detector for the tension measuring tool to the midpoint of the longest belt branch, avoiding any contact.

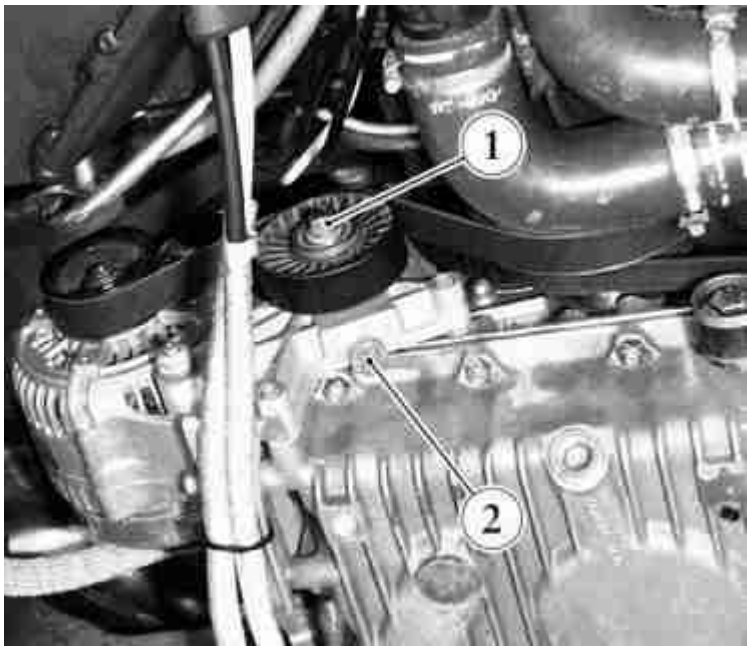
NOTES

For a better understanding of the procedure, tension must be checked through the passenger compartment inspection door.

- Strike the belt with a screwdriver, near the detector, and check the value on the tool.



- If the tension is incorrect, proceed by tensioning, loosening the nut **(1)** on the belt-tensioner pulley.
- Adjust the adjusting screw **(2)** until the prescribed tension is reached.
- Lock the nut **(1)** to the prescribed tightening torque.



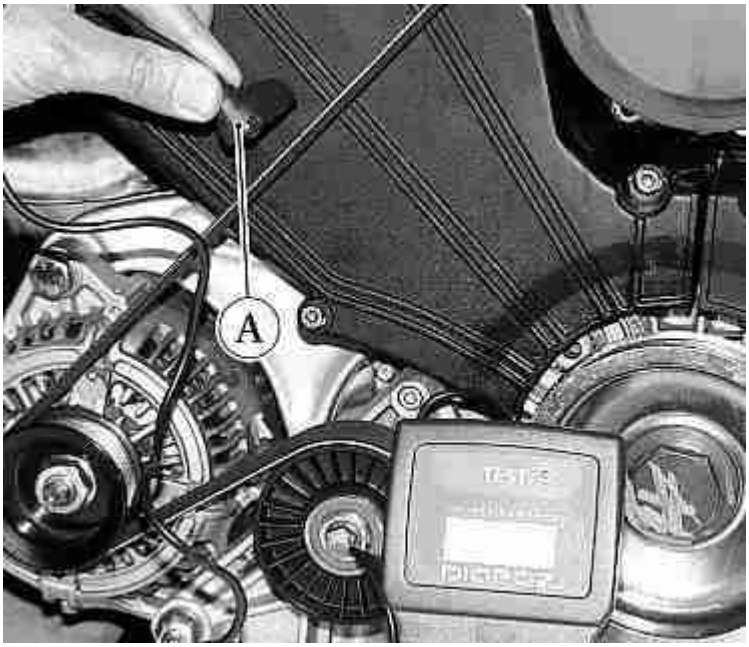
Replacement

- Loosen the nut **(1)** and tighten the adjusting screw **(2)** completely in order to loosen the belt.
- Remove the worn belt.
- Install the new belt using your hands only.

IMPORTANT

Under all circumstances, avoid sharp bending of the belt as this would damage it. Also avoid any contact between the belt and oil or gasoline.

- Tension as described above.

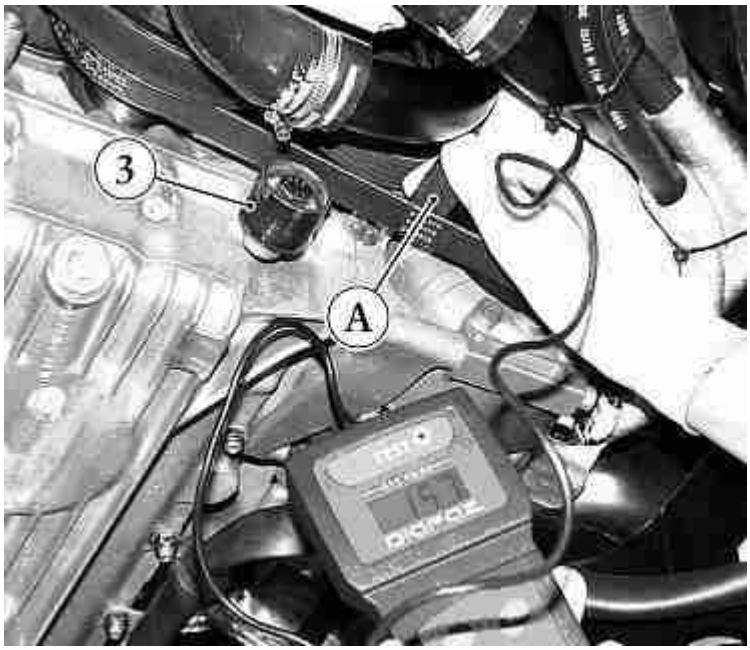


A.C. Compressor Control Belt

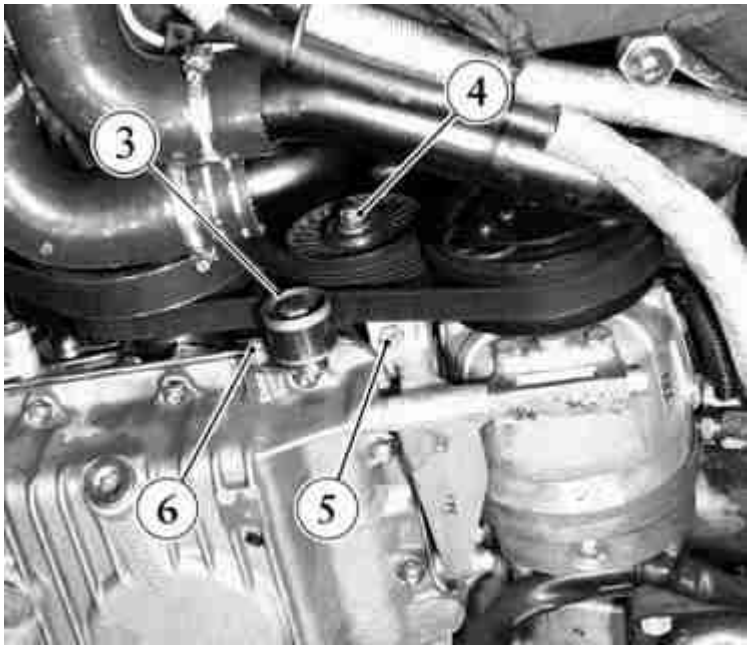
To check the A.C. compressor control belt tension and to replace the belt, you must gain access from the lower part of the car, after having removed the rear part of the underfloor (_____).

Checking Tension

- Rotate the bearing **(3)** downwards.
- Apply the frequency detector **(A)** for the tension measuring tool to the midpoint of the longest belt branch, avoiding any contact.
- Strike the belt with a screwdriver, near the detector, and check the value on the tool.



- If the tension is incorrect, proceed by tensioning, loosening the nut **(4)** on the belt-tensioner pulley.
- Adjust the adjusting screw **(5)** until the prescribed tension is reached.
- Lock the nut **(4)** to the prescribed tightening torque.
- Bring the nut **(3)** into contact with the belt and lock the fastening nut **(6)**.



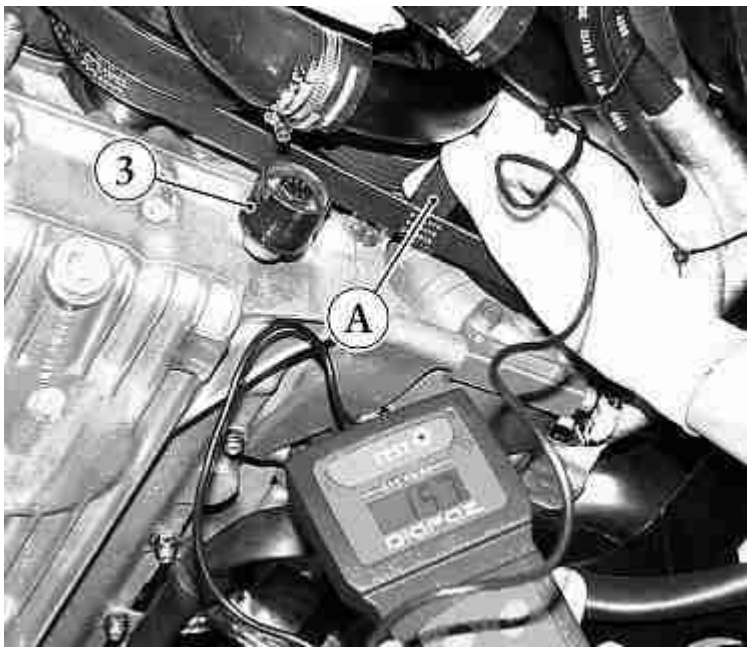
Replacement

- Rotate the bearing **(3)** downwards.
- Loosen the nut **(4)** and unscrew the adjusting screw **(5)** completely in order to loosen the belt.
- Remove the worn belt.
- Install the new belt using your hands only.

IMPORTANT

Under all circumstances, avoid sharp bending of the belt as this would damage it. Also avoid any contact between the belt and oil or gasoline.

- Tension as described above.



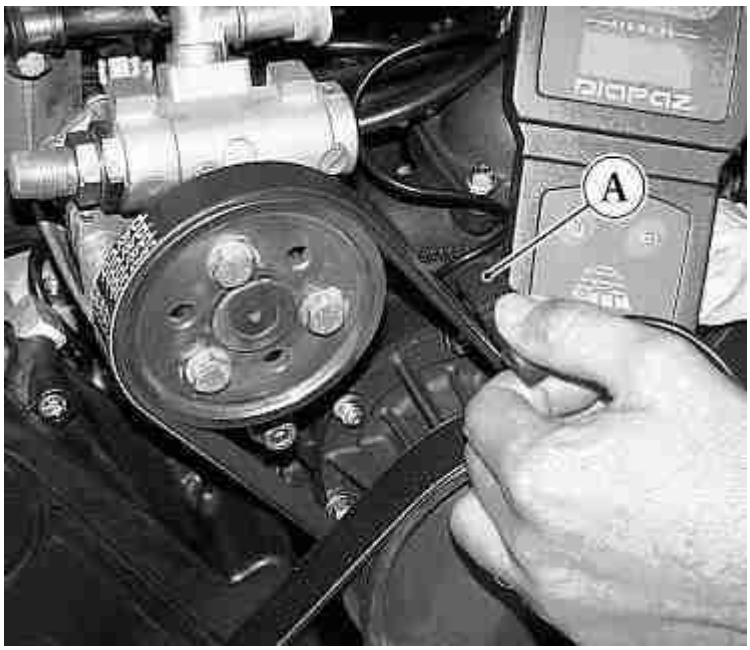
Hydraulic Steering Pump Control Belt

It is also possible to check and replace the hydraulic steering control belt through the opening in the dividing panel between the passenger and engine compartments.

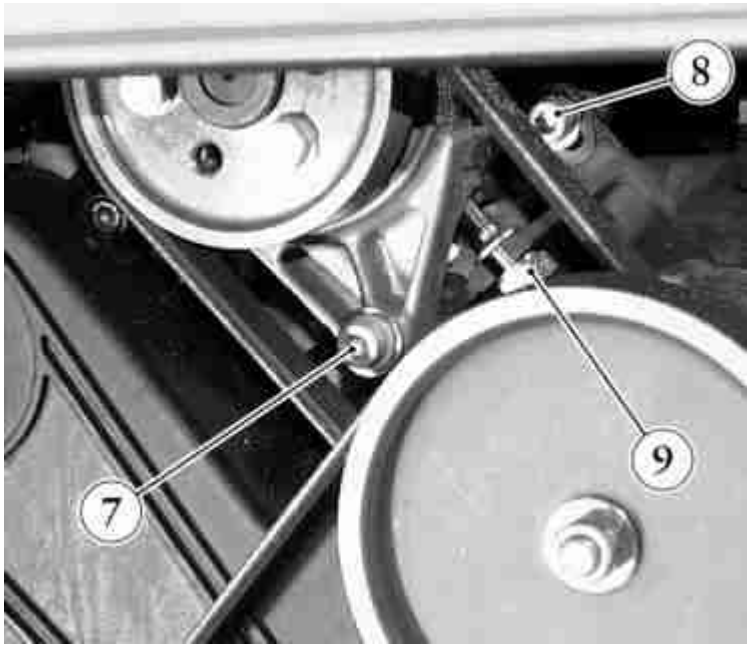
- Some passenger compartment components and the engine inspection door must be removed in order to gain access to said opening (M 3.05).

Tension Checking

- Apply the frequency detector **(A)** for the tension measuring tool to the midpoint of the longest belt branch, avoiding any contact.
- Strike the belt with a screwdriver, near the detector, and check the value on the tool.



- If the tension is incorrect, proceed by tensioning, loosening the two screws **(7)** and **(8)** on the pump support.
- Adjust the adjusting screw **(9)** until the prescribed tension is reached.
- Lock the screws **(7)** and **(8).**



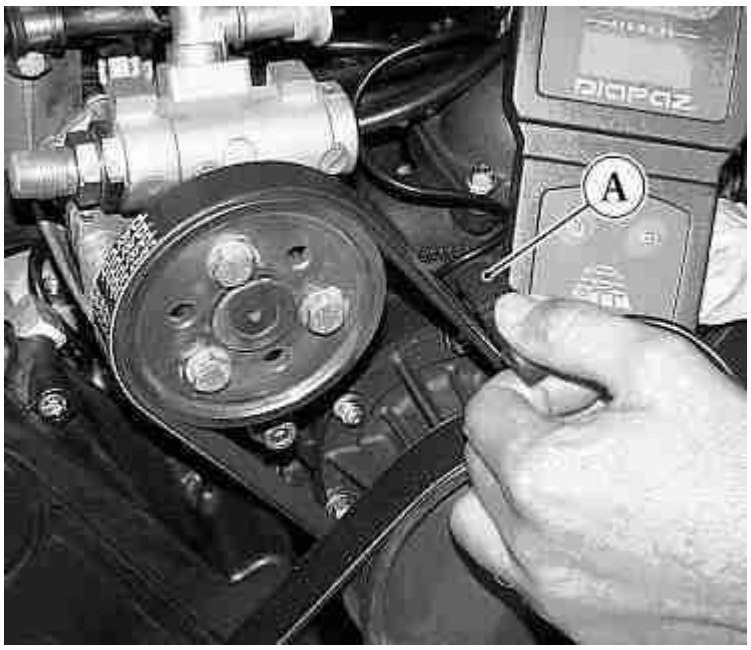
Replacement

- Remove the generator-water pump control belt as described above.
- Loosen the screws **(7)** and **(8)** and tighten the adjusting screw **(9)** completely in order to loosen the belt.
- Remove the worn belt.
- Install the new belt using your hands only.

IMPORTANT

Under all circumstances, avoid sharp bending of the belt as this would damage it. Also avoid any contact between the belt and oil or gasoline.

- Tension as described above.



- Re-assemble and tension the generator-water pump control belt.
- Re-assemble all parts that have been removed to perform the procedures described.

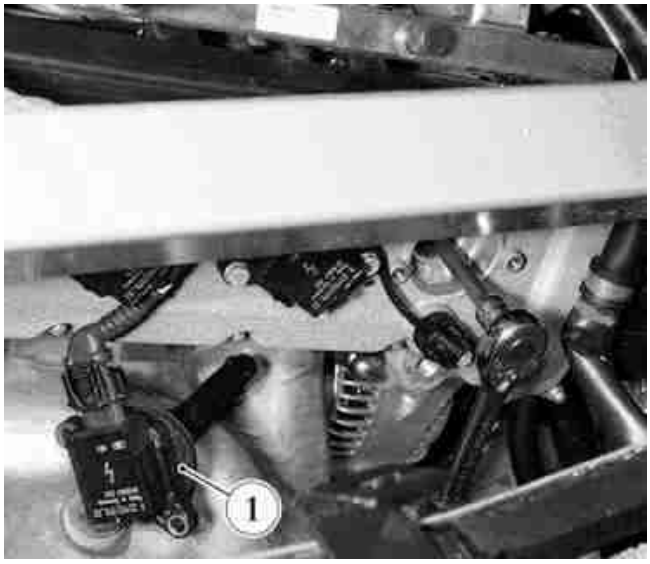
A3.05 CHECKING AND AND REPLACING SPARK PLUGS

Type of spark plug	Tightening Torques	Category	Product
NGK PMR8B (M10x1)	**10 Nm**	**A**	Lubricant **CHAMPION 2612**

The spark plugs must be replaced at regular intervals, as prescribed in the PROGRAMMED MAINTENANCE PLAN.

Disassembly

- Remove the coil **(1)** by unscrewing the two fastening screws (C 3.03).

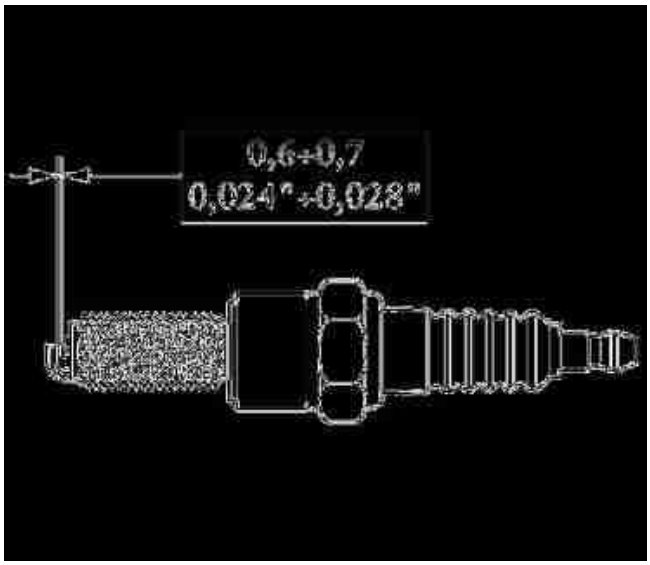


- Use a universal socket wrench to unscrew and remove the spark plug.

Check

The spark plug should prove to be in good condition to obtain maximum performance from the engine.

- Ensure that the distance between the electrodes in the new spark plug is equal to **0.6÷0.7 mm.**



Assembly

- Apply a minimal amount of the prescribed type of lubricant to the threaded part.
- Screw the spark plug in until it meets the gasket on the supporting seat.
- Use a torque wrench to lock the spark plug to the prescribed torque.
- Re-assemble the coil (C 3.03).

IMPORTANT

Once the spark plugs have been replaced, the self-detected parameters must be deleted from the control unit. (C 6.04).

A3.06 CHECKING THE WINDOW-WASHER FLUID LEVEL

Access to the filler for the window-washer fluid tank is possible by lifting up the luggage compartment.
Refill the tank up to the point in which the fluid is visible from the filler.

The tank has a capacity of about **3.5 liters** of fluid.
In the case of the version with headlight-washer, the tank capacity is equal to about **7.5 liters** of fluid.

NOTES
In the event of malfunctioning of the window-washer circuit, check the pump after having removed the front bumper (M 2.03).

A3.07 CHECKING THE THE BLOW-BY SYSTEM PIPES AND CONNECTIONS

- Check the state of the system pipes and tightness of the clamps at the vapor separator, on the heads and on the throttle bodies (B 4.05).
- If any leakage or sweating is detected, replace the pipe and/or the clamp involved.

A3.08 CHECKING THE THE COOLING SYSTEM PIPES AND CONNECTIONS

- Remove the underfloor components (M 2.12).
- Check the state of the couplings and proper tightness of the fastening clamps on the front radiators, the pipes under the floor and on those connecting to the water pump and the expansion tank (B 5.01).
- From the engine compartment, check the connection pipes between the expansion tank and the water pump, as well as those connecting to pipe under the floor.
- If any leakage is detected, replace the pipe and/or the clamps involved.

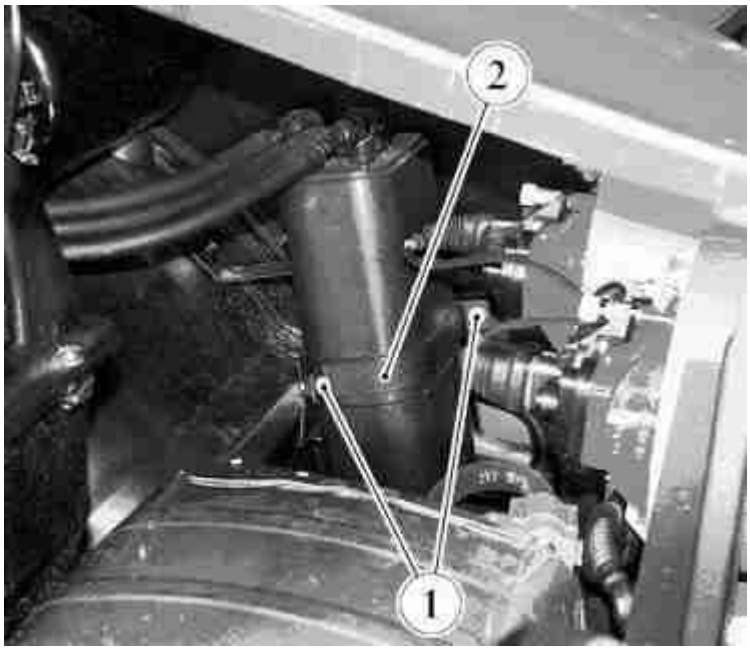
A3.09 CHECKING THE INJECTION AND IGNITION SYSTEM PIPES AND CONNECTIONS

- Check the connection pipes between the tanks and the rails on the intake manifold, in the engine compartment.
- If any leakage is detected, replace the pipe and check the system (B 6.01).
- Check the conditions of the cables and of the connectors on the Motronic ECUs and on the coils (see Table **L**, **S** and **R** - ELECTRICAL SYSTEM). In the event that the outside covering proves to be torn or the closing system connectors are damaged, the cable must be replaced.
- In case of working failures, check the spark plugs conditions (A 3.05) and replace them at the intervals prescribed in the PROGRAMMED MAINTENANCE PLAN.

A3.10 REPLACING THE ACTIVATED CARBON FILTER

The activated carbon filter must be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN". The filter is found under the right-hand rear fender.

- Unscrew the support bracket **(2)** fastening screws **(1)**.

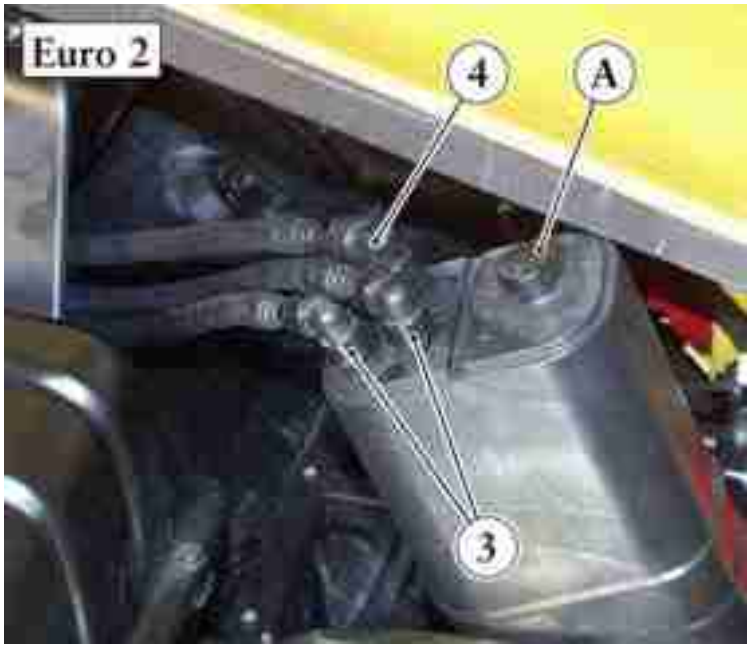


- Shift the filter inward and proceed by detaching the connecting pipe, using a small screwdriver as a lever under the unions.

Notes for the Euro 2 version

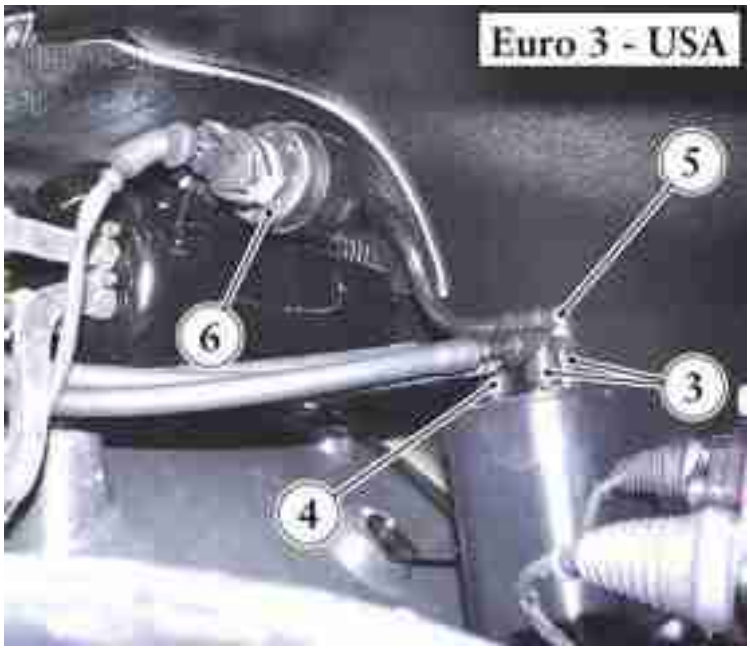
These cars have an active charcoal filter with a vent (**A**) instead of an output union for the interception valve.

- Detach the two unions (**3**, smaller diameter) on the connecting pipes to the anti-evaporative emission valves and the union (**4**, larger diameter) on the connecting pipe to the multifunction valve.



Note for the Euro 3 - US M.Y. 1999 version

Besides the above mentioned pipes, it is also necessary to remove the piping **(5)** which connects the carbon filter's vent stack to the interception valve **(6)**.



- Replace the activated carbon filter.
- Connect the unions **(3)** and **(4)** for the connecting pipes to the filter.
- Re-install the filter on the support and anchor it with the bracket **(2)**.
- Lock the bracket with the screws **(1)**.

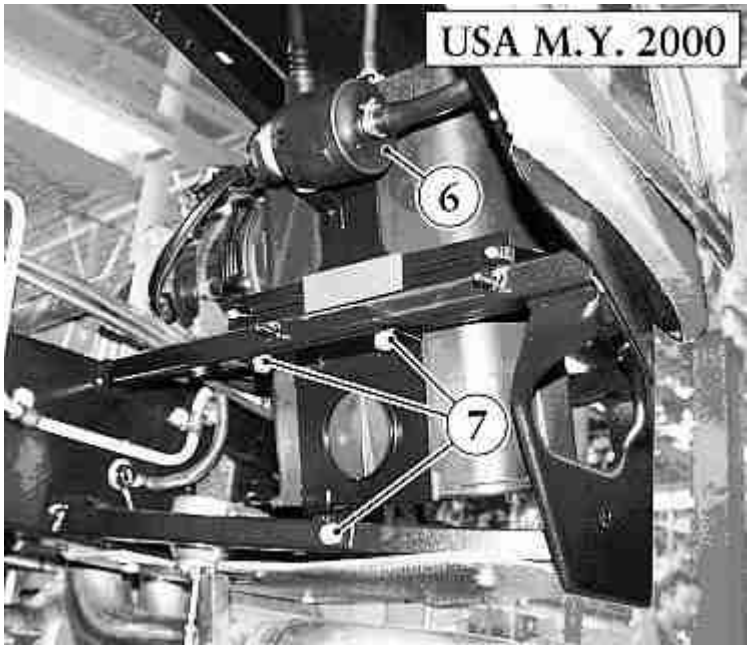
US M.Y. 2000 version

In this version, the active carbon filter is positioned on the left-hand side, under the rear bumper.

- It is necessary to remove the lower edge of the rear left-hand side wheelhouse in order to access the

screws fastening the carbon filter support (M 2.05).

- Unscrew the three screws **(7)** fastening the carbon filter support bracket and the interception valve **(6)**.



- Remove the piping which connects the carbon filter.
- Remove the interception valve from the electric system.
- Remove the carbon filter together with the bracket and interception valve from under the mudguard.
- Separate the filter from the support bracket **(8)** and the interception valve connection, then replace it.

A3.11 CHECKING THE OIL LEVEL ON THE "F1" GEARBOX

The oil tank for the **"F1"** gearbox is located on the right-hand side of the engine compartment.
The level check must be performed when the engine is cold and at the intervals prescribed in the "PROGRAMMED MAINTENANCE PLAN".

- Unscrew the reservoir cap **(1)** and clean the dipstick.
- Turn the ignition key to position **II** (running) and wait for the F1 system's pump to start-up.
- As soon as the pump stops operating, screw-down the cap on the reservoir.
- Remove the cap once again and check that the oil level is between the **"MIN"** and **"MAX"** notches on the dipstick.

- If needed, top-up with the prescribed oil type.
- Screw- down the cap **(1** tightly.

A3.12 REPLACING THE OXYGEN SENSOR

Tightening Torques

Oxygen Sensor **50 Nm**

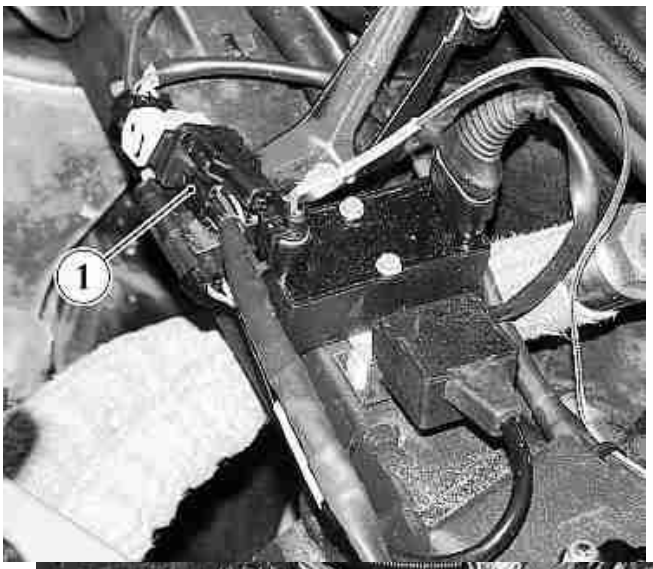
The oxygen sensors must be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN".

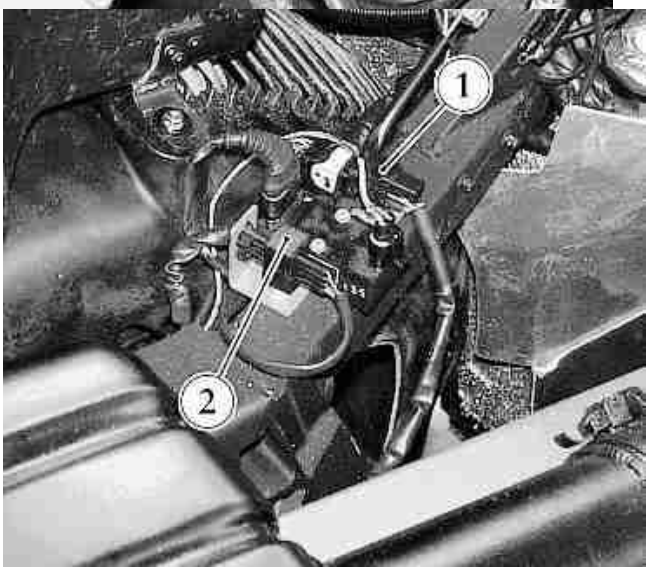
Preliminary Procedures

- Remove the side shields of the engine compartment (M 2.13).
- Remove the expansion tank, but keep it connected to the system (B 5.05)
- Remove the entire air intake (B 7.03).

Front sensor

- Release the connection **(1)** from the support bracket fastening it to the chassis and detach it from the injection wiring harness.

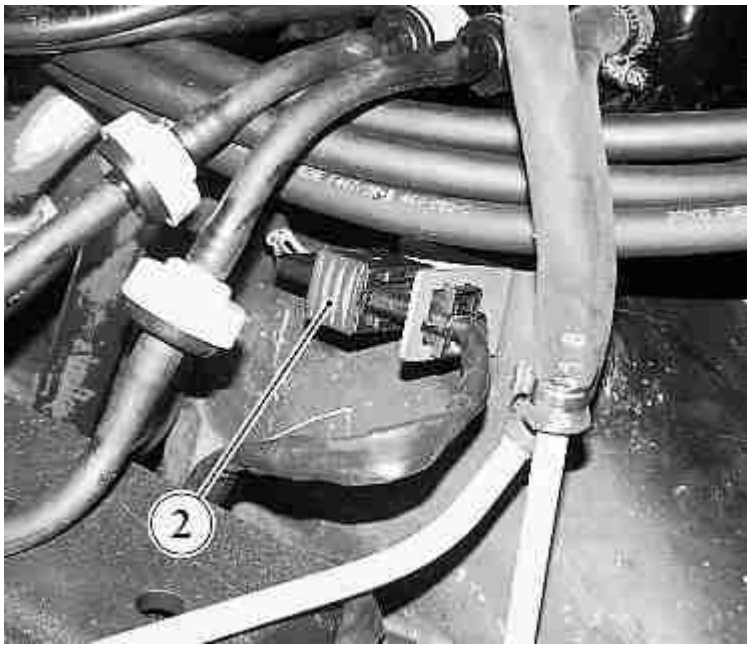




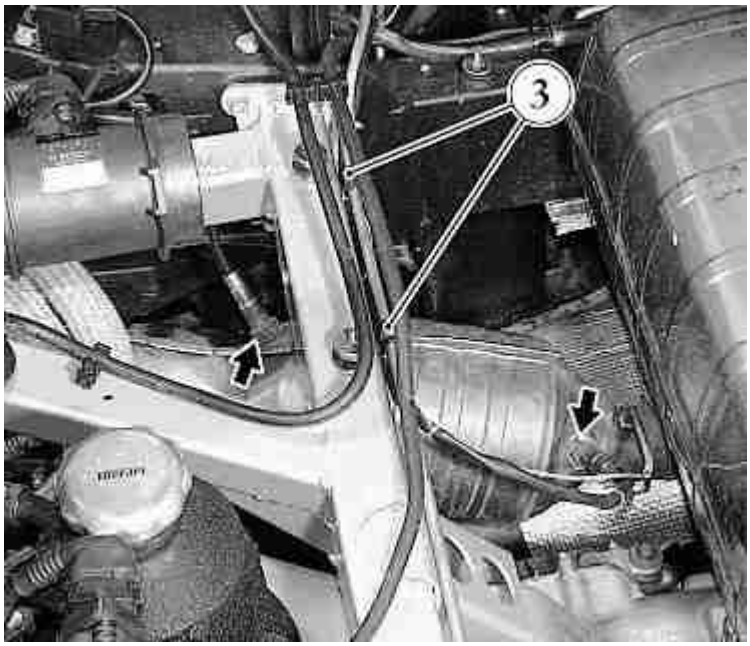
- Unscrew the Lambda sensor and remove it from the catalytic converter.

Rear sensor

- Detach the connection **(2)** from the injection wiring harness.



- Remove the support clamps **(3)** for the oxygen sensor cable from the chassis frame and release the cable from the clamp which fastens it to the thermocouple cable.



- Unscrew Lambda sensor and remove it from the catalytic converter.

Re-Assembly Notes

IMPORTANT
Do not clean the thread or apply grease, solvents, or locking products etc. which may hinder the correct functioning of the sensor. The new sensor thread is ready-lubricated with special grease.

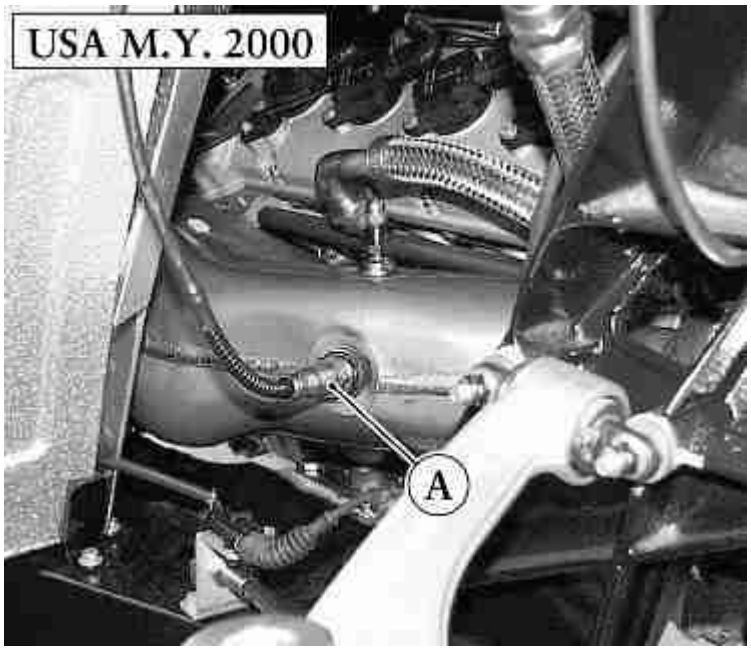
- Tighten the oxygen sensor on the catalytic converter to a **50 Nm** torque.
- Position it correctly and then fasten the sensor cable as before.
- Attach the connector and reassemble the structures removed for the procedure.

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

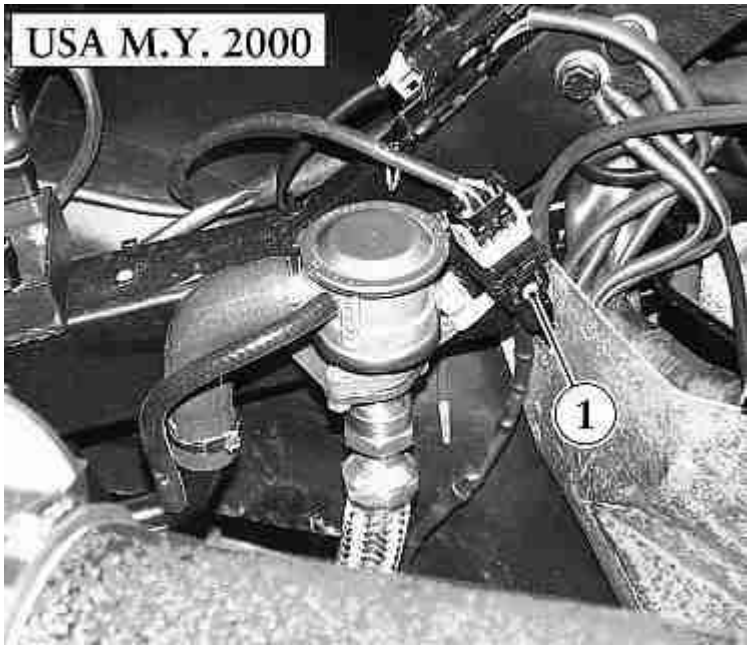
IMPORTANT
Once the oxygen sensors have been replaced, the self-detected parameters must be deleted from the control unit memory (C 6.04).

Note for the US M.Y. 2000 version

In this version the oxygen sensor **(A)** is fitted on the exhaust manifold.

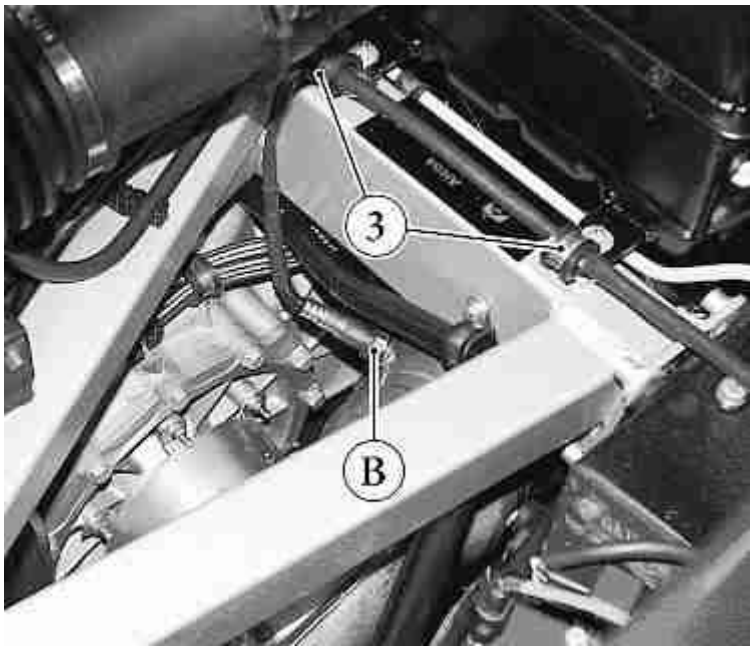


- For its removal it is necessary to detach the connector **(1)**, positioned near the secondary air valve, from the injection harness, then unscrew it from the exhaust manifold



The rear oxygen sensor **(B)** is fitted on the inner side of the catalytic converter; for its removal it is necessary to detach the connector **(2)** from the injection harness and release the cable from the support clamps **(3)** fastened under the nuts which fix the air inlet to the gearbox housing's side frame.

- Unscrew and remove the sensor from the catalytic converter.

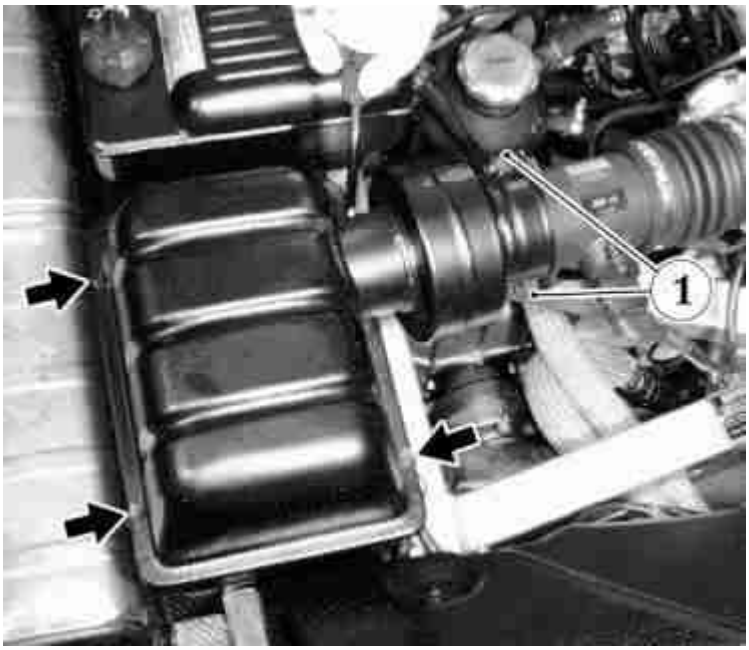


A3.13 REPLACING THE AIR FILTERS

The air filter cartridges must be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN".

IMPORTANT
It is essential that the air filters be in good condition to obtain maximum performance from the engine.

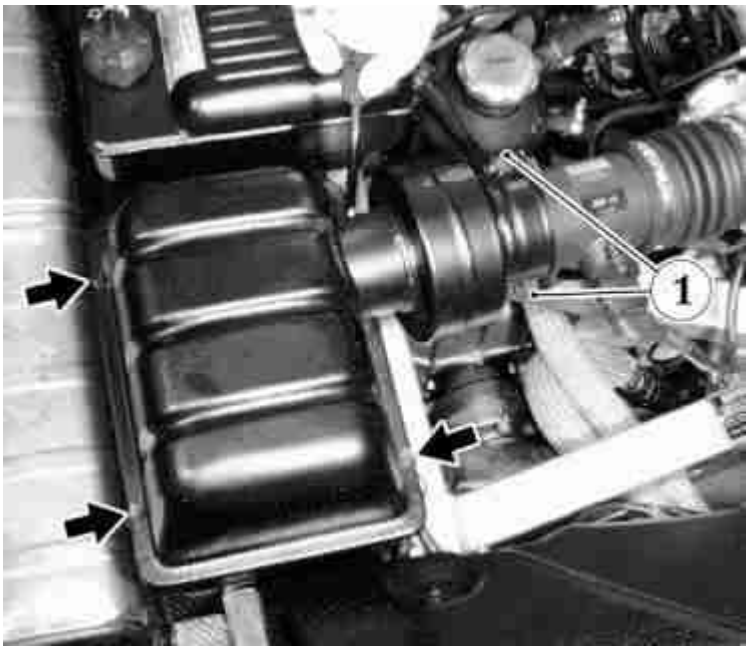
- Unscrew the fastening screws on each cover.
- Release the locks **(1)** in the air flow meter-cover connection.



- Remove the covers.
- Slide the air filter cartridges out and replace them.

IMPORTANT
Do not clean or wash the air filter cartridges that have been removed. Always replace them.

- Slightly lubricate the supporting surface for the filter cartridge on the air intake.
- Position the filter cartridges on the air intake.
- Install the covers and lock them onto the air intake using the fastening screws, and onto the air flow meters with the locks **(1)**.



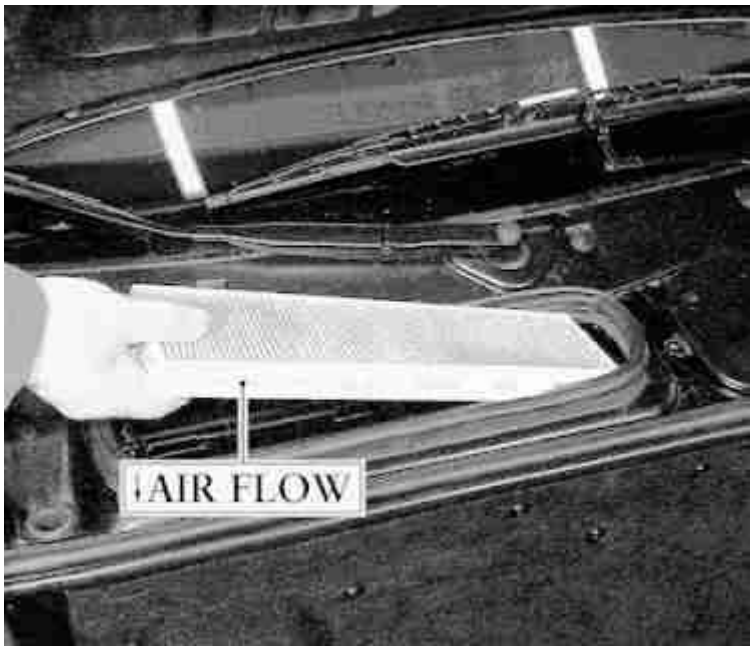
A3.14 REPLACING THE THE AIR TEMPERATURE CONTROL SYSTEM FILTER

The air temperature control filter must be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN. The filter is found on the right-hand side under the windscreen upholstery.

IMPORTANT

A dirty filter obstructs the intake of outside air, impairing satisfactory operation of the air temperature control system.

- Insert the new filter with the arrow indicating air flow direction **(AIR FLOW)** pointing downwards.

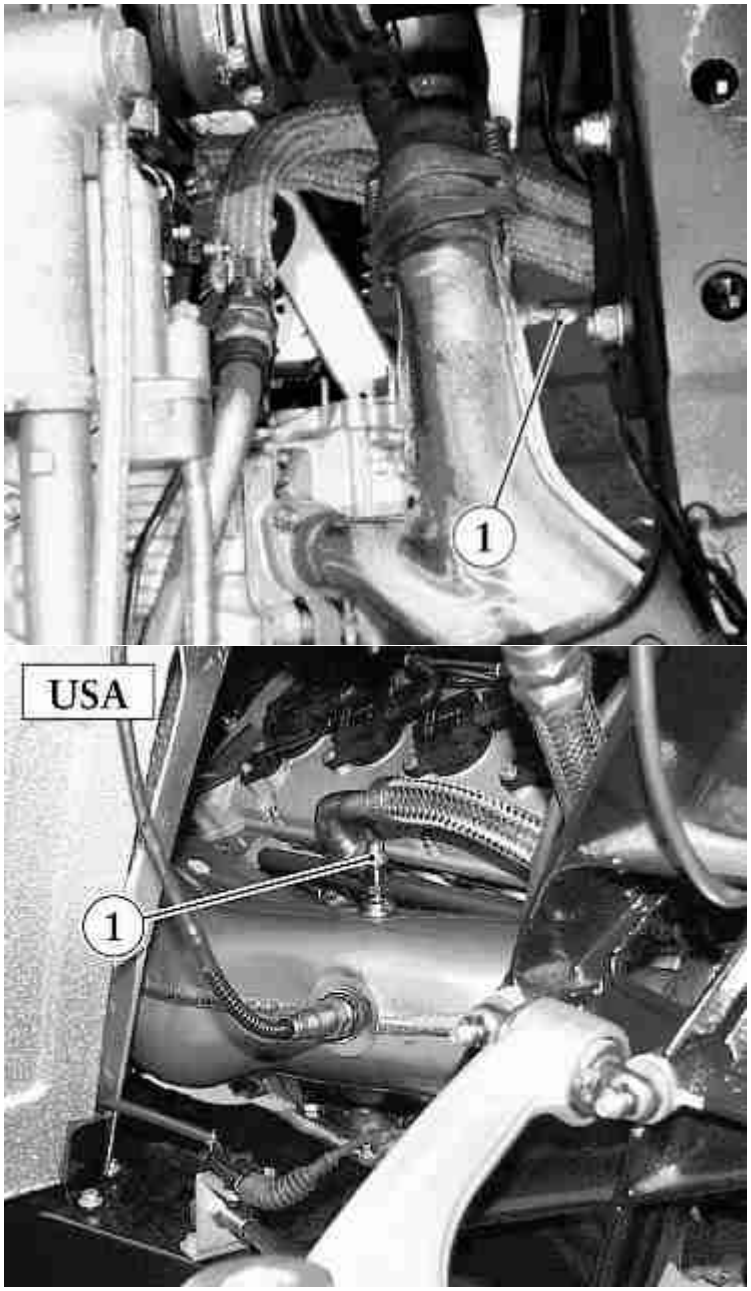


A3.15 CHECKING EXHAUST EXHAUST SYSTEM CONNECTIONS

- Remove the rear component on the underfloor (M 2.12).
- Ensure that all system components are intact and then check to ensure that the fastening parts are tightened properly.

A3.16 CHECKING EMISSION LEVELS

- Check the CO, HC and NOx levels by connecting the instrument to the exhaust manifold unions, after having removed the nuts **(1)**.



- Once the procedure has been completed, lock the nuts **(1)** to the **12 Nm** torque.

A3.17 TIGHTENING OF NUTS, UNIONS AND CLAMPS

At the intervals prescribed in the "PROGRAMMED MAINTENANCE PLAN", check for screw tightening on the main mechanical devices.
For this purpose, refer to the tables specifying the tightening torques at the beginning of each section.
Furthermore, check that the unions and the fastening clamps on the hydraulic pipes are tightened securely.
In case of replacement, use only the prescribed clamp type.

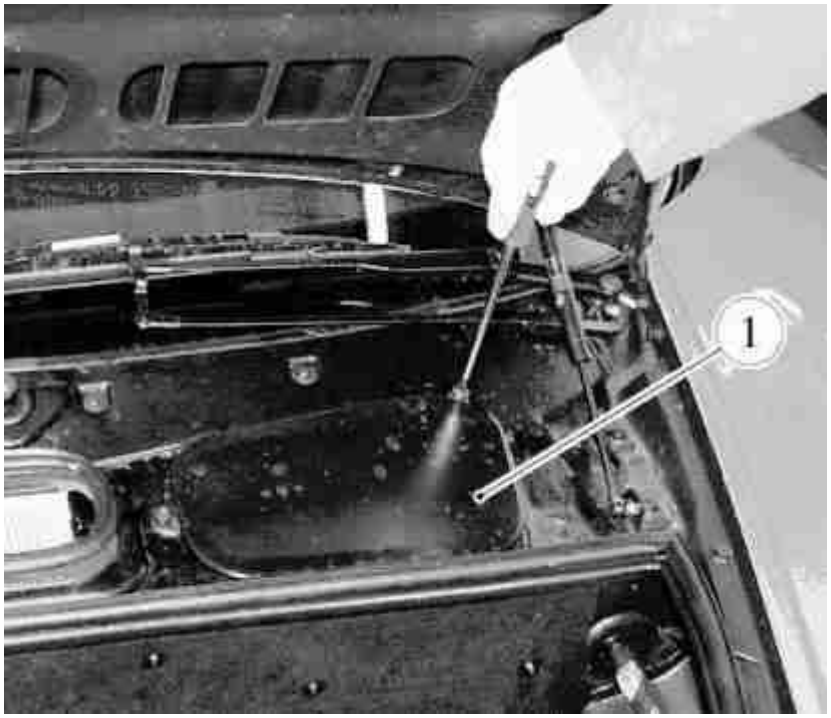
A3.18 CHECKING THE BRAKE AND CLUTCH SYSTEM FLUID LEVELS

The system fluid level must be checked at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN". The fluid is found in the single tank, located on the left-hand side of the compartment under the wind-screen.

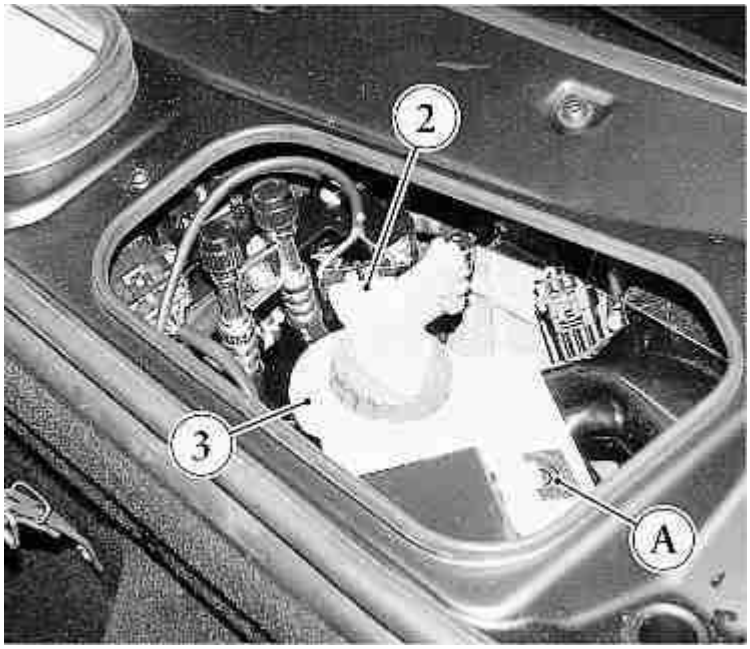
NOTES

In the cars with mechanical gearbox, the brake fluid tank is shared with the clutch system.

- The inspection cover **(1)** must be removed to gain access to the tank.



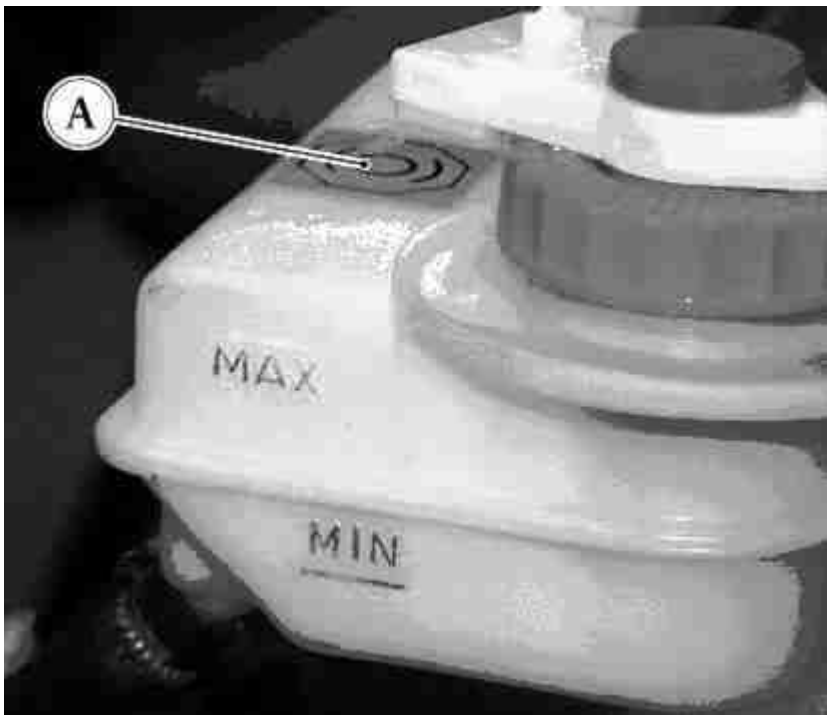
- Check to ensure that the fluid in the tank is always near the maximum level **"MAX"**.
- If the level is low, proceed by refilling after having detached the connector **(2)** and removed the cap **(3)**.



CAUTION

The fluid used in the system can cause injury to eyes and skin. Wash body areas that have come into contact with it under running water. Moreover, the brake fluid can damage painted parts of the vehicle.

- Top up to the **"MAX"** level with the fluid prescribed, using a fresh, unopened container.

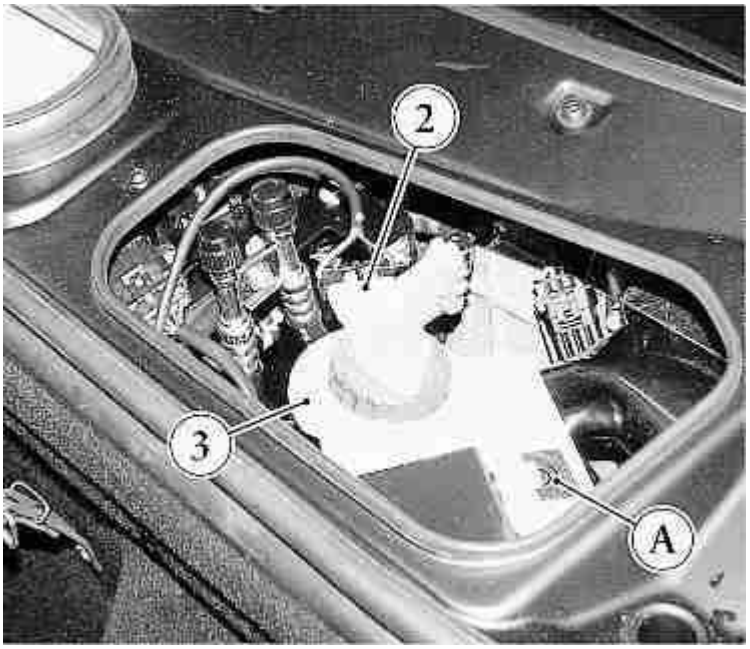


IMPORTANT

*The symbol **(A)** appearing on the tank, indicates the presence of synthetic fluid in the circuit. The use of mineral fluid can cause irreparable damage to the system's rubber gaskets.*

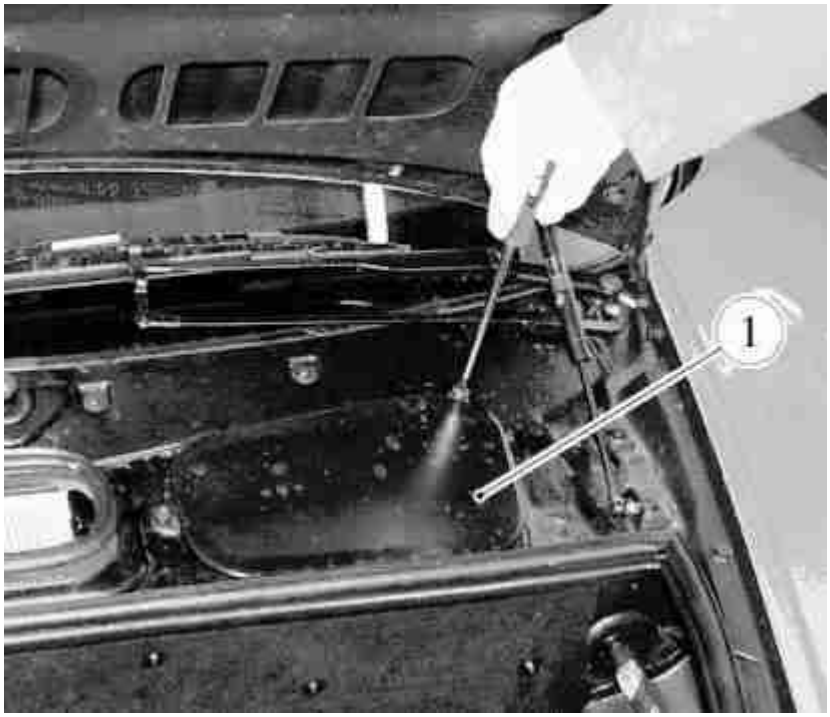
A level that is too low may be an indication of excessive oil consumption.

- Close the cap **(3)** tightly and re-assemble the connector. **(2)**.



- Install the inspection cover **(1)**.

IMPORTANT
It is necessary to replace the liquid and drain the system every year (G 3.02) (D 3.04).



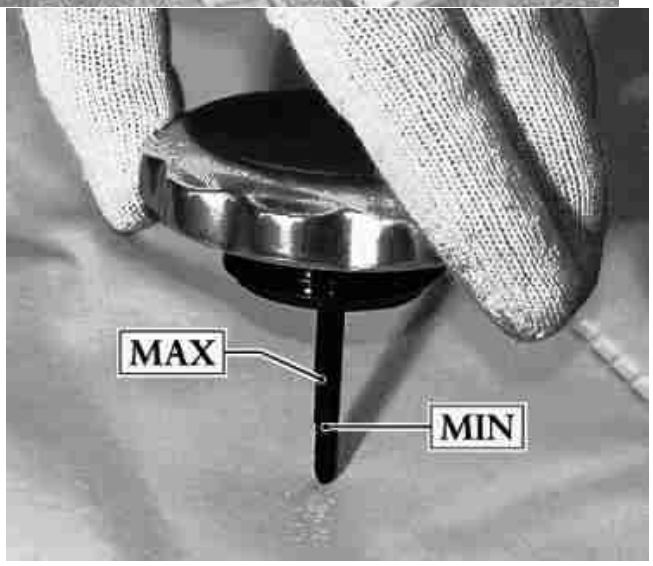
A3.19 CHECKING THE HYDRAULIC STEERING FLUID LEVEL

The hydraulic steering system fluid level must be checked at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN". The fluid is found in the tank located in the engine compartment, in front of the intake manifold.

IMPORTANT

The hydraulic steering oil level should be checked with the engine warm, after having driven for at least 15 km. If checked with the engine cool, it may prove to be decidedly low in spite of the fact that the amount prescribed is present in the system.

- Take the cap off the tank.
- Ensure that the fluid level is between the **"MIN"** and **"MAX"**marks found on the cap inspection dipstick



- If the level is too low, top up to the **"MAX"** level with the oil prescribed, using a fresh, unopened container.

A level that is too low may be an indication of a leak or of air in the system.

A3.20 INSPECTING THE THE BRAKING SYSTEM

- Remove the wheels and check the state of the connecting pipes to the brake calipers and the state of the unions on the pipes.
- Remove rear bulkhead in the luggage compartment (M 3.06) and check for any leaks on the master cylinder and **ABS/ASR** control unit unions.
- If leaks are present, the union must be tightened or the pipe involved must be replaced. In this case, after refilling, the system must be drained (G 3.02).
- Ensure that the warning lights on the instrument panel are working properly.

A3.21 CHECKING THE THE SERVICE BRAKES AND REPLACING PADS

Cut-off Limits for Wear

Minimum pad thickness (with noise-reduction plate)	**7,5** mm (**0.295** in.)
Brake disc thickness	**26** mm (**1.023** in.)

Type of Pads

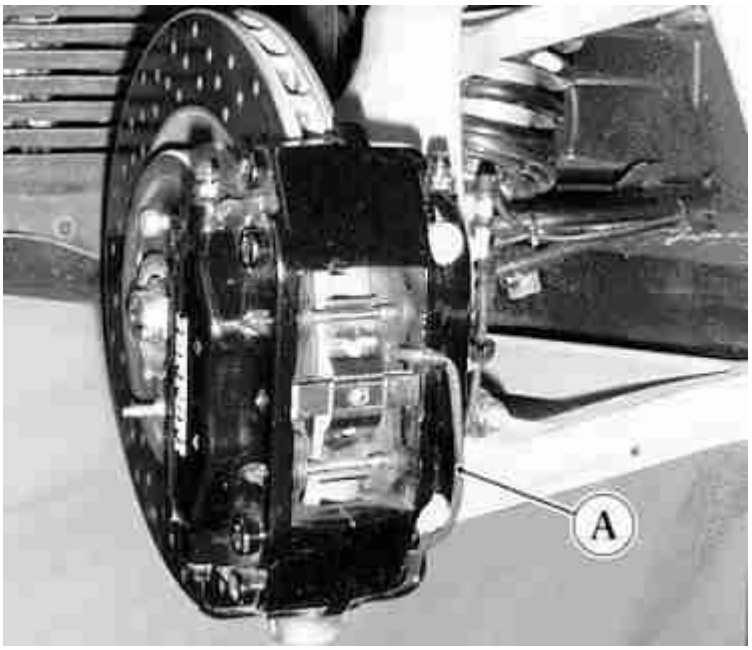
Front brake pads	**GALFER 3321 GF (49)**
Rear brake pads	**GALFER 3321 GF (49)**

The brake pads and discs must be checked for wear at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN", and after having first removed the wheels (F 3.06).
If wear or excessive surface roughness is noted, (G 1.01), proceed with grinding or replacement of the brake disc (G 2.05).
The front brake pads are equipped with a wear indicator that is connected to the faulty brake warning light on the dashboard. Should this warning light turn on, check the thicknesses of the pads and the state of the braking surfaces on the discs.
In the case of excessive wear, even of just one pad, replace all of the wheel axle pads.

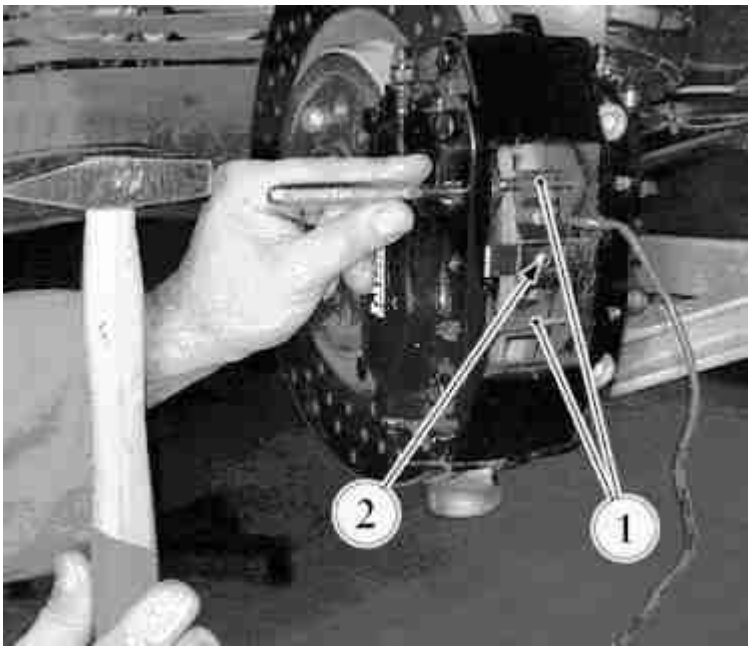
NOTES
Prior to replacement, wash the caliper-disc assembly with a jet of pressurized steam to remove the dust caused by wear of the pads. Dry with compressed air only.

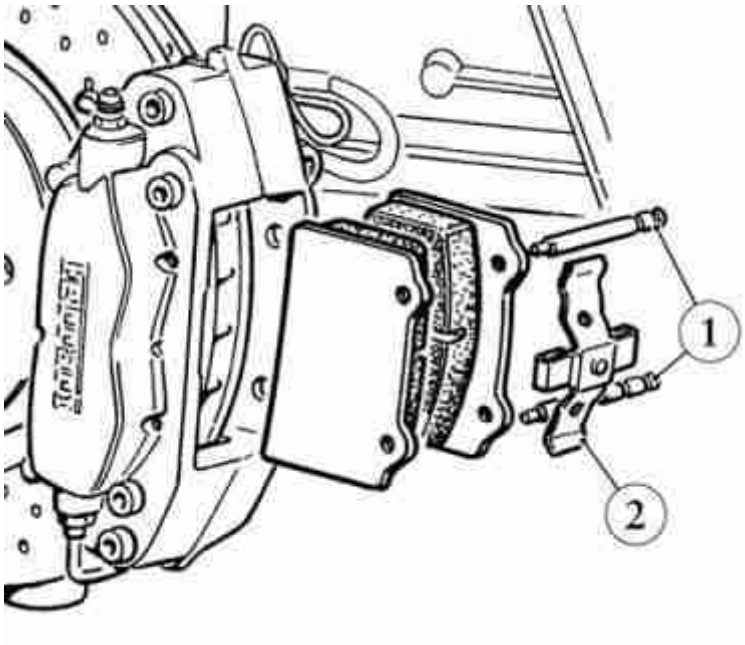
Replacing Front Brake Pads

- Rotate the wheel hub in order to position the brake caliper outward and disconnect the cablehead **(A)** of the pad wear indicator cable from the stub axle cover.



- Remove one of the two pad retention pins **(1)**.
- Remove the spring clip **(2)**.
- Remove the other pin **(1)**.
- Slide the brake pads off and replace them.

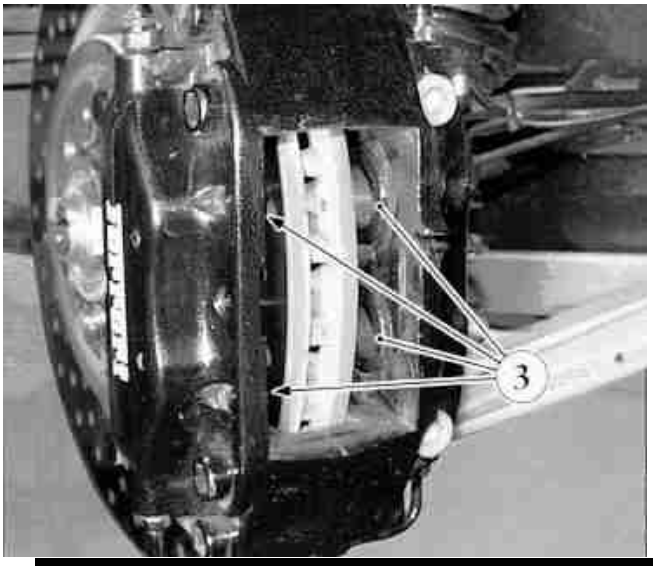


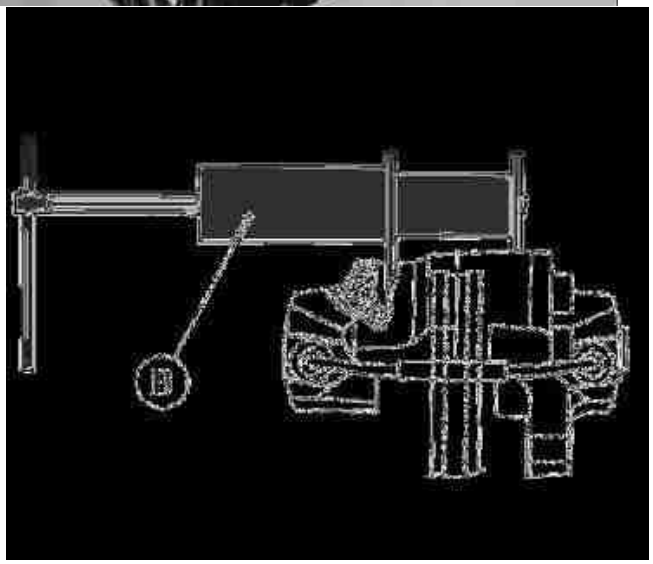


CAUTION

Under these conditions, avoid activating the brake pedal as this could cause leakage of fluid from the caliper. The fluid used in the system can cause injury to eyes and skin. Wash any body areas that have come into contact with it under running water. Moreover, the brake fluid can damage painted parts of the vehicle.

- Ensure that there is no leakage of brake fluid from the pistons. If there is leakage (G 2.04).
- Have the pistons **(3)** retreat into the caliper, using a specific tool **(B)** like the one shown in the figure.





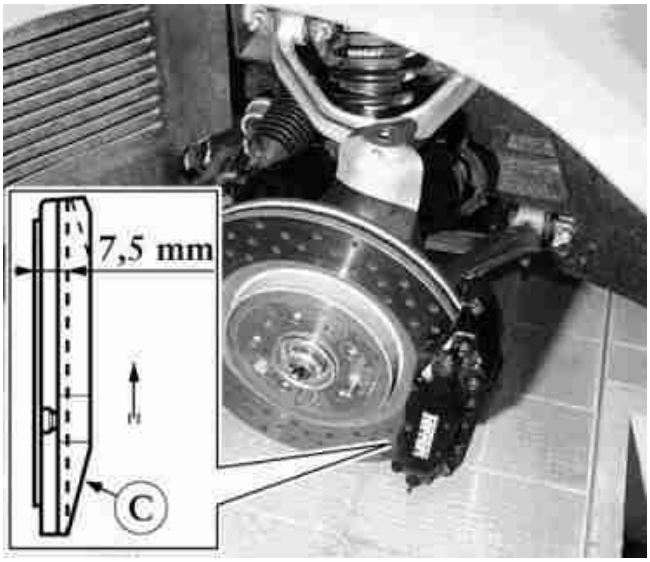
IMPORTANT

Do not use metal tools (pliers, screwdrivers, etc.) for this procedure as they could damage the piston gaskets inside the caliper.

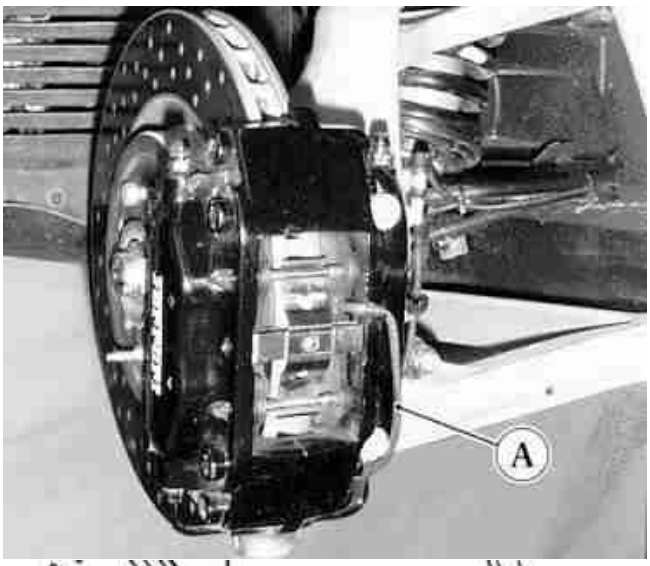
- Fit the new pads, putting the one with the wear indicator cable on the inner face of the disc.

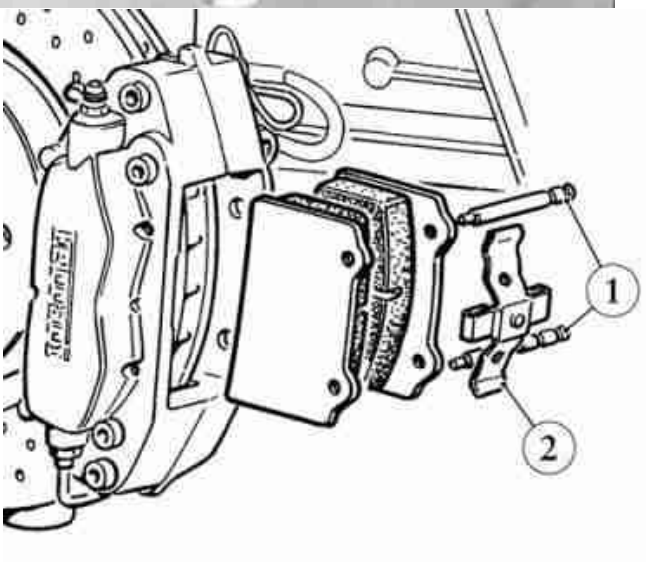
NOTES

*There is a bevel **(C)** on the friction material in the brake pads. It must always be facing towards the direction of disc rotation.*


7,5 mm
C

- Connect the pad wear indicator cable **(A)** and re-install the spring clip **(2)** and the two pins **(1)**.





- Activate the brake pedal several times to allow the pistons to set and check the level of the fluid in the tank (A 3.18).
- After this procedure, it is always best to drain the system (G 3.02).
- Perform the break-in procedure for the new pads, as described below.

Replacing Rear Brake Pads

NOTES

The procedure for replacing the rear brake pads is the same as that described for the front brake, the only difference being that there is no pad with a wear indicator cable.

Breaking in the New Brake Pads

In order to increase the grip of the pads coupled with the brake discs, after replacing the pads only or the brake disc-pads assembly, and also to maintain steady braking performance for the entire duration of the brake pads, it is necessary to stick to the following procedures:

- Sand the brake discs with fine sand paper (do not perform this procedure on new discs).
- Clean the surface of the brake discs with trichlorethylene or another greaseless detergent.
- Avoid sudden or too strong braking as long as the new pads have not been properly broken in (**80÷100 Km** driving).

Once the pads have been broken in, if there is unusual noise when braking, it may be useful to disassemble them and use a scraper to remove any traces of metal deposits that may be stuck on the braking surfaces.

A3.22 CHECKING OPERATION OF THE SERVICE/PARKING BRAKES AND CONTROL CLEARANCE

- Check the brake pedal stroke and for proper operation of the **STOP** lights switch (G 3.06).
- Test drive the car on the road to check braking efficiency.
- Check to ensure proper operation of the hand-operated lever and also check the state of the parking brake system cables (G 3.05).

A3.23 CHECKING THE THE SUSPENSION PARTS

- Test drive the car on the road to check the shock absorption of the car and for any noise from the suspension parts.
- Remove the wheels and check the tightness of the suspension components (F1.02).
- Ensure that the protective casings are intact and that there is clearance of the ball joints on the stub axle and on the rear hub carrier (F2.04).
- Ensure that there is clearance of the bushings at the lever fastening point and of the shock absorbers on the chassis (F2.04).
- Ensure that the levers are not deformed and show no signs of breakage.
- Check the state of the upper rebound stop pads for the suspension on the shock absorbers (F2.05).
- Check the alignment of the front and rear stabilizing rods, as well as the state of the rubber supports and the tie rod ball joints.

A3.24 CHECKING CAR ALIGNMENT

For a proper check of the alignment values, it is necessary to carry out the following procedure beforehand:

- Ensure that tire pressure is correct (F 1.01).
- Check steerage and transmission parts.
- Ensure that there is no clearance between the ball joint tie rod in the steering box and the stub axle and between the ball joint tie rod and the rear hub carrier.
- Ensure that the protective bellows on the steering box tie rods and on the toe-in and axle shafts are all intact.
- Ensure that the suspension parts (A 3.23) are all in perfect working order.
- Check alignment data (F 3.05).

A3.25 INSPECTING THE AIR TEMPERATURE CONTROL SYSTEM

- Remove the underfloor components (M 2.12) and the rear bulkhead in the luggage compartment (_____).
- Check for gas leaks from the unions on the connecting pipes to the condenser, the dehydrator filter, the evaporator and the compressor on the left-hand side of the engine oil sump.
- Ensure that there are no gas leaks from the system hose lines.

- Ensure that there are no coolant leaks from the blow-by pump, the evaporator, the sub-platform* pipe and the water pump (I 1.01).

IMPORTANT

The gas coolant (I 3.01)*.and the dehydrator filter (*I 2.03*) must changed every 2 years.*

A3.26 LUBRICATING AND CHECKING HINGES REGISTERS

- Ensure that the door and the engine and luggage compartment hinges are fastened properly, without clearance and are not noisy when in use (see Section **M 2**).
- Ensure that the door locks and the engine and luggage compartment closure mechanisms are working properly.
- Check the condition of the opening control cables for the engine and luggage compartments and fuel tank flap.
- Ensure that the gas springs for the engine and luggage compartment opening system are in good working order.
- Lubricate all the surfaces subject to friction with protective, water-repellent lithium grease.

A3.27 CHECKING THE FASTENING AND OPERATION OF SEATS AND BELTS

- Ensure that the mechanically-controlled movement of the seats is linear, without obstruction or requiring excessive effort, for the entire length of travel.
- Using the specific switches, ensure that the electrically-controlled movement of the seats takes place freely, without obstruction, for the entire length of travel.
- Ensure that the seat guides are properly fastened to the platform* supports (M3.03).
- Lubricate the guide joints and sliding surfaces with protective, water-repellent lithium grease.
- Ensure that the safety belt anchor screws are tightly locked (M3.03).

A3.28 CHECKING AND RECHARGING THE BATTERY

Battery

Make **FIAMM**
Type **ECO FORCE VR760** (Airtight, recombination type)
Specifications **12V-760A EN -450A IEC-115RC**

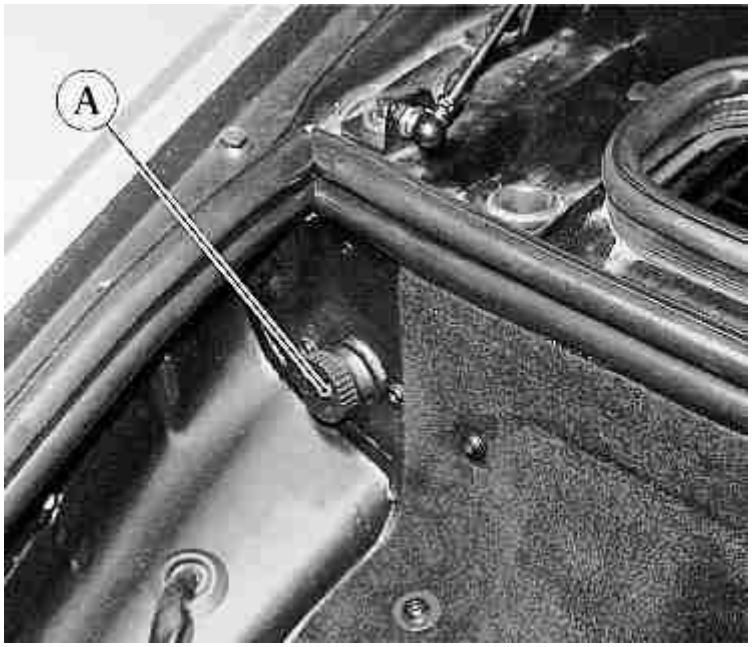
Required Equipment

FERRARI battery charger or battery charger (stabilized)

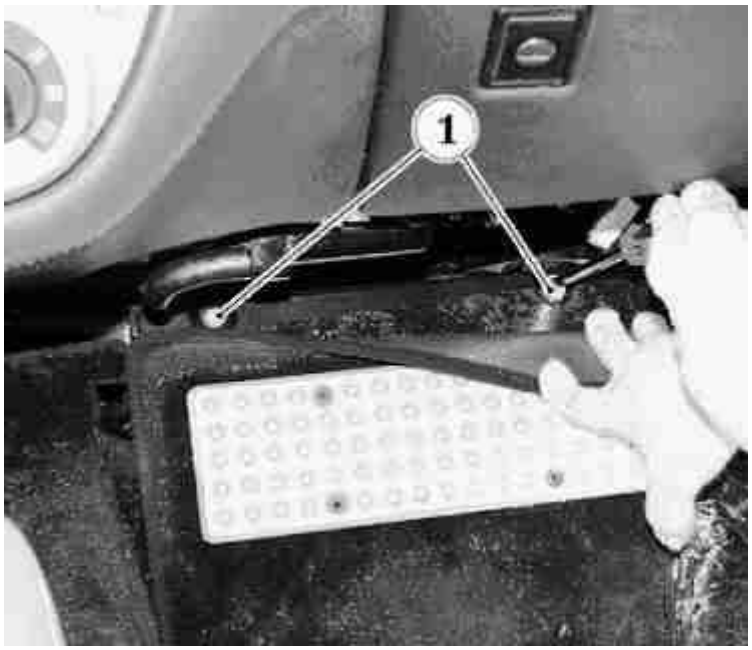
The conditions and charge of the battery must be checked at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN".

N.B.
If the car has a Ferrari battery charger socket, it is not necessary to work on the battery in order to effect a recharging (L 3.03).

To gain access to the battery, proceed as follows:
- Rotate the battery master switch **(A)**, found on the right side of the luggage compartment, to the **"OFF"** position (L 2.02).



- Remove the mat on the passenger side.
- Unscrew the two screws **(1)** fastening the passenger footrest to the chassis.
- Remove the footrest, sliding it out from the lower locks.



- Free the battery from the fastening bracket, unscrewing the two wing nuts **(2)**.

- Ensure that the cable-heads and the terminals are perfectly clean and well-fastened.
- Visually inspect the outer surface for any cracks.
- Detach the cable-heads from the battery poles and remove the left-hand side breather pipe.
- Remove the battery from the car.

NOTES

*To start up the car with a discharged battery, an auxiliary battery an/or a stabilized battery charger must be connected to the onboard battery poles, **without utilizing the battery master switch**.*

Recharging the Battery

When in doubt or if there are signs of battery inefficiency, the battery charge must be checked (L 3.02) and/or check the absorption of the electrical system (A 3.29 and L 3.01).

- Connect the recharging equipment cables to the battery poles.

CAUTION

The battery recharging procedure should be carried out in a well-ventilated area and away from sources of heat and/or flames.

- Turn the device on and recharge. For recharging times, see (L 3.03).
- When recharging has been completed, re-position the battery in its seat, fastening it with the specific bracket and reconnecting the breather pipe.

IMPORTANT

Check the breather pipe for excessive bends or blockages which could raise the pressure in the battery and damage it.

- Apply water-repellent lubricant on the cable terminals of the electric system and re-connect them to the battery poles.
- Re-position the passenger footrest.
- Tighten the terminal screws firmly.
- Re-position the battery master switch on the **"ON"** position.

NOTES

*If the car is not used for prolonged periods of time, recharge the battery at least **every 3 months**, after having first removed the battery.*

*If instead one wishes to leave the battery connected to the electrical system, for the purpose of keeping some services in operation (car radio stations stored in the memory, the alarm system, etc.), recharge the battery at least **once each month**.*

Resetting the Self-adapting Parameters

Each time the battery is detached, all of the self-detected parameters are deleted from the ignition/injection control unit.

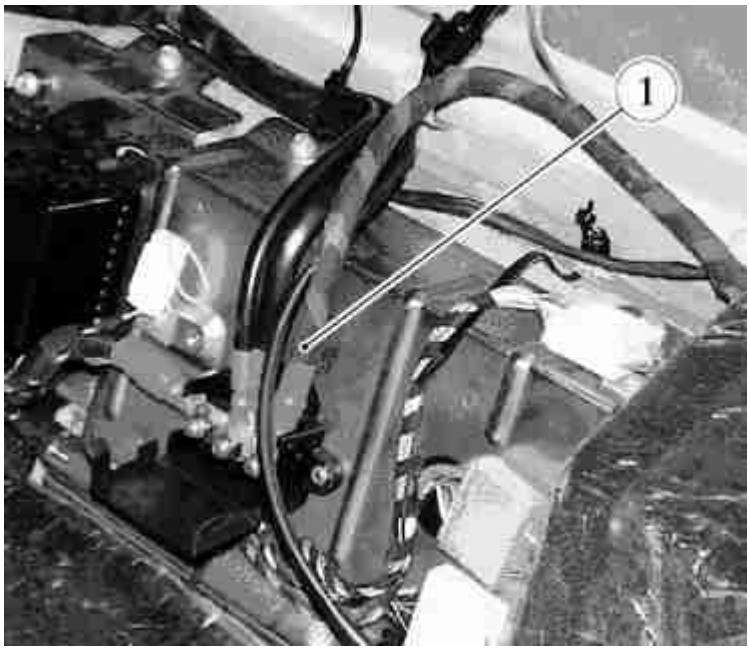
In these cases, they must be reset, before using the car again, as specified below.

- The car must be left running for about **10** minutes under the following conditions:
  - car stopped with the engine idling;
  - water temperature steady;
  - equipment* switched off (lights, windscreen wipers, etc..);
  - conditioner switched off.

This procedure enables the control unit to optimize the self-adapting parameters rapidly, avoiding the engine to work incorrectly.

A3.29 CHECKING ABSORPTION AND RE-CHARGING THE ALTERNATOR

- Remove the left-hand control-unit covering, found behind the driver's seat (M 3.04) and the footrest on the passenger side, for access to the battery (A 3.28).
- Detach the positive alternator cable **(1)** from the terminal board and connect a **Beckman T11 OB** type digital multimeter, between the cable and the terminal board. The multimeter should be suitably calibrated.



- In order to check the voltage and the intensity of the maximum current supplied by the alternator it is advisable to use a digital multimeter and a HALL-effect snp-on ammeter .
- Fit the snap-on ammeter onto the cable **(1)** connected to the alternator.
- Start the engine and keep it running at **3000÷4000 rpm**.
- Switch on all of the devices available, one at a time, and read the intensity value of the supplied current on the multimeter. If the current intensity is more than **5A** below the prescribed value (L 3.03) replace the alternator (L 2.03).
- To check the voltage (L 3.02).

A3.30 CHECKING THE STATE OF THE BOX-TYPE COMPONENTS AND THE CHASSIS

• Check to ensure that the chassis units, the box-type components and the outer sheets are intact. Check for any deformation or breakage and have them repaired.

IMPORTANT

The car chassis, the box-type components and the outer sheets are made of aluminum. Any repairs and/or replacement of parts of the chassis or the body parts must be carried out by skilled experts with the necessary equipment.

A3.31 CHECKING WHEELS AND TIRES

- After removing the wheels, ensure that the rims and tires are intact.
- Ensure that the tire pressure matches the pressure prescribed (F 1.01).
- Check the positioning and fastening of the adhesive balance weights on the inner face of the wheel rim.
- In the event of unusual wear of the tires, check the alignment data (F 3.05) and carry out static and dynamic balancing of the wheels (F 3.07).

A3.32 AIRBAG REPLACEMENT

Every ten years it is necessary to replace the driver and passenger side Airbag modules.
The expiry date for the installed modules is reported on the plate on the inside of the passenger side sun-visor (0 4.04).

- To replace (H 3.02).

A3.33 LEATHER INTERIOR TREATMENT

A suitable periodical treatment, at least 3-4 times a year, means that the quality, the natural characteristics and the softness of the leather seats remains unaltered over time.
This is why Ferrari has created and tested specific ("**Cleaner**" and "**Cream**") products for treating leather.
These products can be ordered through the FERRARI SPARE PARTS SERVICE, both individually or as part of the "**CARE KIT**" which contains the complete range of car cleaning products.

NOTES

*For instructions on how to use "**CARE KIT**" see the "USER'S MANUAL, "CARROZZERIA SCAGLIETTI" PROGRAMME and the instructions contained in the KIT.*

Do no use acids, turpentine, liquid stain removers, petrol, solvents or household cleaning products, as these damage the natural material.

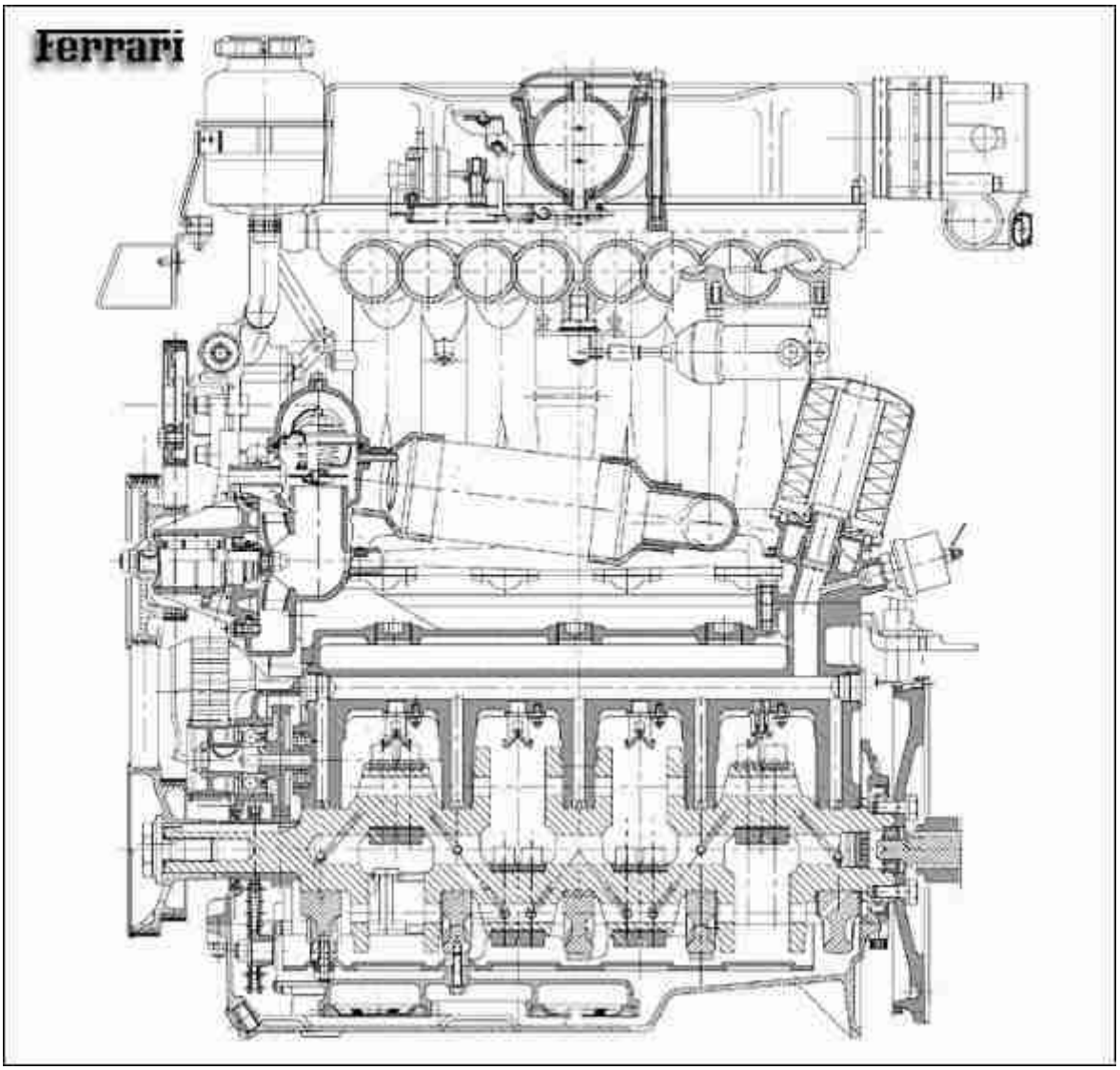
B1.01 TECHNICAL FEATURES

Engine: Main Specifications

Type **F 131 B**
Cylinders **8 - V 90°**
Cylinder bore **85 mm**
Piston stroke **79 mm**
Piston displacement **448,285 cm^3**
Total displacement **3586,2 cm^3**
Compression ratio **11 ± 0,2 : 1**
Max. power (EEC Dir. 88/195) **294 kw**
Corresponding engine speed **8500 min^{-1}**
Specific power **81,98 kw/h**
Max. torque (EEC Dir. 88/195) **373 Nm**
Corresponding engine speed **4750 min^{-1}**

Engine features

- Cylinder heads made of heat-treated aluminium and silicon alloy with high volumetric and thermodynamic yield combustion chamber.
- Crankcase made of heat-treated aluminium and silicon alloy, with steel inserted cylinder liners.
- Enblock, hardened and tempered steel crankshaft, individually balanced, mounted on five journals, equipped with bearings.
- The engine is equipped with a **Bosch ME7.3** integrated injection-ignition system (see Section **C**).
- The timing system includes four overhead camshafts (two per bank) and five valves per cylinder, controlled by self-adjusting hydraulic buckets.
- The exhaust camshafts are equipped with a timing variator, controlled by the injection ECU by means of a solenoid valve. This system makes it possible to change the timing of the exhaust valves according to the different engine utilisation conditions.
- The variable setting intake system consists of two chambers. These are located on the engine and are linked to the underlying cylinder set by means of both short, vertical ducts and longer ones, connected to the opposite bank. The variation is controlled by means of two sets of throttle valves activated by an electro-pneumatic actuator in accordance with the signal given by the ECUs. A large throttle valve positioned between the chambers activates or cuts out the connection between the chambers themselves. Said valve is, in turn, activated by another electro-pneumatic actuator.
- The timing system is controlled by two toothed belts, the tension of which is adjusted by hydraulic tighteners.
- The engine lubrication system is of the dry-sump type with a scavenging pump and a delivery pump, both of which are controlled by a chain driven by the crankshaft.
- The engine is cooled by means of circulation of an anti-freeze mixture. The system is equipped with a centrifugal pump, with a thermostat. The pump is controlled by a belt which is driven by the crankshaft and which also activates the alternator.
- The engine assembly is also fitted with the air conditioning compressor- controlled by a belt driven by the crankshaft - and the power steering pump, which is driven by the water, pump pulley.


Ferrari

B1.02 SPECIFIC EQUIPMENTEQUIPMENT

Code	*Tool No.*	*Description*
95970135	**FST-50**	Staeger tensiometer
95978151	**SEEM Diapaz**	Belt tension control tool
95972060	**TLDF02060**	Plug gauge for small end bushing
95970211	**AM 105784/9**	Hub
95970713	**TLDF00713**	Go-no-go feeler gauge, **Ø 7 mm**
95974488	**CS104488**	Dial indicator tool for TDC checking
95971243	**BOSCH**	Pressure gauge complete with **Bosch KDJE-P-P100**
95971560	**USAG D.156**	Wrench for oil filter
95971655	**AV 1655**	Punch for fitting seal rings on camshaft and on rear crankcase cover
95972023	**AV 2023**	Stand for engine and gearbox overhaul (**1**)
95972621	**AV 2621**	Stand for engine and gearbox overhaul (**2**)
95972032	**AV 2032**	Punch for inserting bearing on crankshaft
95972133	**AV 2133**	Punch for tapered, aluminium plugs
95972612	**AV 2612**	Punch for fitting seal ring on rear crankcase cover
95972687	**AV 2687**	Flexible hose to check fuel pressure
95972947	**AV 2947**	Punch for fitting non-return valve on heads
95972905	**AV 2905**	Support for box wrench
95972906	**AV 2906**	Box wrench
95973002	**AV 3002**	Tool for fitting gudgeon pin stop rings
95973122	**AV 3122**	Crankshaft locking tool for damper assembly

y

Code	*Tool No.*	*Description*
95973039	**AV 3039**	Tool for fitting seal ring on front crankshaft cover
95973011	**AV 3011**	Tool for fitting seal ring on rear crankshaft cover
95975784	**AM 105784**	Engine timing goniometer
95972970	**AV 2970**	Setting dial for goniometer
95972968	**AV 2968**	Goniometer control lever
95973141	**AV 3141**	Reference index for goniometer
95975165	**AM 105165**	Complete goniometer
95970152	**ALZF08501**	**Ø 85** gauge for cylinder liner
95973135	**AV 3135**	(Engine and timing system) crankshaft and camshaft support tool for eccentricity check
95973131	**AV 3131**	Tool for timing system variator or bushing assembly or disassembly on the camshaft
95972938	**AV 2938**	Tool for positioning timing belt-tensioner pulley

3)

95972595	**AV 2595**	Spanner for tightening nuts with cylinder heads
95977148	**CS 7148**	Dial gauge holder for checking the wear of the valve seats
95972714	**AV 2714**	Extractor for front crankcase cover
95976768	**CS 6768**	Gauge
95972734	**AV 2734**	Extracting tool for seal ring on valve guide
95972926	**AV 2926**	Extracting tool for valve guide
95976141	**AS106141**	Valve guide punch **Ø 6mm**
95973101	**AV 3101**	Punch bushing (valve guide fitting)
95976108	**TLDF006108**	Punch gauge **Ø 6 mm**
95971854		Spanner for tightening fuel tank ringnut
95973417	**AV 3417**	Camshaft locking tool
95973420	**AV 3420**	Pliers for camshaft (exhaust side)
95973421	**AV 3421**	Pliers for camshaft (intake side)
95973422	**AV 3422**	Fastening plate for camshaft pliers
95973423	**AV 3423**	Outer ring on camshaft pliers (exhaust side)

Code	*Tool No.*	*Description*
95973424	**AV 3424**	Outer ring on camshaft pliers (intake side)

(Until supply lasts
(Following depletion of supplies of **95972023**
(This tool is also used for fitting the bearing onto the **F50** model gearbox's main shaft

Tools on the market for engine overhaul

Item	*Description*
SPS-UNBRACO Model Sensor 1 - 125 FLT-B	Wrench for tightening torque/angle
BLM 2360 P	Goniometer for angular tightening, with pliers fastening
LTF 245.00/01	Bore meter for checking wear on hydraulic bucket seats and camshaft seats
LTF 245.00/02	Bore meter for wear check on cylinder liners, connecting-rod bearings and crankshaft journals, and timing variator/bushing seat
ABC 3255/1	Tool for inserting piston in the cylinder liner
BERCO CM 130	Tool for checking valve springs
GOVONI S.M.V. mod. 263	Pneumatic tool for valve assembly and disassembly
WALTER 2393/100	Torque wrench **20÷100 Nm**
WALTER 2393/220	Torque wrench **60÷220 Nm**
LTF 279.00/11	Flat surface
ABC 4483/1	Dial gauge
ABC 4502/4	Dial gauge support
BINDA PI 25	Hydraulic pump
ZECA art. 209	Valve lapping machine
FACOM art. U.23	Extractor for built-in bearings
PEG 8 Special FERRARI	Eccentric grinder for valve seats

B1.03 TIGHTENING TORQUES

NOTES

To help the technical personnel carry out a complete engine overhaul, this paragraph also indicates the tightening torques relating to components which are mounted on the engine, but whose description is contained in other Chapters of this manual.

To check the tolerances in relation to the tightening category (02.05).

Description	*Thread - mm*	*Torque - Nm*
Tightening of cylinder head (pre-tightening to **60Nm**): **MIN** torque + **MIN** angle **MAX** torque + **MAX** angle	**M 11 x 1**	(6) **60 + 24°** (**A**) **90 + 76°** (**A**)
Tightening of crankshaft caps (pre-tightening to **40 Nm**)	**M 12 x 1,5**	**80** (**A**) **5**) (B 3.06)
Tightening of camshaft caps and timing variator supports	**M 6 x 1,25**	**8,8** (**A**)
Spark plug	**M 10 x 1**	**10** (**A**) (**1**)
Tightening of driven timing pulley	**M 6**	**23** (**B**) (**2**)
Tightening of crankshaft pulley	**M 18 x 1,5**	**196** (**A**) (**2**)
Tightening of flywheel to crankshaft	**M 10 x 1,25**	**91** (**A**)
Tightening of ring nut for timing control gear	**M 17 x 1**	**118** (**B**)
Tightening of union for nozzle-holders for piston cooling	**M 5 x 0,8**	**5** (**B**)
Tightening of alternator upper mounting	**M 10 x 1,25**	**59** (**B**)
Tightening of belt-tensioner bracket	**M 10 x 1,25**	**49** (**B**)
Tightening of belt tensioner to bracket	**M 10 x 1,25**	**49** (**B**)
Tightening of water temperature unit	**M 16 x 1,5**	**25**
Tightening of pump impeller	**M 8 x 1**	**25**
Tightening of water temperature NTC sensor	**M 12 x 1,5**	**16** (**B**)
Tightening of water pump body to crankcase	**M 8 x 1,25**	**25** (**B**)
Tightening of oil pump control gear	**M 12 x 1,5**	**65** (**B**)
Fastening securing suction screen to oil pump	**M 6 x 1**	**4.9** (**A**)
Tightening of timing variator and variator bushing	**M 18 x 1,5 Sx**	**157** (**A**)
Tightening of timing variator support	**M 8 x 1**	**22** (**A**)
Tightening of control solenoid valve for variable valve timing	**M 24 x 1,5**	**43** (**A**) (**2**)
Tightening of the oil filter cartridge	**1" 12 UNF 2B**	**25** (**B**) (**3**)
Tightening of cylindrical threaded plug for oil channels	**M 22 x 1,5**	**75** (**B**)
Nut fastening cylinder head cover	**M 6**	**10** (**B**)
Fastening securing unions on oil exchanger	**M 16 x 1,5**	**49** (**B**)
Nut fastening rear cover	**M 6**	**10** (**B**)
Tightening of union for oil hose from engine to the radiator	**M 26 x 1,5**	**68** (**B**)
Fastening securing belt cover guard to front cover, compressor and cylinder head supporting bracket	**M 6**	**10** (**B**)
Tightening of mounting bracket to the engine	**M 10 x 1,25**	**53** (**A**)
Tightening of engine mounting pad to chassis plate	**M 10 x 1,25**	**50** (**B**)
Tightening of engine mounting pad	**M 16 x 1,5**	**98** (**B**)
Fastening of engine-chassis stranded earth wire	**M 8 x 1**	**15**
Tightening of cable from alternator to starter motor	**M 8 x 1,25**	**14** (**C**)
Tightening of pipes from engine to radiator and from radiator to blow-by system	**M 30 x 1,5**	**78** (**B**)
Tightening of electric oil pressure unit	**M 18 x 1,5**	**25** (**B**)
Fastening for engine oil thermistore	**M 16 x 1,5**	**25** (**B**) (**4**)
Tightening of thermocouple for exhaust system	**M 10 x 1**	**10** (**B**)
Tightening of oxygen sensor	**M 18 x 1,5**	**50** (**B**)

Tightening of union on the oil filter cartridge mounting	**M 25 x 1,5**	**75** (**B**)
Fastening securing cap on oil pipe from engine to radiator	**M 32 x 1**	**78** (**B**)
Tightening of plug for water drainage on crankcase	**M 14 x 1,5**	**16** (**B**)
Thermometric switch	**M 22 x 1,5**	**39** (**B**)

4)

Fastening ring nut for fuel pump unit **60** (**B**)

(**B**)

(**1**) Lubricate with **CHAMPION 2612**
(**2**) Apply **AREXON 4706 SYSTEM 52 A 43**
(**3**) Lubricate gasket with **engine oil**
(**4**) Apply **AREXON 4740 SYSTEM 56 A 38**
(**5**) Lubricate with **MOLYKOTE 1000**
(**6**) Lubricate with **MOLYKOTE BR2**

B2.01 DISASSEMBLY

This paragraph describes the procedure for disassembling the entire engine -gearbox assembly from the car. This procedure is required in case of overhauls or complete engine replacement, or in case of repair work that cannot be performed with the engine assembled on the car or through the inspection lid.
It is possible to remove only the gearbox from the engine compartment in the case of major repairs or complete replacement (D2.01).

NOTES
The procedure and the figures illustrate the disassembly of an engine-mechanical gearbox unit. The procedure relating to the electronically-controlled gearbox only differs in that the Power Unit must be detached and then secured to the engine, to prevent it interfere during the lifting procedure (D 2.01).

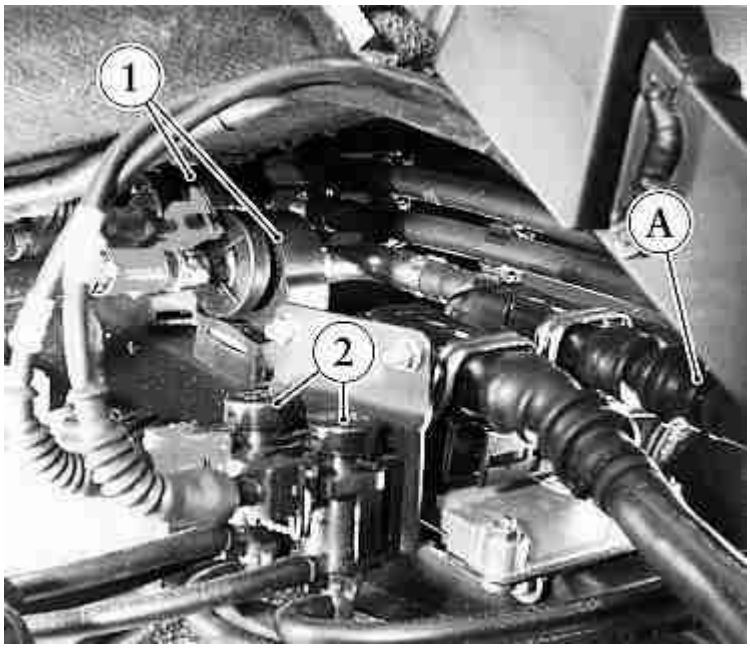
Preliminary Procedures

The engine-gearbox unit must be lifted out of the engine compartment. Therefore, a travelling, hydraulic lifting device or bridge crane is needed to perform this procedure. The lifting device must have a minimum capacity of **300 kg** and two safety slings measuring **2.5 m** in length used to sling the unit.

IMPORTANT
Use suitable means to protect all painted surfaces of the body and the interior upholstery.

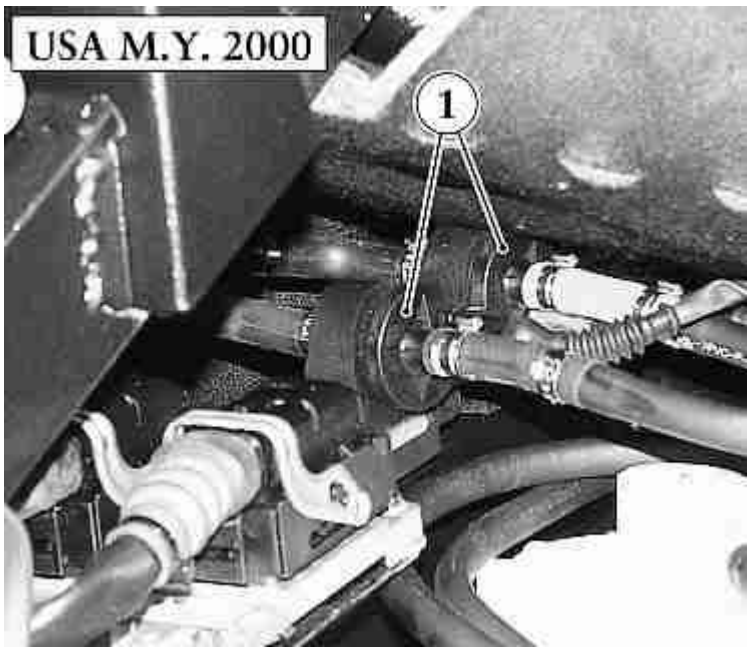
- Disconnect electrical power supplied by the battery (L 2.02).
- Drain the engine oil (_____).
- Drain the cooling system (B 5.04).
- Drain the air-conditioning system (I 3.01).
- Drain the power steering system (E2.01).
- Remove:
  - the engine compartment boot (M 2.01);
  - the protective side shields from the engine compartment (M 2.13);
  - the rear part of the underfloor (M 2.12);
  - the rear bumper (M 2.04);
  - the rear upholstery (M 2.15);
  - the rear wheels (F 3.06);
  - the rear wheelhouses (M 2.05);
  - the engine inspection lid (M 3.05);
  - the coolant expansion tank (B 5.05);
  - the air intake (B 7.03);
  - the air flow meters (C 2.03) with motor-driven throttle bodies (B 6.08);
  - the exhaust silencer with support and terminals (B 7.07);
  - the gearbox support frame (D 4.04);
  - the catalytic converters (B 7.06);
  - the exhaust manifolds (B 7.08);
  - the coils (C 3.03);
  - the timing sensors from the head caps (C 2.01).

- Remove the axle shafts from the gearbox (D 5.02).
- Detach the gearbox control Bowden cables and the clutch pipe from the gearbox block and from the oil sump supporting bracket (mechanical gearbox) or the Power Unit (D6.06) (electronically-controlled gearbox) then detach the lower connecting rod from the gearbox housing (D2.01).
- Detach the oil hoses from the blow-by system and from the stiff pipe on the engine (B 4.04).
- Detach the blow-by system pipes and remove the complete blow-by system (B 4.03).
- Detach the A.C. pipe union from the compressor (I2.01).
- Disconnect the following cables:
  - the injection cables **(A)** of each bank from the MOTRONIC control units (C 5.01), from the connection with the engine compartment cables, from the earth terminals on the chassis, from the exhaust by-pass control solenoid valves and from the front and rear oxygen sensors;
  - the right-hand bank injection cable from the solenoid valves **(1)** of the anti-evaporative emission system and from the solenoid valves **(2)** of the actuating system.

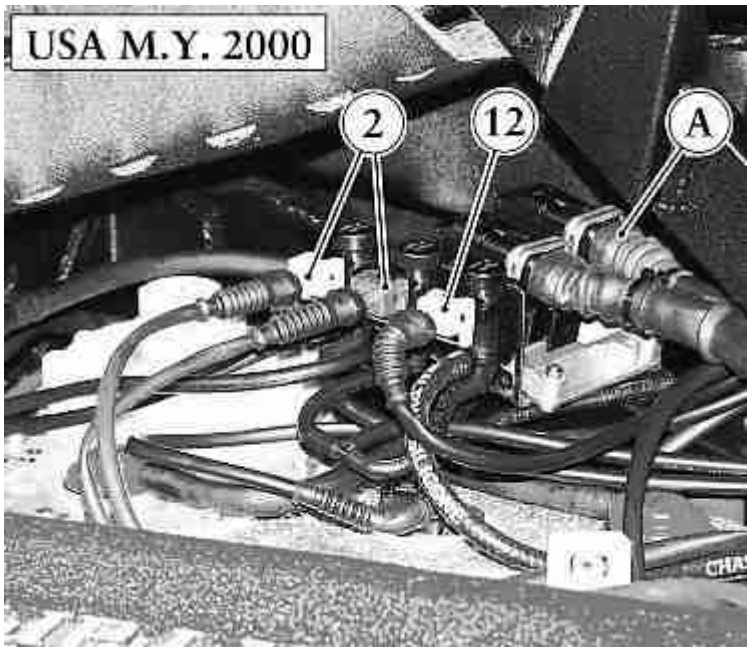


Note for the US M.Y. 2000 version

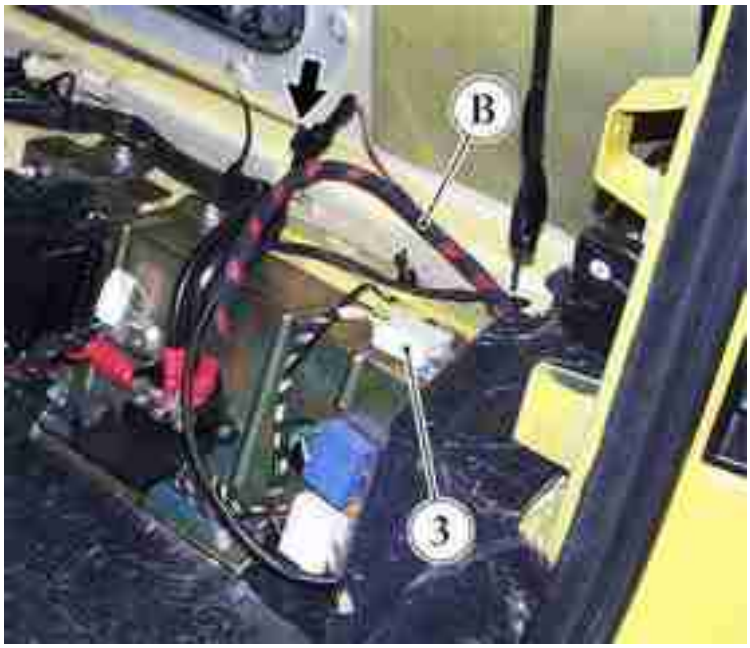
In this version the solenoid valves **(1)** for the anti-evaporation system are positioned on the left-hand side of the engine compartment and are connected to the injection harness **(A)** for the left-hand side bank. The interception valve, positioned in front of the charcoal filter, is also connected to this cable.



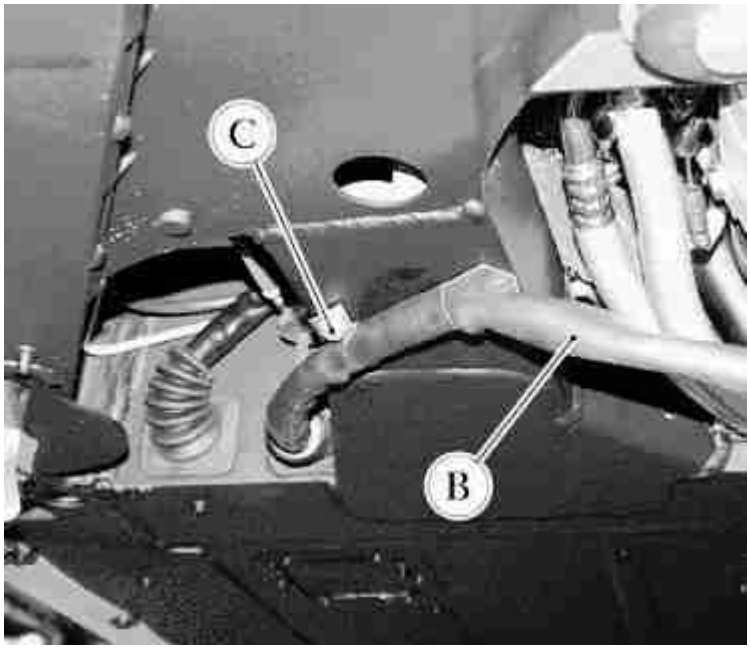
Furthermore, the solenoid valve **(12)** for the secondary air control, fitted near the actuating system's two solenoid valves **(2),** must be disconnected from the right-hand side bank.



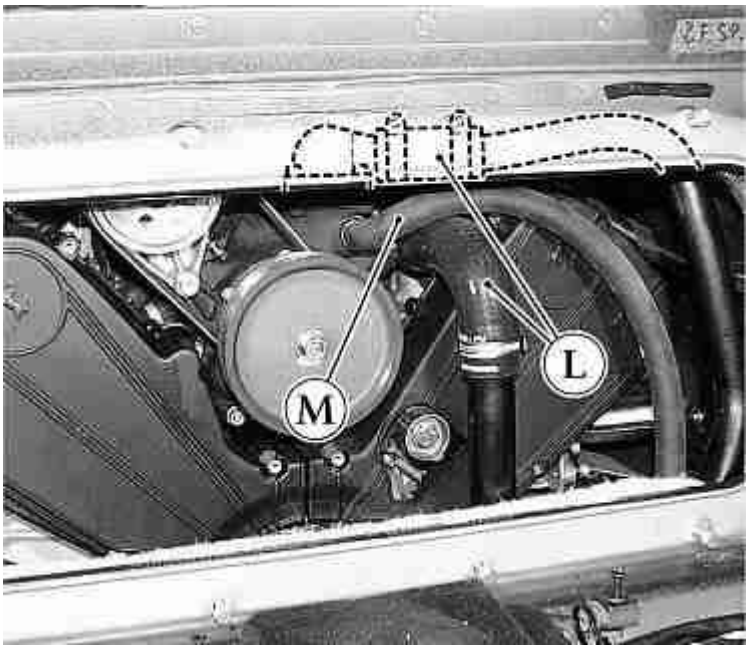
- Working from the passenger compartment, detach the engine services wiring loom cable **(B)** from the terminal board and from the connector **(3)** for the left-hand tunnel system connectors; also remove the charge indicator connector.



- Working from underneath the car, slide the engine services wiring loom cable **(B)** out of the core hitch and detach the supporting bracket **(C)** from the chassis.



- Gather the injection and engine services wiring looms, then position them on the engine so that they do not get in the way of the removal procedures.
- Detach the following pipes:
  - the pipes for the engine cooling (**L**) and heating (**M**) system from the water pump;

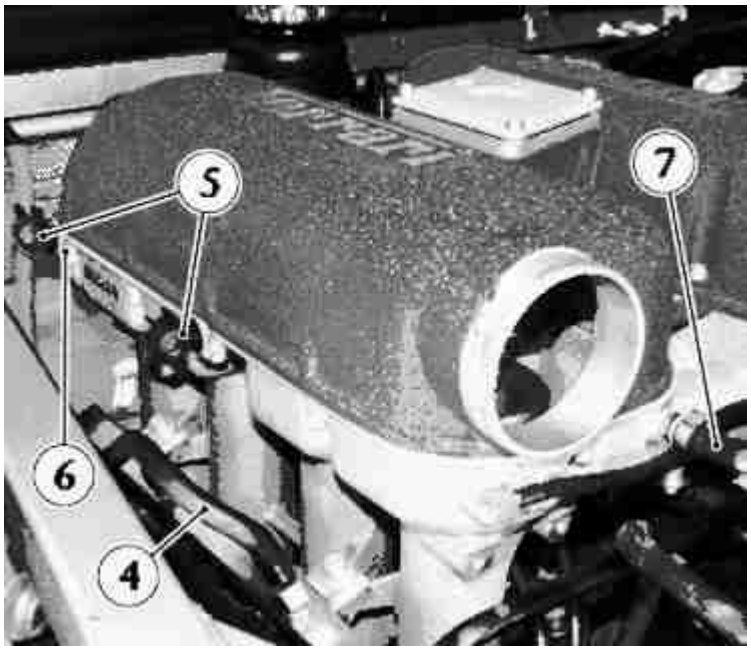


  - detach the radiator draining pipe from the engine, leaving it on the bodywork;
  - the fuel supply system pipes **(4)** from the injector rails and from the small support brackets **(5)** on the intake manifold;
  - the anti-evaporative emission system pipes from the solenoid valves **(1)**;
  - the solenoid valve pipes **(2)** for the actuating system from the front part of the intake manifold;
  - the pipe connecting the tank and the power steering pump;

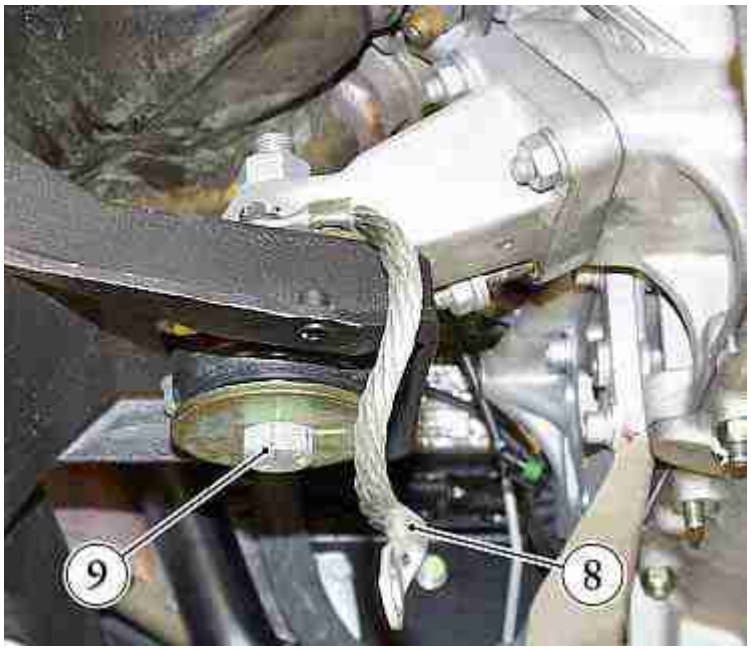
NOTES

*It is advisable detach the power steering tank from its support and the front brackets **(6)** supporting the fuel pipe on the intake manifold, in order to prevent damaging them during the slinging phase or when lifting the engine.*

- the pipes **(7)** connecting the empty reservoir from the intake manifold;
- the servo brake stiff pipe from the pipe on the right-hand side of the intake manifold.

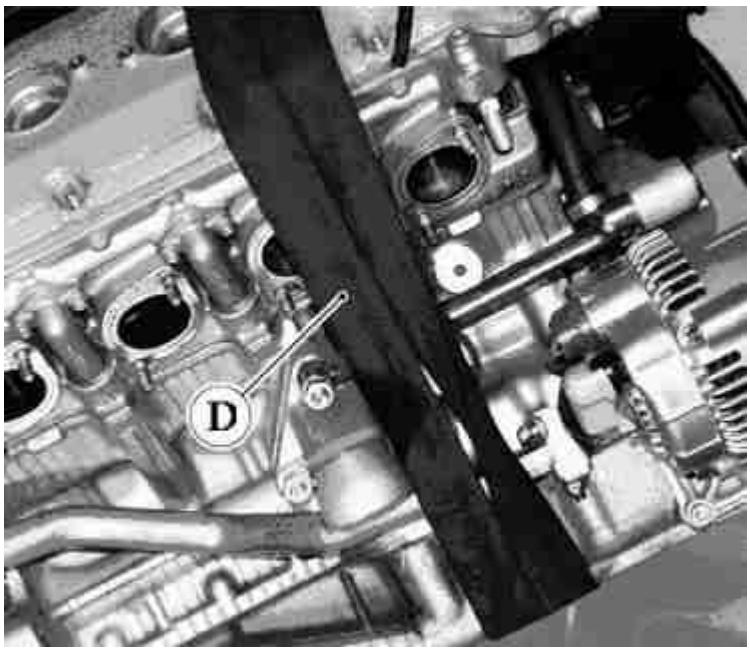


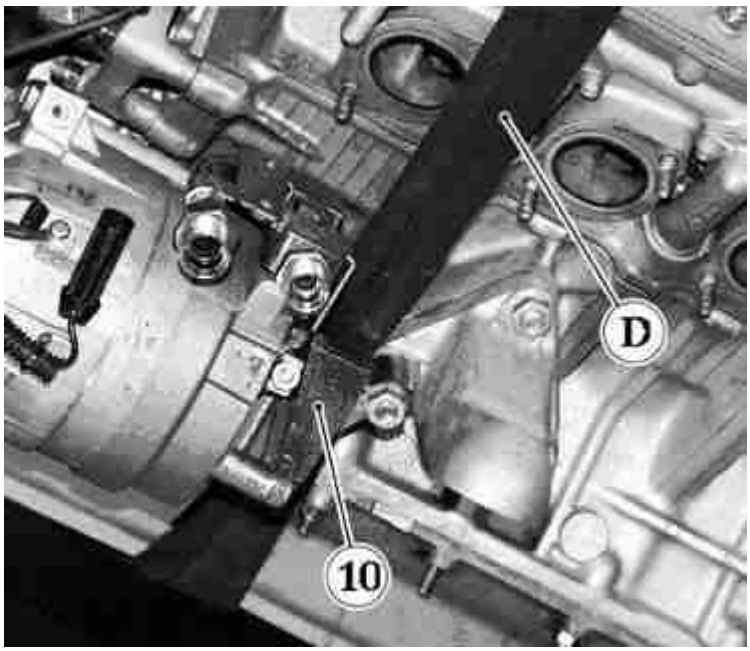
- Detach the ground cable **(8)** from the fastening point on the engine.
- Unscrew the screw **(9)** fastening the engine mounting brackets to the chassis.



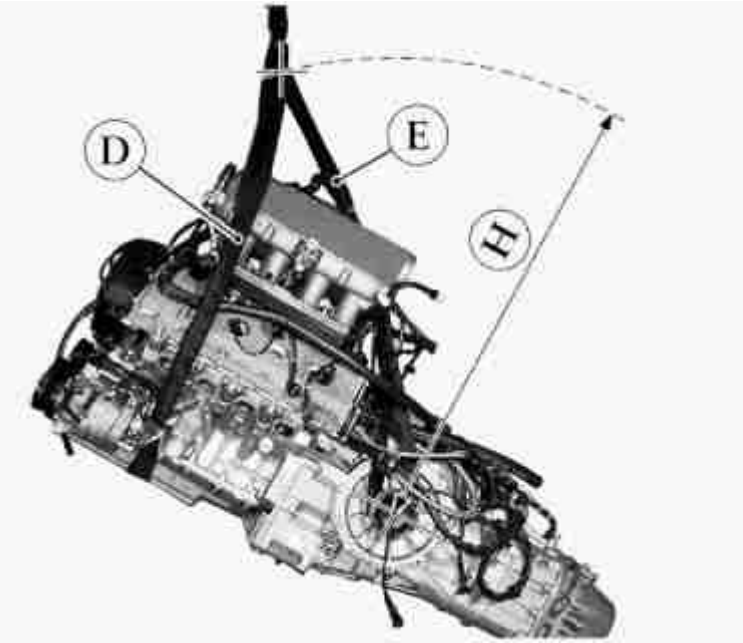
Lifting

- Insert one end of the front sling **(D)** into the lifting hook and pass it between the mounting bracket and the alternator on the right-hand side, and between the compressor support **(10)** and the crankcase on the left-hand side.





- Pass the rear sling **(E)** under the attachment flanges for the axle shafts and wrap it around itself until the height **(H)** of about **113÷115 cm** is reached.

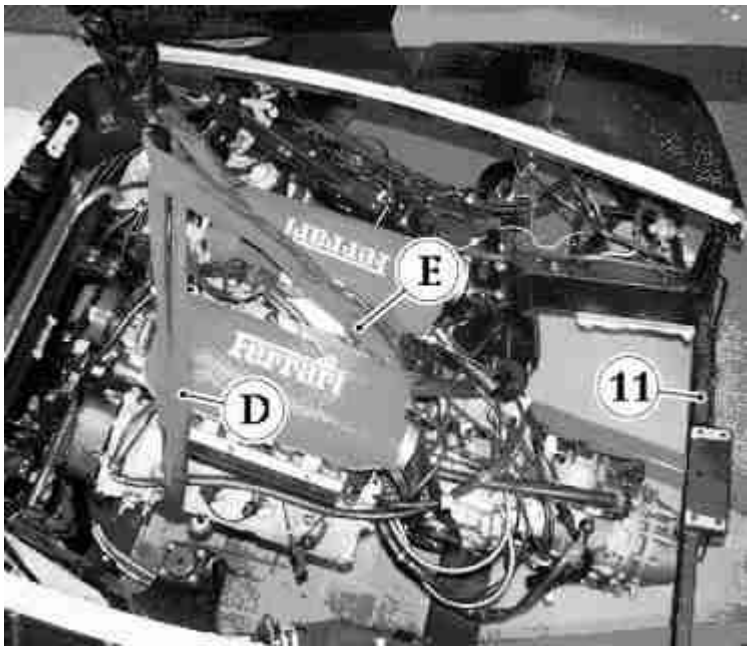


- Fasten the sling ends on the lift hook securely.

CAUTION

The positioning of the slings as described above is of essential importance for working under safe conditions and to obtain the best tilting of the engine-gearbox unit, to permit it to be lifted and removed from the engine compartment.

- Lift the front part of the engine until the rear sling **(E)** is tensioned tightly.
- Move the unit to the rear until flush with the small rear chassis small cross element **(11)** and then lift it slowly, ensuring that it does not touch the edge of the roof panel.



- Position the unit on a suitable support.

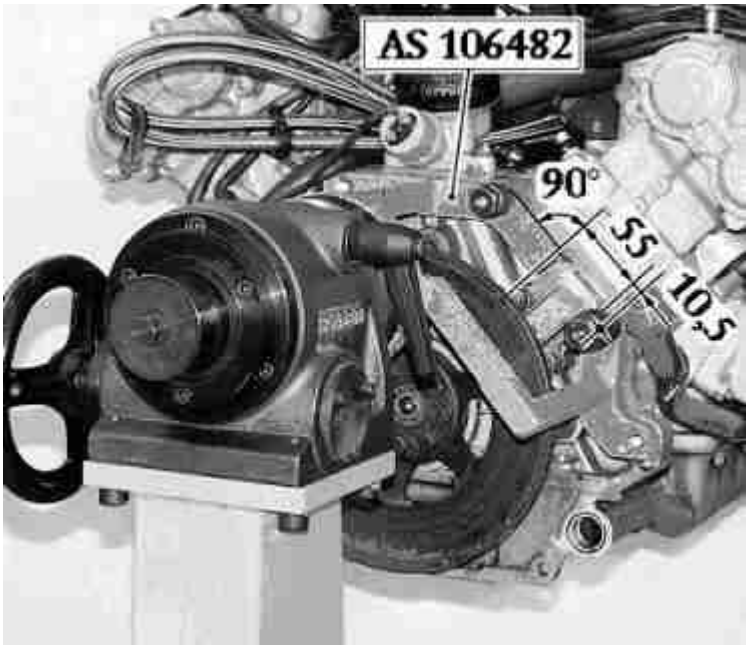
NOTES

See Paragraph (D2.01) *for information on detaching the gearbox unit from the engine.*

- For overhauls and replacements, position the complete engine assembly on the special **AV2621** stand equipped with the **AV 3123** bracket.

NOTES

*In order to use the **AS 106482** bracket, which is specifically designed for F355 engines, a cut of the dimensions indicated must be made in the zone highlighted in the figure, that is, where the rear crankcase cover is found.*



B2.02 RE-ASSEMBLY

Tightening torques	Nm	Category
Screws fastening engine support pads to the chassis	**50**	**B**
Screws fastening the engine-framework stranded earth wire	**15**	**C**
Nut for screw fastening the lower part of the gearbox	**75**	**B**
Nut for screw fastening the upper part of the gearbox	**98**	**B**
Nut fastening engine mounting bracket to pad	**98**	**B**

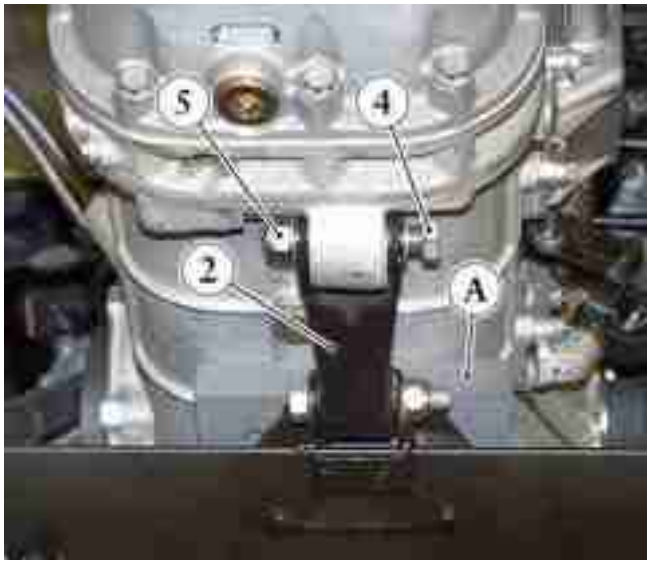
NOTES

See Paragraph (D 2.02) for information on re-attaching the gearbox unit to the engine.

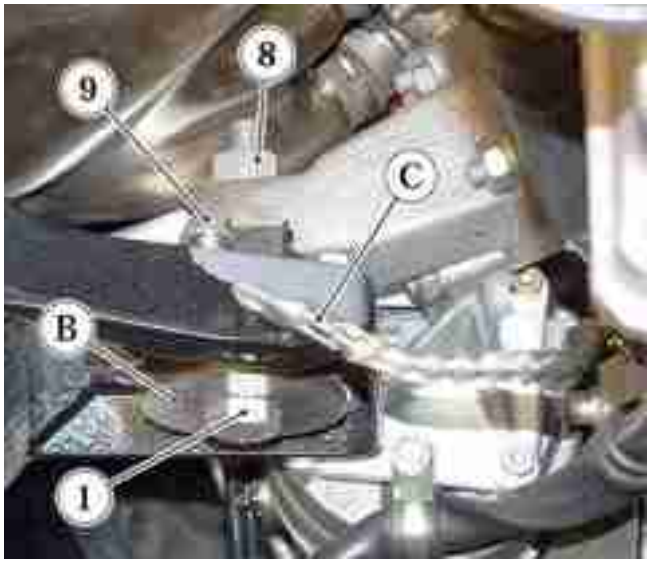
The procedure and the figures illustrate the re-assembly of an engine-mechanical gearbox unit. The procedure for the electronically controlled gearbox only differs in the positioning and connection of the Power Unit (D 2.02).

A rubber pad **(A)** (of about **80 mm** in thickness) is needed for re-assembly of the engine-gearbox unit. The pad should be fastened with adhesive tape on the lower connecting crosspiece of the chassis. The same equipment used for the disassembly is also required.

- Sling the engine-gearbox unit as described for disassembly.
- Position the unit over the engine compartment and lower it until it is resting on the pad **(A)**.



- Move the unit to the rear, sliding it over the pad and lower it until the mounting brackets are resting on the chassis supports.
- Insert the bushing **(B)** from underneath, on both sides of the engine, with the protruding part directed towards the punch, and screw **(1)**. Then position nut **(8)** with washer, without locking it.
- Fasten the stranded earth wire **(C)** to the chassis using screw **(9)**, check that the contact zone is without rust or traces of dirt.
- Tighten screw **(9)** to the prescribed torque.



If the engine and/or gearbox have been replaced, and the original fastening points have been left, the unit may not prove to be aligned with respect to the torque connecting-rod **(2)** on the lower end of the gearbox. In this case, the four nuts on the screws **(3)** fastening the pads to the chassis, must be loosened to permit a slight shifting of the unit as well as the insertion of the gearbox support in the torque connecting-rod **(2)** without any forcing.

- Tighten the pad fastening screws to the prescribed tightening torque.
- Insert the screw **(4)** fastening the gearbox to the torque connecting-rod **(2)** and tighten the nut **(5)** to the prescribed torque.

- Re-fit the gearbox support frame (D 4.04).
- Insert the screw **(6)** and tighten the nut **(7)** to the prescribed torque.

- Tighten the nuts **(8)** on the screws **(1)** to the prescribed, final torque.

- Reconnect all the piping which were removed during the disassembly stage, paying particular attention to the positioning of the tubes and unions on the vacuum tank and on the solenoid valves for the pneumatic actuation system (B7.04).
- Proceed to re-fit all of the components that were removed previously, restoring their original position (B 2.01).
- Activate the electrical system using the battery master switch.
- Re-fill with engine oil (A 3.01) and gearbox oil (A 3.02).
- Fill up the cooling (B 5.07) and power steering system (E3.02).
- Fill up the air conditioning system (I 3.02).

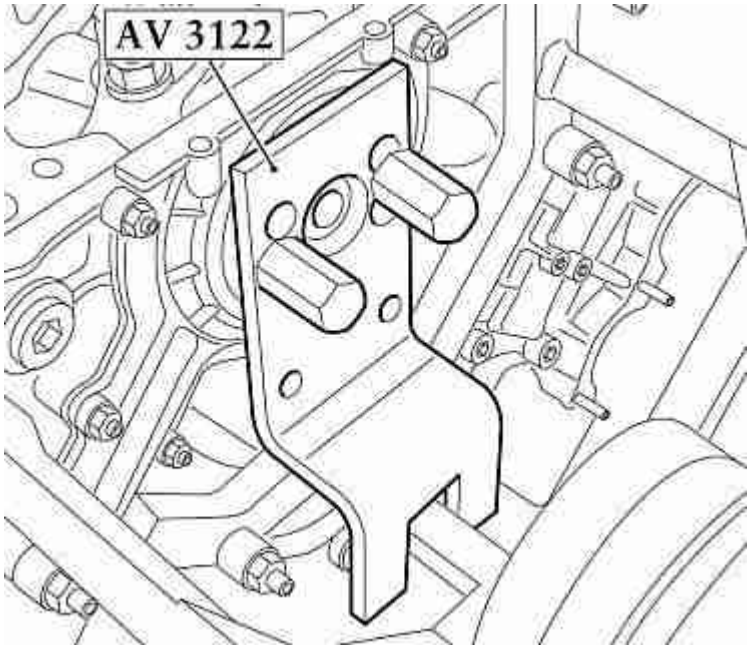
B3.01 TIMING SYSTEM DRIVING BELTS

The tightness of the timing system driving belts is determined by hydraulic tensioners and it is set during assembly. The tightness should never be changed thereafter.
The timing system belts should be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN".
When fitting the belts, avoid contact with oil or gasoline, as they could damage the belts. In addition, ensure that the belts are not bent or twisted excessively.

Replacing and Checking Tension

NOTES
Belt replacement and checks on belt tension are also possible with the engine installed in the car, through the opening found in the dividing panel between the passenger and engine compartments.
This paragraph only describes differences in procedure compared to the procedures listed in the case of the engine assembled in the car (A 3.03).

- Remove the water pump-alternator driving belt and the A.C. compressor driving belt (A 3.04).
- Remove the timing cases.
- Fit tool **AV 3122** to lock engine rotation.



- Loosen the fastening screw for the pulley on the crankshaft.

- Slide the pulley out and fit the **AM 105784** hub onto the crankshaft, for engine rotation.
- Follow the procedure described (A 3.03).

Re-Assembly

- Re-install the pulley on the crankshaft, by fastening it with the original washer and screw and applying the **AREXON 4706 SYSTEM 52A42** loctite on the thread.
- Re-fit the **AV 3122** tool to lock crankshaft rotation and tighten the screw to the **196 Nm** torque.
- Re-fit the rear covers with gasket onto the heads, the spark plugs and the coils.
- Slide off the lock on the hydraulic tensioner and re-assemble the timing system cases, with special care as to the spacers to be installed under the left-hand cover, where the two upper screws are found.
- Proceed by re-assembling the water pump-alternator driving belts and the air-conditioning compressor driving belt (_____).

B3.02 CAMSHAFTS-TIMING VARIATORS-PULLEYS

Timing Data

Intake

- Start before T.D.C.	(A.A.)	**10° ± 1°**
- End after B.D.C.	(C.A.)	**50° ± 1°**

Exhaust *(timing variator disabled)*

- Start before B.D.C.	(A.S.)	**76° ± 1°**
- End before T.D.C.	(C.S.)	**9° ± 1°**

Exhaust phase end variation: **20° ± 1°**

Main Specifications (mm)

Coupling between shafts and respective seats

• Radial installation play

Pins' maximum eccentricity

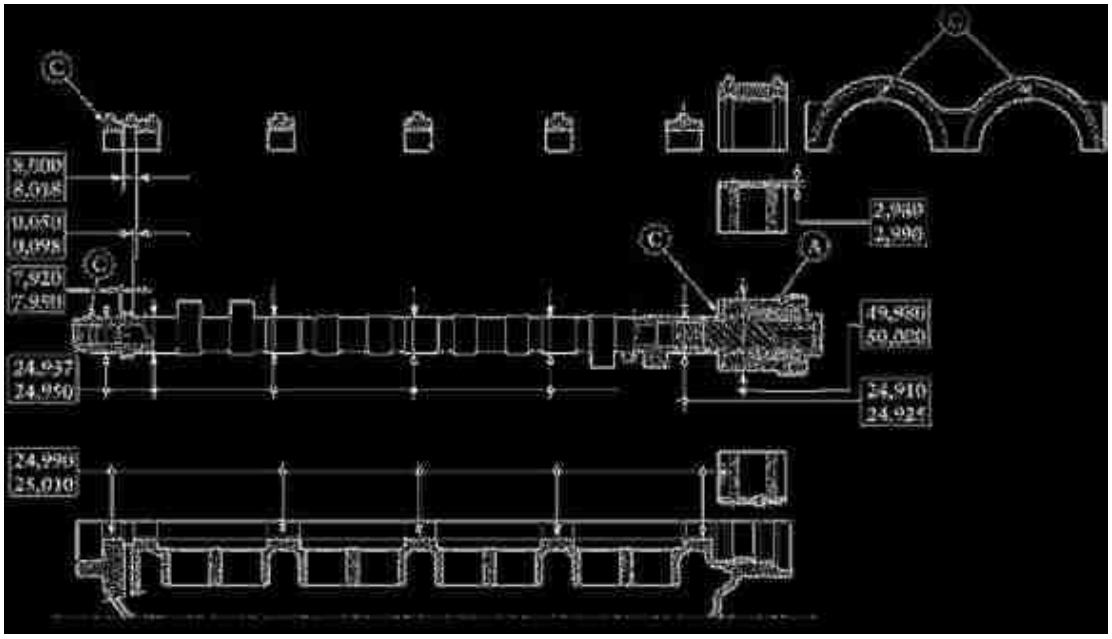
• Mid pins	**0,040**
• Pin end for variator/bushing	**0,070**

Valve upstroke (on the non-floating axle)

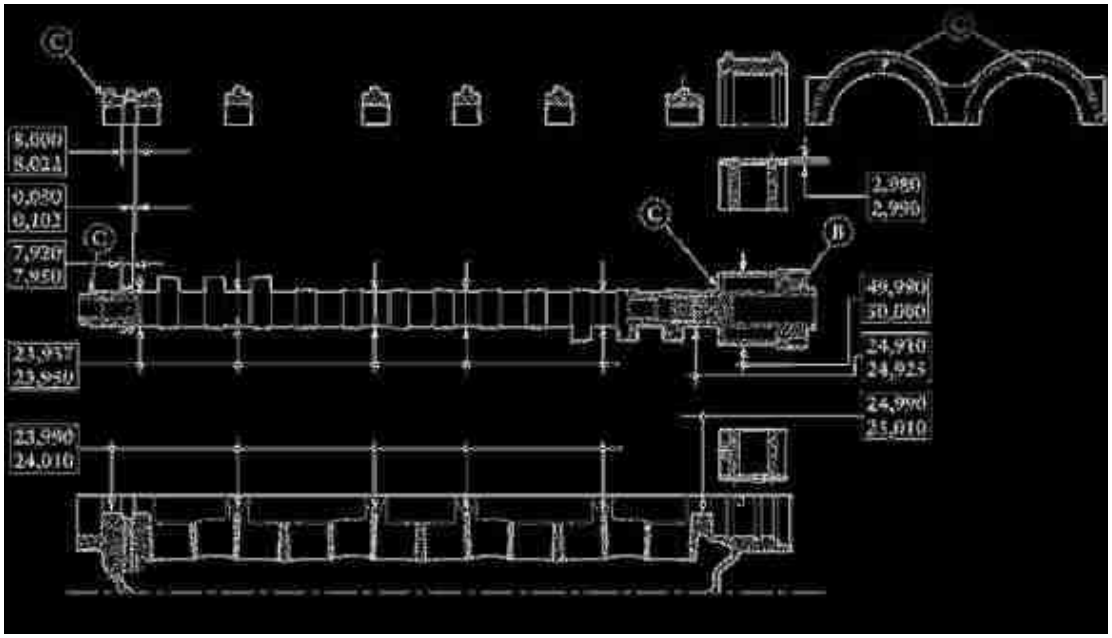
• Intake	**9,610**
• Exhaust	**9,690**

Tightening Torques		**Product**
Fastening nuts for M6 camshaft caps	**8,8 Nm**	
Fastening nuts for M8 camshaft caps M8	**21,6 Nm**	
Timing variator and variator side bushing	**160 Nm**	
Pulley fastening screws	**23 Nm**	**AREXONS SYSTEM 52 A42**

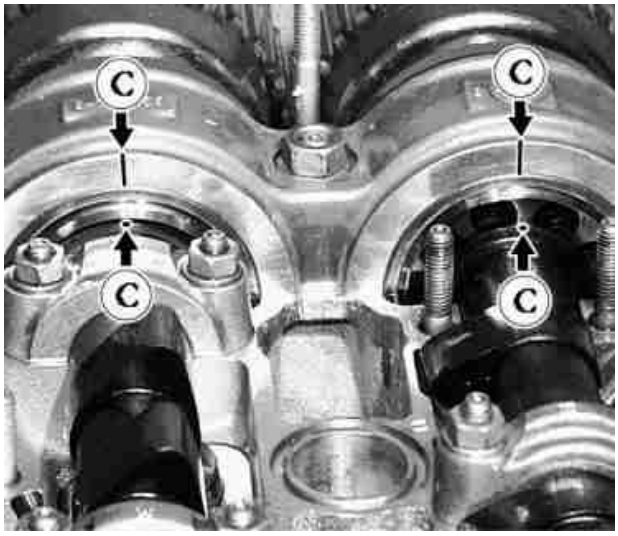
The exhaust camshaft is equipped with a timing variator **(A)** that is controlled by a solenoid valve which, in turn, is controlled by the MOTRONIC electronic control unit.

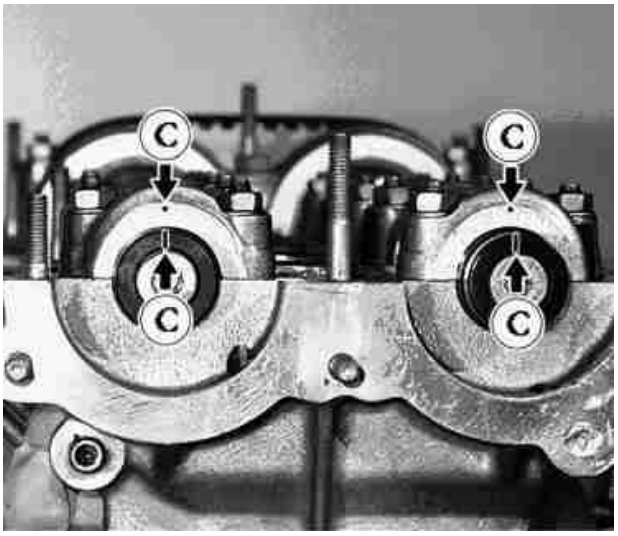


The intake camshaft is fitted with a bushing **(B)** of the same dimensions as the timing variator.



Each camshaft bears reference notches **(C)** found on the front and rear cap to facilitate timing procedures.
With cylinder no. 1 piston at T.D.C. during combustion, the notches **(C)** on the four shafts should be aligned with those found on the respective caps.



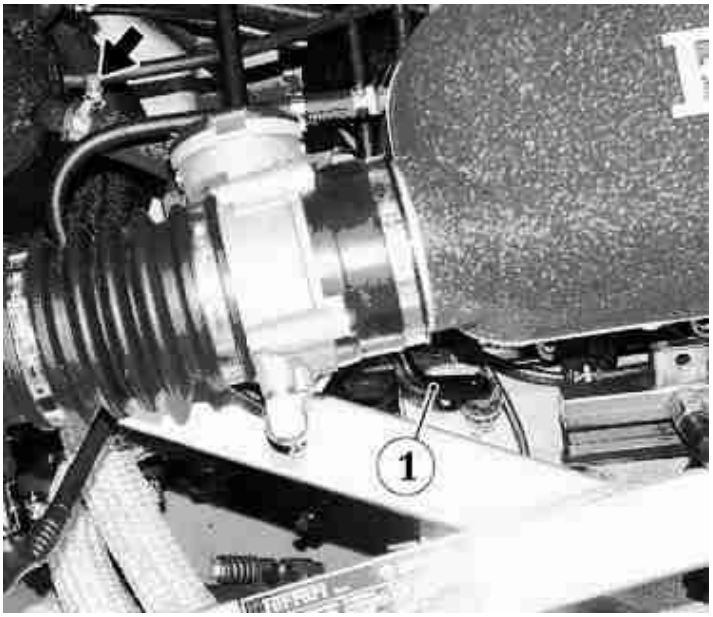


The caps are machined together with the heads and cannot be exchanged with each other. For this purpose, matching numbers have been printed on the heads and the respective caps.
The timing system belt control pulley has four slots where the screws for fastening it to the shaft are found. Should the pulley be detached from its respective shaft, the two elements must be properly timed.

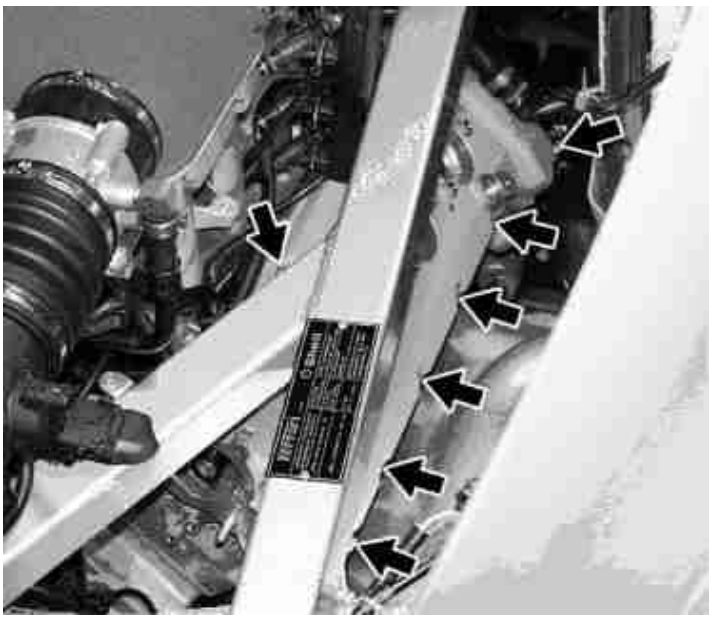
Replacement of the Head Cover Gasket and Seal Ring on the Camshaft (with the Engine Installed in the Car)

If there is leakage from the head cover gasket or from the front seal ring, the camshafts can be removed even with the engine installed in the car. Work through the engine inspection lid (M 3.05). It is advisable to put cylinder no. 1 piston at T.D.C., in the combustion phase in order to facilitate re-assembly.

- Remove the timing belts (A 3.03).
- Detach the injector rail with injectors from the intake manifold (C 3.02) and plug the seats.
- Remove the timing sensor from the head cover (C 2.01).
- Detach the blow-by system pipe **(1)** from the head cover and from the oil separator.

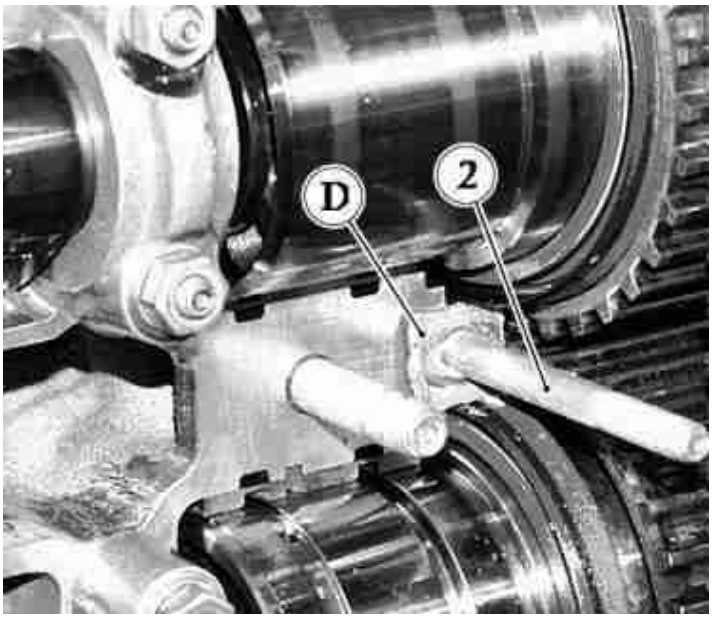


- Unscrew the nuts fastening the head cover and remove the cover along with the O-rings found at the spark plug slots.

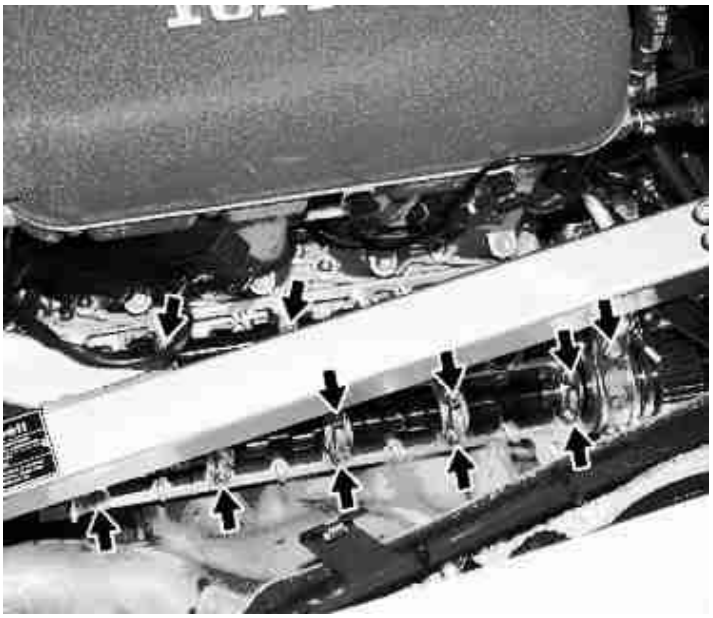


- Detach the gasket and keep the detached fragment located **(D)** on the front central stud bolt **(2)**.

NOTES
*If only the gasket is being replaced, the fragment **(D)** must be suitably trimmed in order to be positioned properly.*



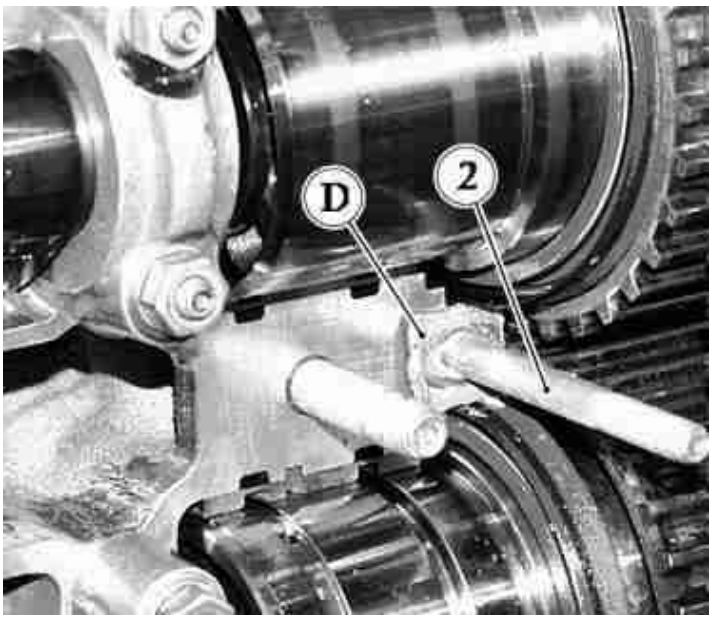
- Unscrew the nuts fastening the camshaft caps and remove them.



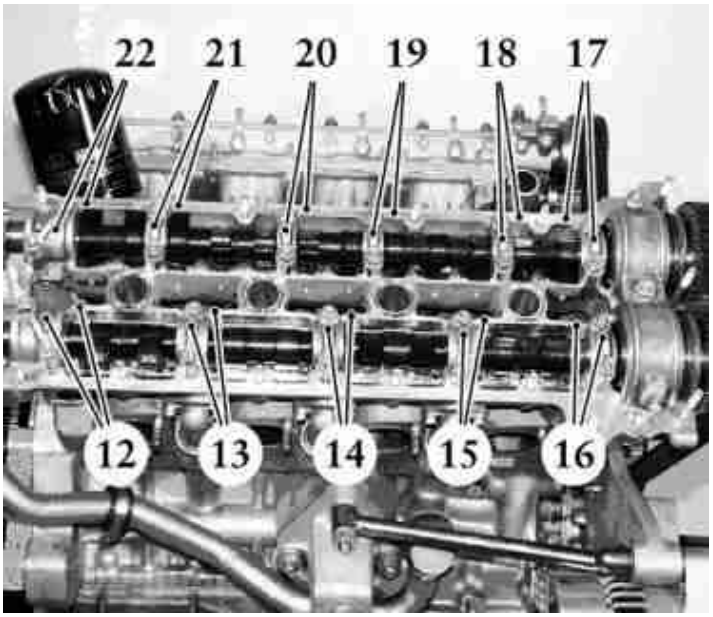
- Remove the camshafts, complete with pulley and seal ring.
- Slide the seal ring off of the rear tip of the camshaft and replace it.

Re-assembly

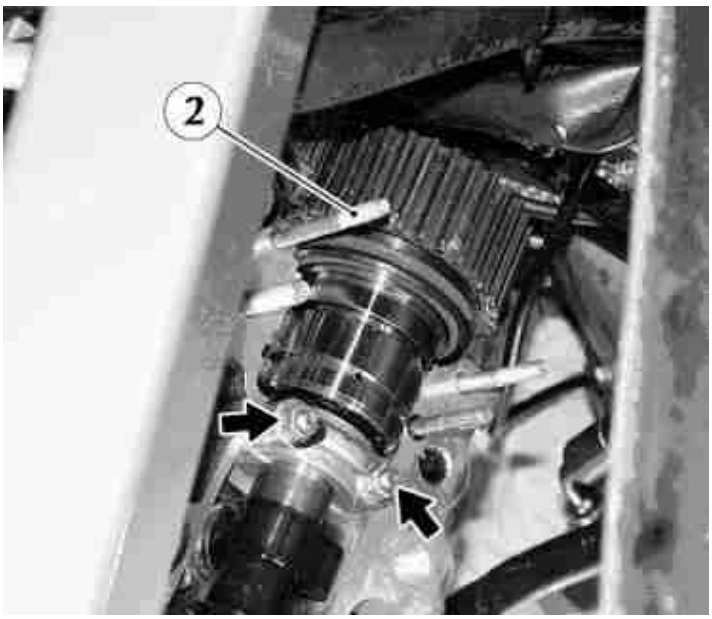
- Clean the cover and head coupling surfaces thoroughly and eliminate any traces of the gasket or sealer.
- Lubricate the camshaft with engine oil and fit the new seal ring with the closed side facing the pulley.
- Position the camshafts on the head and prepare the new gasket by cutting the fragment **(D)**.



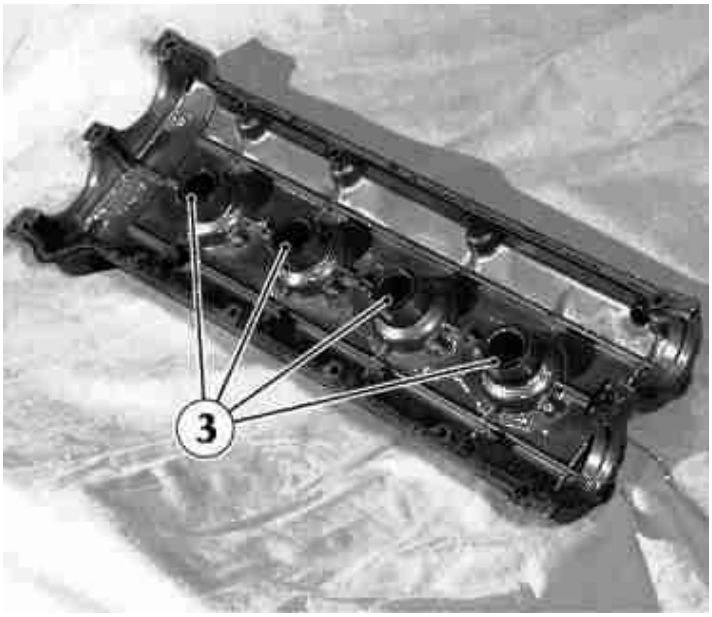
- Fit the caps according to the original numbering.



- Rotate the camshafts until the timing reference notches match.
- Tighten the cap fastening nuts to the prescribed torque.
- Position the gasket on the head and apply **CAF 4** silicon sealer to the end where the gasket rests on the head and cover.
- Fit the fragment **(D)** where the stud bolt **(2)** is found.



- Fit the head cover with the O-Rings **(3)** and secure it using the original nuts.



- Tighten the nuts, proceeding crosswise and starting from the rear nuts.
- Re-assemble all parts removed previously and then proceed by fitting and then tensioning the timing belts (A 3.03).

Replacing the timing variators with tool AV 3417 (with the engine installed in the vehicle)

NOTES

The timing variators must always be replaced in pairs. The illustrated procedure must not be considered in the event of engine overhaul, since, in this condition, the engine will be removed from the vehicle.

Preliminary procedures

Connect the diagnosis SD2 system for reading the timing angle of the banks, LH / RH exhaust camshafts: from **652 bit** Min to **6,72 bit Max**, with the engine idling.

Battery master switch turned to **OFF**.

Remove the engine inspection lid (M 3.05).

Removal

1- Remove the belt tensioner bearing **(A)** on the generator driving belt.

2- Using a special 19 wrench, set at 90° (ref. **USAG 285-L**, **Ø 19mm**), loosen the lower screw on the pulley tensioner for the generator driving belt.

3- Remove the belt tensioner pulley, then take out the generator driving belt.

4- Release the water recirculation pump pipe from the fastening bracket.

5- Remove the protective shields for the timing belts, taking care not to drop the spacers on the vehicle's underfloor.

NOTES

Position some protection on the exhaust manifolds, to prevent components or tools from falling on the vehicle's underfloor.

Operations on the LH bank

6- Disassemble the rear head cover and take off its gasket.

7- Install the dial gauge tool **CS 104488** into the spark plug hole on cylinder no. **1**, then rotate the crankshaft until it reaches the TDC.

-Check that the reference marks on the caps and exhaust and intake camshafts are correctly aligned; draw new reference marks with a felt-tip pen if necessary.

8- Using a spatula, carefully clean the contact surface on the gasket for the rear head cover.

9- Mount the support plate **AV 3422**, for tool **AV 3417**, securing it on the stud bolts of the rear head cover by means of 3 Kylock **Ø 6** nuts.

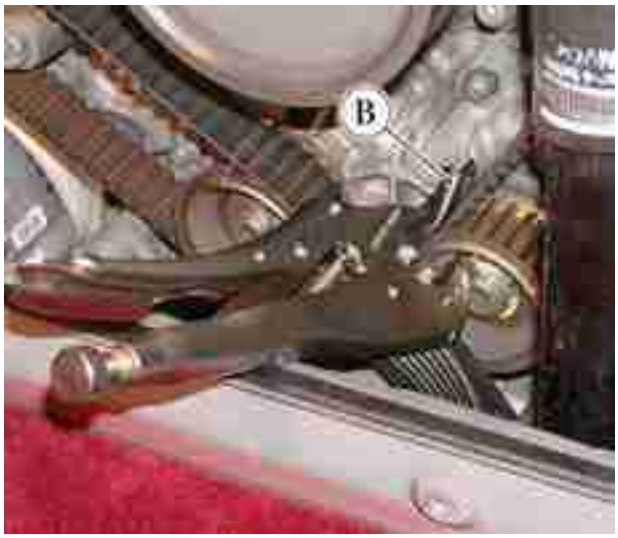
10- Lock the hydraulic tensioner's pin in order to stop the timing belt. To do this, insert the special stop into the hole on the tensioner body, after having aligned it with the hole on the tensioner's inner piston.

11- Using a felt-tip pen, draw some position reference marks between the exhaust and intake pulleys and between the pulleys and the timing belt.

NOTES

The reported procedure describes the operation keeping the original timing belts. Should the belts be damaged or near to the expiry date indicated in the Service Time Schedule, they must be replaced.

12- Lock the belt on the timing control pulley and on the intake pulley by means of two adjustable self-locking pliers, placing a rubber protection between the pliers and the belt.



13- When the end-of-travel has almost been reached, loosen the 8 screws on the flange of tool **AV 3420**. Position the tool on the support plate **AV 3422**, in the exhaust camshaft hole, with the unloaded eyelet in position with the outer stud bolt for the rear head cover.

14- Using a rubber hammer, fit tool **AV 3420** (shown in the figure) onto the exhaust camshaft, and tool **AV 3421** onto the intake camshaft.

15- Lock tool **AV 3420** (shown in the figure) and **AV 3421** onto the support plate **AV 3422** using 8 screws (supplied) and inserting them into the outer eyelets.

16- Lock tool **AV 3420** onto the exhaust camshaft and tool **AV 3421** onto the intake camshaft, tightening the 16 central screws (supplied) proceeding crosswise, until a final torque of **15 Nm** is attained on each screw.

17- Disassemble the exhaust camshaft pulley, without removing the timing belt.

18- Using the wrench **AV 3131**, disassemble the timing variator working in a clockwise direction (two operators are required for this procedure).

19- Take out the timing variator, taking care not to drop oil onto the vehicle's underfloor, then clean its seating.

Refitting

20- Insert the new timing variator tightening it to **160 Nm**, working in an anti-clockwise direction with wrench **AV 3131**, without applying a locking product.

21- Refit the exhaust camshaft pulley, matching the reference marks drawn before removal; In the event that the eyelets on the exhaust manifolds do not match with the timing variators hole, rotate the pulley in an anti-clockwise direction until they match.
In this case, the reference marks between the exhaust and intake pulleys and the timing belt will no longer be aligned.

22- Fasten the exhaust camshaft pulley applying medium thread-locking Loctite on the threads and tighten to **24 Nm**.

23- Remove the stop from the hydraulic tensioner pin and release the timing belt from the pliers on the control and intake pulleys.

24- Undo and remove the fastening screws from the outer eyelets on tool **AV 3420** (shown in the figure) and on tool **AV 3421**, so to release them from the support plate **AV 3422**.

25- Undo and remove the central screws from tool **AV 3420** (shown in the figure) and from tool **AV 3421**, so as to loosen their tightening on the camshafts.

26- Fit 4 of the previously removed screws (8 in total) into the holes opposite each other on the locking flange for tool **AV 3420** (shown in the figure) and for tool **AV 3421**. Progressively screw up the screws until extracting the tools from the camshafts and from the support plate **AV 3422**; use a lever if needed.

27- Check that the reference marks between the caps and the exhaust and intake camshafts are still aligned.

28- Fit the rear head's gasket and cover.

29- Carry out all the above cited operations on the RH bank, starting from point **6**, after having released the bracket retaining the engine oil cooling pipes, which is fastened underneath the movable chassis. It will be then possible to move the pipes, rendering the work easier.

NOTES

Rotate the engine (one complete turn) in a clockwise direction, and position it to the TDC. check the belt tensioning.

30- Refit the pulley and the generator driving belt, without installing the protection shields for the timing belts.

31- Connect the SD2 diagnosis system for reading the timing angle of the banks, LH / RH exhaust camshafts:

If the SD2 diagnosis system detects an ERROR, proceed as follows.

32 -Disassemble the rear head cover.

33- Rotate the crankshaft until it reaches the TDC, checking that the reference marks between the caps and the exhaust and intake camshafts are aligned.

34- Using a felt-tip pen, make a position reference mark between the timing variator and the exhaust pulley.

35- Loosen the 4 screws on the exhaust camshaft pulley.

36- Using a wrench size 21, rotate the exhaust camshaft in an anti-clockwise direction, according to the positive or negative parameter to be restored.

NOTES
If the exhaust camshaft has no slots for fitting the wrench, use adjustable self-locking pliers.

37- Secure the exhaust camshaft pulley applying medium thread-locking Loctite onto the screws and tightening to **24 Nm**.

38- Connect the SD2 diagnosis system for a final test and check.

39- Fit the protective shield for the timing belts.

40- Refit the bearing for the generator driving belt tensioner.

41- Secure the water recirculation pump pipe.

42- Refit the bracket retaining the engine oil cooling pipes, underneath the movable chassis.

To complete the updating procedure and for an easier identification of the vehicles fitted with the timing variator, part no. **190042** on their exhaust camshaft, the heads must be punched with the code “VD” (Definitive Variator) as shown in the figure.

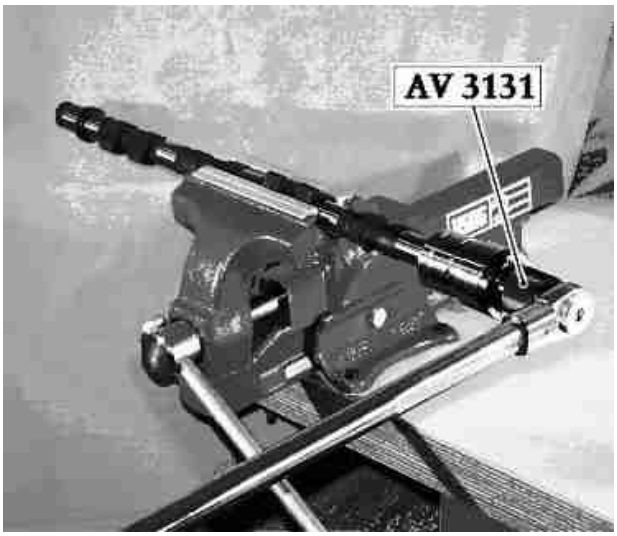
Overhauling the Timing Variator- and Camshafts

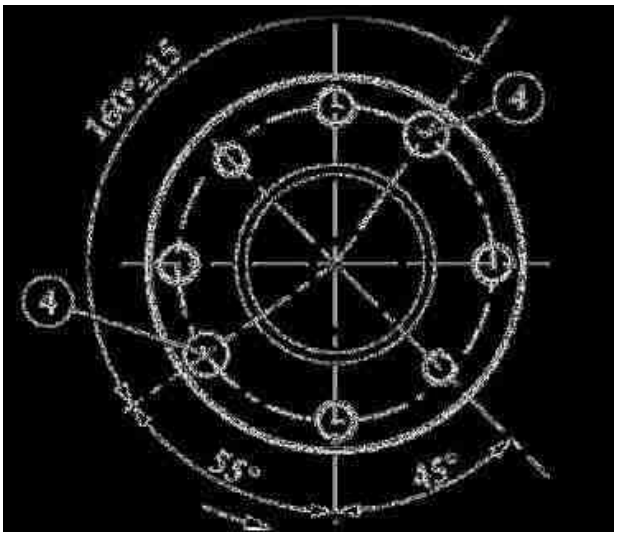
- Remove the camshafts according to the procedure outlined previously.

Timing variator

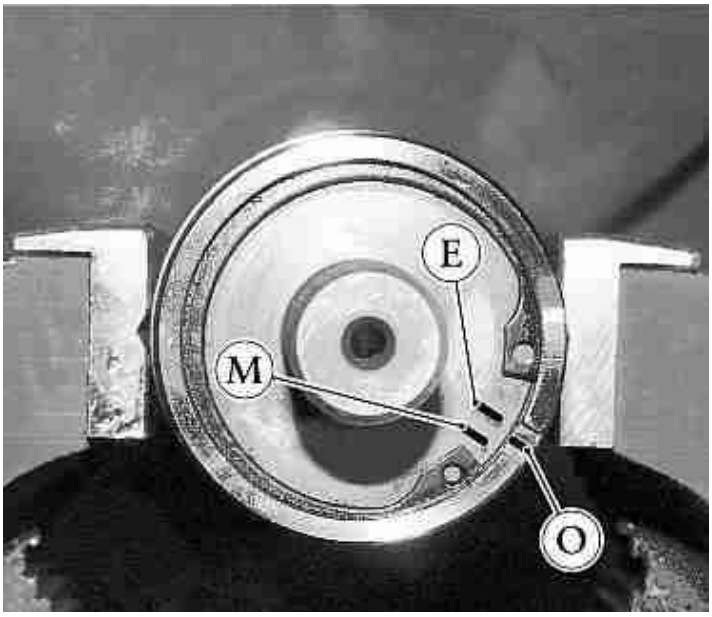
If broken or malfunctioning, the timing variators on the exhaust side camshafts or the bushings on the intake side shafts can be replaced.
Replacement procedures are as follows:

- Tighten the shaft in a vise and using the **AV3131** tool inserted in the specific holes **(4)** and unscrew the timing variator or the bushing presenting a left-handed threading.





The timing variator is provided with positioning marks on the camshaft side. In the event of malfunctioning or overhauling, the rest status (disabled phase) must be checked to ensure that the reference mark **(E)** on the part connected to the camshaft matches the one **(O)** on the part connected to the pulley. If this is not the case, use a rubber hammer and strike the end of the pin splined to the camshaft, thereby permitting its rotation and alignment of the marks.



- Position the variator on the **AV 3134** tool, with the latter connected to a compressed air intake. Blow air at the pressure of **2.5÷3.0 bar** and check for the alignment of the maximum aperture mark **(M)** on the part connected to the camshaft, with the mark **(O)** on the part connected to the pulley (enabled phase).

Should the variator lock during rotation, tap the end with the hammer as described previously and then repeat the trial more than once in order to verify proper functioning. Incomplete rotation cycles in the enabled phase keep the engine from operating properly. In such cases, the variator must be replaced.

- Variator life has a limit of about **100000 km**.
- Ensure that the variator is in the disabled position before re-assembly.
- Clean the threaded edge of the timing variator and the threaded seat on the camshaft, **avoiding to apply any lubricant**.
- Tighten the variator or bushing on the camshaft to the prescribed torque, using the same tool used for disassembly.

After assembly of the variator or bushing, check the eccentricity of the shafts according to the procedure described below.

Camshafts

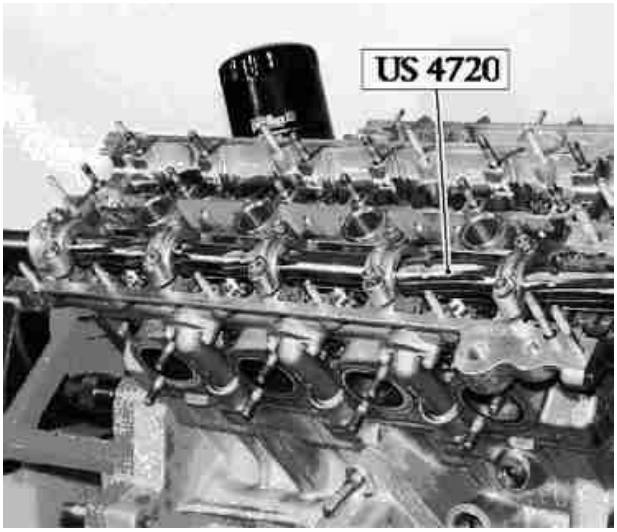
When overhauling, check to ensure that the camshafts are intact. If there are any cracks or surface scratches, even if minimal, they must be replaced.

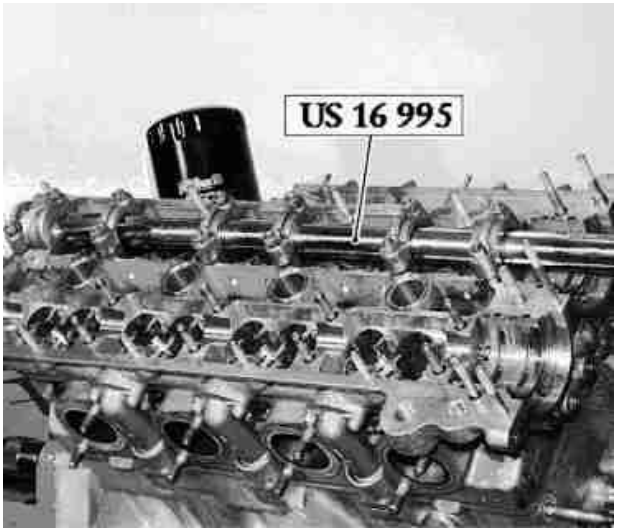
- Clean the lubrication channels by injecting petroleum under pressure from the seat of the threaded rear plug.
- Check the condition of the camshaft seats on the head. Bore them if they are in poor condition.

NOTES

The heads should be mounted on the crankcase with the used gaskets and nuts tightened to the prescribed torque, in order to bore the seats.

- Position reamer **US 4720** in the exhaust shaft seat and reamer **US 16995** in the intake shaft seat, having lubricated the cutting edges plentifully.

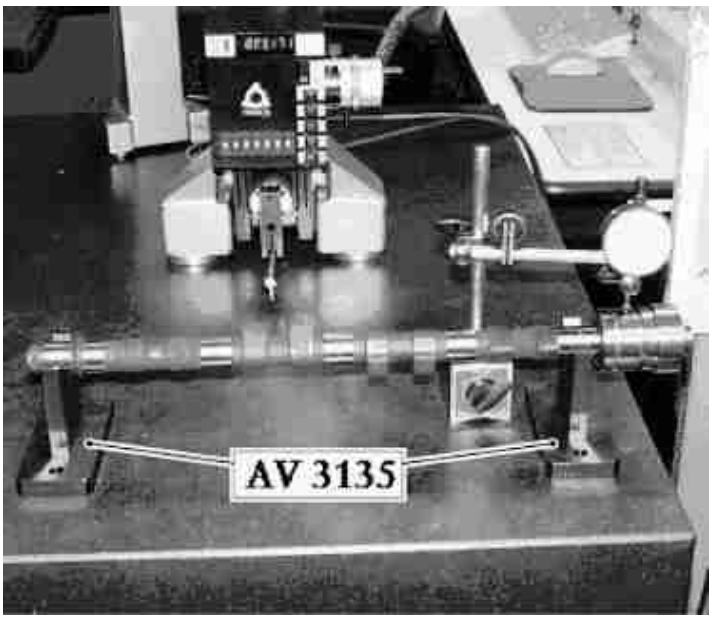




- Fit the caps and tighten them gradually until reaching the prescribed torque while turning and advancing with the reamer at the same time, making sure not to tighten them completely.
- Following this procedure, the heads must be disassembled (B 3.03) and carefully washed by injecting petroleum under pressure into the lubrication channels.

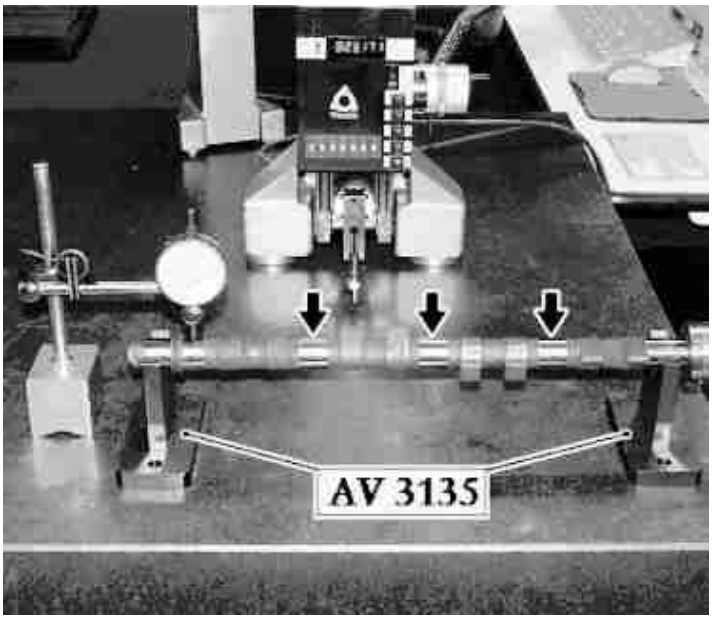
When replacing the timing variator, eccentricity must be checked on the camshaft (exhaust side) or the variator bushing, on the intake side, prior to re-assembly. Follow the steps listed below for eccentricity checks.

- Put the end pins of the assembly on the specific **AV3135** supports, over a flat checking surface.
- Use a dial gauge with a feeler pin resting on the outer surface **(Ø 50 mm)** of the timing variator or the bushing and while rotating the shaft, ensure that eccentricity does not exceed **0.07 mm**.



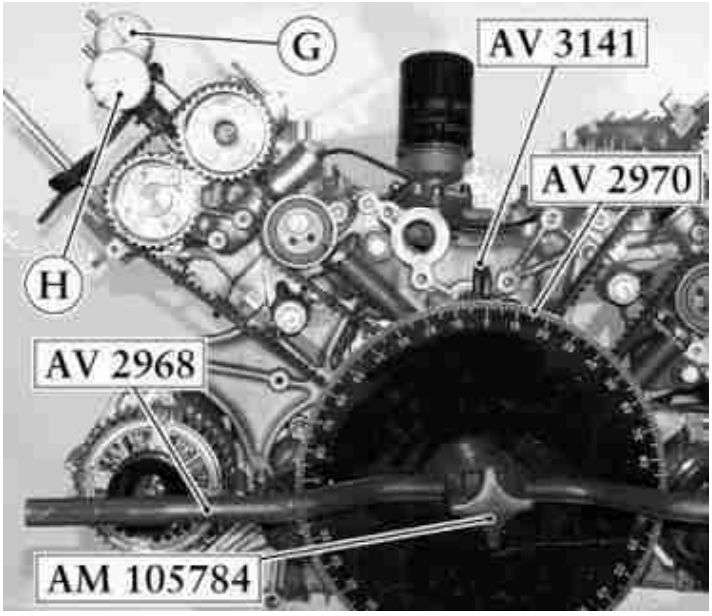
If this is not the case, use a plastic hammer to tap on the outer circumference of the variator or bushing in order to adjust eccentricity within the range of allowance.

- Put the dial gauge feeler on the pins specified above and check for fluctuations in eccentricity . This makes it possible to check for shifts in the eccentricity of the middle pins of the camshaft. The fluctuations should not exceed **0.04 mm**.

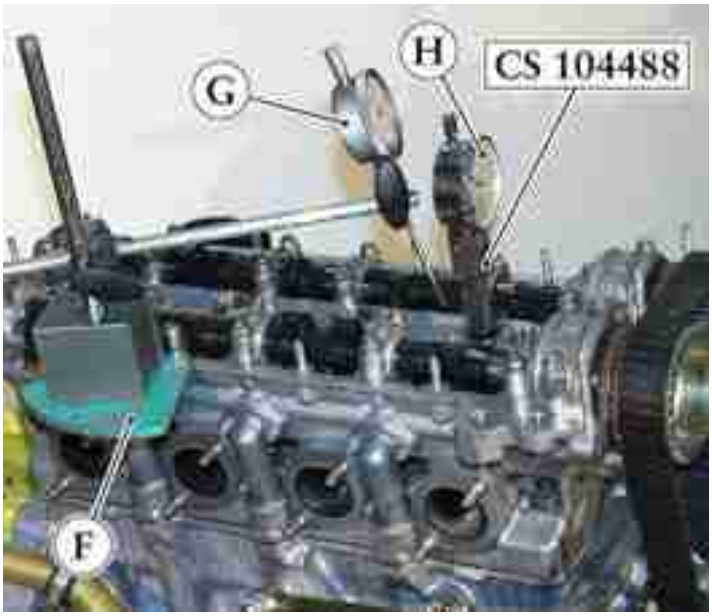


Camshaft re-assembly

- Secure the **AV2970** goniometer on the crankshaft, complete with **AM 105784** hub tool, the **AV 2968** control lever and the respective **AV 3141** reference index on the crankcase.



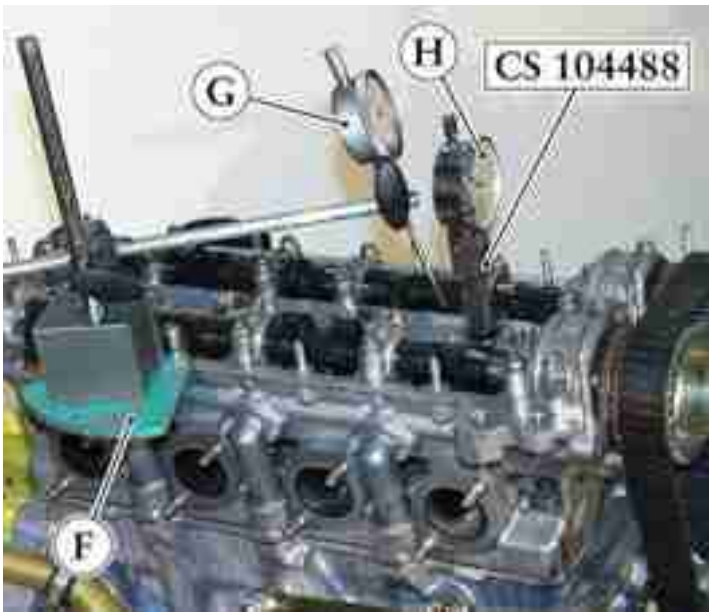
- Insert the **CS104488** dial gauge-holder tool with the relative instrument into the cylinder no. 1 spark plug space and then rotate the crankshaft and display the exact T.D.C. figure on the dial gauge **(H)**.



- Align the instrument pointer with this position.
- Position the variator and bushing support half-bearings on the head and respective caps.
- Insert the seal rings on the camshafts, positioning them on the head and arranging them in such a way as to have them match the timing reference marks with the caps.
- Push down the seal rings against the variator and the bushing.
- Fit the caps in their respective positions, aligning them and respecting the original numbering.
- Tighten the fastening nuts to the prescribed torque.
- After having determined the T.D.C., remove the goniometer along with the control lever.
- Align the timing reference marks for the camshafts and their respective caps and fit the driven pulleys. Secure them temporarily with the specific screws, fitting them in the centre of the slots.
  Using self-locking pliers, lock the two pulleys into position.
- Put the timing control belts on the pulleys, avoiding excessive bends, and then re-position the goniometer with its control lever.
- Proceed with belt tensioning (A 3.03).

Checking timing

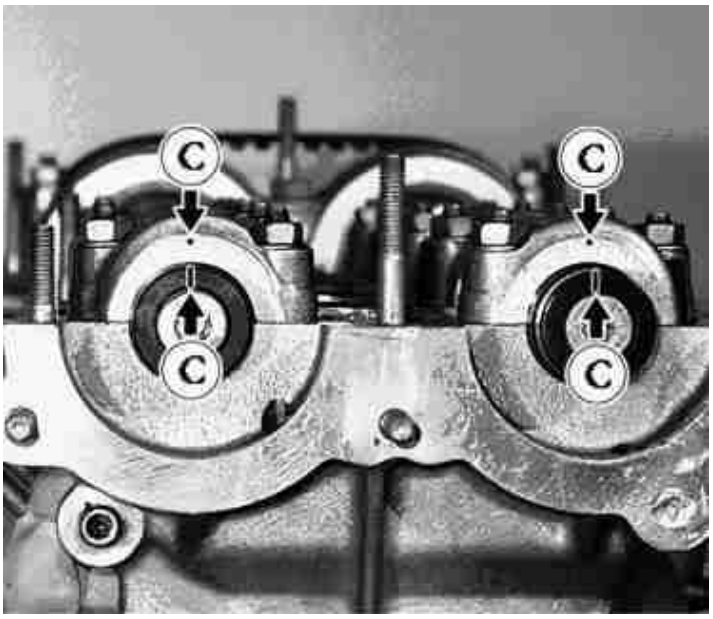
- Position bank 1-4 cylinder no. 1 piston at T.D.C. during combustion and secure the base **(F)** of a dial gauge **(G)** on the head, intake side, with the feeler pin resting on the upper surface of the bucket of one of the two cylinder no. 1 side valves.



- Reset the dial gauge indicator **(G)**: in this position, the buckets can rotate freely in their housing.
- Have the crankshaft rotate clockwise (ca. 360°) thereby approaching the crossover phase, and check to ensure that the dial gauge **(G)** is still showing zero, before the crankcase starts opening the valves.
- Rotate the crankshaft further until the dial gauge **(H)** reads the T.D.C. Under these conditions, the instrument should indicate **1.66±0.12 mm**.
- Rotate the crankshaft nearing the crossover phase, up to an indication of **9°** on the goniometer prior to T.D.C. for the end of exhaust stroke.
- Anchor the dial gauge base onto the exhaust side of cylinder no. 1, with the feeler pin resting on the upper level of the bucket of one of the two exhaust valves.
- Reset the dial gauge indicator **(G)** in this position.
- Rotate the crankshaft further until the dial gauge indicator **(G)** is stable on a value and the bucket proves to rotate freely in its housing. Under these conditions, the dial indicator should show a value of **0.60±0.08 mm**.

In the event that the conditions reported above are not met, loosen the pulley fastening screws and anticipate or delay rotation of the camshafts until the prescribed values are detected.

- Rotate the crankshaft by a few turns, re-position cylinder no. 1 piston at T.D.C. during combustion and check the reference marks **(C)** on the camshafts for alignment with the marks on the respective caps.



- Proceed in the same manner for bank 5-8, using cylinder no. 8 for the check.

Compliance with the conditions described above (with the variator deactivated) will permit the engine to run with opening of the intake with an advance of **10°**, and opening of the exhaust with a delay of **–9°**.

- Following these procedures, the pulley fastening screws must be unscrewed and the prescribed adhesive sealer must be applied to the threading.
- Tighten the screws completely to the prescribed torque.

Following the procedures outlined above, have the crankshaft perform several revolutions, then check the belts for proper tightness (A 3.03) and the reference marks for alignment.

IMPORTANT

In the event of camshaft replacement, restore the rear reference marks as they have been made manually during assembly. The same instructions hold for the reference marks on the driven pulleys in the timing system.

- Remove all of the instruments and tools used and proceed with re-assembly of the head cover according to the instructions outlined previously.
- Install the timing system covers and re-fit all of the parts removed previously.

B3.03 CYLINDER HEADS

Main specifications (mm)

Interference between valve guide and seat on head	**0,032 ÷ 0,068**
Interference between valve seat and housing on head	
• Intake.	**0,120 ÷ 0,160**
• Exhaust	**0,100 ÷ 0,140**
Valve stem and respective guide coupling	
• Installation clearance (intake and exhaust)	**0,030 ÷ 0,060**
• Wear limit	**0,100**
Maximum offset between valve stem and bucket contact area	
• Intake and exhaust	**0,025**
Clearance between bucket and respective seat	
• Installation clearance	**0,030 ÷ 0,067**
• Wear limit	**0,100**

Tightening torques	Nm	Category	Product
Cylinder head fastening nut (pre-tightening **60 Nm**) - MIN torque/MIN angle - MAX torque/MAX angle	 **60 Nm / 24°** **90 Nm / 76°**	**A**	**MOLYKOTE BR2 plus** grease
Timing variator control solenoid valve	**43 Nm**	**A**	**AREXON 4706 SYSTEM 52 A43**

Introduction

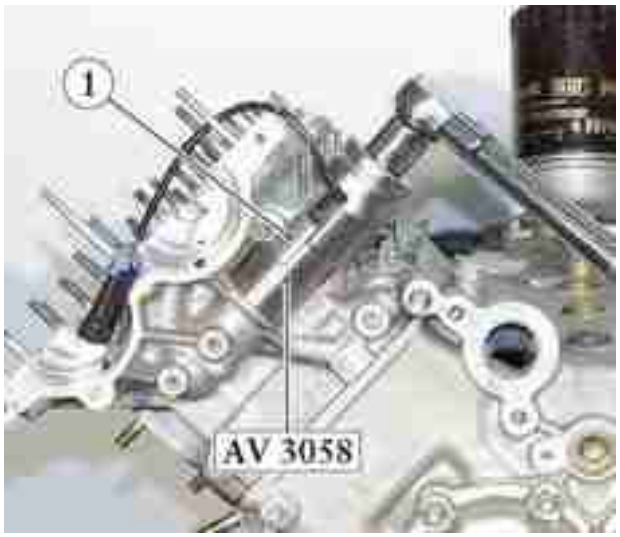
The cylinder heads are made of heat-treated aluminium silicon alloy. The specially shaped combustion chamber is connected to the intake and exhaust lines. Besides improving feed, this configuration makes it possible to obtain a high volumetric and thermodynamic yield.
The valve seats are made of cast iron and the valve guides are made of sintered steel.

Disassembly of cylinder heads

NOTES

These procedures refer to the right-hand cylinder head. The camshafts (B 3.02). Have already been removed from the head. The same procedures are valid for the left-hand head. If repair work is not required, the head can be removed complete with the camshafts and cover.

- Remove the solenoid valve **(1)** controlling the timing variator from the head, using the **AV 3058** tool.



- Remove the three outer oil pipes **(2)** to gain access to the nuts fastening the outer part of the cylinder head to the crankcase.

- Using the **AV 2906** box wrench together with the **AV 2905** support, unscrew the ten nuts fastening the cylinder head to the crankcase.

- Slide the cylinder head off of the stud bolts and remove the gasket. The gasket must always be replaced.

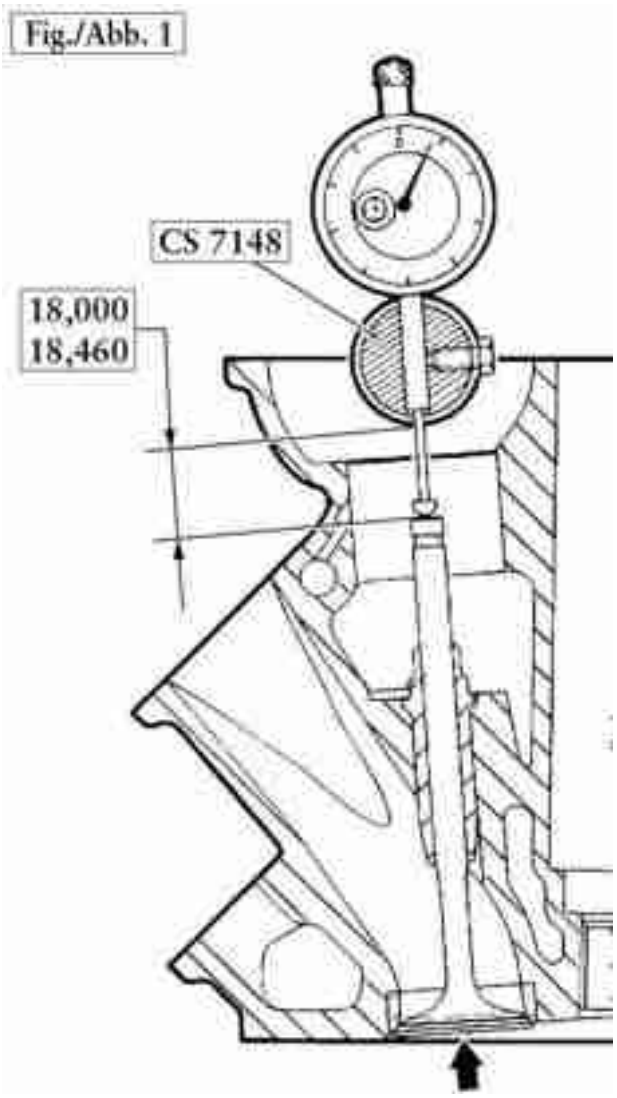
Checking the cylinder heads

- Before removing the valves, use the **CS 7148** tool to check the seats for wear.
- To perform this procedure, position the tool on the camshaft seat. Then reset the dial gauge with the plunger resting on the camshaft seat.

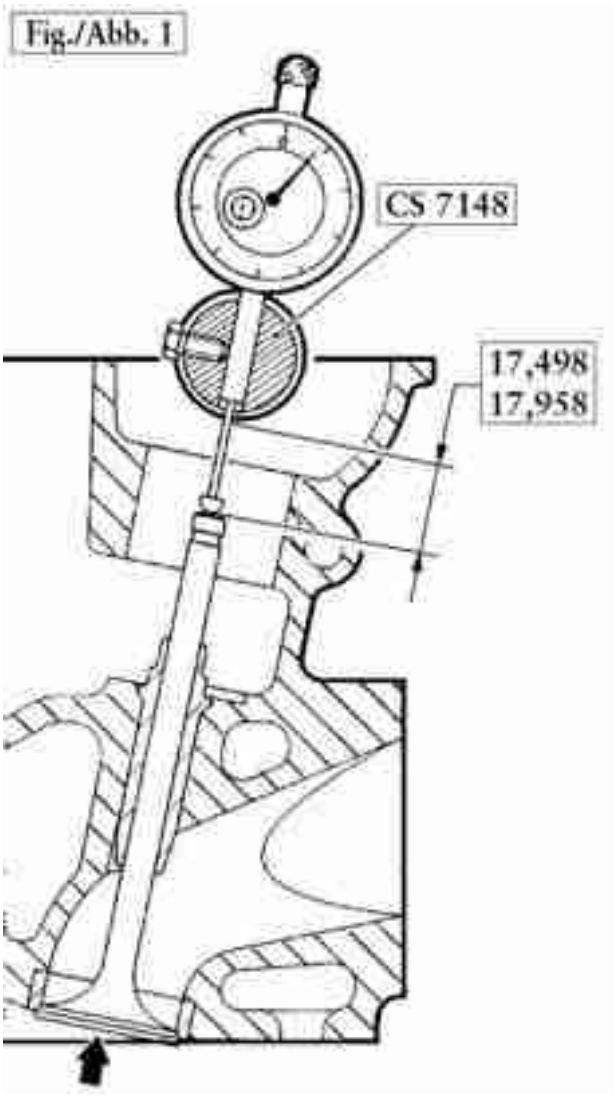
NOTES

Use the bushings supplied with the tool, according to the different diameters of the camshaft supports, and centre the plunger axis in the middle of the valve stem upper surface.

- The valve seat must be replaced if the reading drops more than **0.200 mm** below the minimum limit indicated in **Fig. 1**.

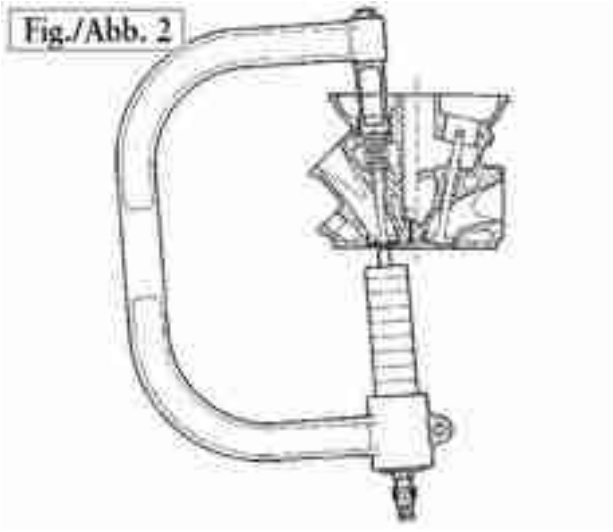


Intake



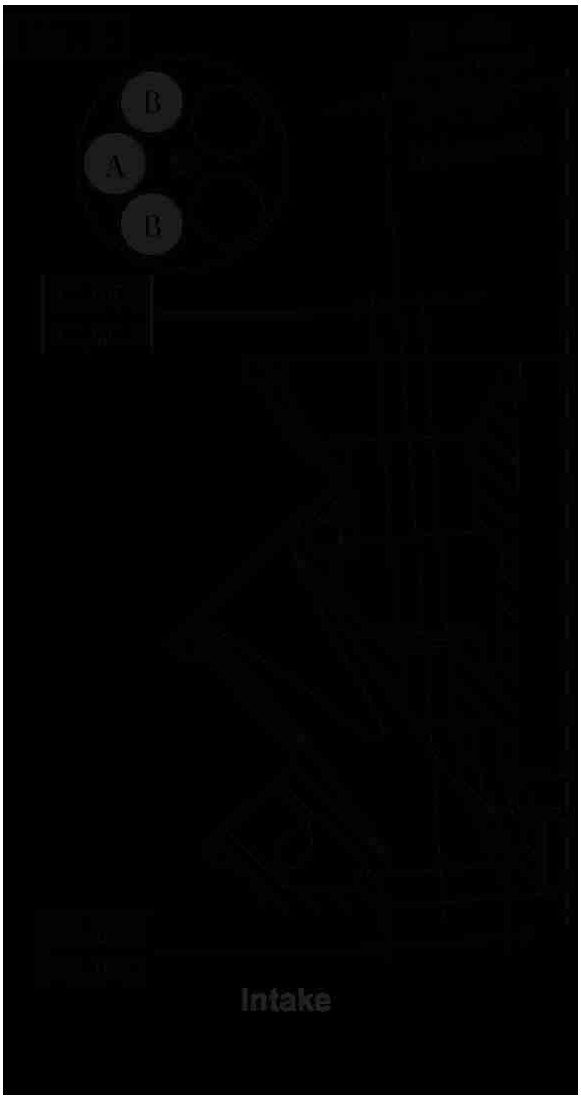
Exhaust

- Use a commercially available pneumatic tool designed specifically for valve removal **(Fig. 2)** to remove the valves.



- Clean the heads thoroughly, removing any deposits from the combustion chamber and the oil and water lines. For these purposes, it is advisable to inject pressurised wash oil into the oil lines and a commercially available descaling liquid into the water lines.
- Check the state of the spark plug seats.
- Using the bore meter, check the valve control bucket seats for wear (see "Main specifications"), as well as the camshaft seats (B 3.02).
- Ensure that the head and crankcase coupling surface is perfectly level, on a flat checking surface.

- If it is necessary to grind the head surface, the value shown in **Fig. 3** must be maintained



Checking the valve seats and guides

- Following the checks, if replacement of the valve seats is required, they must be removed by milling in order to prevent damage to the housing on the head.
- Check the dimensions of the grooves and the seats to ensure that the prescribed interference (see "Main specifications") is created after assembly.
- To insert the new seats, heat the head in a kiln until it reaches a temperature of **190 °C**, for **six minutes**, then cool down the seats in liquid nitrogen, for about **five minutes**.

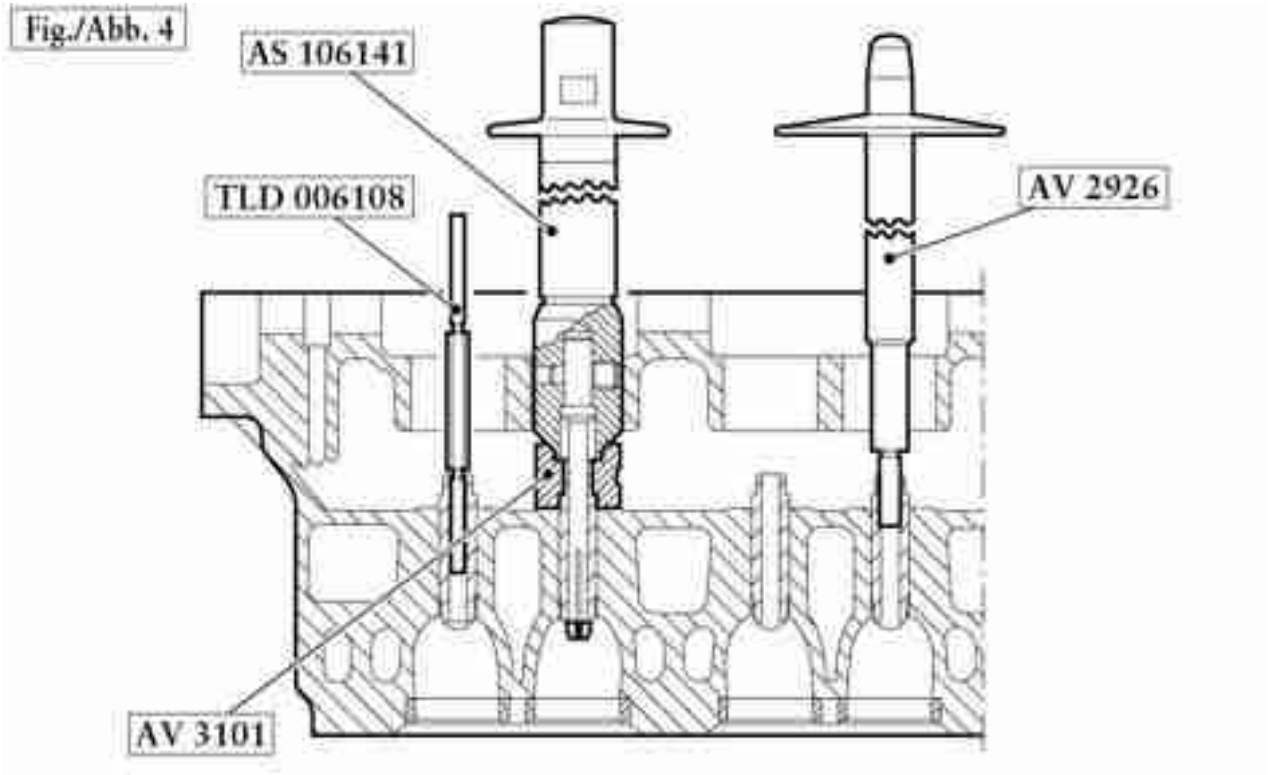
NOTES

The above described operation must be exclusively carried out by a specialized laboratory.

- Insert the seats onto the head using the special punch. Carefully check that the kickback does not cause the previously installed seats to fall out; if necessary, check that all installed seats are correctly fitted.

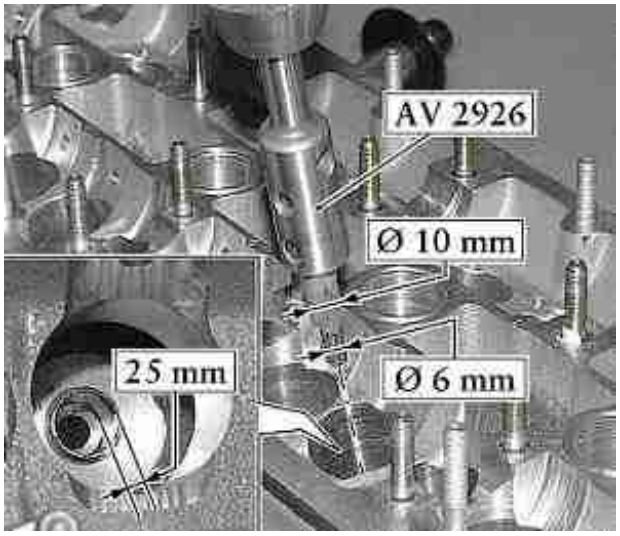
- Using gauge **TLDF 006108**, check the valve guides for wear.

If the gauge inside the guide features an excessive backlash, replace with new guides in order to obtain the prescribed assembly engagement (see "Main data").
The guides can be removed following the below procedure (**Fig. 4**).



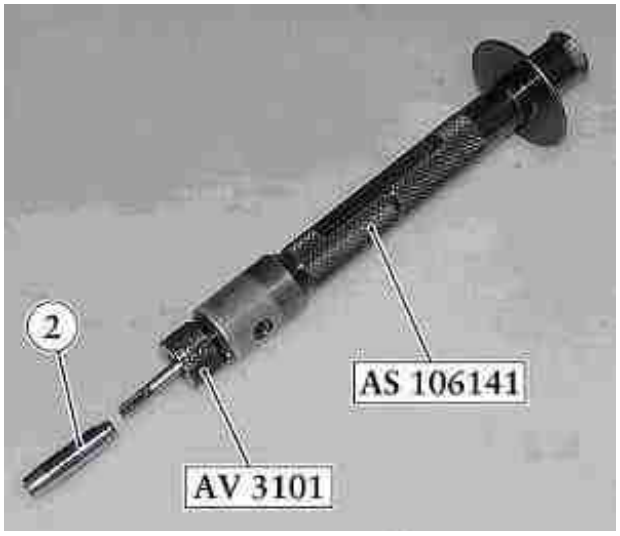
- Using tool **AV 2734** extract the seal rings **(1)** from the valve guides.

- Using a Ø 10 mm miller, with a Ø 6 mm tapered shank, supplied with tool **AV 2926**, mill the guide on the seal ring side for about **25 mm** from its end, lubricating the miller to prevent it from breaking and keeping it aligned with the valve guide.

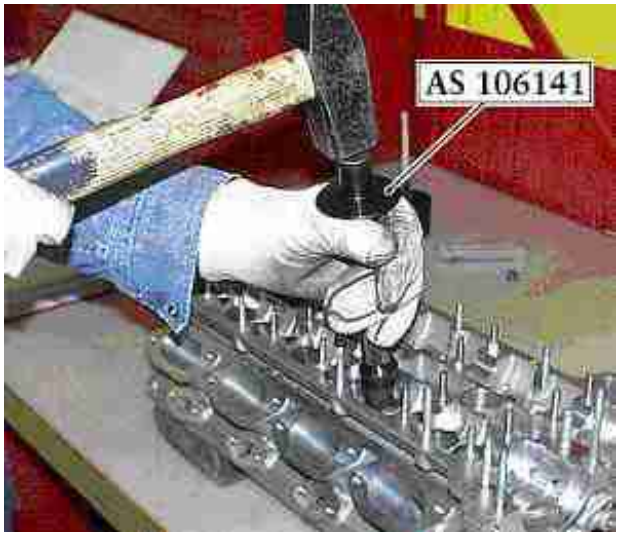


- Heat the head in a kiln at about **100 °C**, for ca. **thirty minutes**, to ease removal, then position it on two rubber shims.
- Extract the guide using the punch supplied with tool **AV 2926.**

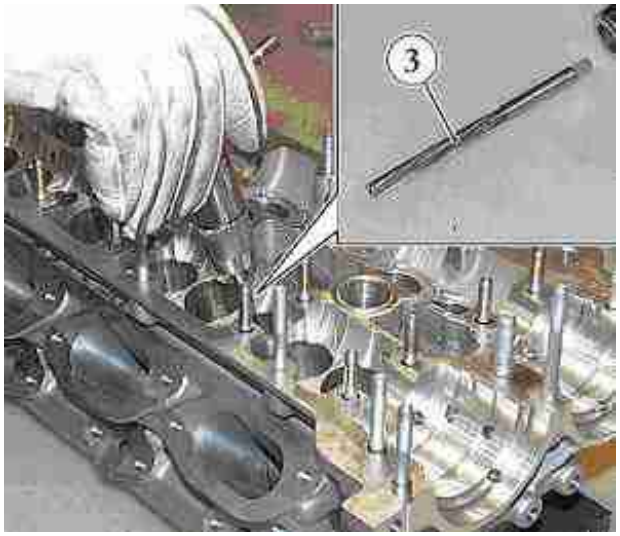
- To insert the new guides, it is necessary to heat the head at about **100 °C** for ca. **1 hour** and then cool down the guides in liquid nitrogen.
- To install the new guide (**2**) use tool **AS 106141** with shim **AV 3101**.



- Lubricate the guide with "SEGO" grease and push it into its seat, until the shim **AV 3101** comes flush with the head.



- After this procedure, **dry bore** the guides using a reamer (**3**) diameter **6 H7 mm**, fitted in the speacial hand-operated spindle. Before carrying out the operation, check that the reamer cutting edges are sharp.

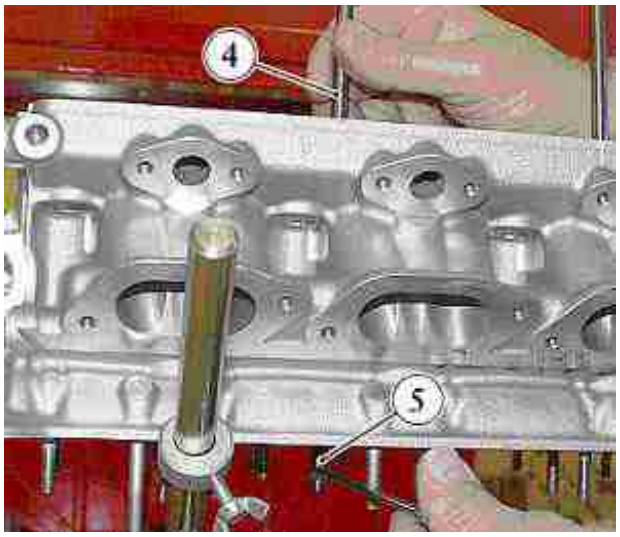


- Using gauge **TLDF 006108,** directed towards side "P", check that the guide is properly bored.

After having replaced the valve guides, it is necessary to grind the valve seats, thereby obtaining the prescribed union angle in order to perfectly match the seat-valve support surfaces. For this operation, use the recommended grinder for valve seats equipped with the relative (B1.02).

- To work on both sides of the head, position it on the special supports, working from the lid side.
- Insert the centering stem into the guide (**4**), diameter 6 mm, working from the side equipped with tightening screw.

- Lock the centering stem in the guide (**4**), by means of the tightening screw (**5**).

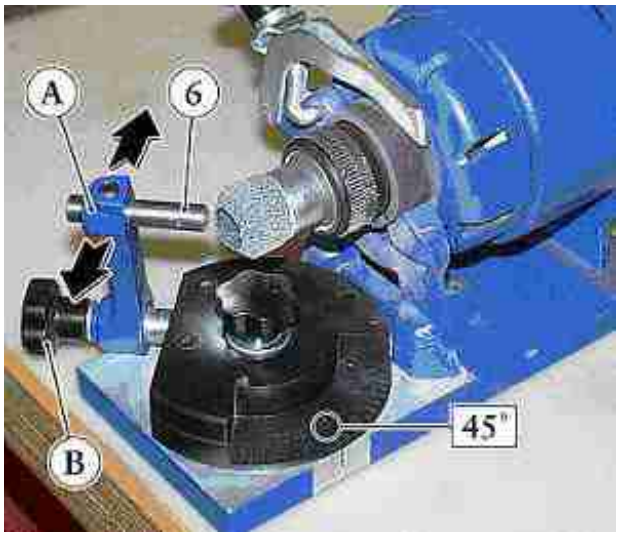


- The grinder must be fitted with the specific wheel for the valve seat to be machined:
- for the intake valves (diameter 27,7 mm) use a **28mm** diameter wheel;
- for the exhaust valves (diameter 28,5) use a **30 mm** diameter wheel.

NOTES
The wheel outer diameter must be slightly larger than that of the valve.

- Set the diamond point inclination (**6**) to **45°**, with respect to the fixed index on the base.
- Sharpen the wheel swinging the small connecting rod (**A**) which holds the diamond point and, at the same time, operate the control knob (**B**).

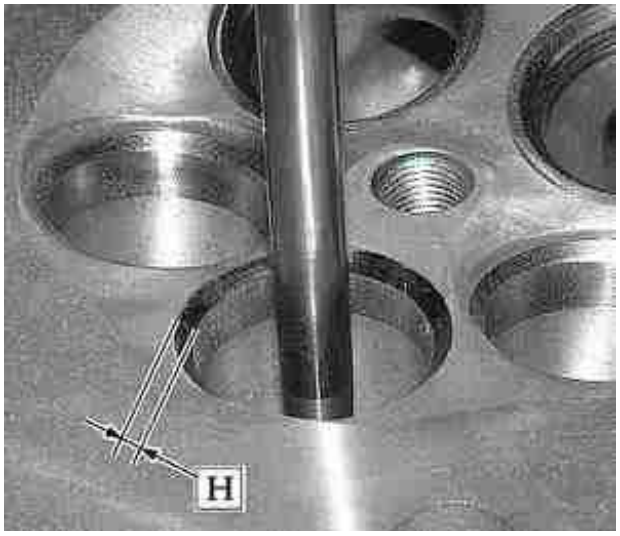
IMPORTANT
To prevent the abrasive product from infiltrating into the camshaft central hole, plug the latter and clean with compressed air.



- Grease the centering stem (**4**) and fit the grinder.
- Move the wheel so that it skims the valve seat, and lock the screw which positions the knob (**7**) used to adjust the cutting depth.

- Start-up the grinder and machine the valve seat, gradually increasing the cutting depth using the knob (**7**).

- Grind the whole surface (**H**) of the valve seat, letting the machine work freely for a few seconds. Check the working depth and the alignment (centering) of the machining with respect to the seat, adjusting the grinder position if necessary.



- Once the machining procedure is completed, lift the wheel operating the knob (**7**) then remove it from the centering stem.
- Release the centering stem (**4**), working on the lower tightening screw.
- Using tool (**C**) supplied with the grinder, extract the centering stem (**4**) from the valve guide.

IMPORTANT
After having ground the seats as described above, it is not necessary to lap the valves before re-assembly.

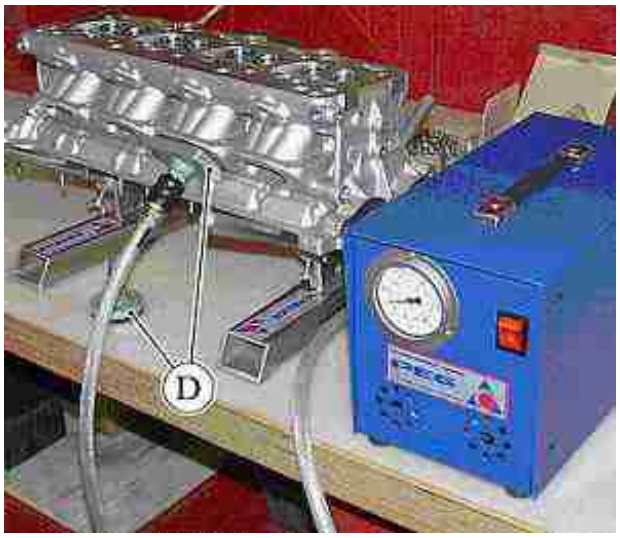
There are two methods for checking the seat machining:
- application of a "Prussian Blue" layer;
- check of the hydraulic seal with "Vacutest".

Check through the application of a "Prussian Blue" layer

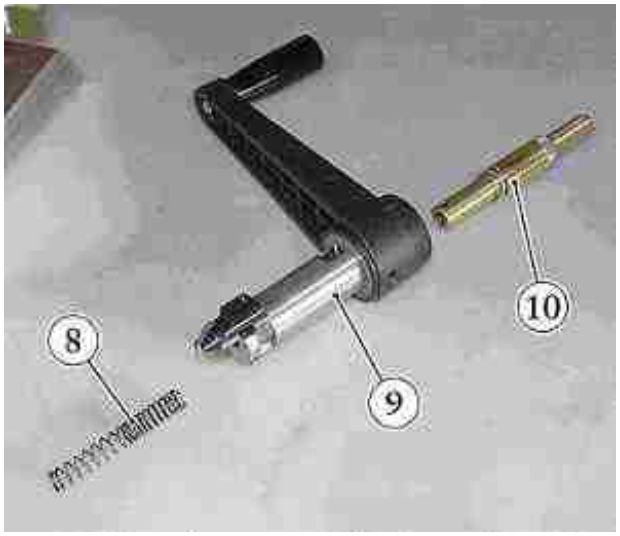
- Using a paintbrush, apply a thin and uniform layer of "Prussian Blue" on the whole resting surface of the valve.
- Insert the valve into its guide, making it "strike" on its seat.
- Then rotate it manually and, after having removed it, check that the "Prussian Blue" layer is evenly distributed on the whole seat. If this is not the case, grind the seat once again.

Check of the hydraulic seal with "Vacutest"

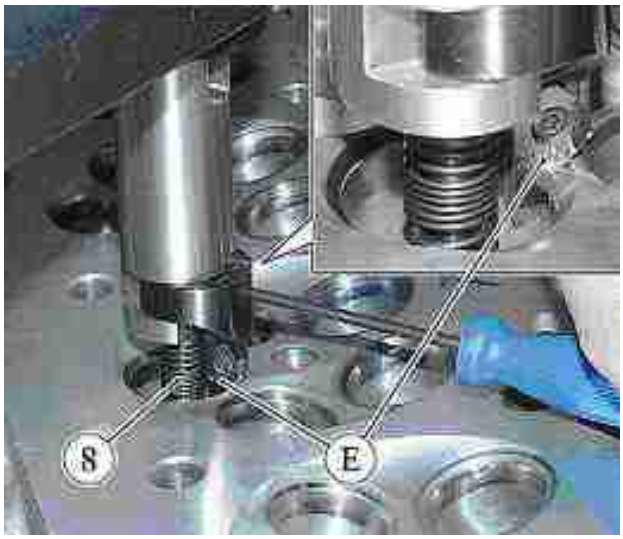
- Fit the seal rings into the valve seats to be tested.
- Insert all the valves of a duct (intake or exhaust) and fit the rectangular punch (**D**), supplied with the equipment, to plug the intake duct. Fit a round-shaped punch to plug the exhaust duct.
- Activate the "Vacutest" and check on the pressure gauge that vacuum ranges between **0,94** and **0,86 bar**. If the value proves to be lower, check once again applying a "Prussian Blue" layer, in order to verify which is the seat to be ground once again.



To improve the valve seal, chamfer the seat inside diameter, using the special tool consisting of a spring, (**8**), shaft with handle (**9**), together with carriage with shaped plate and screw (**10**) serving to adjust the cutting depth.

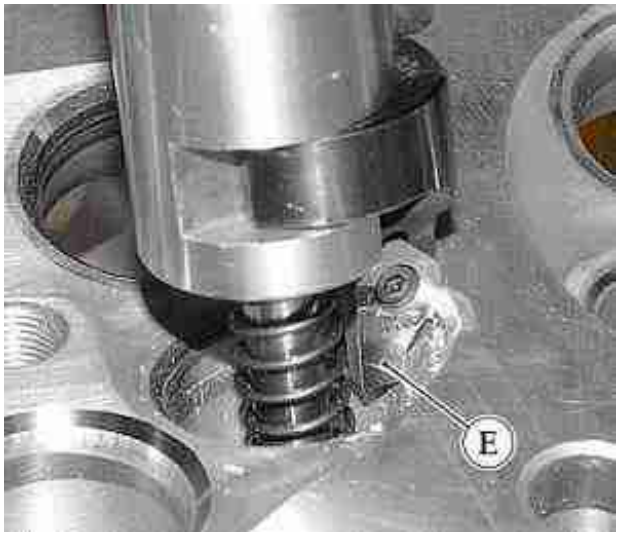


- Re-fit the centering stem (**4**) into the guide, then insert the spring (**8**) and the shaft with handle (**9**).
- Check that the shaped plate is working in the correct position (**E**), with respect to the seat to be machined, moving the adjustment screw found on the plate holder carriage.



- Fit the screw (**10**) onto the stem and shaft (**9**) with handle for adjusting the cutting depth, then lock it on the centering rod (**4**) using the special dowel.

- Start machining the seat by rotating the shaft with handle clockwise (**9**) and adjusting the screw at the same time (**10**) in order to increase the cutting depth. Check that the shaped plate (**E**) is working correctly on the inside diameter of the valve seat only.

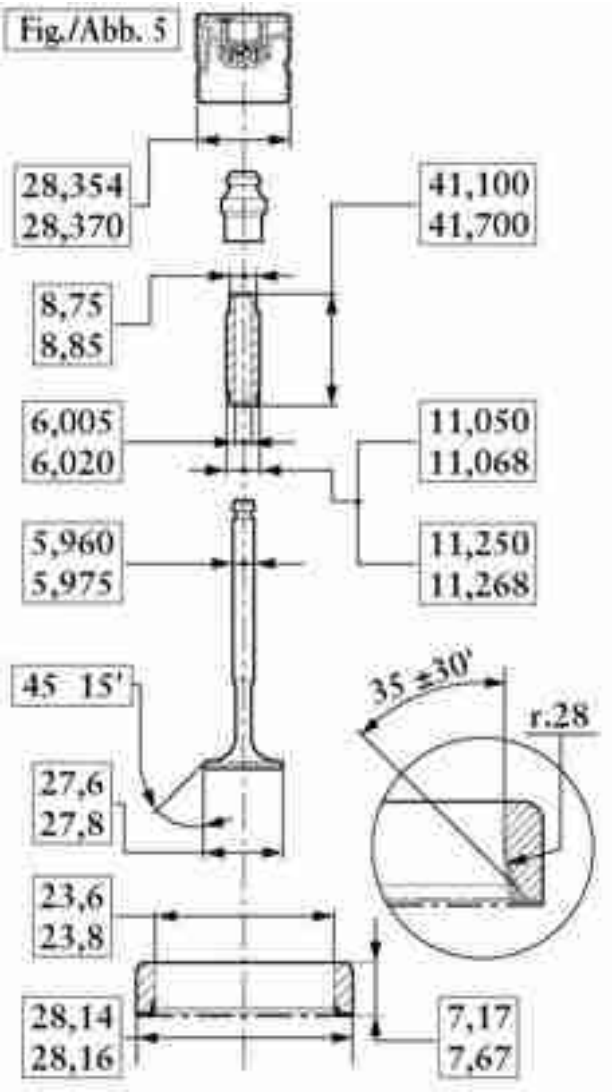


IMPORTANT

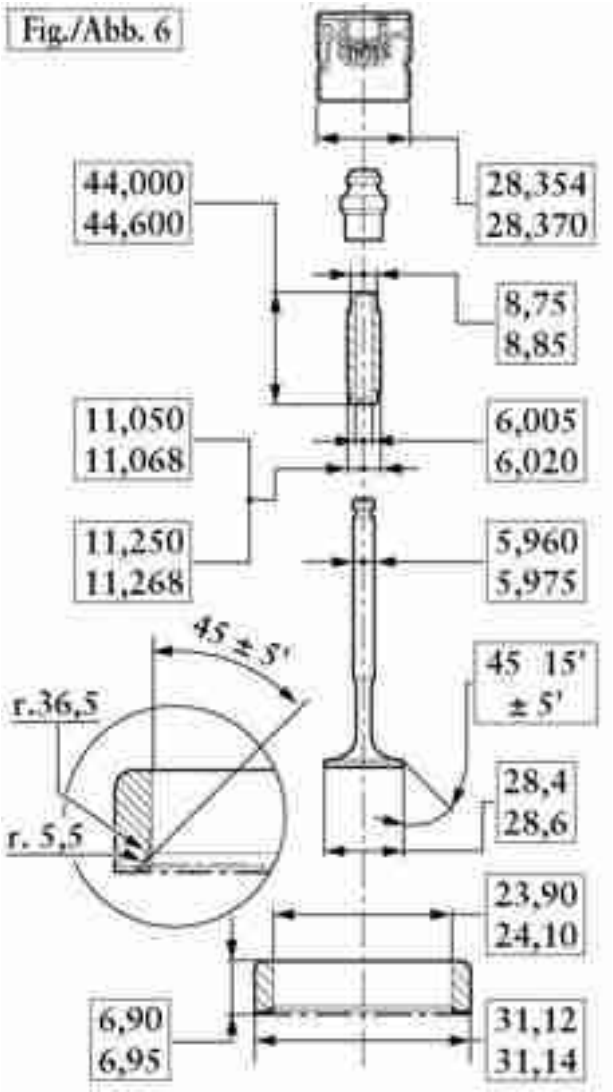
After grinding and chamfering, check that the area of the seats where chamfering is less angled is always on the duct side.

Assembling the valves and checking the springs

During overhauls, after a careful inspection, check the state of the valves (see **Figs. 5** and **6**) and replace them if necessary.

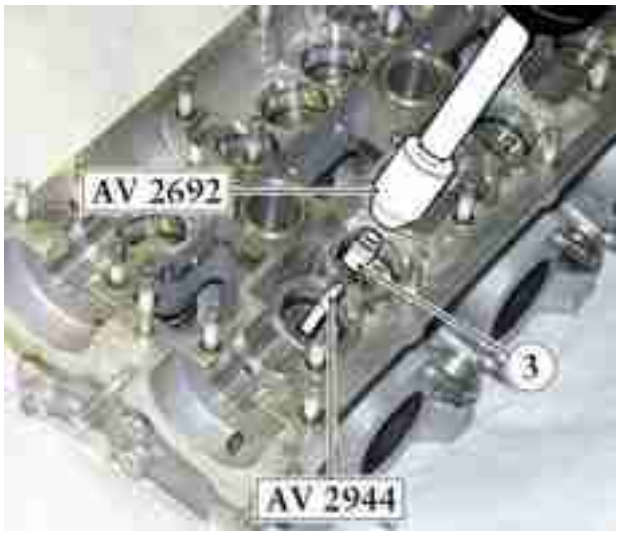


Intake

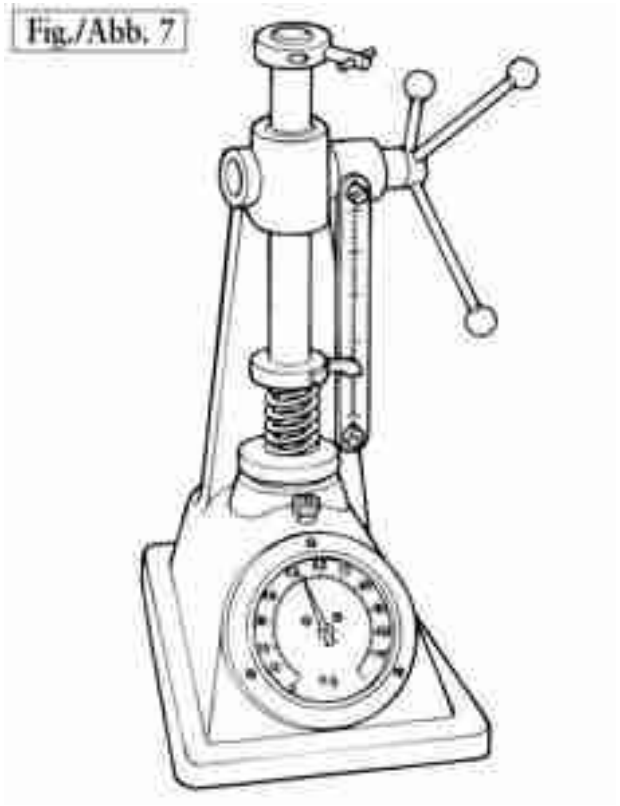


Exhaust

- The oil seals **(3)** must be replaced if necessary, or in any case, whenever new valves are being fitted. Use the **AV 2692** punch for oil seal insertion.
- Fit the **AV 2944** protection cap and lubricate the coupling with engine oil to prevent the groove for the cotters, found on the valve stem, from damaging the inner sealing surface of the oil seal.



- Check the state of the springs. Check the load and elastic deformation using the specific and commercially available tool **(Fig. 7)**.



- Compare the readings detected using the instrument with the nominal levels detected when they were new.

NOTES

Figures 8 *and* ***9*** *indicate the nominal lengths* ***(L)*** *that the springs should have depending upon the load* ***(N)*** *applied with the testing instrument.*

External *Internal*

Ll Free length
Ls - Static length
Ld - Dynamic length
Lp - Compressed length

- Replace springs that are deformed by a static load of **30 ÷ 50 N**.
- Visually inspect the upper and lower cups to ensure that they are intact.
- Re-fit the components using the compression tool used for disassembly.

Re-assembling the cylinder heads

- Thoroughly clean the head and crankcase coupling surfaces.
- Check the crankcase to ensure that the centring dowels **(4)** and **(5)** are fitted.
- Fit the new head gasket **(6)** on the crankcase.

NOTES

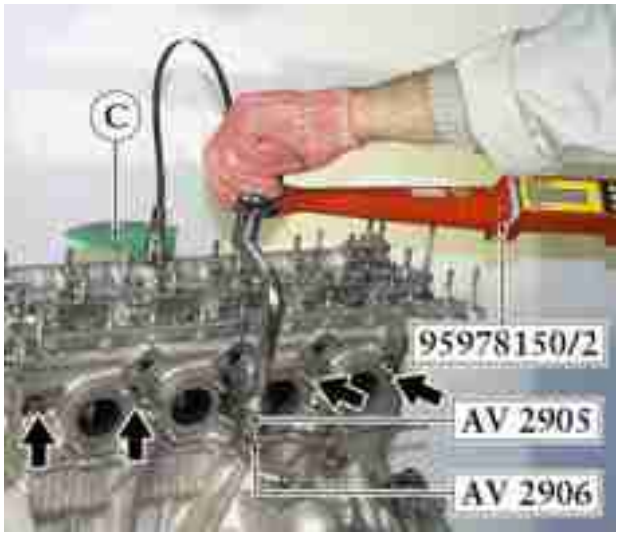
*The head gaskets have the word **"Alto"** (i.e. up) printed on them to facilitate positioning when re-assembling.*

- If the camshafts have already been assembled, rotate them in order to align the reference marks on both heads (B 3.02) and position the cylinder no. **1** piston, on the engine crankcase, at T.D.C.

IMPORTANT

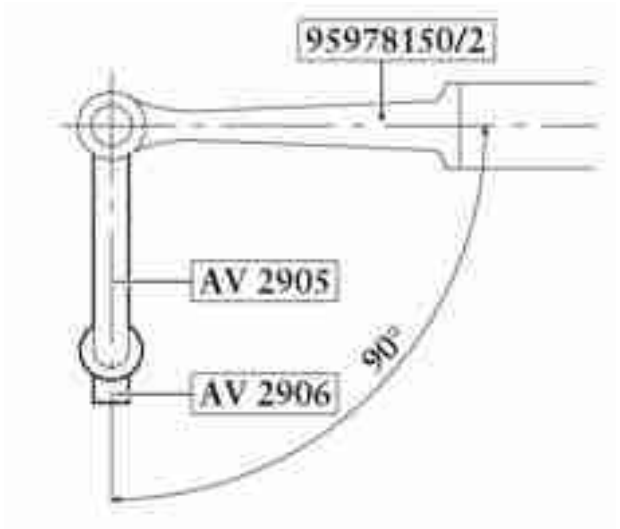
Be very careful during the next steps to ensure that the camshafts do not rotate. This would cause the valves to interfere with the piston crowns.

- Fit the heads on the crankcase and have them rest on the gasket.
- Lubricate the threading on the stud bolts and the contact surfaces between the nut and the washer with the prescribed grease.
- Tighten the nuts using the **AV 2906** box wrench and the **AV 2905** support provided with the **95978150/2** torque wrench for angle adjustment.
- Secure the wrench m agnet to the metal plate **(C)** installed and locked onto one of the head stud bolts.

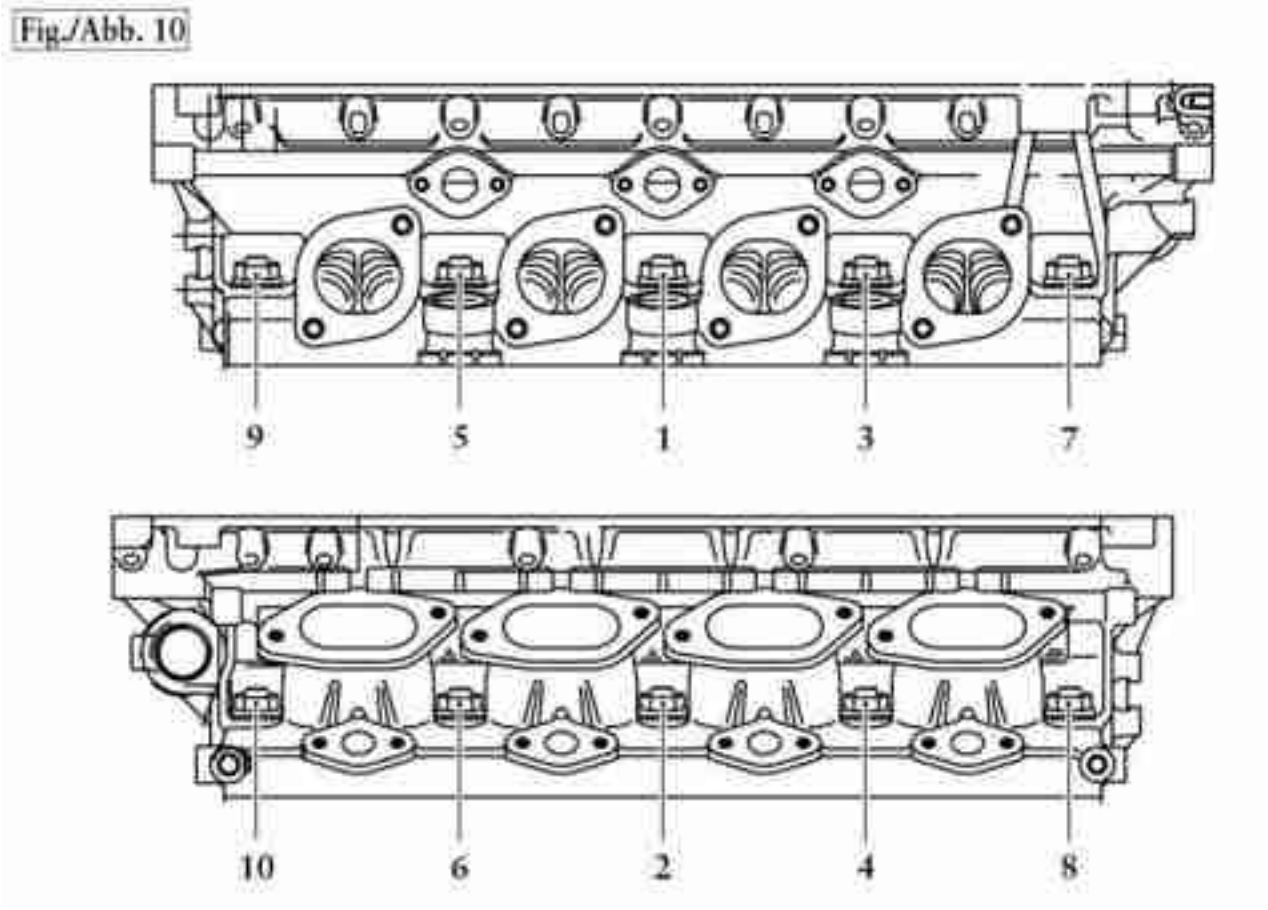


IMPORTANT

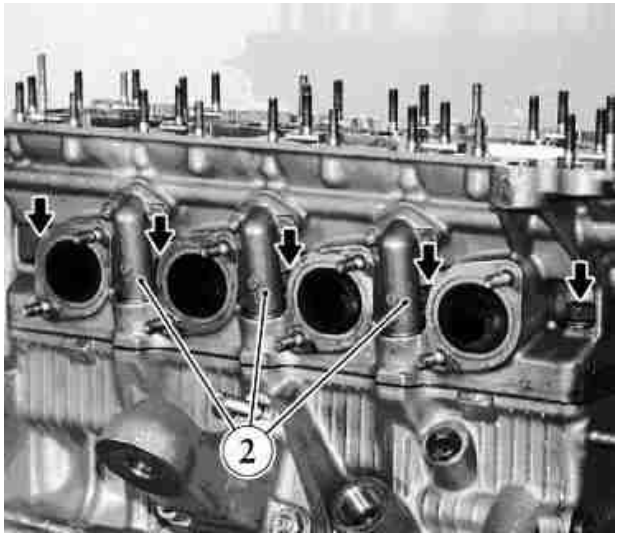
When the snap-lock occurs, the extension should prove to be at 90∞ with respect to the torque wrench arm.

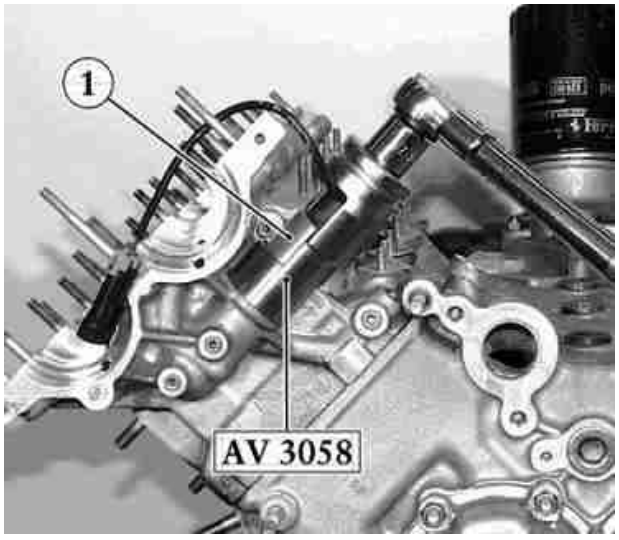


- Tighten the head nuts to the prescribed torque/angle, starting from the central nuts (see **Fig. 10**).



- Check the condition of the O-Rings on the oil drainage lines **(2)** from the heads. Then proceed with re-assembly on the head, lubricating them with the prescribed grease.





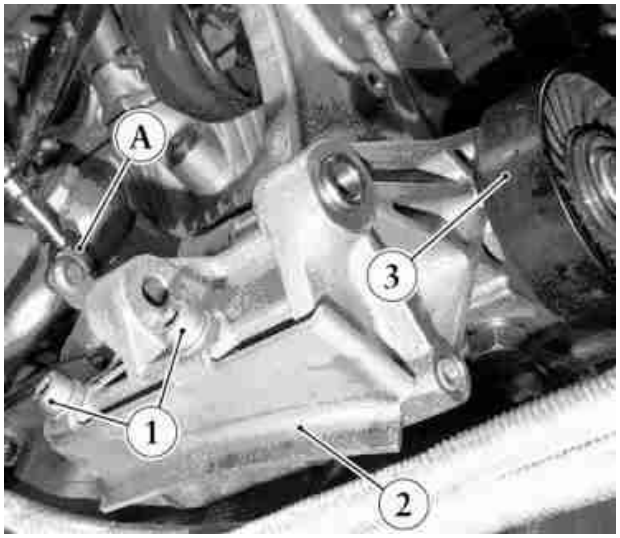
- Apply the prescribed sealant on the threaded part of the timing variator control solenoid valve **(1)** and tighten it on the head using the **AV 3058** tool, to the prescribed tightening torque.
- When replacing a solenoid valve, it is advisable to ensure that the new one is operating properly prior to assembling it.
- Connect it to a **12-V** electrical power outlet and check the noise level upon engagement.
- Proceed by re-assembling the camshafts (B 3.02), if they have been removed. Then re-fit the timing belts and adjust belt tension (A 3.03).

B3.04 OIL SUMP

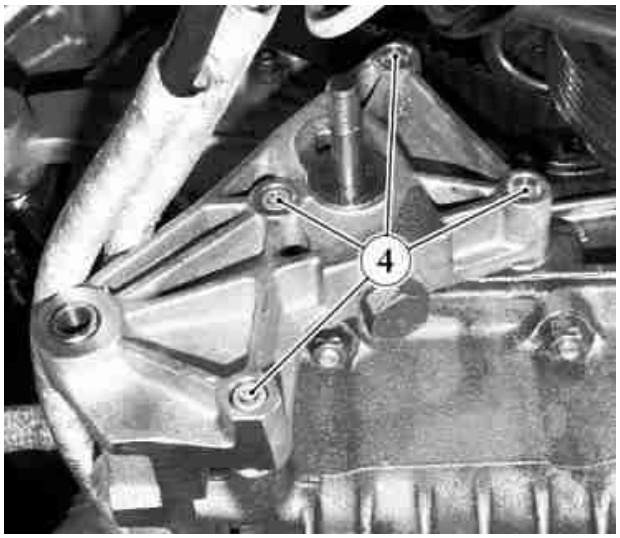
Tightening torques	Nm	Category
Nuts fastening the suction screen to the oil pump	**4,9**	**A**
Nuts fastening the buffle plate	**25**	**B**
Nuts fastening the oil sump to the crankcase	**25**	**B**
Screws fastening the oil sump to the rear cover	**25**	**B**
Screws fastening the oil sump to the gearbox housing	**56**	**A**
Screws fastening the generator support to the engine	**28**	**B**
Screws fastening the support and compressor to oil sump	**25**	**B**

Disassembly of the oil sump with the engine installed in the car

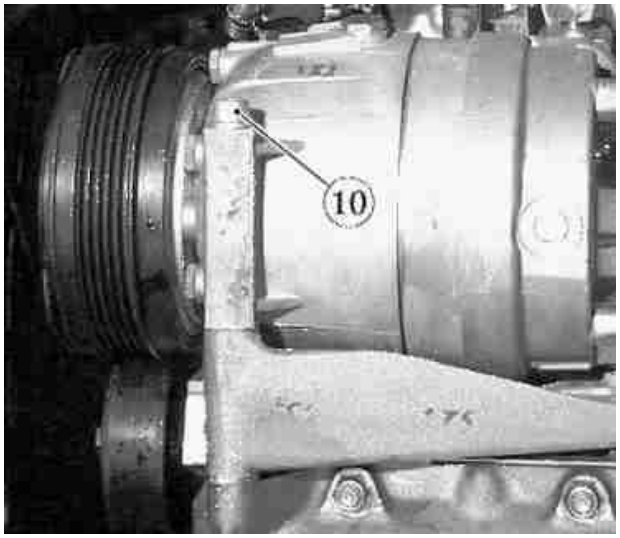
- Remove the rear element on the underfloor (M 2.12).
- Drain out all the oil in the engine (A 3.01).
- Remove the generator-water pump control belt (A 3.04).
- Remove the power generator (L 2.03).
- Remove the generator mounting from the crankcase by unscrewing the two side screws **(1)** on which the guide bracket **(2)** for the gearbox control Bowden cables is fitted.
- Detach the belt-tensioner pulley **(3)** from the generator mounting.
- Detach the clutch control oil pipe from the oil sump fastening bracket **(A)**.



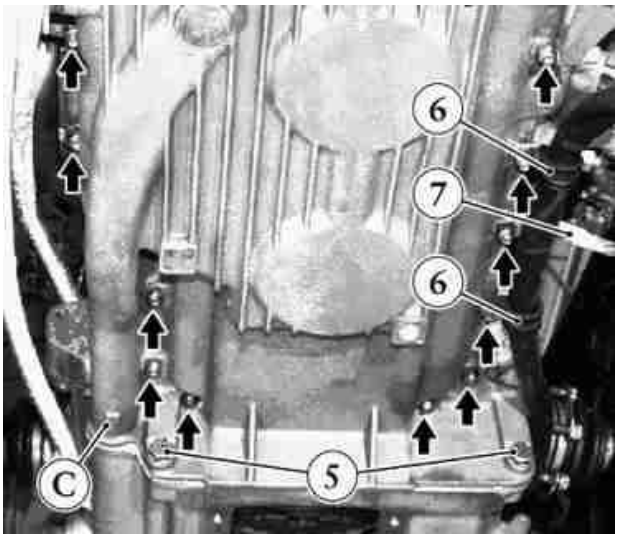
- Unscrew the four front screws **(4)** fastening the generator mounting and remove it from the crankcase.



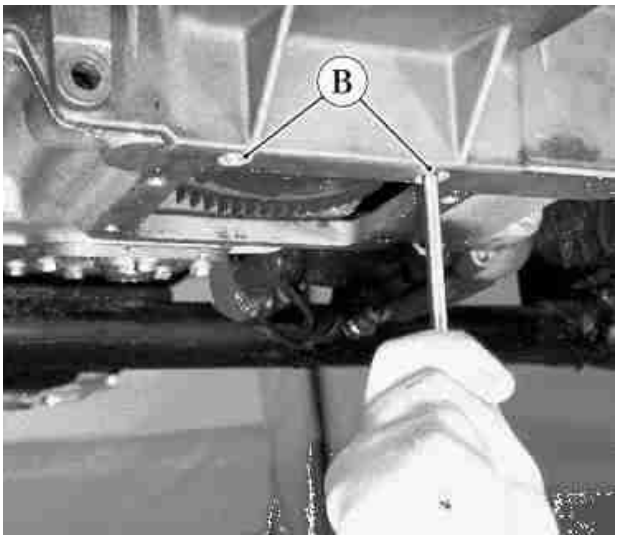
- Remove the screw **(10)** securing the A.C. compressor and respective mounting to the oil sump.



- Unscrew the two screws **(5)** fastening the oil sump to the gearbox housing, as well as all of the nuts fastening it to the engine crankcase.
- Slide the two supporting clamps **(6)** for the engine services wiring loom and the stranded earth wire **(7)** off of the stud bolts.

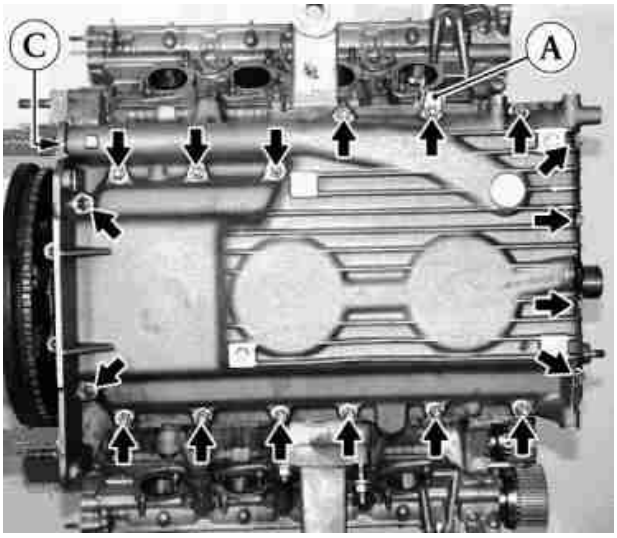


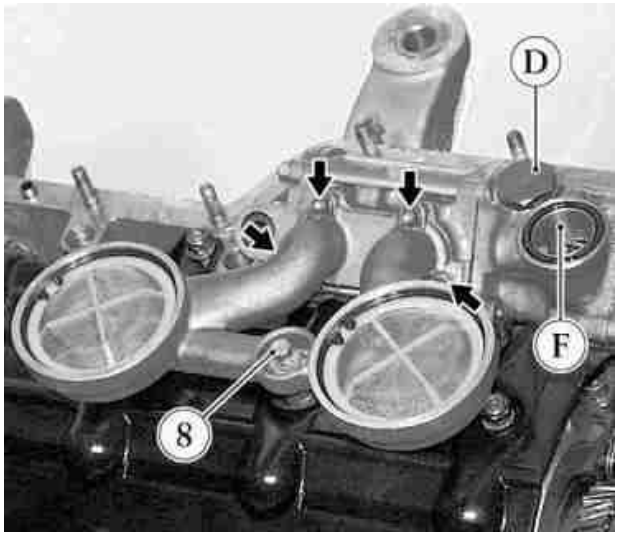
- After removing the clutch inspection cover, unscrew the two screws securing the oil sump internally to the rear cover of the crankcase, by working through the holes **(B)**.



- Strike various points of the oil sump with a rubber hammer until the crankcase is detached.

Remove the oil sump from the crankcase keeping the O-Rings found at the pipe **(C)** and on the intake pipe **(F)** for the delivery pump.





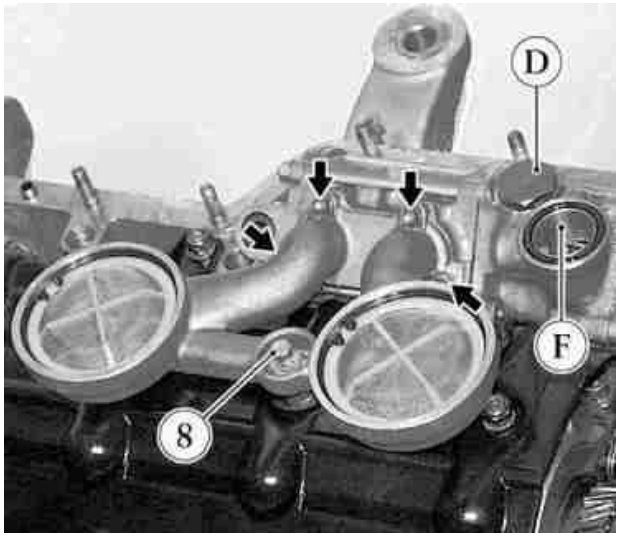
Disassembly of the oil sump with the engine on the bench

This procedure is relatively simpler in that many of the components have already been removed in order to move the engine to the bench. It includes the following phases already described above:

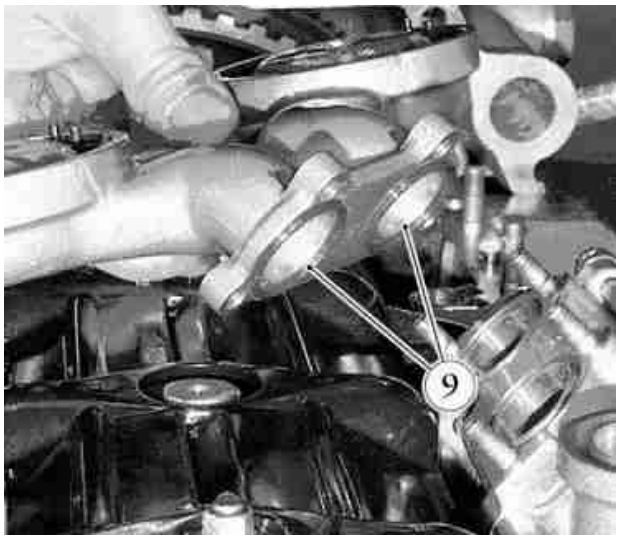
- generator mounting disassembly;
- removal of screws fastening the A.C. compressor and mounting;
- removal of nuts fastening the oil sump to the crankcase;
- disassembly of the oil sump and use of O-Rings on the delivery pump intake pipe **(F)**.

Disassembly of the suction screen and buffle plate

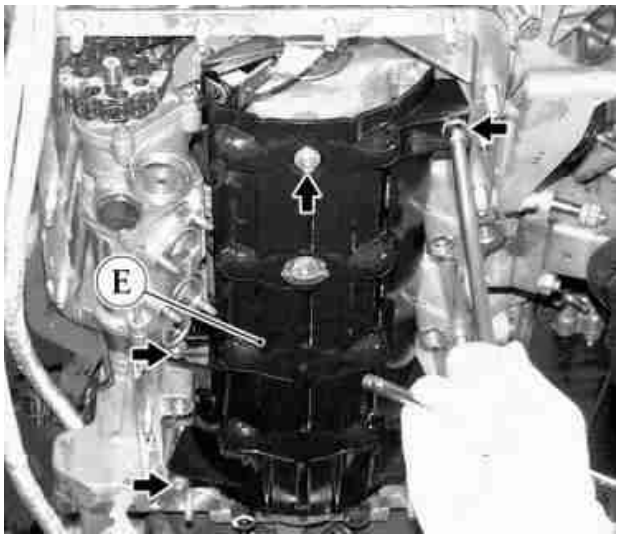
- With the engine in this condition, after having removed the cap **(D)**, it is possible to remove the pressure relief valve components (B 3.05).
- Unscrew the screw **(8)** between the two filters and the four fastening nuts.



- Remove the scavenging pump suction screen and the O-Rings **(9)**.

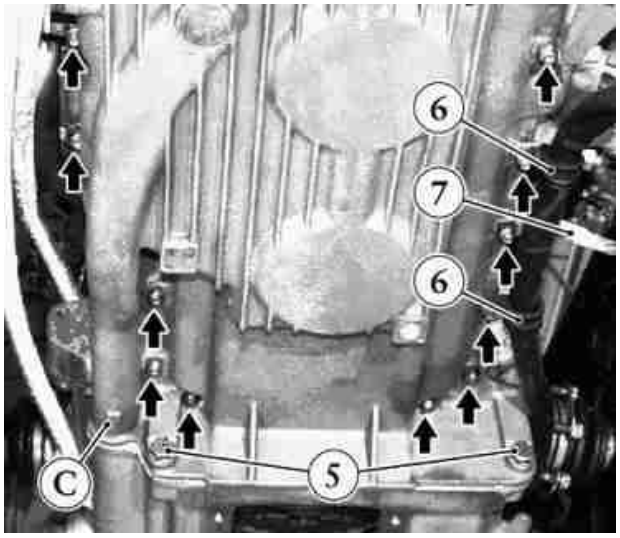


- Remove the buffle plate **(E)**, by unscrewing the six fastening nuts.



Re-assembly Notes

- Use tallow grease to lubricate the O-Rings on the suction screen and on the oil sump lines.
- Reassemble the suction screen and tighten the screws **(8)** and the fastening nuts to the prescribed torque.
- Carefully clean and degrease the coupling surfaces on the crankcase and the oil sump.
- Apply a thin, uniform and even layer of **CAF 4** sealer on the oil sump surface.
- With the engine installed in the car, be very careful with the O-Ring on the pipe **(C)** when re-assembling the oil sump on the crankcase. In these cases, it is useful to make use of a thin piece of foil to keep the O-Ring in the right position while coupling the sump with the crankcase.
- Position the supporting clamps **(6)** for the engine services wiring loom and the stranded earth wire **(7)** on the respective crankcase stud bolts.
- Tighten all screws and nuts to the prescribed tightening torque.



B3.05 OIL PUMP

Main specifications (mm)

Total gear - pump body radial clearance	
- Delivery and scavenging	**0,055 ÷ 0,105**
Total support - gear pin radial clearance	
- Driving and driven	**0,009 ÷ 0,043**
Wear limit	**0,080**
End float	
- Delivery and scavenging	**0,040 ÷ 0,086**
Backlash	**0,060 ÷ 0,140**

Tightening torques	Nm	Category	Product
Nuts fastening pump covers	**10**	**B**	
Pressure relief valve cap	**70**	**B**	
Screws fastening the pump to the crankcase	**25**	**B**	
Nut fastening pump gear unit	**65**	**B**	
Nuts fastening journal (pre-tightening 40 Nm)	**80**	**A**	Grease **MOLYKOTE 1000**

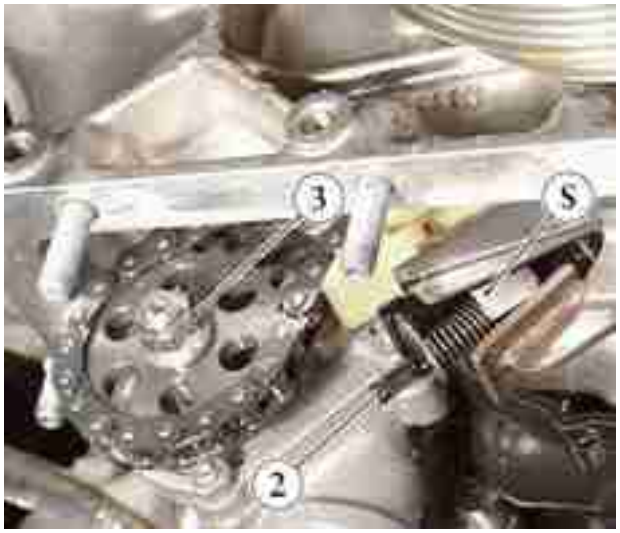
NOTES

The oil pump can be removed also with the engine installed in the car. Follow all of the steps listed in (B 3.04.)

Disassembly of the complete oil pump unit

- Remove the oil sump, the suction screen and the buffle plate (B 3.04).
- Remove the front crankshaft journal by unscrewing the two nuts **(1)**.

- Release the pressure from the chain created by the chain tightener, by compressing the spring by shifting the small support **(S)** and rotating the pin **(2)** counterclockwise.
- Unscrew the nut **(3)** fastening the gear unit on the oil pump and remove it.



- Remove the chain tightener device from the support bracket, removing the stop ring **(4)** and the respective washer.

- Unscrew the four screws fastening the oil pump and remove the pump from the crankcase. Keep the two O-Rings **(5)**.

Oil pump overhaul

- Carefully inspect the bodies and covers. Replace parts if any irregular grooves or wear are observable.
- Carefully clean the scavenging pump and delivery pump intake lines, delivery lines and intake filters by injecting pressurised wash oil.
- Unscrew the nuts **(6)** fastening the covers and disassemble the pump parts.

- Inspect the driving and driven gears. Replace them if any traces of deterioration or excessive wear is observable.
- Check the gear units and seats to ensure that the radial clearance and end float are within the nominal limits listed in **Fig. 1** and **2**. Replace them if excessive wear is observable (see "Main specifications").

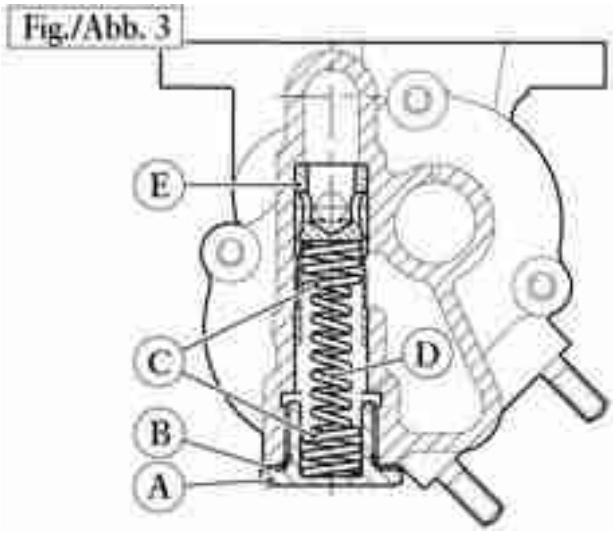
Re-Assembly

- When re-assembling the pump components, the contact surfaces on the pump bodies and covers must be cleaned thoroughly and degreased.
- Apply **AREXONS 4734 SYSTEM 35A10** sealer on the cover contact surfaces.
- Tighten the nuts **(6)** to the prescribed tightening torque.

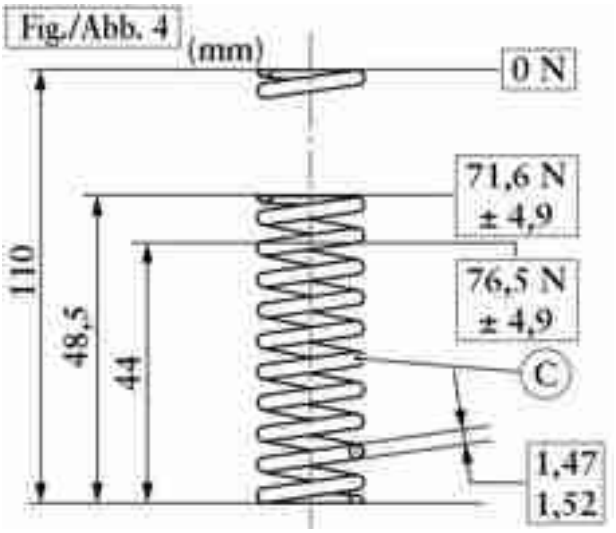
- Refill both pump bodies completely with engine oil (A 1.02).

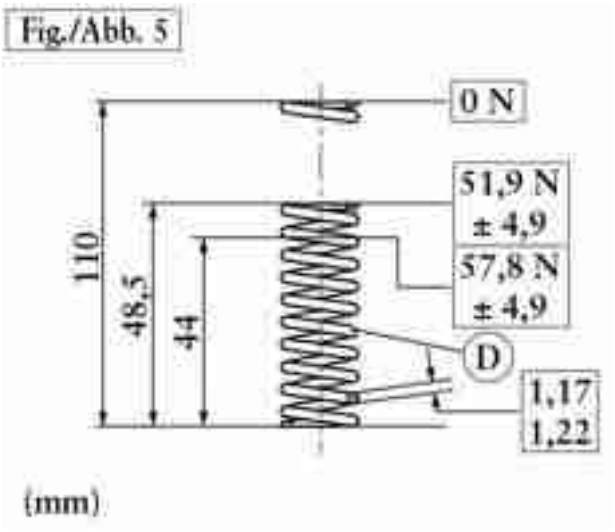
Pressure relief valve

It is necessary to unscrew the outer cap **(A)** with the gasket **(B)** to remove the valve components (**Fig. 3**).
The internal part of the pressure relief valve consists in an outer spring **(C)**, an inner spring **(D)** and a small piston **(E)**.



- Check to ensure that the small piston in the pressure relief valve is travelling uniformly and without interferences in its seat.
- Check the spring loads (**Figs. 4** and **5**).





- When re-assembling the valve, tighten the outer cap **(A)** to the prescribed torque.

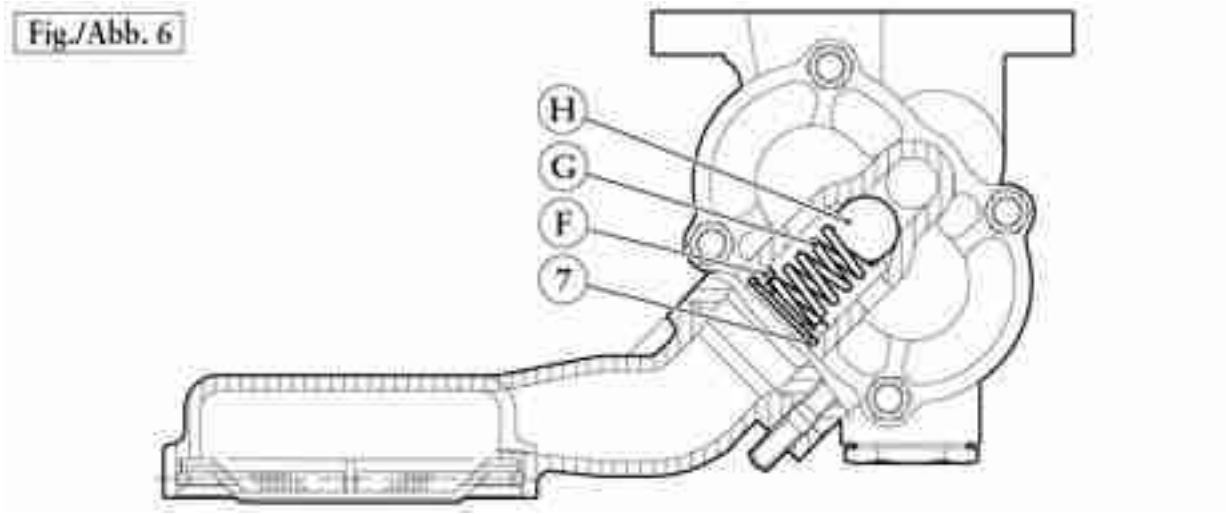
Safety valve

The stop ring **(7)** must be removed in order to remove the safety valve components **(Fig. 6).**

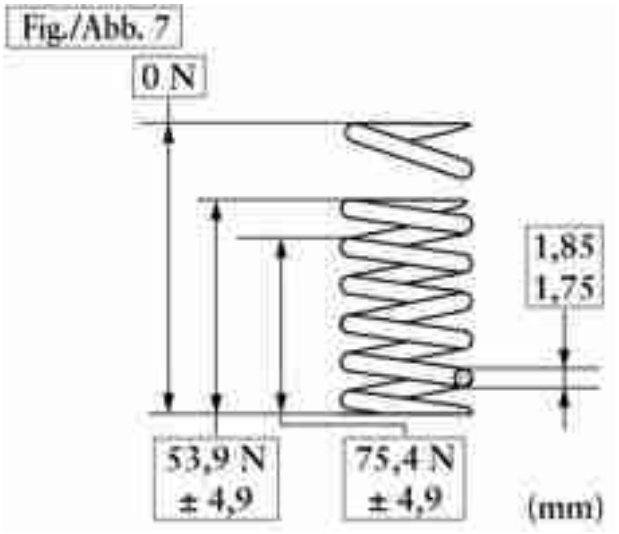
The valve is composed of a spacer **(F)**, a spring **(G)** and a ball **(H)**.

From engine No. 70853 a new spacer **(F)** has been introduced in order to increase the spring pre-load. Whenever the pump on the pre-modification engines is serviced, we recommend you replace the existing spacers with the new spacer **code number 196077**.

Fig./Abb. 6



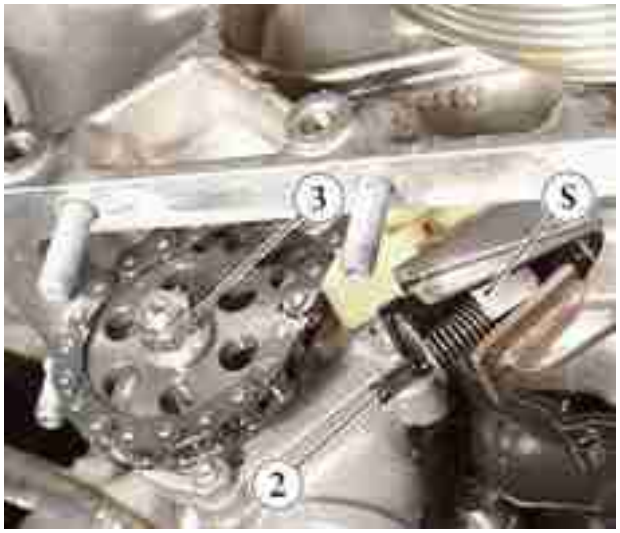
- Check the spring load **(Fig. 7)**.



Re-Assembly of the complete pump unit

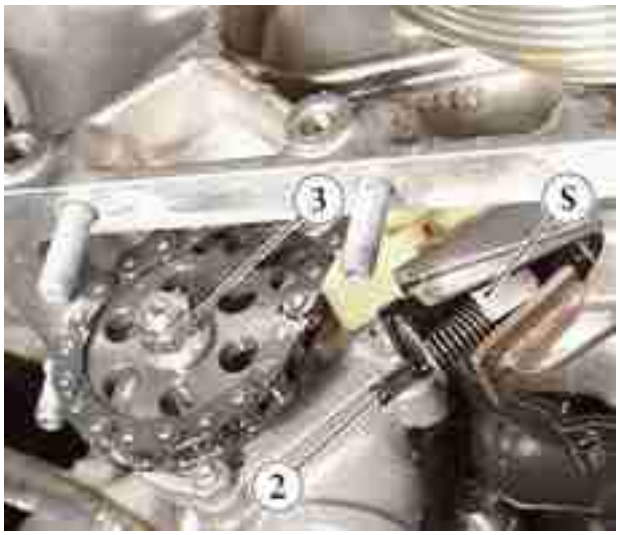
- Prior to re-assembly, check the state of the O-Rings **(5)** and lubricate them with tallow grease.
- Ensure that the bushing **(8)** is installed on the crankcase and then position the complete pump unit.

- Tighten the fastening screws to the prescribed torque.
- Fit the chain on the pinion and insert it on the pump shaft.
- Tighten the nut **(3)** to the prescribed tightening torque.



- Re-fit the chain tightener device and lock it with the washer and stop ring **(4)**.

- Release the pin **(2)** by rotating it clockwise in order to tension the chain.



- Re-fit the journal.
- Lubricate the washer contact surfaces on the nuts **(1)** and the inner threading with the prescribed lubricant.
- Tighten the nuts **(1)** to the prescribed tightening torque.

- Proceed by assembling all the parts previously removed for the procedure.

B3.06 PISTONS AND CONNECTING RODS

Main specifications (mm)

Piston *(in press)*

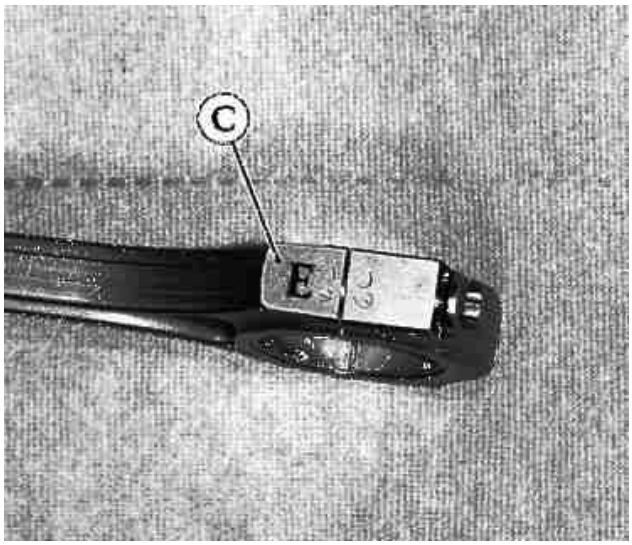
Piston - cylinder liner coupling	
- Installation clearance	(B 3.09).
- Wear limit	**0,100**
Seal rings - piston ring grooves (vertical) couplin	
- 1st oval ring (clearance)	**0,025 ÷ 0,070**
- 2nd cone-shaped ring (clearance)	**0,020 ÷ 0,055**
- 3rd oil-scraper ring (clearance)	**0,020 ÷ 0,055**
- Wear limit	**0,080**
Piston - gudgeon pin coupling	
- Installation clearance	**0,005 ÷ 0,016**
Seal ring wear limit	
(detected using the **ALZF 08501** tool)	**0,800 ÷ 1,000**

Connecting rod *(in titanium)*

Gudgeon pin - connecting rod small end coupling	
- Installation radial clearance	**0,015 ÷ 0,030**
- Wear limit	**0, 050**
Hub and connecting rod seat interference	**0,040 ÷ 0,090**
Coupling for connecting rod big end bearings-crankshaft	
- Installation radial clearance	**0,018 ÷ 0,067**
- Wear limit	**0,120**
Coupled connecting rods end float	**0,200 ÷ 0,339 (UP TO engine No. 89459)** **0,360 ÷ 0,499 (FROM engine No. 89460)**
Diameter of camshaft crankpins	
- Major diameter	**43,621 ÷ 43,637**
- 1st undersize (- 0,254)	

Classification

The pistons are sub-divided into two size classes, each of which is distinguished by a colour (pink and green), on the basis of the machining tolerances.
You must mount pistons and liners of the same colour.
The connecting rods complete with bushings and screws, are classified on the basis of their weight, and marked with a letter **(C)** on the head.

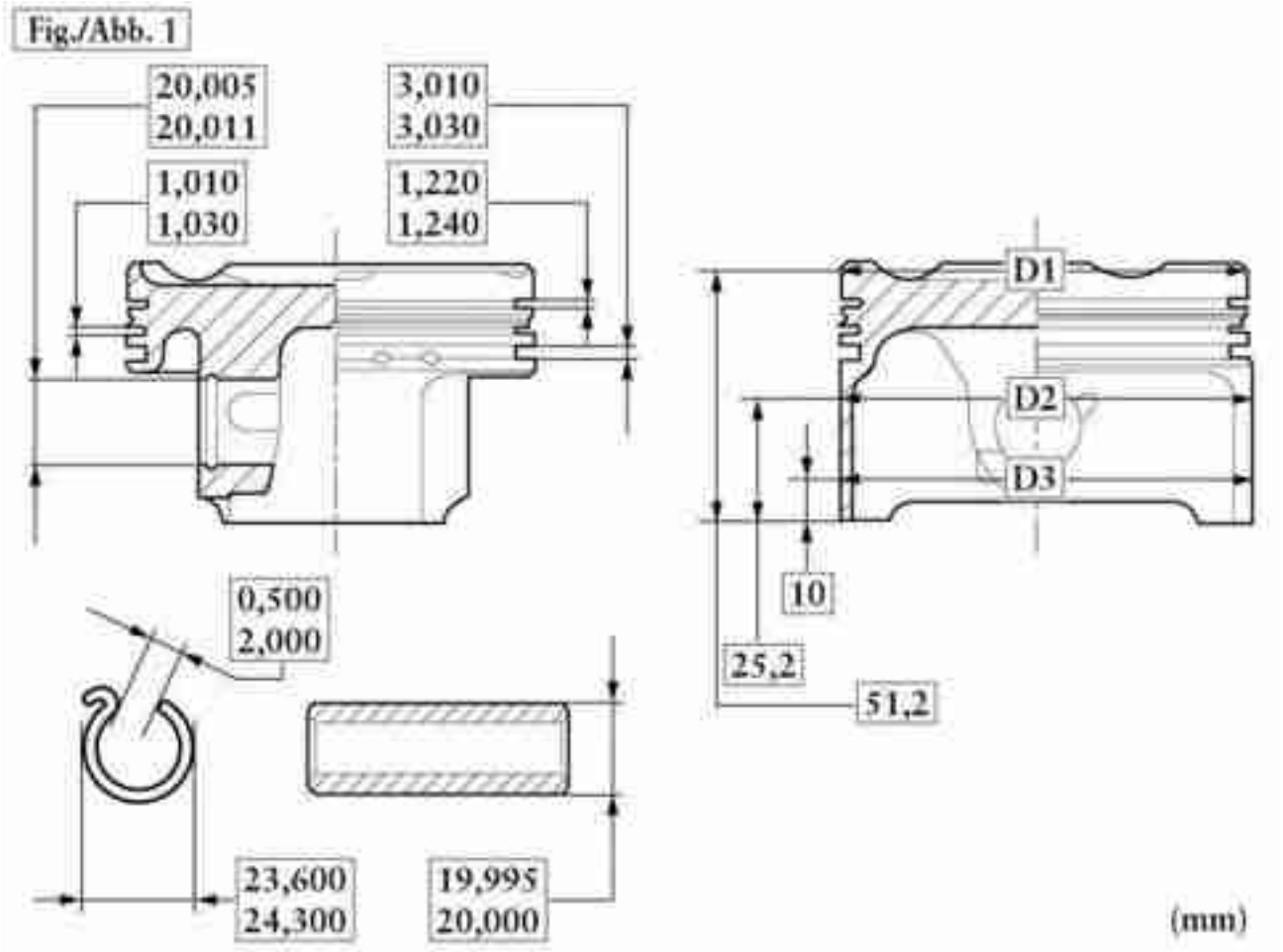


Connecting rod classification letter (C)	*Weight (gr)*
A	**380 ÷ 384**
B	**384 ÷ 388**
C	**388 ÷ 392**
D	**392 ÷ 396**
E	**396 ÷ 400**
F	**400 ÷ 404**
G	**404 ÷ 408**

-

Replace connecting rods with others bearing the same classification letter.

Piston classification colour		*Green*	*Pink*
*(see **Fig. 1**):*	**D1**(mm)	**84,913**	**84,903**
		84,927	**84,917**
	D2 (mm)	**84,883**	**84,873**
		84,897	**84,887**
	D3 (mm)	**84,495**	**84,485**
		84,525	**84,515**



Disassembly

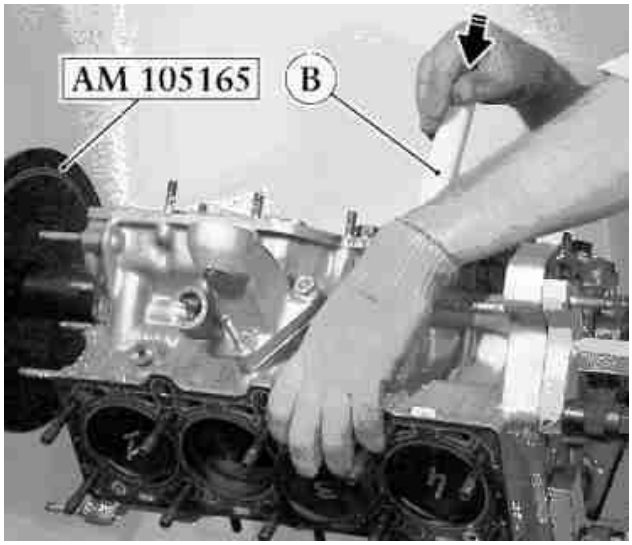
- Remove the cylinder heads (B 3.03).
- Remove the oil sump, the scavenging pump suction screen and the buffle plate (B 3.04) to gain access to the connecting rod screws.

NOTES

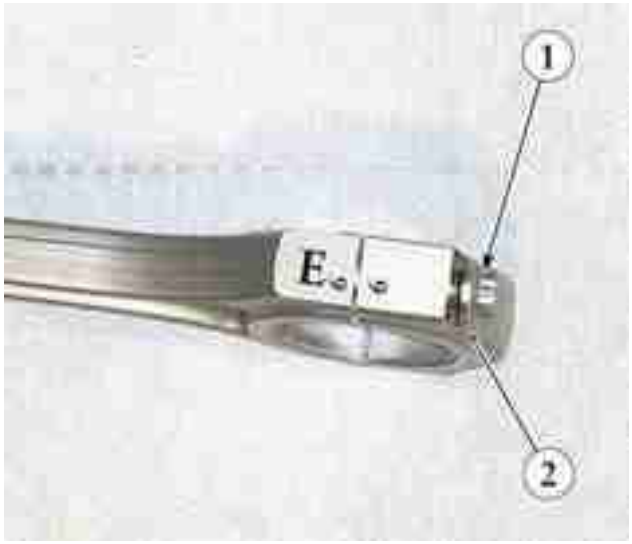
*It is advisable to mark each piston with a number **(A)** referring to its position on the bank in order to re-fit each piston in its respective liner.*

- Loosen the connecting rod screws **(1)** and remove the cap **(2)** from the crankshaft.

- Push the connecting rod towards the upper end of the liner, using a rubber pin **(B)**. In addition, be very careful not to bump it against the piston cooling nozzle. If necessary, rotate the crankshaft using the goniometer-holder tool **AM 105165** to facilitate access to the screws.



- Remove the piston complete with the connecting rod from the liner.
- Re-assemble the connecting rod by securing the respective cap **(2)** to the stem with the fastening screws **(1)**.

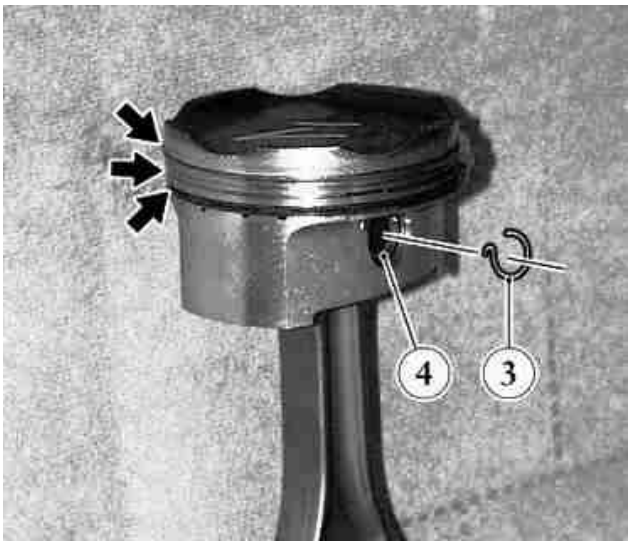


- Remove the stop ring **(3)** and the gudgeon pin **(4)** to free the connecting rod small end from the piston

NOTES

Mark each connecting rod with the number of its respective piston to avoid mismatching them during re-assembly.

- Remove the segments from the piston ring grooves.

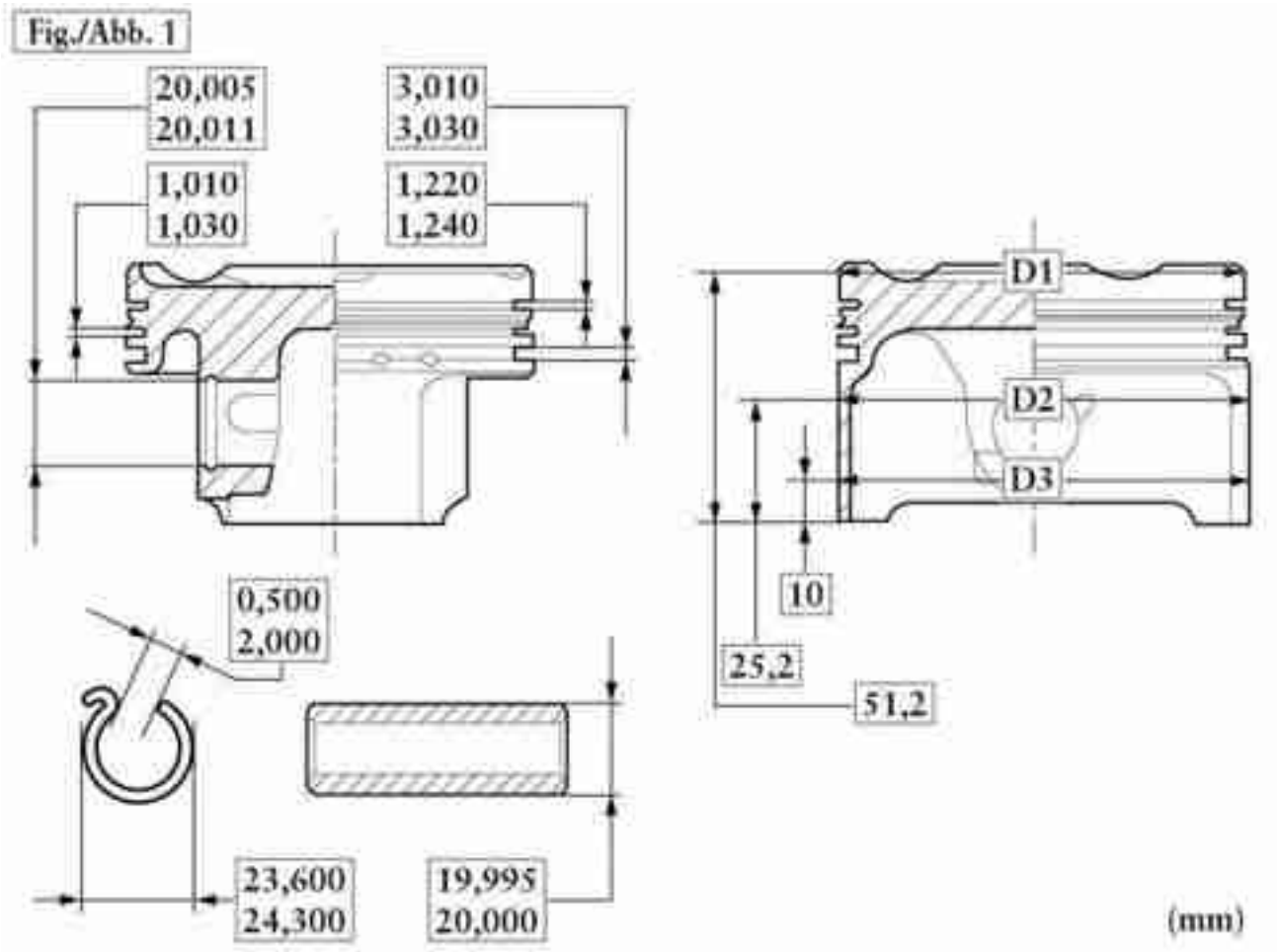


Cleaning and checking pistons

- Carefully clean the pistons. Remove deposits from the crown and grooves of the seal rings.

IMPORTANT
Do not use scrapers or pointed tools as they could damage the coupling surfaces.
Avoid tightening the piston in a vise.

- Clean the lubrication holes.
- Proceed by checking the dimensions of the piston (see **Fig. 1**) and its respective liner (B 3.09).



- Perform a thorough inspection of the skirt and check for wear, using the prescribed values as a reference (see "Main specifications").

IMPORTANT
Replace the pistons if uncertain as to their conditions.

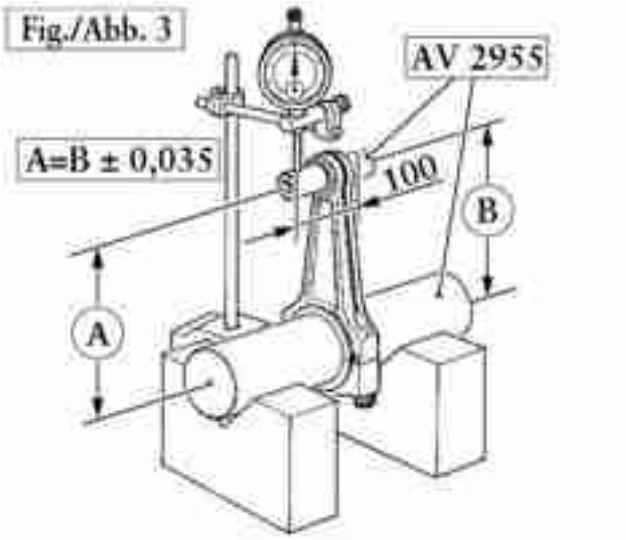
Checking the connecting rods

- With each engine overhaul, check the bushing in the small end of the connecting rod for wear using the **TLDF 02060** punch.
- Check the total end float of the coupled connecting rods (see **Fig. 2**).

- In order to check the end float, use a suitable fork feeler gauge and check upon the sides of the connecting rods that are touching and also the external sides of the connecting rods touching the crankshaft counterweights.

In the event that the values exceed the wear limit (see "Main data"), replace the bushings and/or the connecting rods.

- Use punch **AV 865** to insert a new bushing and be especially careful about having the lubrication holes on the bushing coincide with the holes on the small end of the connecting rod.
- Use the **AV 2955** pins **(Fig. 3)** to check the small and big end axes* of the connecting rod for parallelism.



- The connecting rods are made of titanium. Check them with penetrating fluids if uncertain about their condition.

On the **Euro 3** cars, **FROM Ass. No.** 41323 (Engine **61587**)**,** and on **USA** cars, **FROM Ass. No. 42010** (Engine **62332**), a “slot” has been machined on the internal sides of the connecting rods to improve the lubrication of their contact surfaces after fitting onto the engine shaft.

From engine no. **89460**, a new connecting rod has been introduced which has a molybdenum insert in the area where the connecting rods are touching and allows greater end float.

The engines installed in the vehicles produced until now are equipped with four types of connecting rods, each of which has a different fitting technique.

The table below shows the specifications and the use on the engines manufactured.

Type	*Spare parts code*	*Use on engines*	*Processing*
A	**176477**	**FROM the** first engine produced **TO** No. **61586** (Rest of the world) **TO** No. **62331** (USA)	No lubricating channels machined
B	**190113**	**FROM** engine No. **61587** (Rest of the world) and No. **62332** (USA **TO** engine No. **71272**	Machined with lubricating channels
C	**196976**	**FROM** engine No. **71273**	Machined with lubricating channels
D	**212652**	**FROM** engine no. **89460**	With molybdenum insert

The type **A** connecting rods, (no slot), can be used as long as the coupling end float is respected (see "Main data").

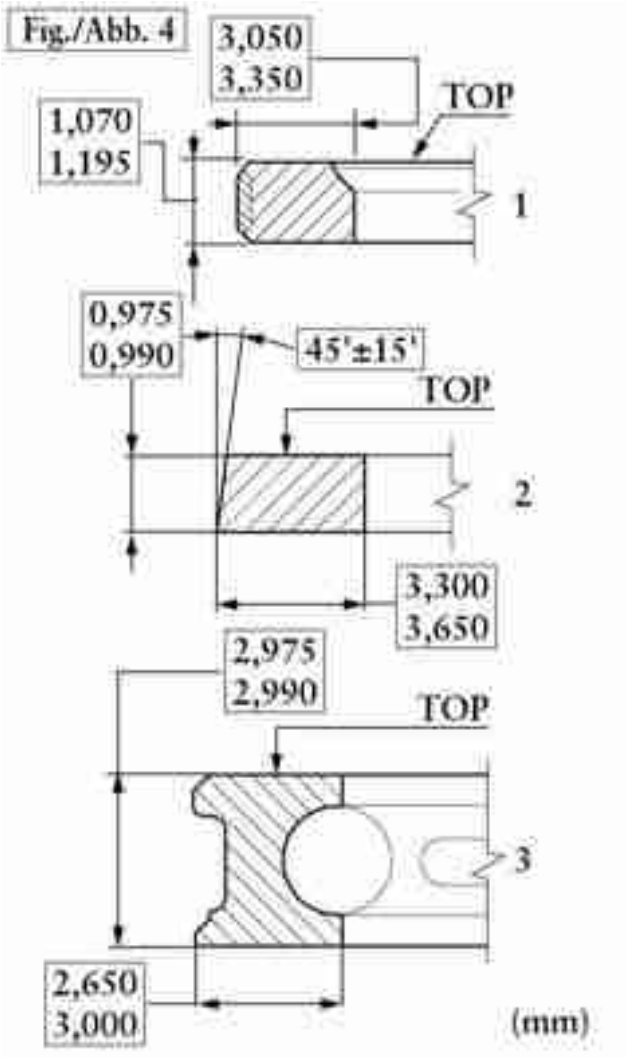
Connecting rods types **B** and **C**, machined with lubricating channels, must be arranged on the crankshaft with the machined surface positioned in the area where the connecting rods are touching.

Type **D** connecting rods must be arranged on the crankshaft with the machined surface positioned in the area where the connecting rods are touching.
When fitting new connecting rods Type **D**, mark the external side of the cap with a **M** (molybdenum) to facilitate future checks.

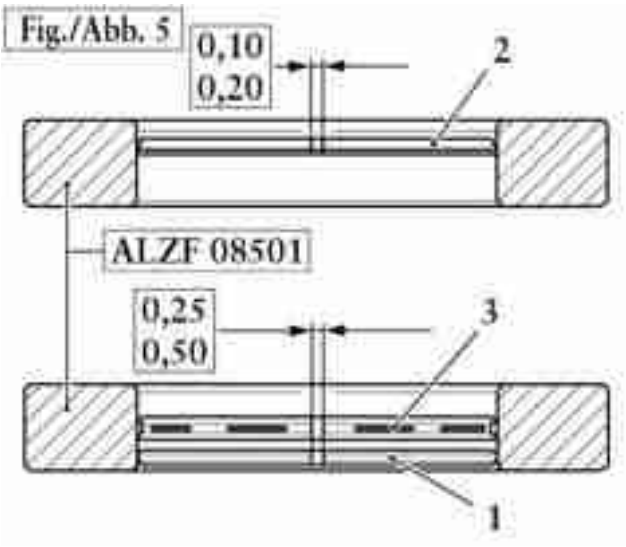
The half-bearings to be used for all the different types of connecting rod are those with the **red** rated colour class, part No. **193622**.

Checking the seal rings

- After removing the seal rings from the piston and removing any deposits, check them thoroughly for grooves, cracks or traces of excessive wear. Replace them if any of the above are observed.
- Perform a dimensional check on the seal rings, using the nominal levels listed in **Fig. 4** as the reference levels.



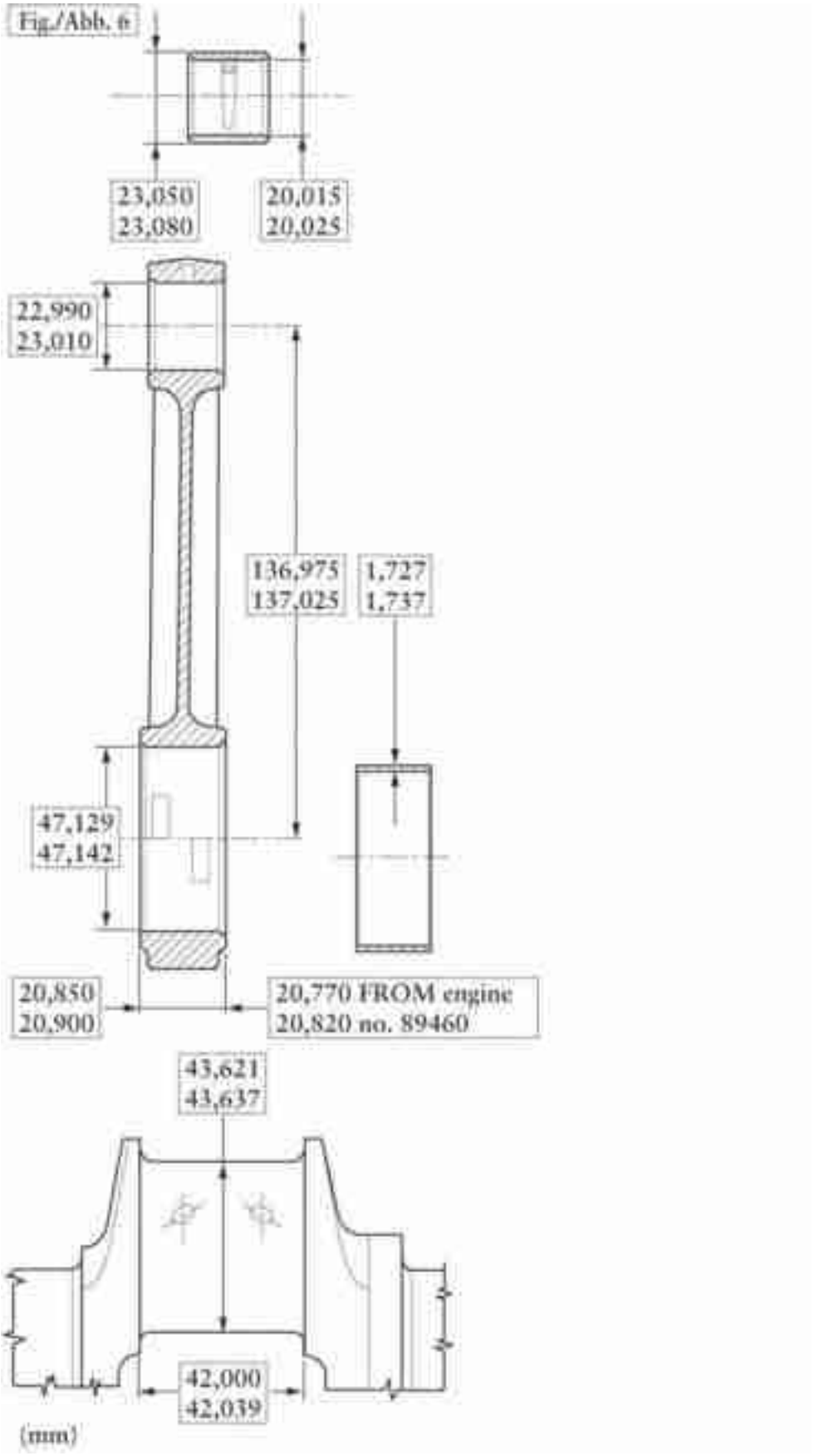
- Insert each ring in the **ALZF 08501** tool, ensuring that they are at perfect right angles with respect to the tool axis. Also check to ensure that the end opening value lies within the prescribed range (see **Fig. 5**).



Checking the pins and connecting rod bearings

- When overhauls are being carried out, carefully check the connecting rod bearings. Replace them if any grooves or traces of excessive wear are observed.
- If the connecting rod bearings **(5)** are in good condition, fit them in their seats on the connecting rod head and cap. Then tighten the screws **(1)** to the established torque.

- Use the bore meter to measure the bore of the bearings **(5)** and the diameter of the crankshaft pins (see **Fig. 6**).



- If the dimensions of the diameter of the crankshaft pins fall within the tolerance range and the undersize from wear of the bearings is lower than the cut-off limit (see "Main specifications"), it is not necessary to replace them.

- Should wear prove to exceed the cut-off limits, replace the bearings with other oversized ones and reduce the pins on the crankshaft to the prescribed values.

NOTES

The connecting rod bearings have a thin shell and cannot undergo machining of any type. This rule serves to prevent removal of the white metal layer.

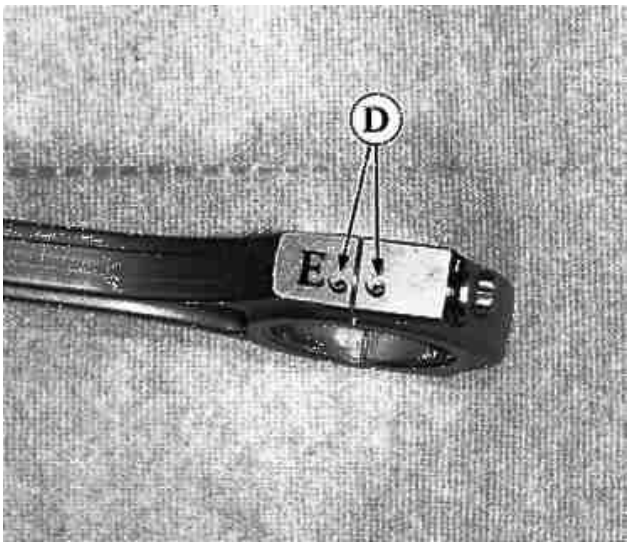
Assembly of the piston with the connecting rod

Assembly of the Piston with the Connecting Rod

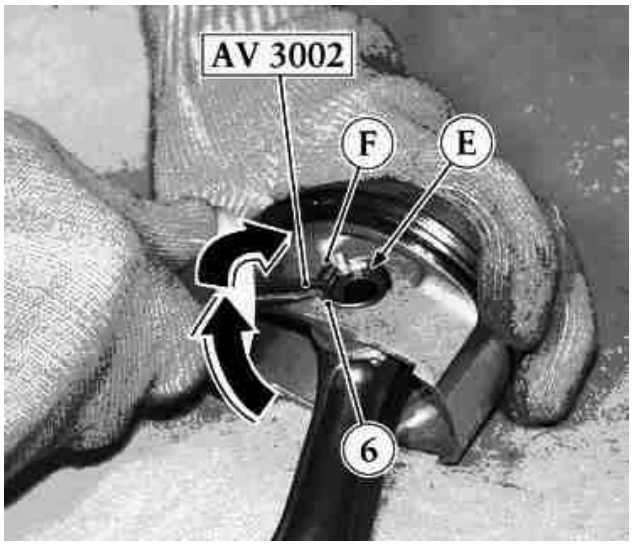
- On the upper peripheral edging, the pistons have five milling faces, where the valves are situated. When assembling, ensure that the edging with three milling faces is facing the intake side.
- When the piston is coupled with the connecting rod, ensure that the markings **(D)** on the stem and the cap, which distinguish the specific connecting rod cylinders, are always positioned towards the exhaust side.

IMPORTANT

If new connecting rods are used, mark the cylinder reference number on the stem and on the rod cap by means of an air or electric pen.



- Ensure that the gudgeon pin Seeger ring is correctly installed on one side of the piston.
- Lubricate the gudgeon pin and the bushing on the small end of the connecting rod with engine oil. Then proceed with fitting by bringing the gudgeon pin flush with the insertion point on the stop ring.
- Using the **AV 3002** tool, lay the end **(E)** of the stop ring **(6)** at the point of the piston highlighted in the figure. Turn the ring while pushing it with the tool until it reaches the curved end **(F)** found on the piston ring grooves.
- Raise the tool grip for insertion of the end **(F)** in the piston seat.



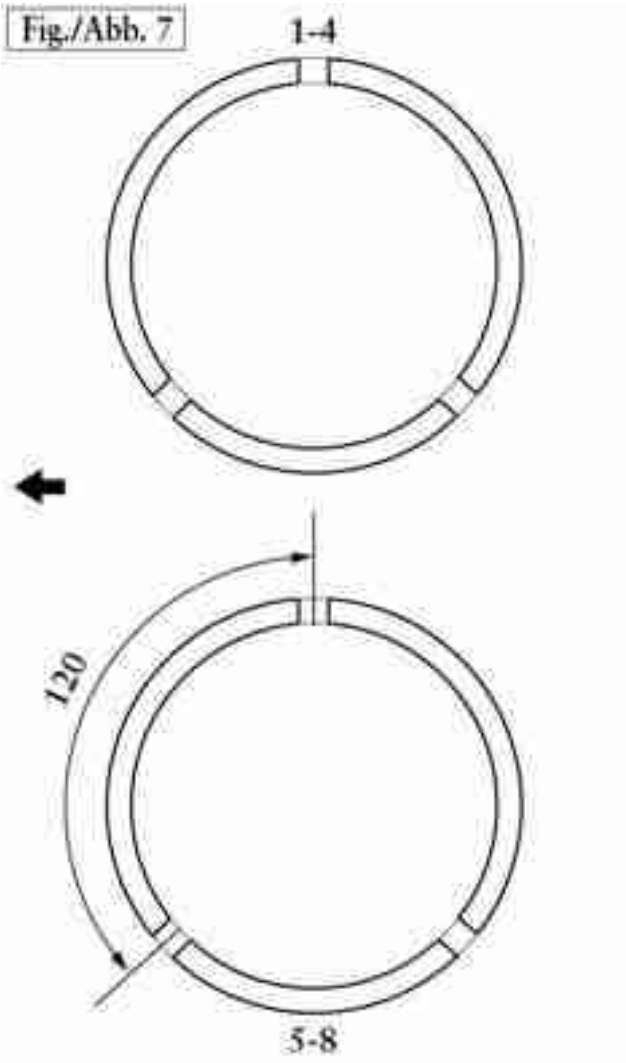
IMPORTANT

To avoid damaging the engine, after each re-assembly procedure, ensure that the two gudgeon pin seeger rings are properly positioned in the piston ring grooves.

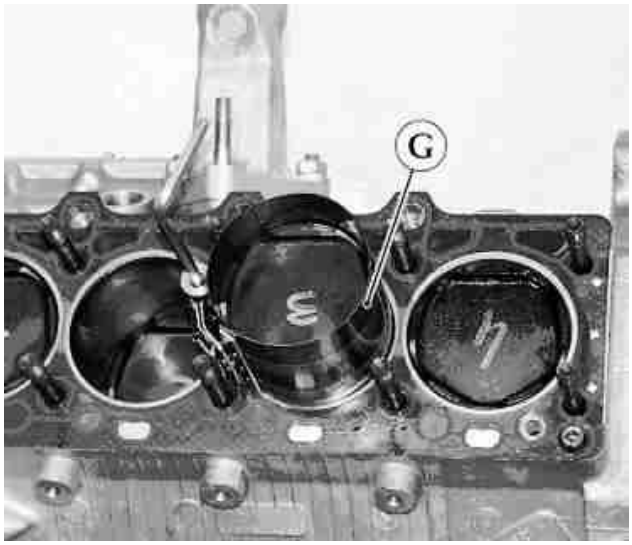
Re-Assembly of the piston-connecting rod unit

Use a special tool that is available on the market to facilitate assembly of the seal rings on the pistons.
Ensure that the word **"TOP"**, printed on the seal rings, is facing upward.

- Be especially careful about ensuring that the oil scraper clamp joint is not found over the aperture of the ring itself.
- Once they have been inserted in the piston, ensure that the seal rings rotate freely in their seats.
- Prior to final assembly of the connecting rod - piston assembly in the liner, lubricate the rings and liner with engine oil.
- Position the apertures at intervals of about **120°** (see **Fig. 7**) so that they are not on the piston thrust side (RH bank intake, LH bank exhaust).



- Compress the seal rings without changing their position, using a commercially available taker-in **(G)** and then push the piston into the liner.



- Lubricate the crankshaft pins and the connecting rod bearings with engine oil. Then position the caps.
- To tighten the connecting rod screws using the **95978150/2** torque wrench for angle-checking, proceed as follows:

- carefully wash the screws and threading on the connecting rod with solvent;
- lubricate the thread and underhead of the screws with **MOLYCOTE 1000** grease;
- screw in the screws with a torque of **15 Nm**;
- complete the tightening procedure, setting the angle prescribed for the type of connecting rod that will be fitted, as shown in the table below.

Type	*Spare parts code*	*Tightening the connecting rod screws*	*Notes*
A	**176477**	Screw up the screws (without tightening them) to a torque of **15 Nm** and complete the tightening procedure by setting an angle of **45°±1**° Check that the total tightening torque falls between **35 and 55 Nm**	This is no longer used and must be replaced by type **B** connecting rod
B	**190113**	Screw up the screws (without tighening them) to a torque of **15 Nm** and complete the tightening procedure by setting an angle of **45°±1°** Check that the total tightening torque falls between **35 and 55 Nm**	Connecting rod to be used in the procedure for tightening to **15 Nm** + **45°±1°**
C	**196976**	Screw up the screws (without tighening them) to a torque of **15 Nm** and complete the tightening procedure by setting an angle of **65°±1°** Check that the total tightening torque falls between **50** and **75 Nm** and that the extension of the screws falls between **0.140** and **0.170 mm**	Sole connecting rod to be used in the procedure for tightening to **15 Nm** + **65°±1°** only.
D	**212652**		

IMPORTANT
Connecting rod screws can be used once only.

- Re-fit the buffle plate, the scavenging pump suction screen and the oil sump (_____).
- Re-fit the cylinder heads (B 3.03).
- Proceed by re-fitting the timing belts and adjusting the tension (B 3.01).
- Re-assemble all of the components removed previously, re-fit auxiliary part belts and adjust belt tension (A 3.04).

B3.07 CRANKCASE COVERS AND SUPPORTS

The front cover is secured to the crankcase and to the oil sump. It contains the seats for the bearings supporting the driven gears in the timing system.
There is a seat for the seal ring on the crankshaft.
The rear cover is secured to the crankcase and to the oil sump. It serves to support the seal ring at the rear point of the crankshaft.

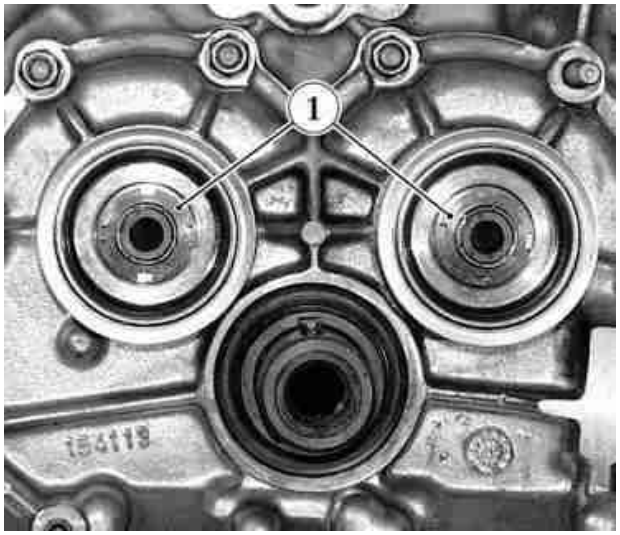
Tightening torques	Nm	Category
Ring nut fastening the pulley	**118**	**B**
Nuts fastening front cover	**25**	**B**
Nuts fastening brackets on front cover	**28**	**B**
Screws fastening hydraulic tighteners	**25**	**B**
Screw fastening belt-tensioner arm	**49**	**B**
Screw fastening A.C. compressor mounting	**28**	**B**
Nut fastening oil pump pinion	**65**	**B**
Nut fastening rear cover	**10**	**B**

Replacing timing system pulleys and driven gear bearings, with the engine installed in the car

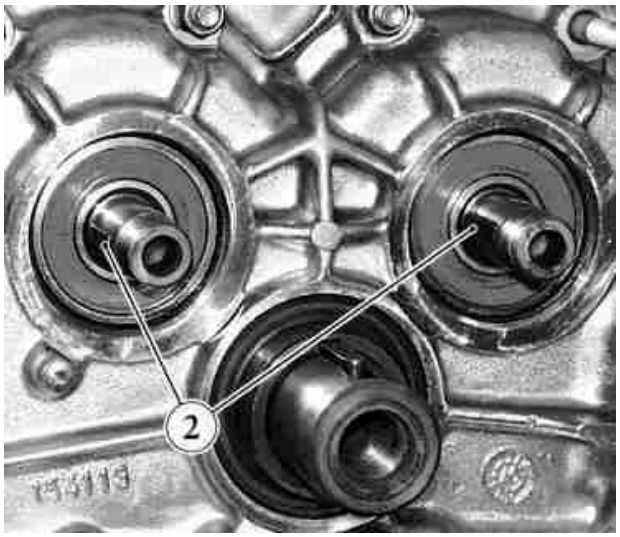
NOTES
Pulleys and driven gear bearings can also be replaced with the engine installed in the car and working through the engine inspection lid (M 3.05). The figures show an engine on the bench to offer a better understanding of the procedure.

- The timing belts (A 3.03) must be removed in order to disassemble the front pulleys.
- Use tool **AV 815** to loosen the ring nut **(1)** fastening the pulley on the driven gear.

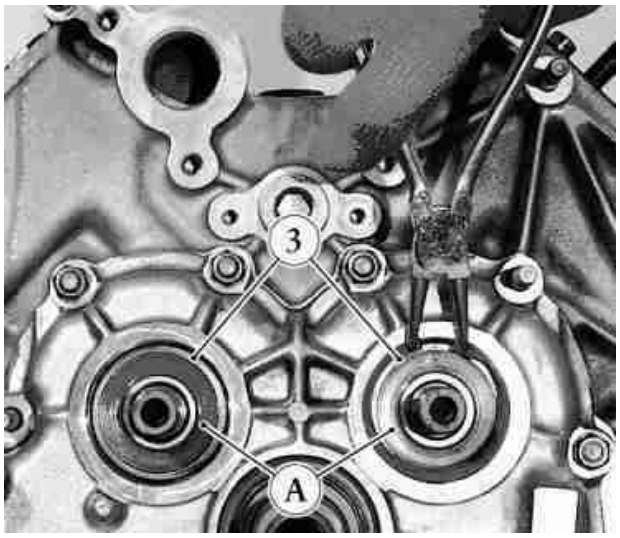
NOTES
*In order to use the **AV 815** tool in every situation, both if the engine is on the bench or inside the car, its length should be adjusted.*



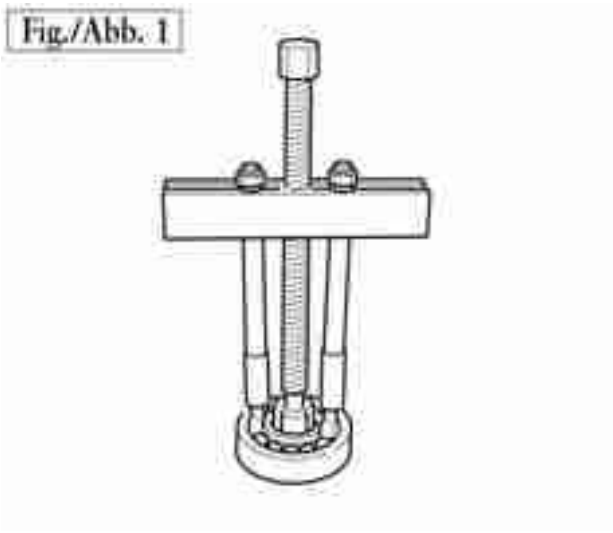
- Extract the pulley and remove the tab **(2)** on the timing system driven gear shaft.



- Remove the Seeger ring **(3)** and the bearing shield **(A)**.



- We recommend to use the extractor Model **U.23** manufactured by **FACOM** (see **Fig. 1**) to extract the bearing.

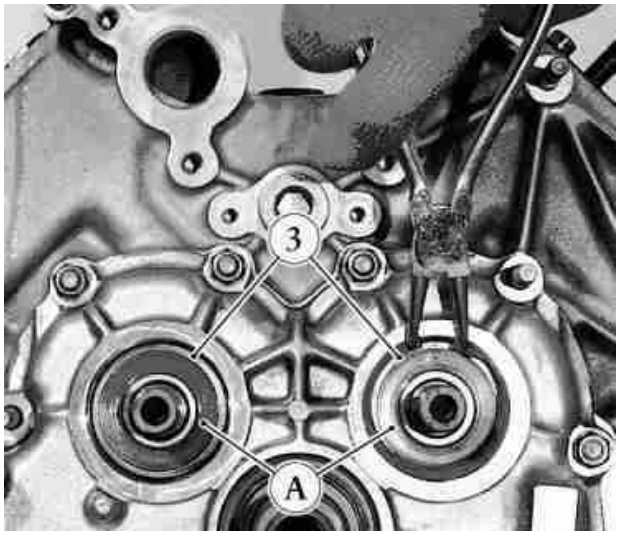


- Two diametrically opposite holes must be made on the ball bearing cage to permit insertion of the round tips of the tool.
- Proceed with extraction, carefully following the manufacturer's instructions to prevent damage to the seat on the cover.

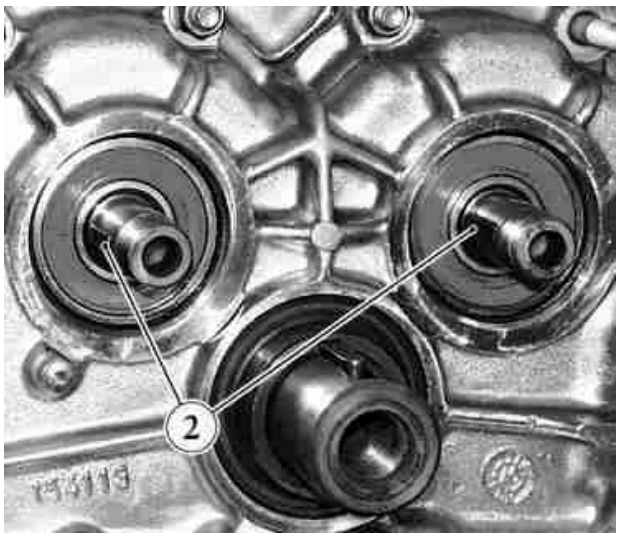
Re-Assembly

- Ensure that the inner shimming is installed in the seat of the bearing that has been removed. Then insert the new bearing, using the **AV 3047** punch.

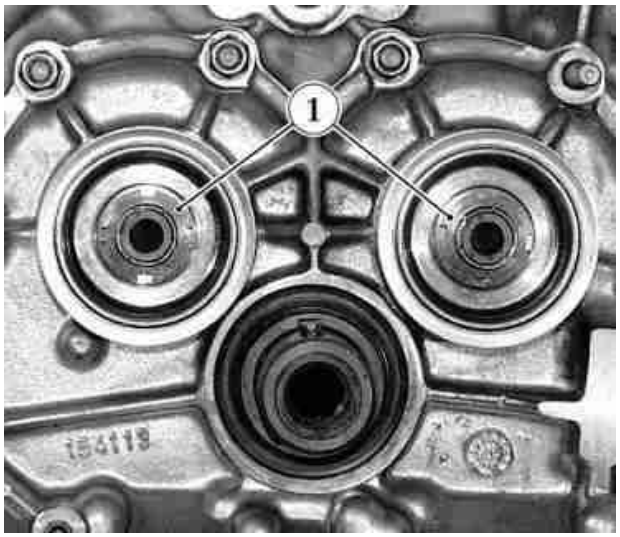
- Position the new bearing so that it is perfectly perpendicular in the cover seat, with the shielded side **(A)** facing outwards. Then bring it flush with the inner shim.
- Fit the Seeger ring **(3)**, ensuring that it has been inserted perfectly.



- Proceed with fitting the tab **(2)** and the pulley on the gear shaft



- Use a new self-locking ring nut **(1)** and tighten it to the prescribed torque



- Proceed by re-fitting the timing belts (A 3.03) and all of the components previously removed for the procedure.

Replacing the seal ring for the crankshaft on the front cover, with the engine installed in the car

NOTES

The seal ring on the crankshaft can also be replaced with the engine installed in the car and working through the engine inspection lid (M 3.05). The figures show an engine on the bench to offer a better understanding of the procedure.

- Remove the pulley on the crankshaft (A 3.03).
- Remove the worn seal ring **(4)** using two screwdrivers for leverage at diametrically opposite points.

IMPORTANT

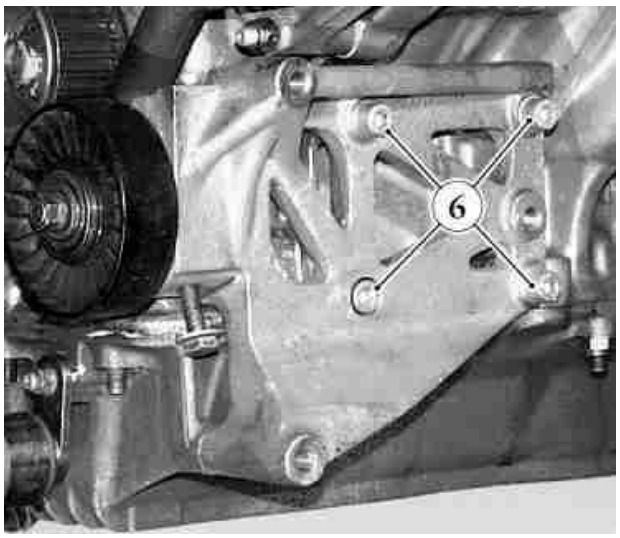
*Be careful to avoid damaging the outer surface of the driving pinion **(5)**.*

Re-Assembly

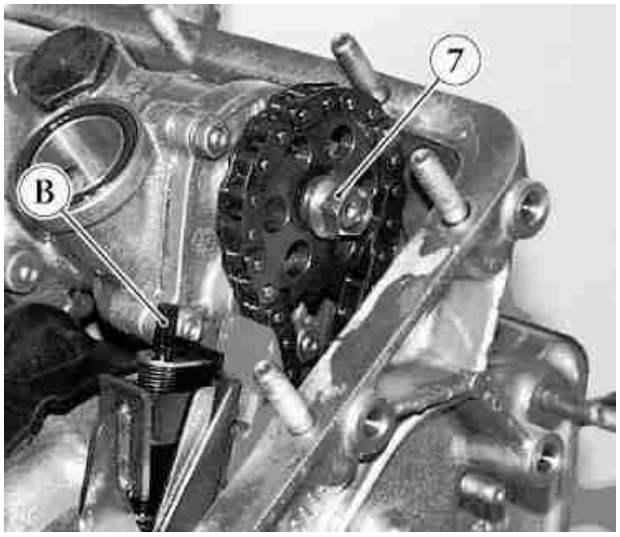
- Lubricate the surface of the driving pinion **(5)** and the lip of the new ring with engine oil.
- Position the **AV 3039** tool inserter on the crankshaft and insert the seal ring with the side equipped with the spring facing the engine.
- Use the tool punch to bring the seal ring flush with the front cover.
- Proceed by re-fitting the pulley on the crankshaft (A 3.03) and re-assembling all components previously removed for the procedure.

Detaching the complete front cover unit

- Remove the timing belts (B 3.01).
- Remove the A.C. compressor (I 2.01).
- Remove the A.C. compressor mounting by unscrewing the screws **(6)**.

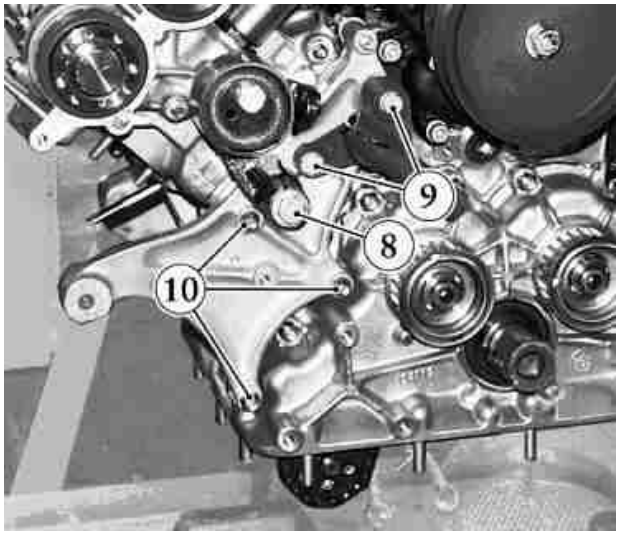


- Remove the oil sump (B 3.04).
- Turn the pin **(B)** counterclockwise and push it to release the oil pump control chain tension.
- Unscrew the nut **(7)** fastening the oil pump pinion.

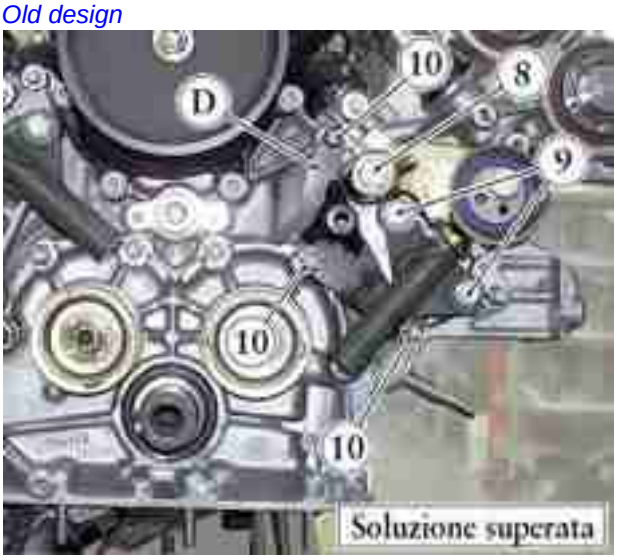


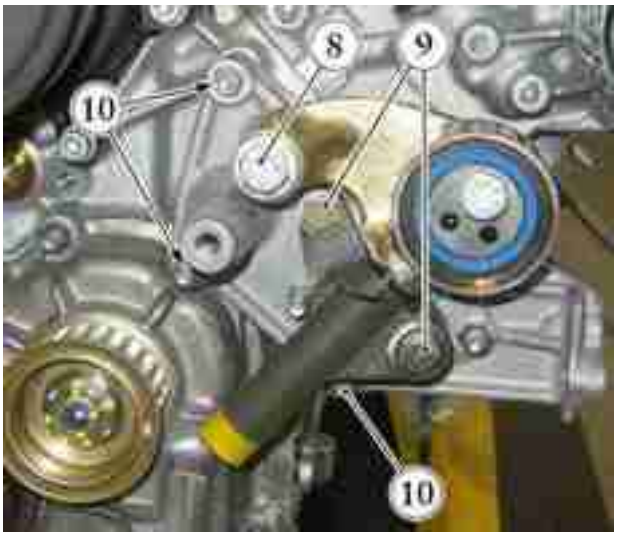
- Remove the brackets with the timing belt-tensioner pulleys by unscrewing the screws **(8)**.
- Remove the belt-tensioners by unscrewing the screws **(9)**.
- Unscrew the nuts **(10)** and remove the alternator supporting bracket, on the right-hand side, and the A.C. compressor supporting bracket, on the left-hand side.

In the first engines produced, there was a mount **(D),** fitted on the left-hand bracket, which supported the pulley holding the alternator/water pump belt's tensioner bearing (no longer supplied as a spare part).
With the new design, the said mount is incorporated into the cast piece of the left-hand bracket.

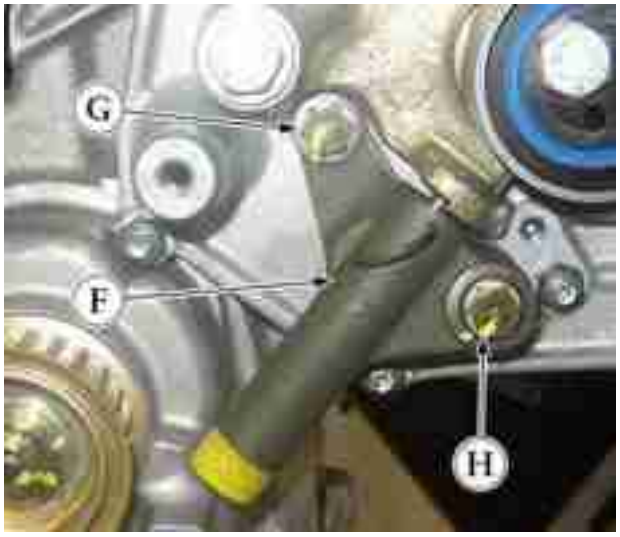


Old design





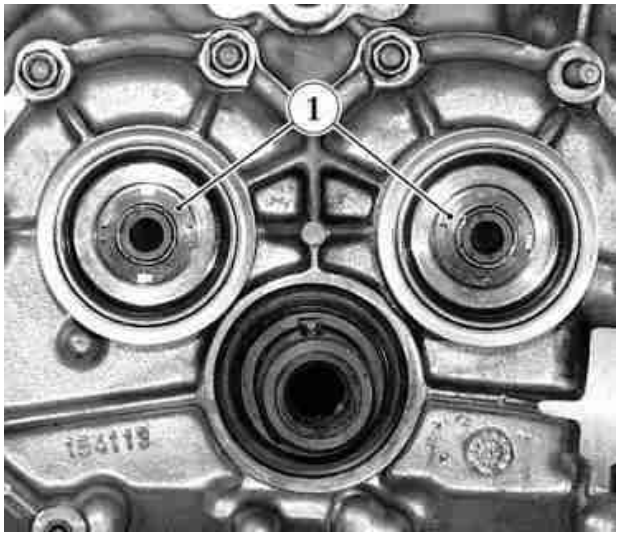
From engine No. 75740 a new left-hand belt tensioner **(F, part no. 192920)** has been fitted. This new part features a reinforced section, which the previous version did not have and must therefore no longer be fitted.
In addition to the said left-hand belt tensioner, the fastening screws **(G, part no. 205693)** and **(H, part no. 185234)** have also been replaced and are now built with a more resistant material (from R80/100 to R120).
The new screws are recognisable by their yellow or silver zinc coating and they ensure the tightening torque remains unaltered.



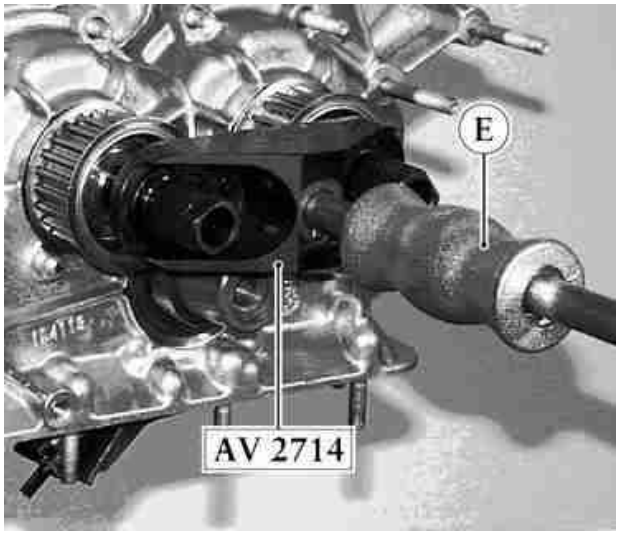
From engine No. 82119 a new left-hand belt tensioner supporting bracket (**part no. 202786**) has been fitted, with a hole for fastening a mechanical retainer **(L)**, composed of a screw with the relative washers and nut.
In the event of breakage of the tensioner, the said retainer may prevent serious damage to the engine.

From engine No. 83762 a new left-hand belt tensioner (**part no. 202784**) has been fitted, with a dowel to prevent the tensioners being swapped.

- Unscrew all the nuts fastening the front cover to the crankcase.
- Remove ring nuts **(1)** fastening the driven pulleys of the timing system, as explained above.



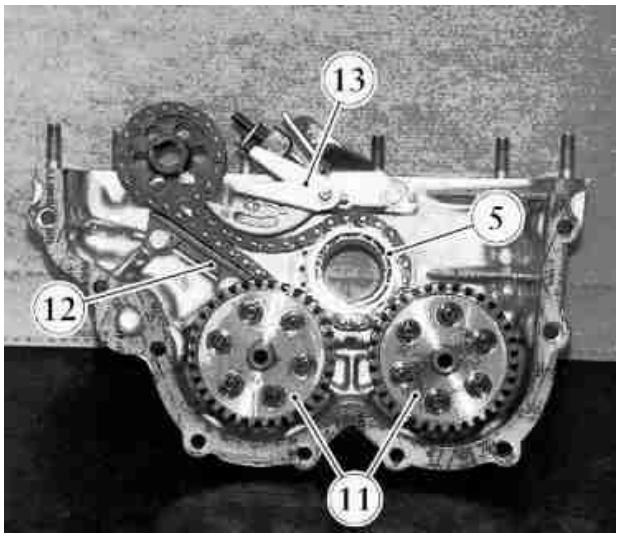
- Tighten the **AV 2714** extractor pins on the driven gear shafts of the timing system and by means of the grip **(E)**, detach the front cover from the crankcase.



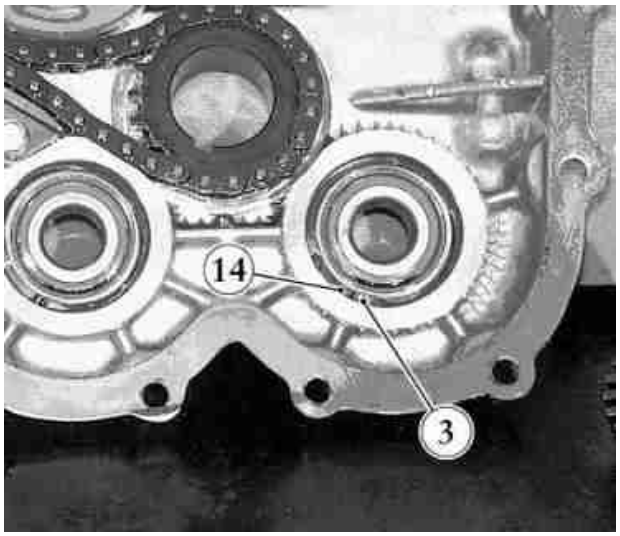
- Slide the pinion with the chain off of the oil pump and remove the complete cover unit.
- Remove the gasket, which must always be replaced.

Replacement of front cover components

- Remove the complete front cover unit, as explained above.
- The following can be replaced with the cover removed:
  - the driven gears **(11)** of the timing system;
  - the entire oil pump control gearing, including the driving pinion **(5)**, the chain and the driven pinion;
  - the fixed shoe **(12)**;
  - the chain tightener device **(13)** and the respective supporting bracket.



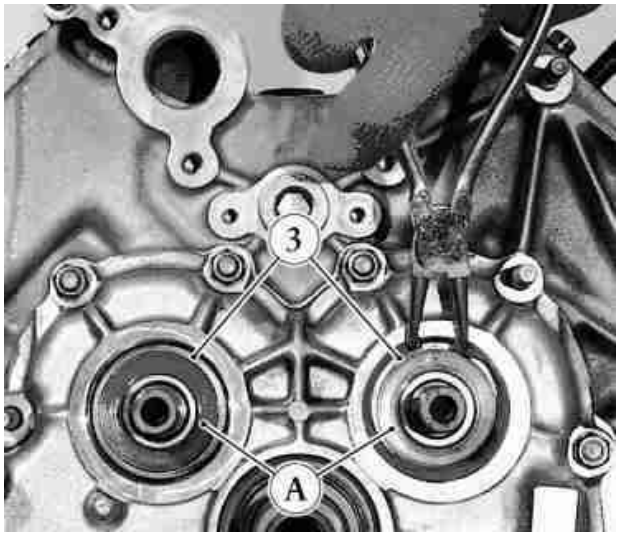
- The outer and inner Seeger rings **(3)** and the shimming **(14)** must be removed in order to remove the support bearings for the driven timing gears.



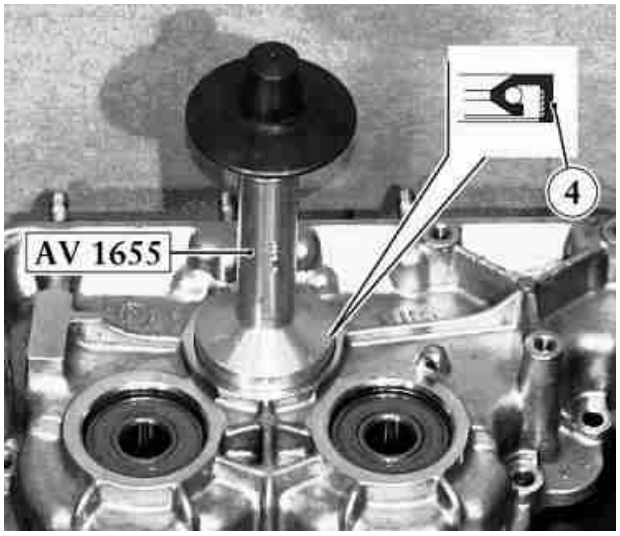
- Lay the cover on a level surface (the oil pump control gearing must be removed) and use the **AV 3106** punch to remove the bearing.

NOTES

*To fit a new bearing, proceed in reverse order, positioning the shielded side of the bearing facing outwards and checking to ensure that the Seeger rings **(3)** are perfectly inserted.*



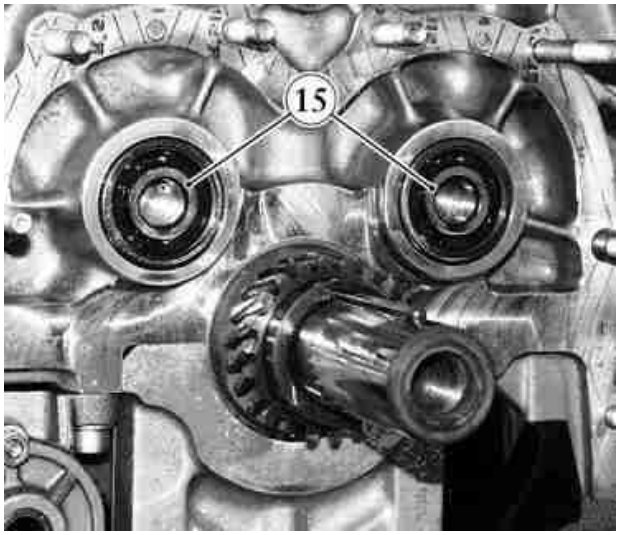
- In order to replace the crankshaft seal ring, it must be removed from the outer face of the cover, using a suitable punch.
- Insert the new seal ring **(4)** in the **AV 1655** punch, with the side fitted with the spring facing the cover.



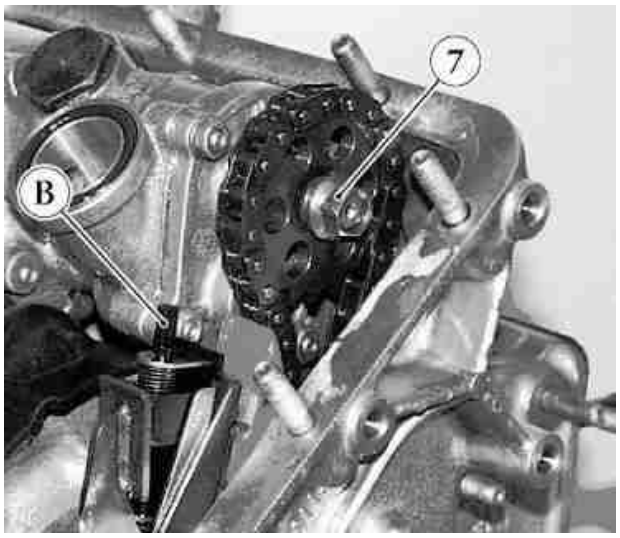
- Insert the seal ring flush in its seat on the cover

Re-Assembly of the front cover

- Carefully clean the contact surfaces on the cover and on the crankcase, eliminating any traces left by gaskets.
- Re-fit all components previously removed on the cover and lubricate couplings with engine oil.
- Fit a new gasket in the crankcase stud bolts and lubricate the inner ring of the support bearings **(15)** for the timing system driven gears with tallow grease.



- Assemble the complete cover unit, resting it on the crankcase and fitting the driven pinion onto the oil pump shaft.
- Tighten the nuts fastening the front cover to the prescribed torque.
- Tighten the nut **(7)** to the prescribed torque and release the belt tensioner.



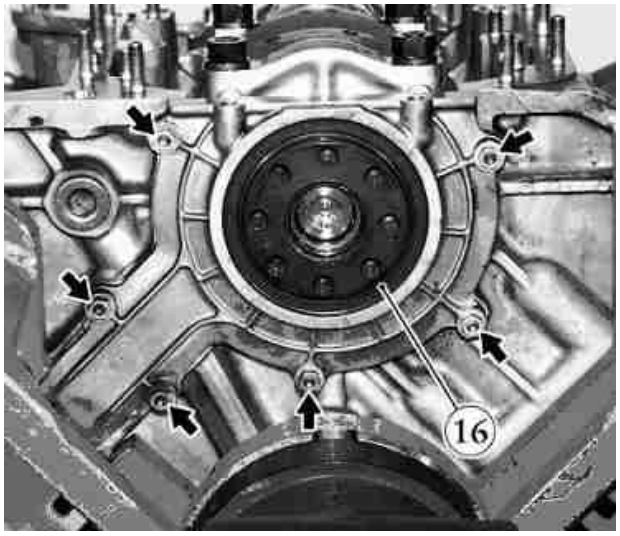
- Position the goniometer control lever on the crankshaft and while rotating the engine, ensure that all gears are turning correctly.

If the driven gears and/or support bearings have been replaced, after refitting the driving pulleys of the timing system, the backlash must be checked to prevent noisy operation.

- Install a dial gauge onto the crankcase and position the plunger in contact with the flank of the driving pulley tooth.
- Perform the check at four points, over an arc of **360°**.
- Backlash should range between **0.02÷0.05** mm. If this is not the case, loosen the nuts fastening the cover and re-adjust the backlash by means of light taps on the cover.
- Re-fit the oil sump (B 3.04).
- Re-fit all components previously removed on the crankcase. Tighten the screws and fastening nuts to the prescribed torque.
- Re-fit the timing belts (B 3.01) and all the other components previously removed for the procedure.

Detaching the rear cover

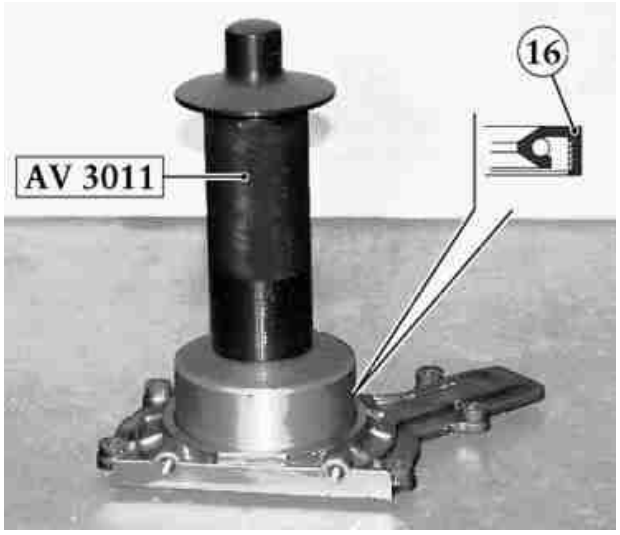
- Unscrew the fastening nuts and remove the rear cover with the seal ring **(16)**.



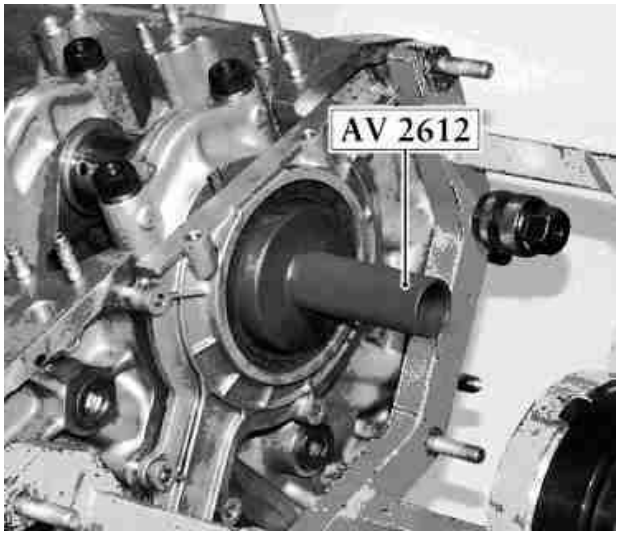
- Remove the gasket, which must always be replaced.
- Remove the seal ring from the cover.

Re-Assembly

- Carefully clean the contact surfaces on the cover and on the crankcase, eliminating any traces left by gaskets or sealer.
- Rest the cover on a level surface and position the new seal ring **(16)** with the side equipped with the spring facing the cover.
- Using the **AV 3011** tool, push the seal ring flush to its insertion point.



- Apply **CAF 4** sealer on the cover surface and fit the new gasket.
- Lubricate the end of the crankshaft and the lip of the seal ring with engine oil.
- Position the **AV 2612** taker-in on the crankshaft and mount the rear cover, having it touch the crankcase.



- Remove the tool and tighten the fastening nuts to the prescribed torque.

B3.08 CRANKSHAFT

Main Specifications (mm)

Main bearing - main journal coupling	
- Installation radial clearance	**0,014 ÷ 0,035**
- Wear limit	**0,150**
Crankshaft end float with shimming spacers	
- Installation clearance	**0,100 ÷ 0,250**
- Wear limit	**0,350**
Maximum tolerance on main journal alignment	**0,050**
Maximum tolerance on crankpin parallelism with respect to main journals	**0,010**
Maximum ovalisation of main journals and crankpins after grinding	**0,010**
Maximum tapering of main journals and crankpins after grinding	**0,016**
Maximum tolerance on verticality of the flywheel flange surface with respect to the rotation axis	**0,025**
Nitriding depth	**0,300 ÷ 0,350**
Surface hardness of the main journals and crankpins HV	**690 ÷ 850**
Surface finish of the main journals and crankpins	**0,200 µ**

Tightening Torques		Product
Nuts fastening caps (pre-tightening: **40 Nm**)	**80 Nm**	**MOLYKOTE 1000** Grease
Taper plug on crankshaft	**80 Nm**	**AREXON SYSTEM 52A70**

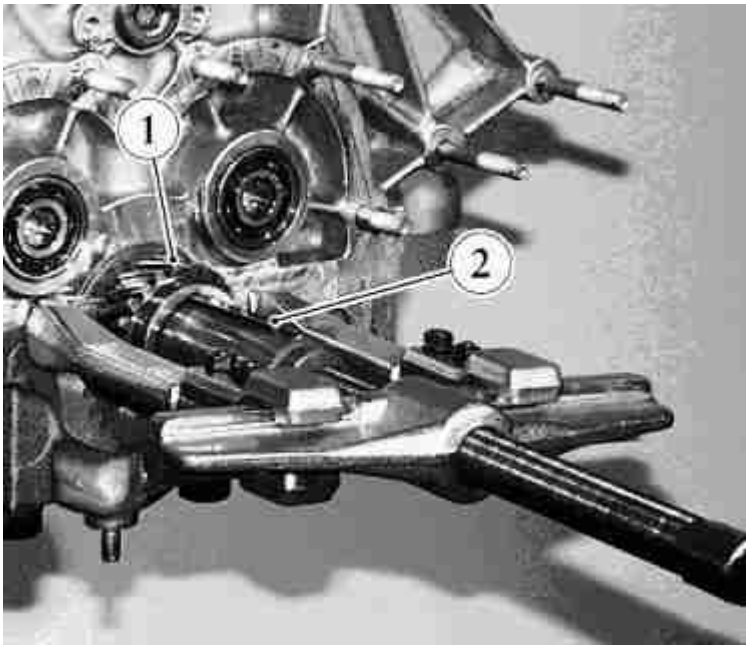
Introduction

The enblock, hardened and tempered steel crankshaft features ground, nitrided and buffed work surfaces.
The crankshaft rests on five journals and rotates on bearings made of three metals with a thin shell.
The crankshaft is completely balanced and equipped with four cranks. The two end cranks are rotated by **180°** with respect to the central pair.

Replacement of the Timing System Driving Gear

NOTES
In event of the replacement of the driving gear, the driven gears must also be replaced (B 3.07).

- The front crankcase cover must be removed, (B 3.07) to gain access to the gears.
- Remove the timing system driving gear **(1)**, using a universal extractor with two arms. Insert an aluminium spacer resting on the tip to avoid damaging the crankshaft with the extractor thrust pin.
- Remove the tab **(2)** from the crankshaft seat, prying the front end and pushing it towards the engine with a screwdriver.

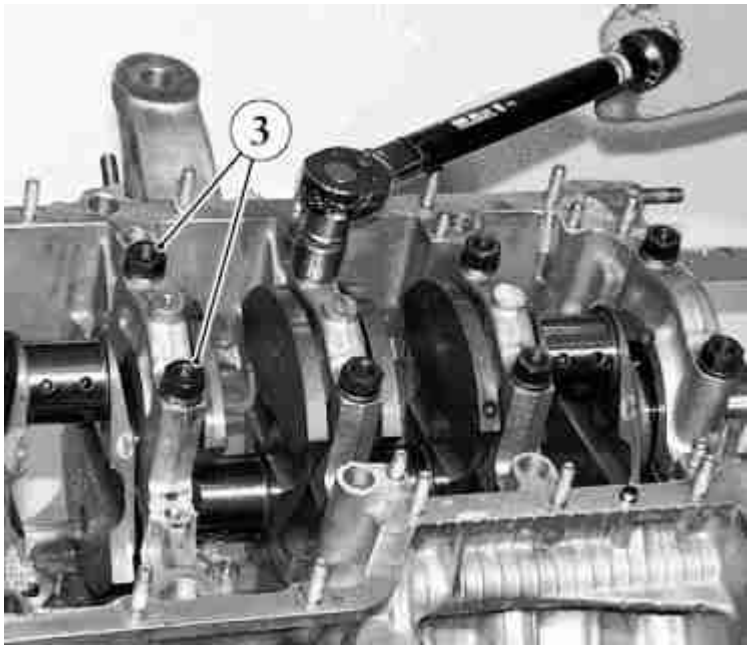


Re-Assembly

- Check the conditions of the tab **(2)**. Replace it if it is bent or cracked.
- Fit the tab into the crankshaft seat, inserting it with a rubber hammer.
- Lubricate the crankshaft and the tab with tallow grease and heat the driving gear **(1)** in a kiln to facilitate assembly.
- Using the **AV 3043** punch, push the gear onto the crankshaft until it is resting in position.

Crankshaft Disassembly

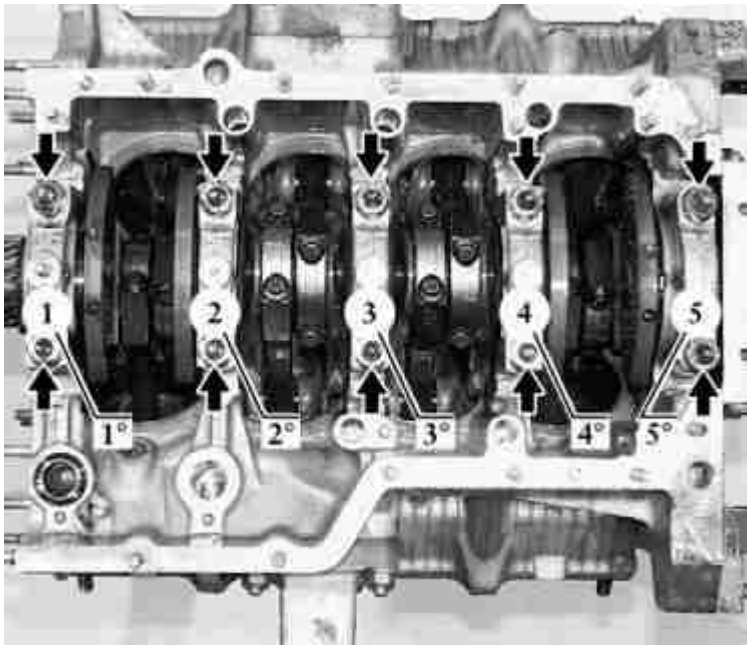
- To gain access to the crankshaft, the following must be removed:
  - the cylinder heads (B 3.03);
  - the oil sump (B 3.04);
  - the oil pump (B 3.05);
  - the pistons and connecting rods (B 3.06).
  - the front and rear covers (B 3.07).
- Remove the timing system driving gear with the respective tab, as described above.
- Gradually loosen the nuts **(3)** fastening the caps.



- Remove the caps complete with the half bearings.

NOTES

The caps are identified by a number which specifies their assembly position with respect to the front part of the crankcase.

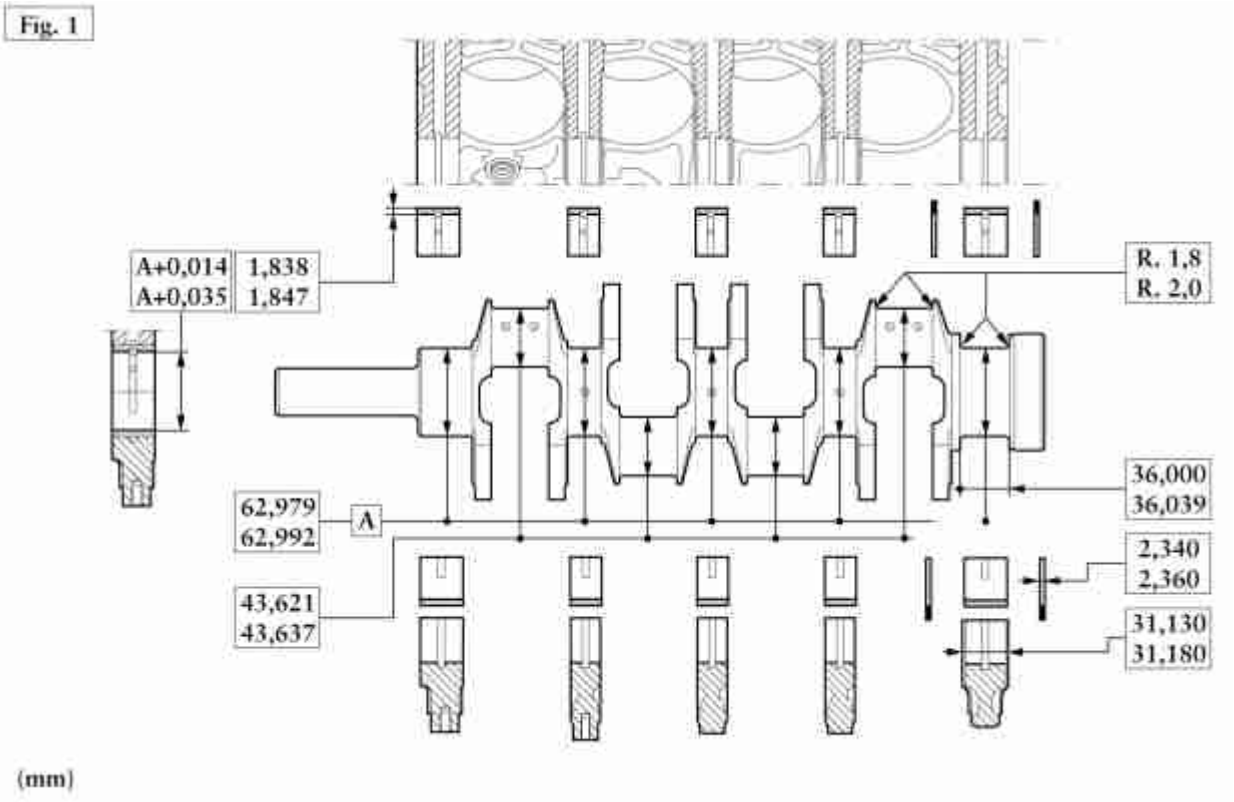


- Remove the crankshaft and the shoulder half rings.

Cleaning and Checking

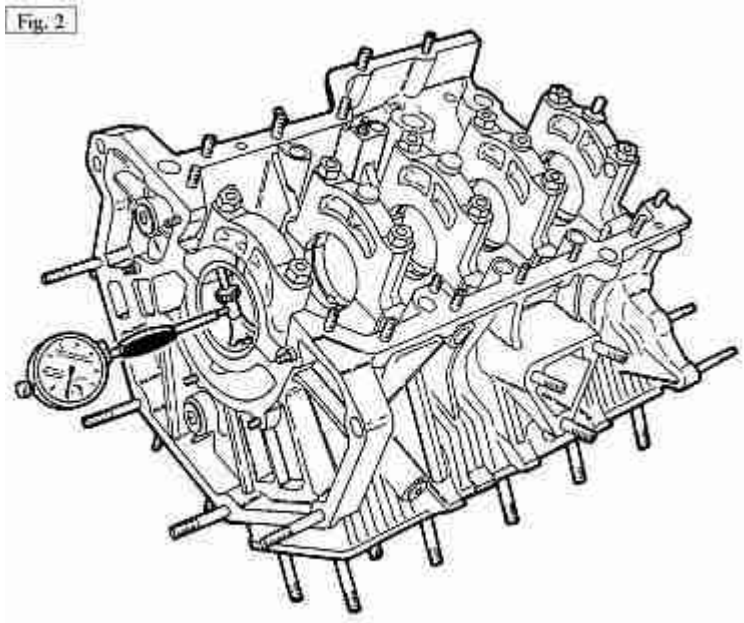
- When performing overhauls, clean the internal lubrication ducts thoroughly with pressurised wash oil.
- Check the shaft with penetrating fluids if uncertain about its condition.
- Perform a dimensional check on the crankshaft and compare the results with the nominal values (see **Fig. 1**).

Fig. 1



- Fit the main half bearings on the crankcase and on the caps.
- Proceed by tightening the fastening nuts, according to the procedure described below (see "Crankshaft re-assembly").
- Use the micrometer to measure the diameters of the main journals and reset the bore meter at that value.
- Measure the diameters of the bearings **(Fig. 2)** with two cross-readings and check to ensure that the radial clearance and ovalization fall within the prescribed limits (see "Main specifications").

Fig. 2



When the main journals and/or crankpins require a size reduction, you must establish the size reductions on the basis of the data listed (for the main journals (B 3.09), i valori delle minorazioni.
Usually after the first size reduction, the main journals and crankpins still preserve a surface hardness that

exceeds the minimum requirement. The second size reduction calls for re-nitriding of the shaft.

- After machining, ensure that the ovalization and tapering fall within the prescribed levels.
- Rest the crankshaft on the special **AV 3135** supports and check the alignment of the main journals with the dial gauge as shown in the Figure.

The crankshaft and the flywheel replacements are supplied individually balanced and therefore when replacing one of these parts, re-balancing is not required.

- Install the half bearings on the journals and position the shaft on the crankcase.
- Mount all of the crankshaft caps complete with half bearings and shim half rings **(5)**. Then tighten the nuts **(3)** to the established load (see procedure below).
- Move the shaft axially using a screwdriver **(A)** inserted between the crank and the crankcase. Check the end float with the dial gauge **(B)**.

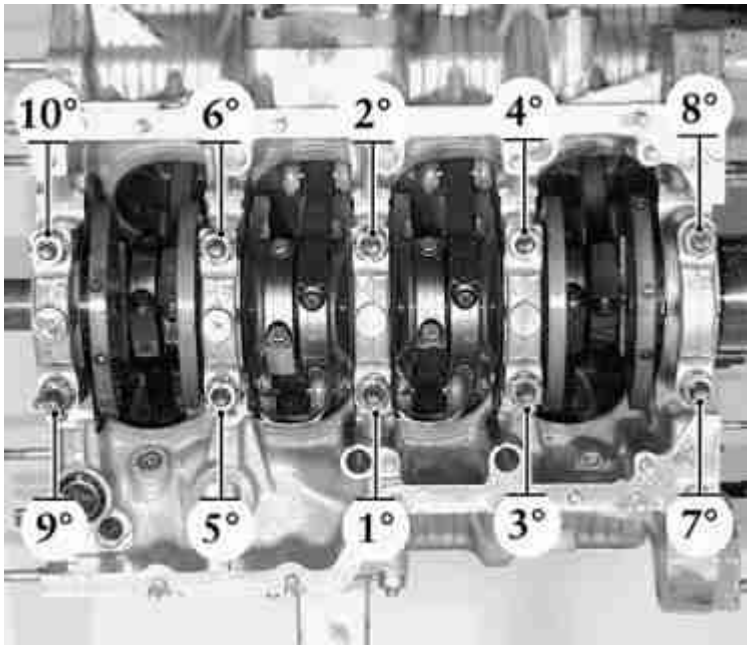
- If the end float proves to be over the permissible limit, replace the shim half rings with others of the next size up (_____).

IMPORTANT

The grooves made on one side of the half-rings (which also bear the size indication) must be positioned facing the shoulder side of the crankshaft.

Crankshaft Re-Assembly

- Lubricate the half bearings with engine oil and fit them on the crankcase and the caps.
- Position the crankshaft on the crankcase and fit the shim half-rings **(5)**.
- Wash the stud bolts and nuts **(3)** with solvent.
- Position the caps on the basis of their numbering and dry fit the washers on the caps.



- Lubricate the upper face of the washers, the threading and the lower face of the nuts with the prescribed grease.
- Tighten the nuts to the pre-tightening torque of **40 Nm**, starting from the central cap (see figure).
- Using torque wrench **95978150/2**, tighten the nuts to the final prescribed torque.
- In the event that it has been removed for cleaning the ducts, refit the taper plug **(6)** on the crankshaft end, using the prescribed locking product.
- Tighten the plug to the prescribed torque.

- Position the goniometer control lever on the crankshaft and while rotating the engine, ensure that it is rotating freely, without strain.
- Check the end float as described above and remove the control lever.
- Proceed by re-fitting the tab and timing system driving gear as described above, if they have been removed.
- Re-fit the pistons with the connecting rods (B 3.06).
- Re-fit the oil pump (B 3.05).
- Re-fit the oil sump (B 3.04).
- Re-fit the front and rear covers (B 3.07).
- Re-fit the cylinder heads (B 3.03).
- Proceed with re-assembly and tension adjustment of the timing belts (B 3.01).
- Re-assemble all components removed previously and re-assemble and adjust the tension of the belts for the auxiliary parts (_____).

B3.09 CRANKASE AND CYLINDER LINERS

Introduction

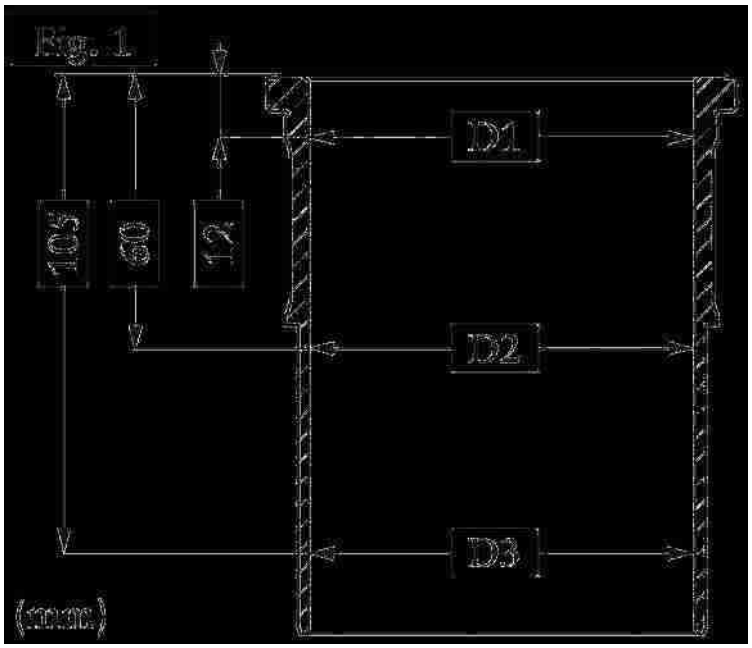
The crankcase is made of high-resistance heat-treated aluminium and silicon alloy.
The steel inserted cylinder liners have an inner surface hardened by a facing in nickel and silicon **(Nikasil)**, created with a special manufacturing procedure.
Due to the very high degree of hardness created by this treatment, the wear of the liners is very limited.

Main Specifications

Maximum wear of cylinder liner bore	**0,050 mm**
Maximum tapering	**0,021 %**
Ovalization	**0,015 mm**
Grinding degree (roughness)	**0,300 µ**

The cylinder liners are sub-divided into two size classes, each of which is distinguished by a colour (pink and green), on the basis of the machining tolerances.
You must mount liners and pistons (B 3.06) **of the same colour.**

Cylinder liner diameters (mm) (see **Fig.1**)



Selection colour	***Green***	***Pink***
D1	85,005 85,020	84,995 85,010
D2	85,005 85,015	84,995 85,005
D3	85,000 85,010	84,990 85,000

Piston-cylinder liner coupling (mm)

Selection colour	***Green***	***Pink***
D1	0,078	0,078

	0,107	0,107
D2	0,108 0,132	0,108 0,132
D3	0,475 0,515	0,475 0,515

Tightening Torques

Nut fastening nozzles	**6 Nm**
Nuts fastening oil filter support	**25 Nm**
Oil pressure unit	**25 Nm**
Union on oil filter mounting	**75 Nm**
Oil pipe plugs	**75 Nm**

Disassembly

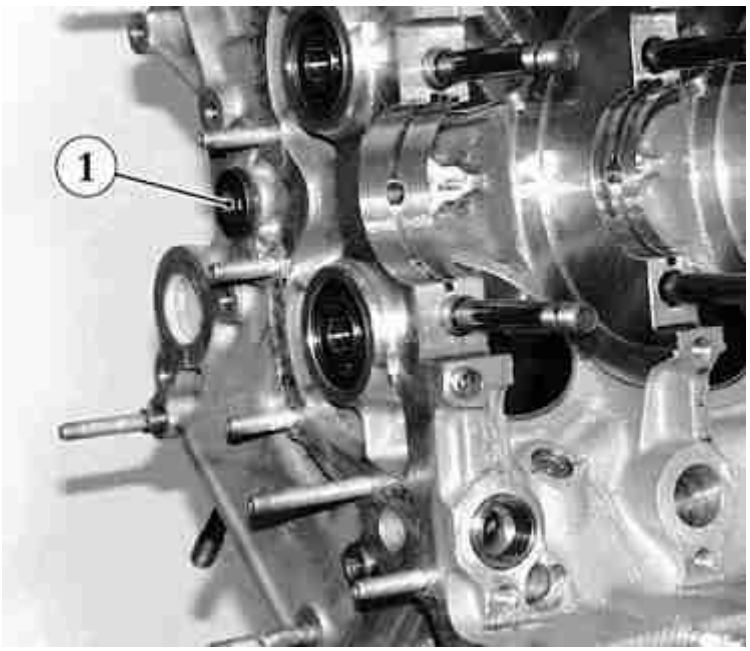
Remove the following in order to work on the crankcase:

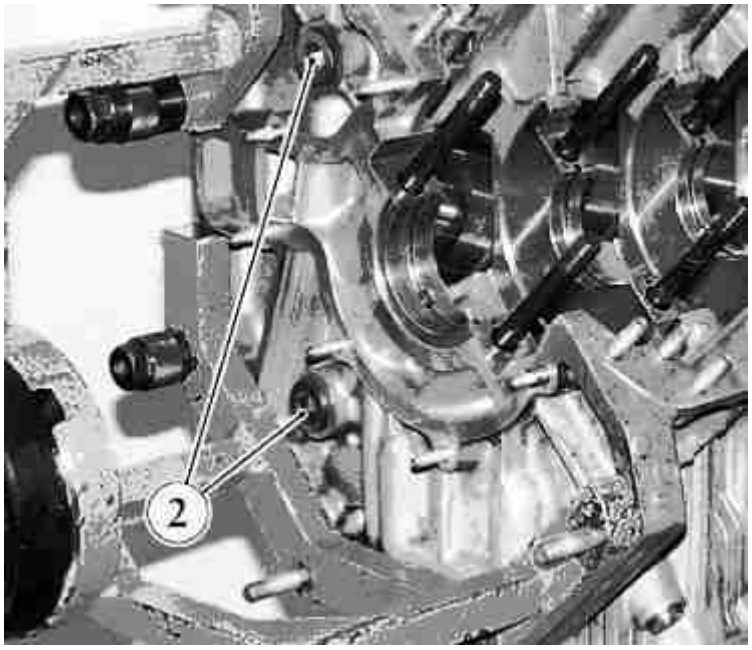
- the cylinder heads (B 3.03);
- the oil sump (B 3.04);
- the oil pump (B3.05);
- the pistons with the connecting rods (B 3.06);
- the front and rear covers (B 3.07);
- the crankshaft (_____).

Cleaning and Checking

With each disassembly, the crankcase must be cleaned thoroughly to identify any cracks or bending. If found, the crankcase must be replaced without further delay.

- Unscrew the front plug **(1)** and the rear plugs **(2)** and inject pressurised wash oil inside the lubrication ducts.





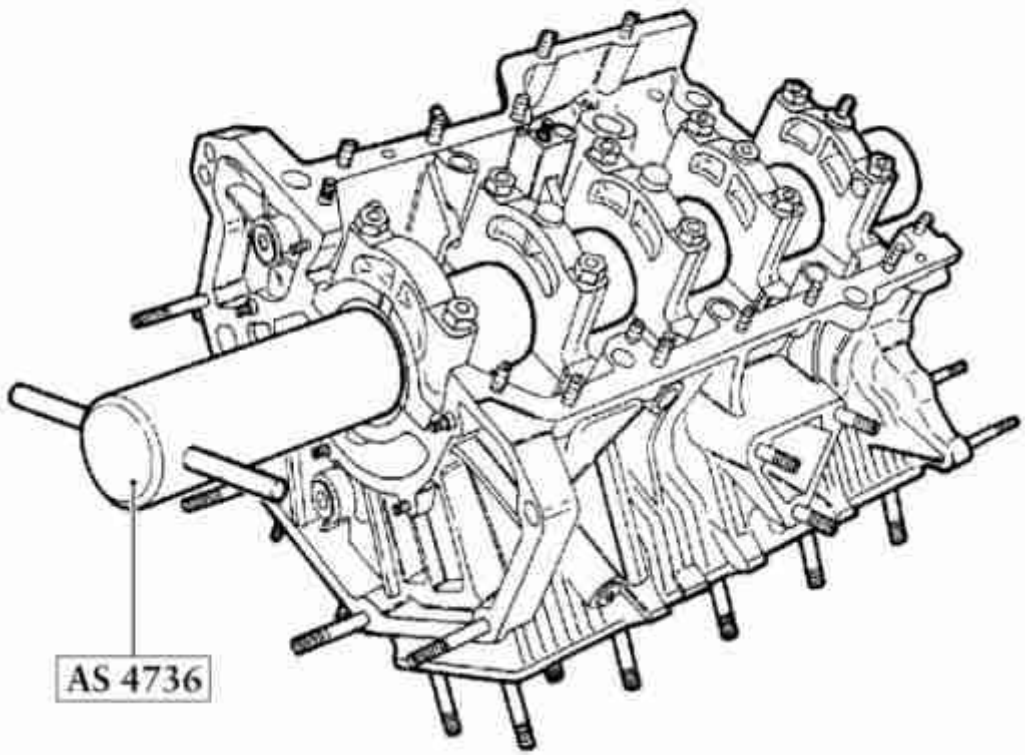
- Dry the crankcase with compressed air and proceed with the dimensional checks.

NOTES

The crankcase shown in the figures is merely indicative as it does not represent the configuration with the heads assembled, which is necessary for the procedure.

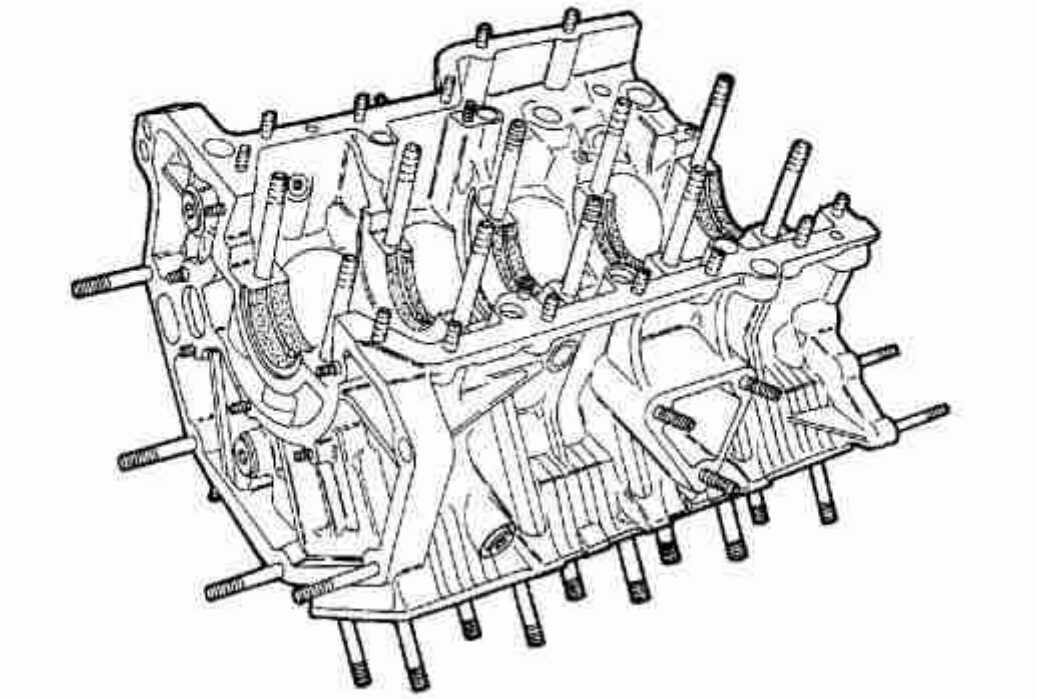
- Fit the cylinder heads on the crankcase with the (used) gaskets and tighten the nuts to the prescribed torque (B 3.03).
- Fit the crankshaft caps (B3.08) and tighten the nuts to the prescribed torque.
- With boring bar **AS4736** coloured with Prussian blue, check the alignment of the journals (see **Fig. 2**).

Fig. 2



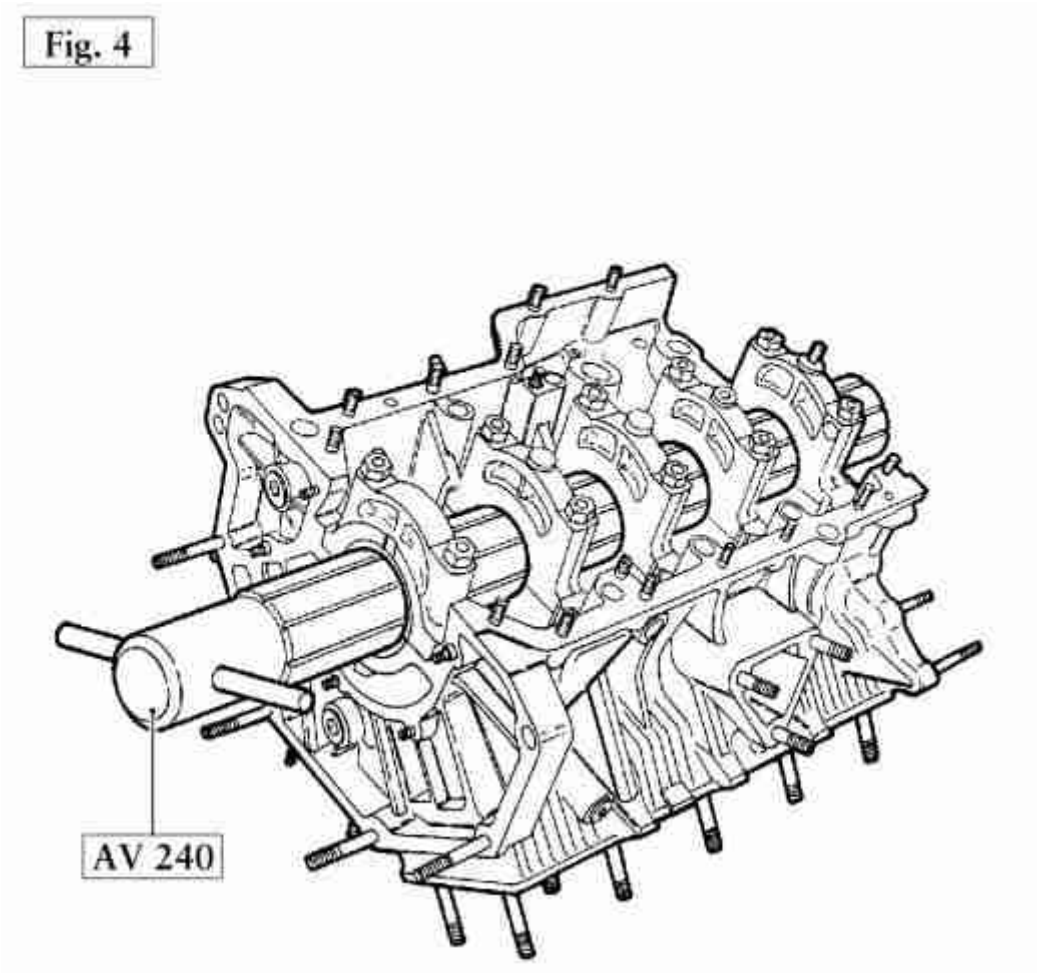
- Ensure that the contact point highlighted by the "Prussian blue" is uniform throughout the half-bearing seat (see **Fig. 3**).

Fig. 3



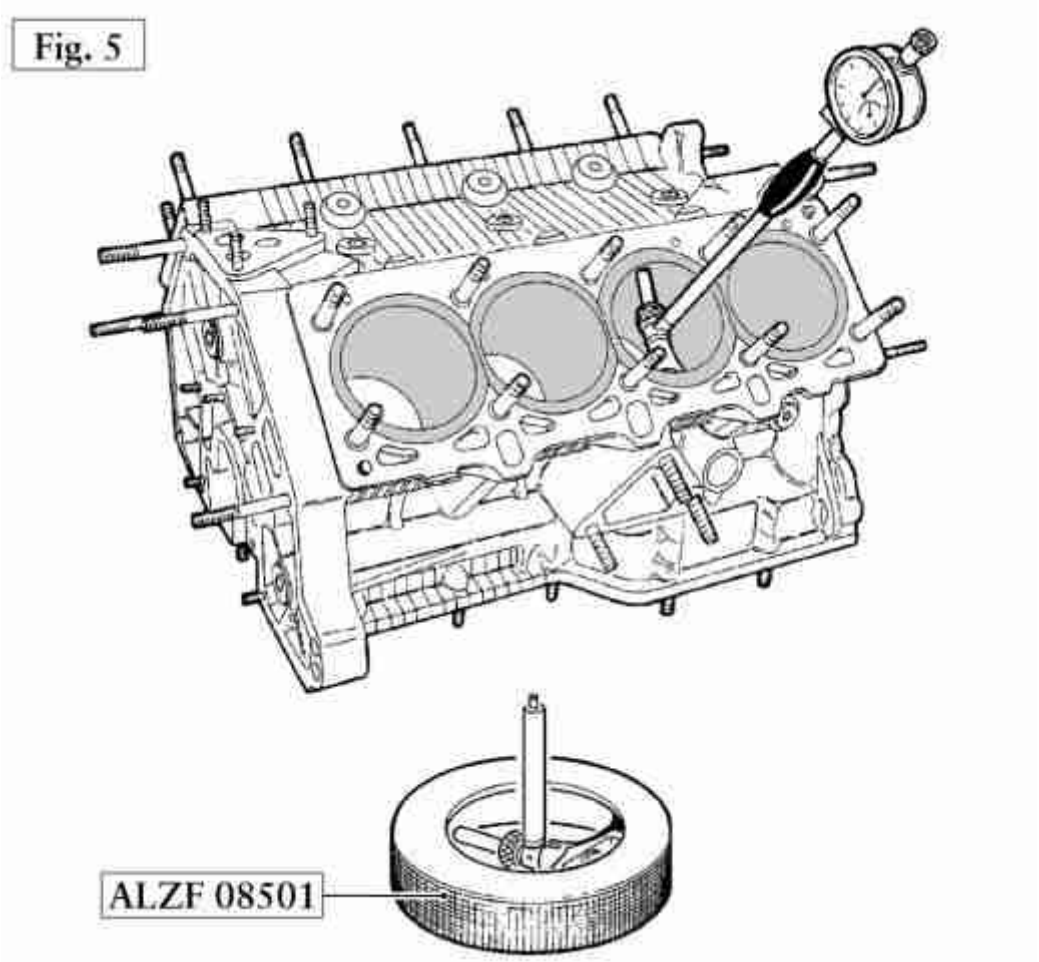
- If rotation of the boring bar requires some effort, use the **AV 240** tool (see **Fig. 4**) to re-finish the half-bearing housings by means of manual lapping.

Fig. 4

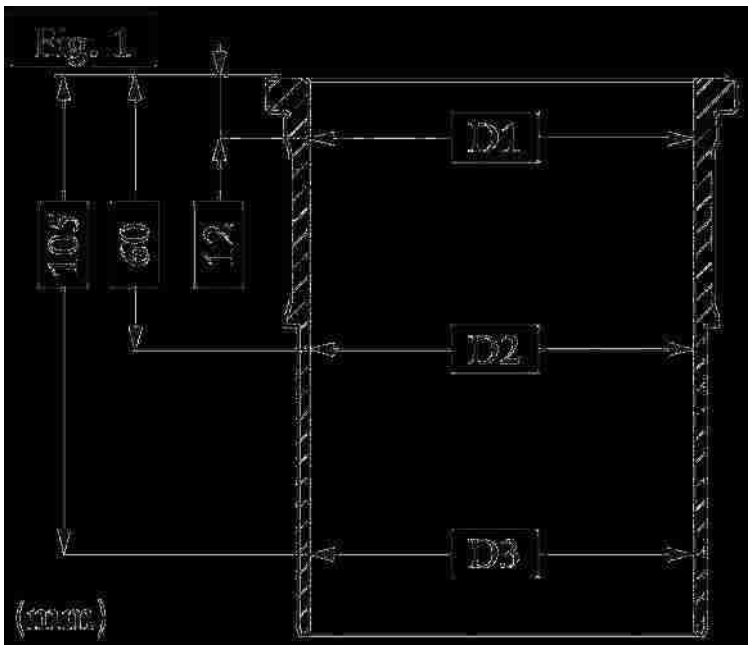


- Repeat the procedure with the crankcase turned by **180°**.
- If boring bar **AS 4736** shows excessive clearance and/or the journals show insufficient alignment, **0.04÷0.05** mm of material must be removed from the crankshaft caps with a **400÷600**-grain emery cloth, using a flat checking surface.
- Re-fit the caps and repeat the lapping procedure.

- Check the liners accurately with a dial gauge (see **Fig. 5**),



with cross-measurements for each diameter, at the levels indicated in **Fig. 1.**



- Replace the liner if the diameter has increased beyond the prescribed limit (see "Main specifications").
- Visually inspect the inner surface. It should be shiny and free from grooves or signs of seizure. Replace the liner if the surface proves to be damaged.

IMPORTANT

Do not perform any lapping on the inside of the liners under any circumstances as this would remove the surface treatment.

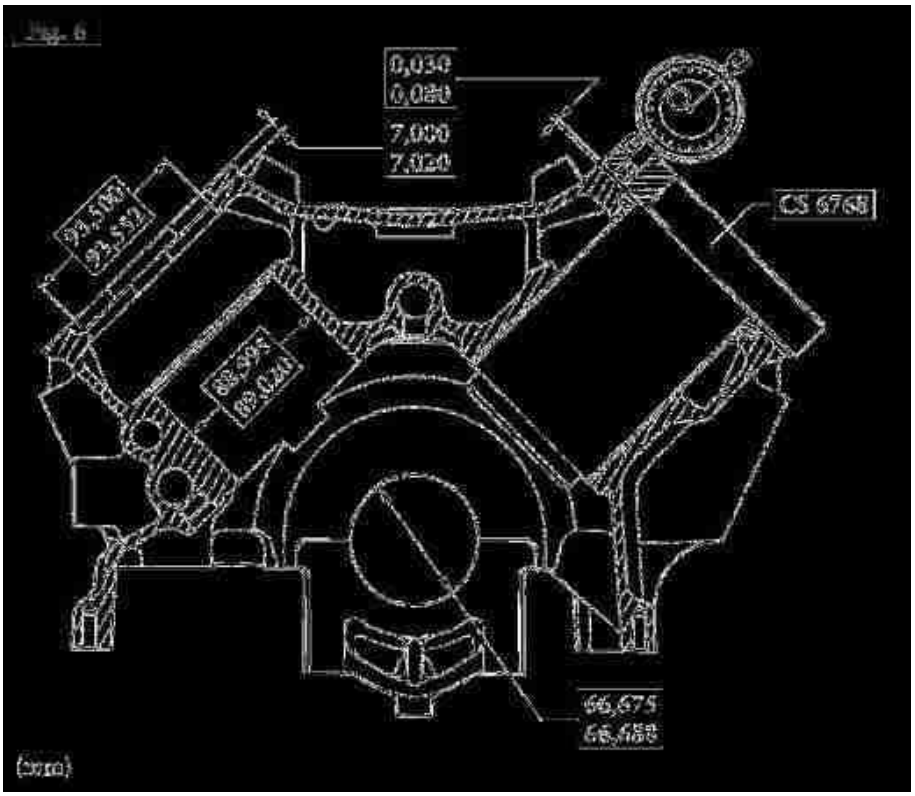
Cylinder Liner Replacement

Use of the **AV 2159** tool with the inner insert **(A)**, **Ø 85**, is required for cylinder liner removal.

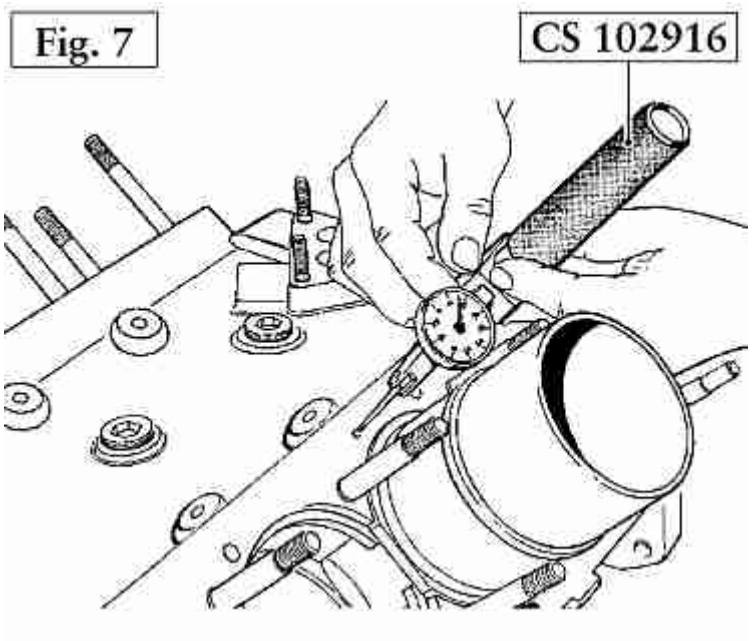
- Remove the piston cooling nozzle as described below.
- Slowly rotate the central pin on the tool until the liner is extracted completely.

IMPORTANT
Be very careful when handling the liners in order to prevent chipping of or marks on the sealing surfaces.

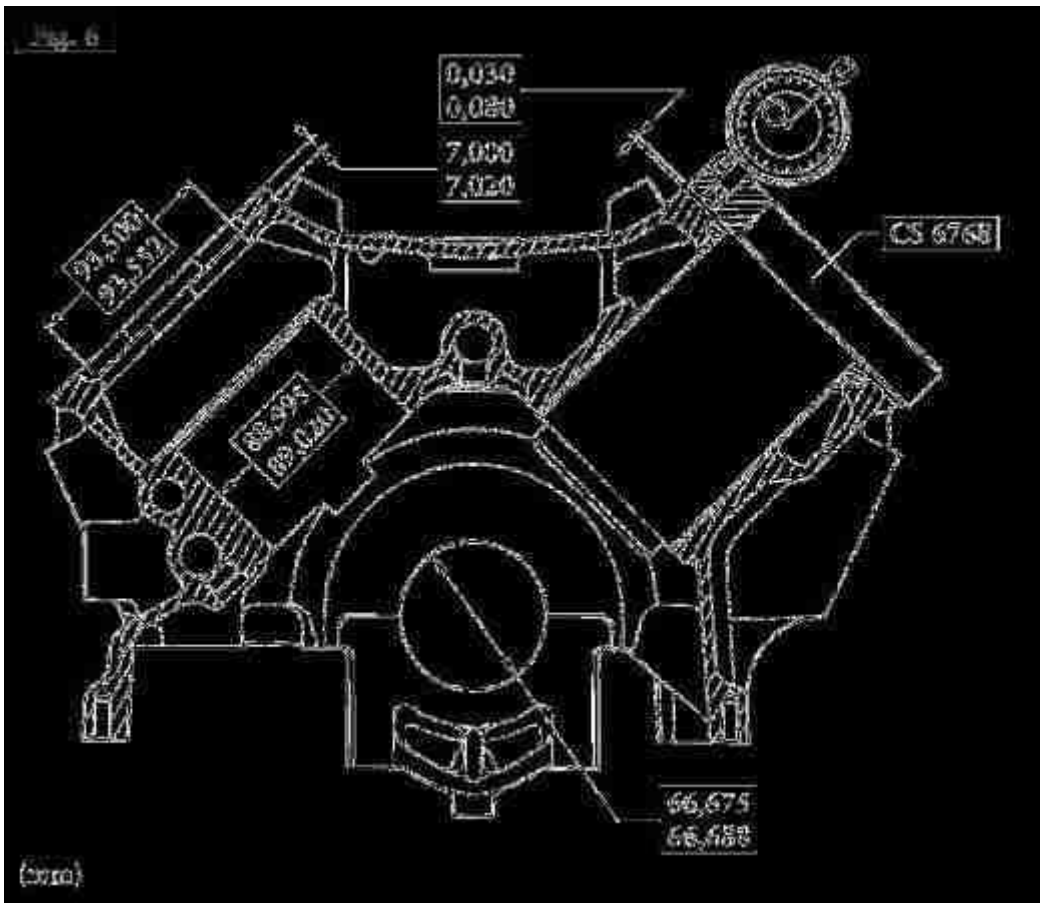
- Clean the supporting surfaces on the crankcase thoroughly with fine-grained abrasive paper.
- Check the dimensions of the cylinder liner (see **Fig. 1** and "Main specifications") and the housing, referring to the nominal dimensions listed in **Fig. 6**.



- Insert the overturned liner on the crankcase and using the **CS 102916** dial gauge with DTI plunger (see **Fig. 7**), check cylinder liner protrusion from the crankcase.



- Ensure that the protrusion falls within the prescribed limit (see **Fig. 6**).



- If this is not the case, change either the housing or the liner, in order to obtain a suitable coupling.

IMPORTANT
It is essential that all cylinder liners in the same bank protrude by the same degree.

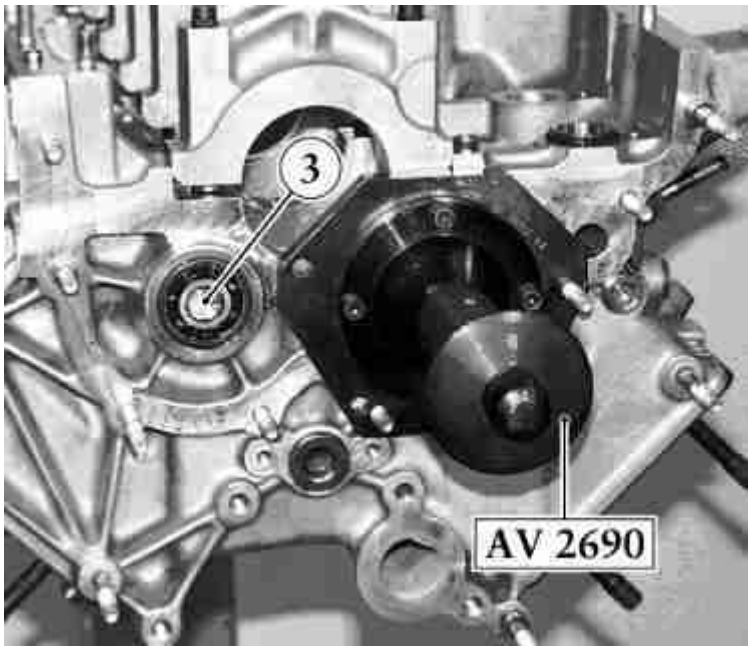
- Once the liners have been coupled with their respective housings, you should number them so that they will not be mismatched during subsequent phases. Proceed with numbering starting from the first front liner in the right-hand bank and continuing along a "**U**-shaped" course.
- Cool the liners at a temperature of **–15 ÷ –20 °C**, placing them in a freezer or immersing them in liquid nitrogen.
- Insert the seal rings on them.
- Lubricate the seat to facilitate insertion of the liners and heat the crankcase to a temperature of **40÷ 0 °C**, avoiding any use of sealers.
- After having inserted the liners in their respective seats, check protrusion once again with the **CS 6768** tool.

Replacement of Crankcase Components

Timing system driven gear support bearings

- Using the suitable universal extractor, remove the bearings from the crankcase **(3)**.

The **AV2690** tool must be used for fitting the new bearings. The tool is equipped with a flange for fastening them to the stud bolts on the crankcase.

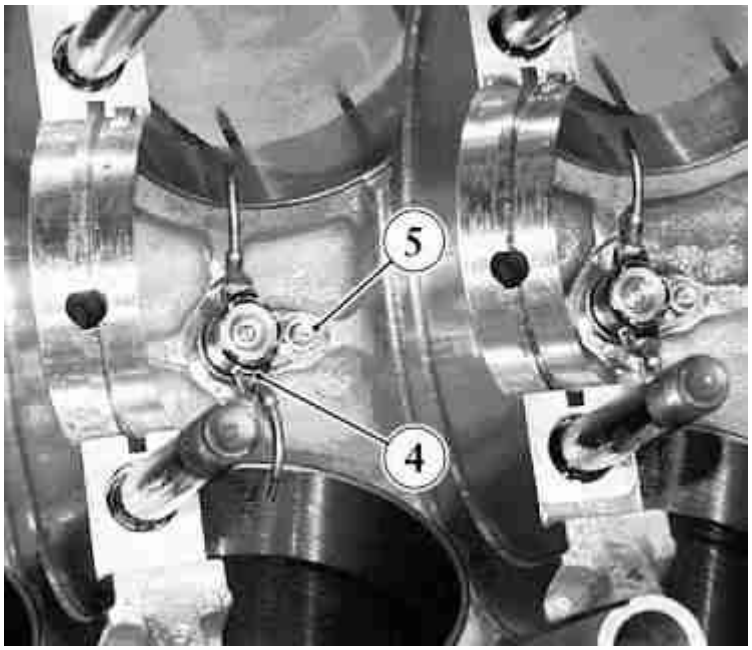


- Position the bearing with the plastic shield facing outwards and lubricate the outer ring with tallow grease.
- Using the tool, bring the bearing flush into its seat on the crankcase.

Piston cooling nozzles

The nozzles **(4)** are secured to the inside of the crankcase, on the surface between the liners in the two banks.

- Unscrew the fastening nuts **(5)** and remove them from the crankcase, along with the O-Rings.



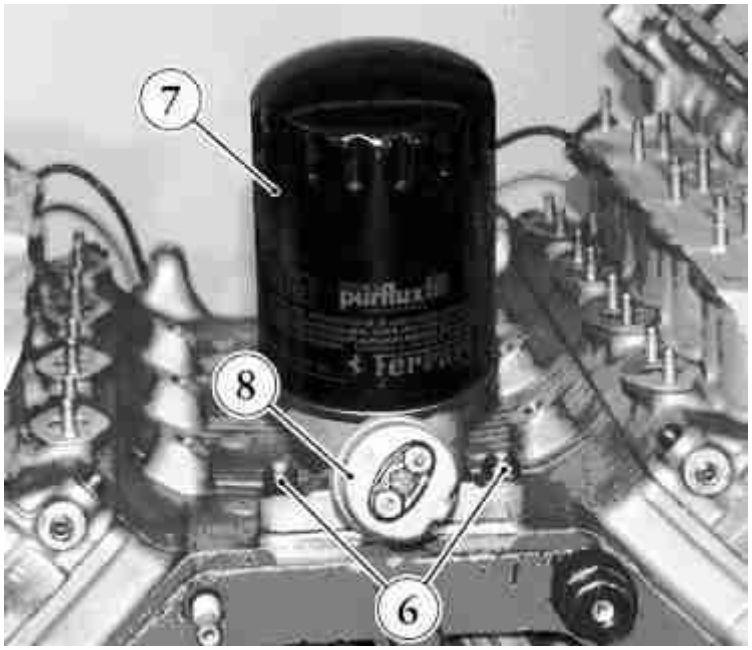
- Be very careful not to alter the direction of the jets when re-assembling.
- Lubricate the O-Ring and re-fit the nozzle on the crankcase.
- Tighten the nut **(5)** to the prescribed tightening torque.

Oil filter mounting

NOTES

This component and/or the cartridge and the oil pressure unit can also be removed with the engine installed in the car or on the bench, even during less advanced stages of disassembly (A3.01).

- Unscrew the three fastening nuts **(6)** and remove the mounting complete with the filter cartridge **(7)** and oil pressure unit **(8)**.
- Remove the base gasket, which should always be replaced with a new one.

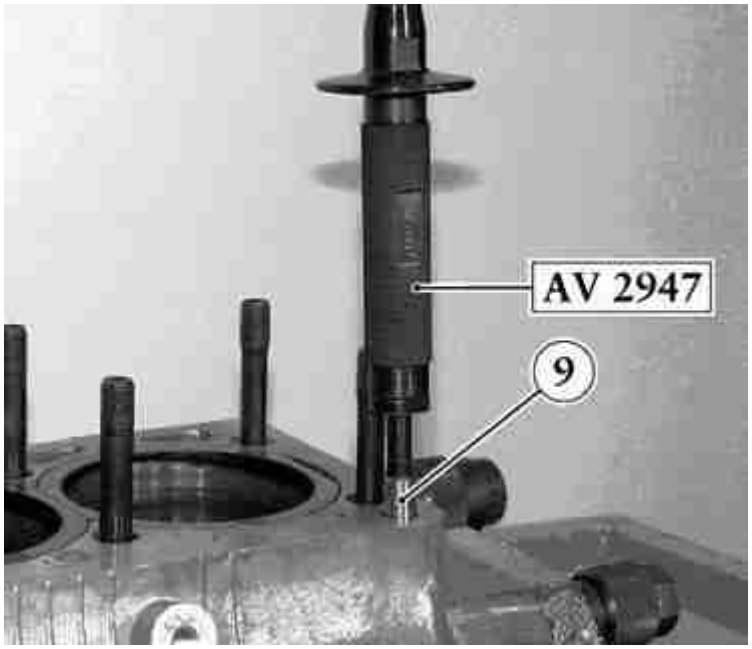


- After replacing the oil pressure unit **(8)** and/or the threaded filter cartridge union, fasten the new components on the mounting, tightening them to the prescribed torque.
- Prior to re-assembly, clean the coupling surfaces thoroughly, to prevent any entry of foreign matter in the crankcase lines.
- Fit a new gasket and position the complete mounting unit.
- Tighten the nuts **(6)** to the prescribed torque.

Check valve

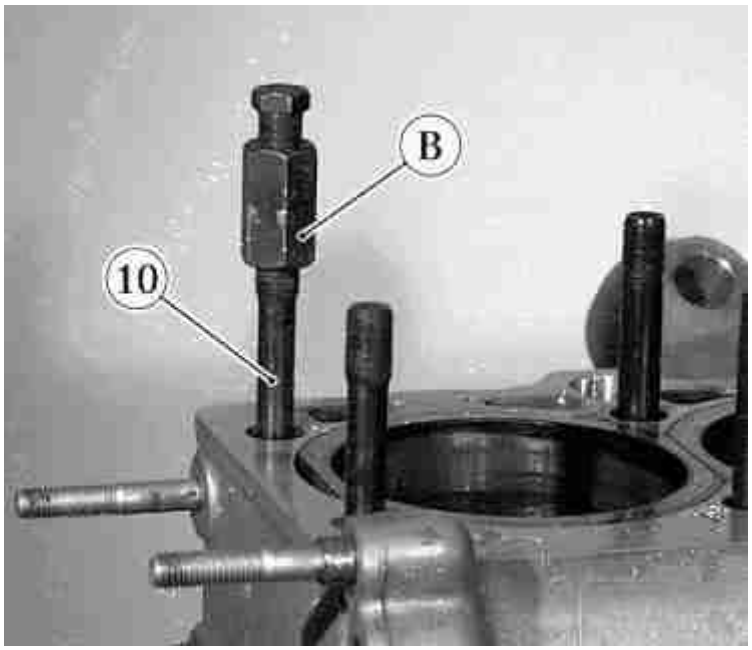
A check valve is positioned under the rear head dowel on the crankcase. It serves for the oil entering the head.

- To replace it, the upper dowel must be removed and with a **M6x1** extractor fastened over the inner valve hole, it can be extracted from the crankcase.
- For re-assembly of the new valve **(9)** you must use the **AV 2947** punch to push the valve into its seat.



Cylinder head stud bolts

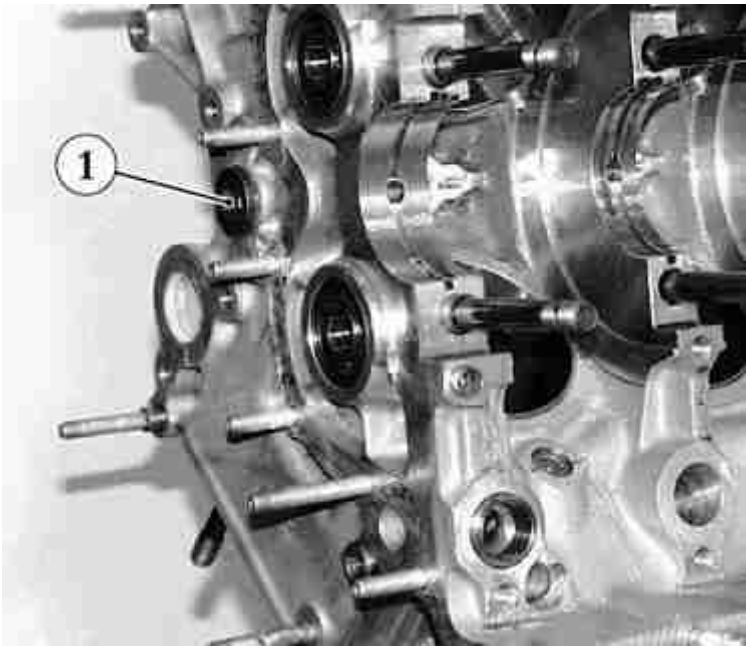
- Using a commercially available **M11x1** stud bolt extractor **(B)**, unscrew the stud bolt **(10)** to be replaced, from the crankcase.

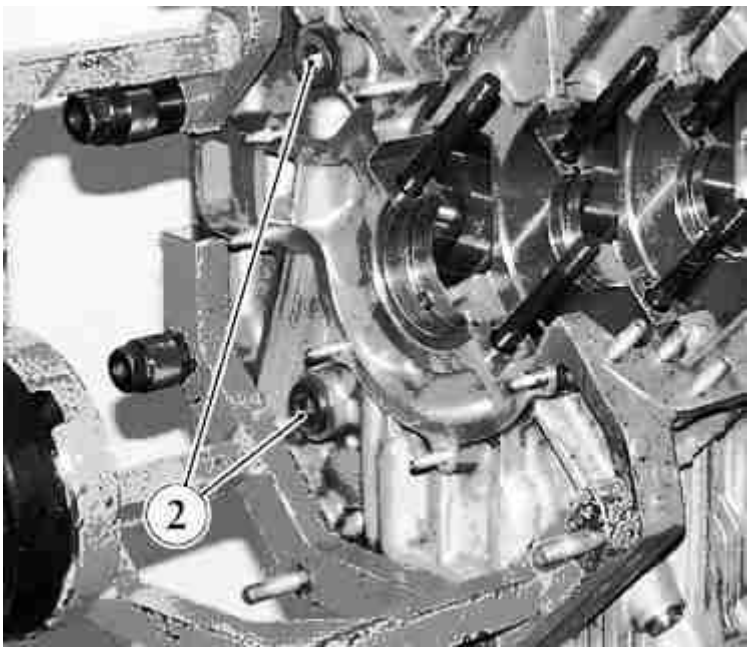


- Clean the seat with a degreasing product and blow with compressed air.
- Lubricate the thread of the new stud bolt with **SHELL HELIX ULTRA 5W/40** oil and then re-tighten it with the tool **(B)** until it is flush in its seat.

Crankcase Re-Assembly

- Re-fit the plugs **(1)** and **(2)** on the crankcase and tighten them to the prescribed tightening torque.



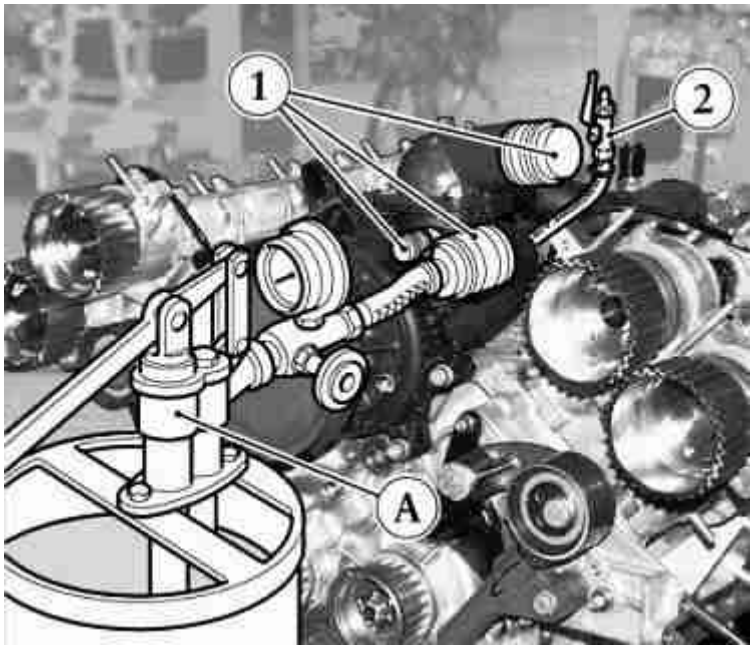


- After performing all of the required checks, re-assemble the crankshaft on the crankcase (B 3.08).
- Re-fit the front and rear covers (B 3.07).
- Re-fit the pistons with the connecting rods (B 3.06).
- Re-fit the oil pump (B 3.05).
- Re-fit the oil sump (B 3.04).
- Re-fit the cylinder heads (B 3.03).
- Proceed with re-assembly and tension adjustment of the timing belts (B 3.01).
- Re-assemble all of the components removed previously, re-fit auxiliary part belts and adjust belt tension (A 3.04).

B3.10 PRESSURE-TIGHTNESS TEST

After the engine has been overhauled, before proceeding with timing checks and adjustments and re-assembly of the engine accessory parts, it is advisable to perform the pressure test to check all of the couplings for tightness.

- The water pump assembly must be installed on the crankcase for this test (B 5.02).
- Connect a hydraulic pump **(A)** ref. **CORADE**, of the **BINDA PI 25** type, to the engine water inlet line on the water pump.
- Obstruct water outlets with coupling stoppers **(1)**, equipped with clamps to tighten them on the pump union.
- Fit a pipe with a cock **(2)** on the union on the water backflow pipe to the expansion tank. The cock serves to breathe air and it should be kept positioned beyond the highest point on the engine.



- Fill with water until reaching a pressure level of about **5 bar** and then maintain the pressure at that level for **10 minutes**.
- Check to ensure that there is no leakage. If the pressure remains steady during the entire time interval stated above, the tightness can be considered to be satisfactory.
- Blow compressed air through the spark plug seats and check to ensure that there is no water leakage.
- Proceed with timing checks and adjustments (B 3.02) and re-assembly of all components removed previously.

B4.01 SYSTEM OUTLINE

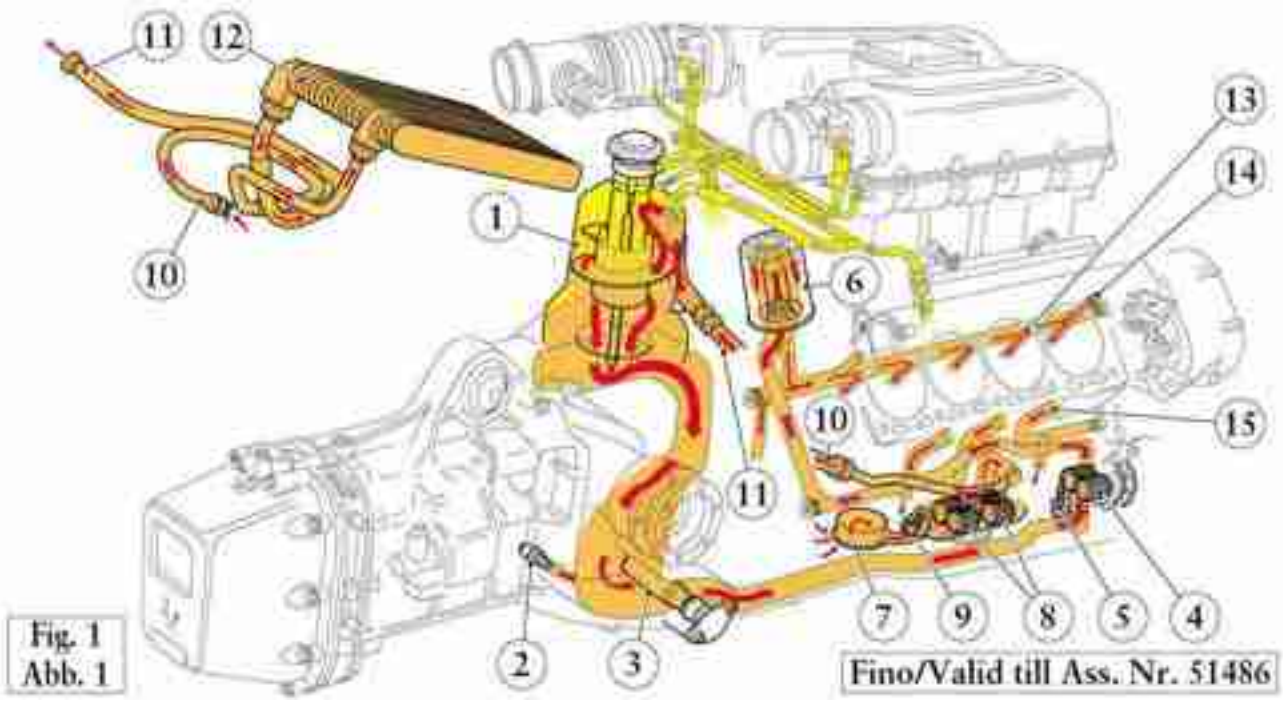


Fig. 1
Abb. 1

Fino/Valid till Ass. Nr. 51486

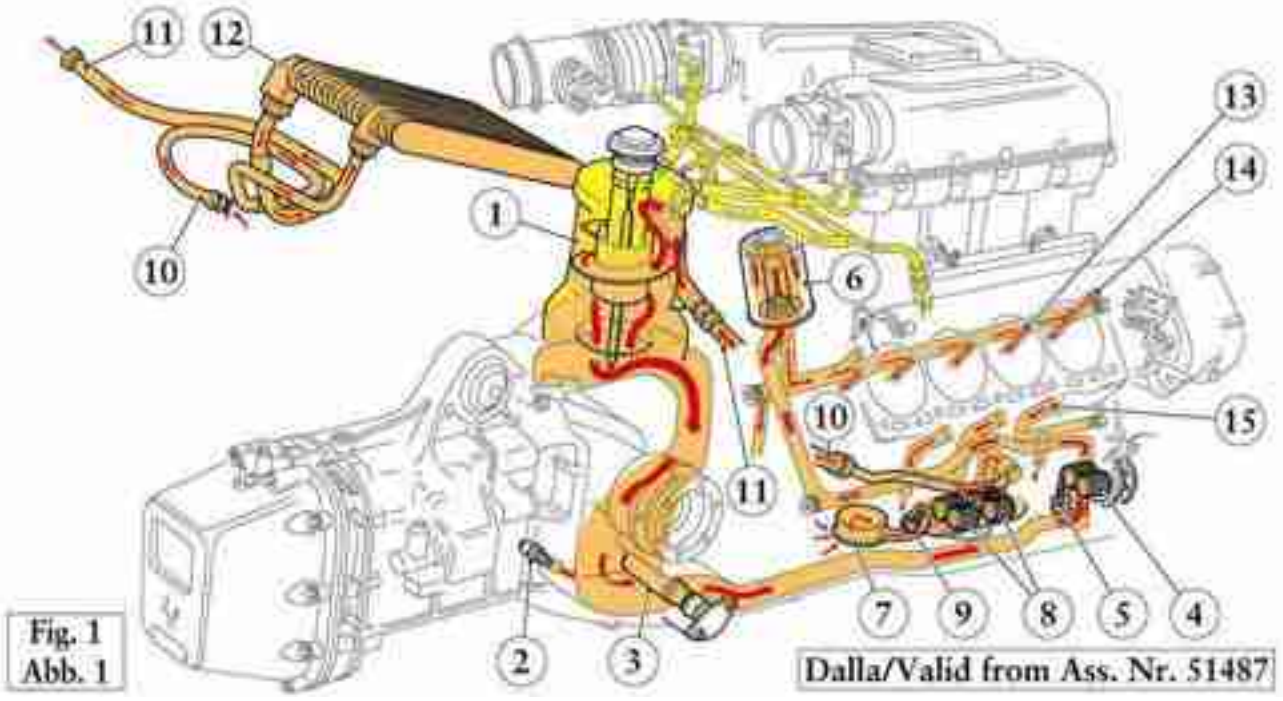


Fig. 1
Abb. 1

Dalla/Valid from Ass. Nr. 51487

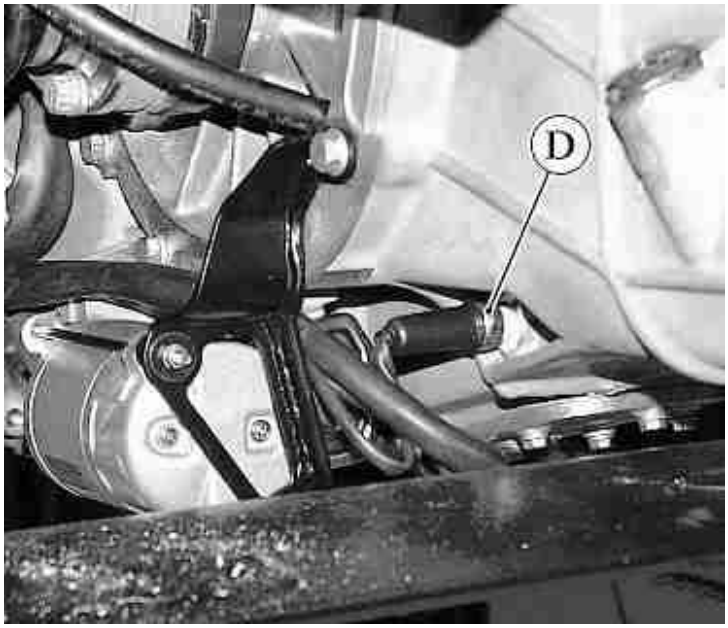
Engine lubrication consists of a dry-sump type lubrication (**Fig. 1**).
The reservoir/separator **(1)** is fastened on the upper part of the gearbox housing.
FROM Ass.ly No. 51487 a more capacious tank/separator **(1)** than the Challenge Stradale model has been introduced, along with the relative pipes connecting it to the motorised throttle bodies on the gas recirculation and blow-by system.
For the gas and oil vapour recirculation system, (B 4.05).
The oil, after passing through internal channels, reaches the bottom of the gearbox housing, where the thermisor **(2)** and the mesh filter **(3)** are located.
One channel connects the gearbox housing with the crankcase sump.
A delivery pump **(4)**, made up of a gear pair and equipped with a pressure regulation valve **(5)**, takes up the oil from the oil tank. After filtering the oil in the cartridge**(6)**, the pump sends it simultaneously to the connecting rod/main journals lubrication line **(13)** and to the camshaft/head lines. On the way through the connecting rod/main journals lubrication line **(13)**, the oil reaches the piston lubrication jets and then flows, in the final phase, into the supply lines of the timing variators **(14)**. The oil flows downwards from the heads, through the recovery lines **(15)**, to the crankcase sump where it is recovered by the scavenge pump **(8)**.
The scavenge pump **(8)** is made up of two parallel gear pairs and includes a safety valve **(9)**. This pump takes up oil from the sump by means of two priming elements **(7)** equipped with mesh filters, and sends it to the radiator **(12)** through one rigid and one flexible tube **(10)**. From the radiator, the cooled oil flows into the tank/separator via a flexible tube**(11)**.
See Paragraph (B 3.05) for information on overhauling and/or replacement of pumps and respective valves.

Oil pressure and temperature

The engine oil pressure **(A)** and temperature **(B)** indicators are found on the instrument panel, along with their respective **RED** warning lights. Under normal engine operating conditions, these warning lights are not lit.

The oil pressure warning light switches on when with the engine stopped, the car key is turned to the running position, or when with the engine running, there is insufficient pressure.
The engine oil pressure is detected by a transmittor **(C)** positioned on the base of the cartridge oil filter.
The temperature warning light switches on when the oil exceeds the temperature of **155 °C** and switches off when it drops below **153 °C**.

The temperature of the engine oil is detected by a thermistor **(D)** positioned on the gearbox housing, under the left-hand side differential cover.



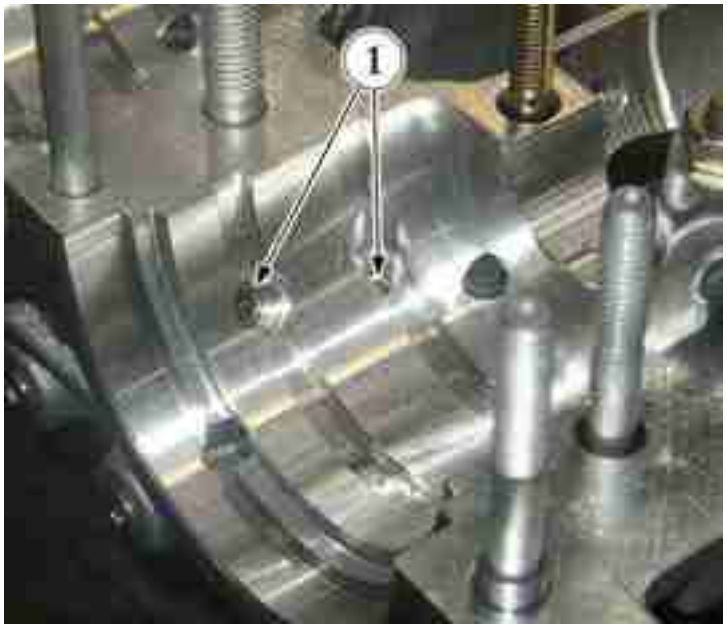
Under normal operating conditions (i.e., engine running at **6000 revolutions/1'**), the oil pressure range must be between **5** and **6 bar** and the temperature should be about **100 °C**.
Heavy-duty use of the car can raise the oil temperature up to **150 °C**. In such cases, the engine load must be lowered in order to restabilize the temperature. If the temperature continues to remain high, inspect the system components to ensure that they are intact.
With the engine warm and idling, a pressure lower than **4.5 bar** should be considered normal.
The pressure level is determined by the pre-loading of the spring in the pressure regulating valve **(5**, Fig. **1)** (B 3.05).

Service campaigns

To improve the engine oil lubrication pressure, a number of changes have been made to the crankcase and the oil lines running to the heads. With these operations, the oil pressure value, when the engine is warm and idling, is improved.

From engine No. 78673 the diameter of the lubrication holes on the supporting bearings of the gears driven by the timing system have been reduced from 1.2 mm to **1.0 mm**.

From engine No. 198823, to choke the lubrication system lines on the dummy variators (intake side), dowels have been fitted on the heads with a **1.5 mm** gauged hole.



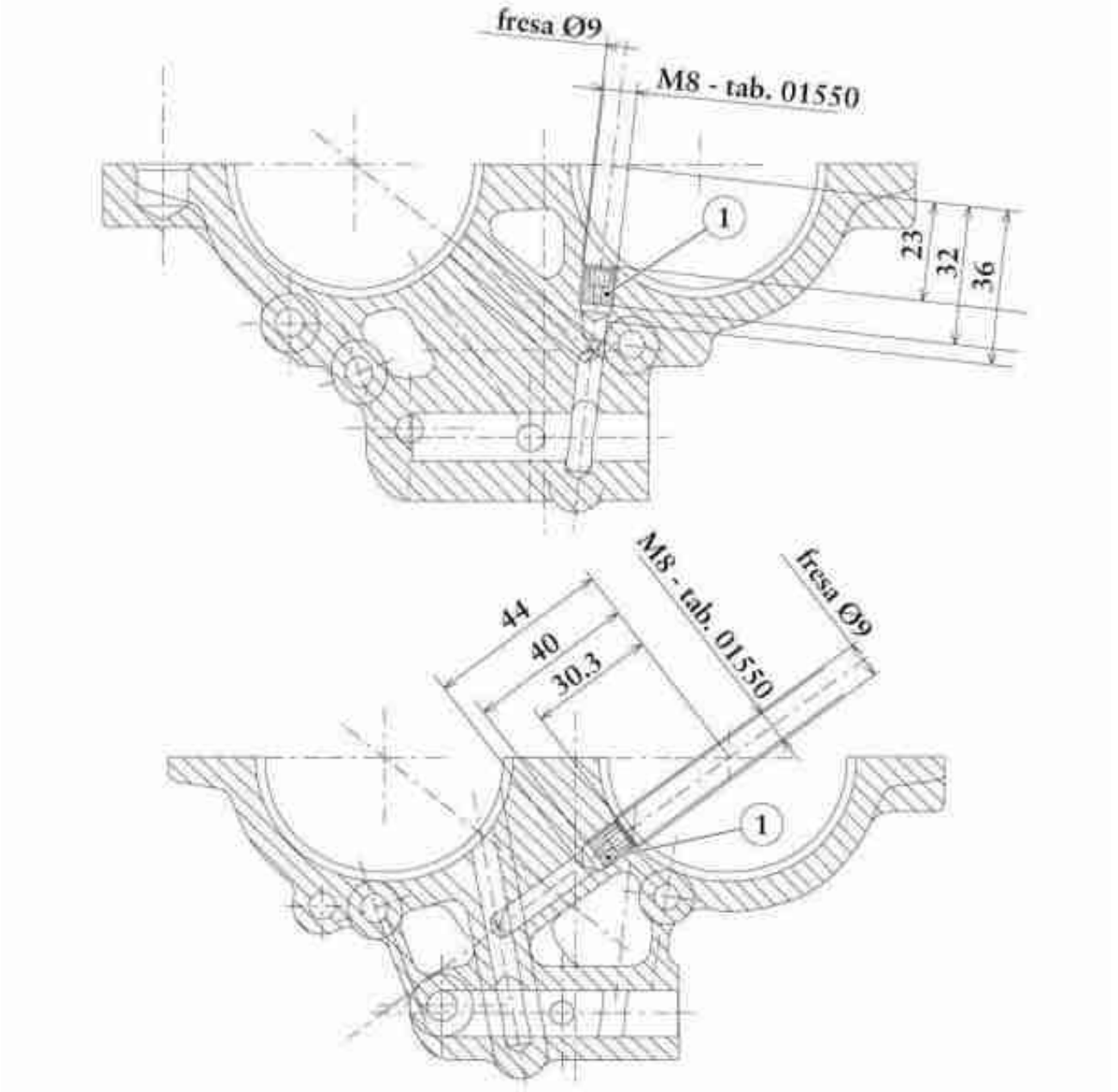
As far as the pre-modification engines are concerned, we recommend you fit the choking dowels (**1**) when servicing the related vehicles for overhauls. The dowels must be fitted working on the head lines, intake side, as shown in the sections in **Fig. 3**.

Using a **9 mm** mill, drill the hole on both heads' lines until the depth indicated is reached.

Drill and thread with a male **M8** screw, until the depth indicated is reached.

Blow compressed air to remove any burrs or swarfs left on the lines.

Then fit the dowels **(1)** into the threaded holes, tightening them to a torque of **7 Nm, without using any locking materials that may clog the lubrication system hole**.


fresa Ø9
M8 - tab. 01550
1
23
32
36
44
40
30.3
M8 - tab. 01550
fresa Ø9
1

B4.02 OIL FILTER

The oil filter is found in the rear part of the enginecrankcase, in the area between the two banks. The filter is of the total-flow type with an anti-depletion valve.

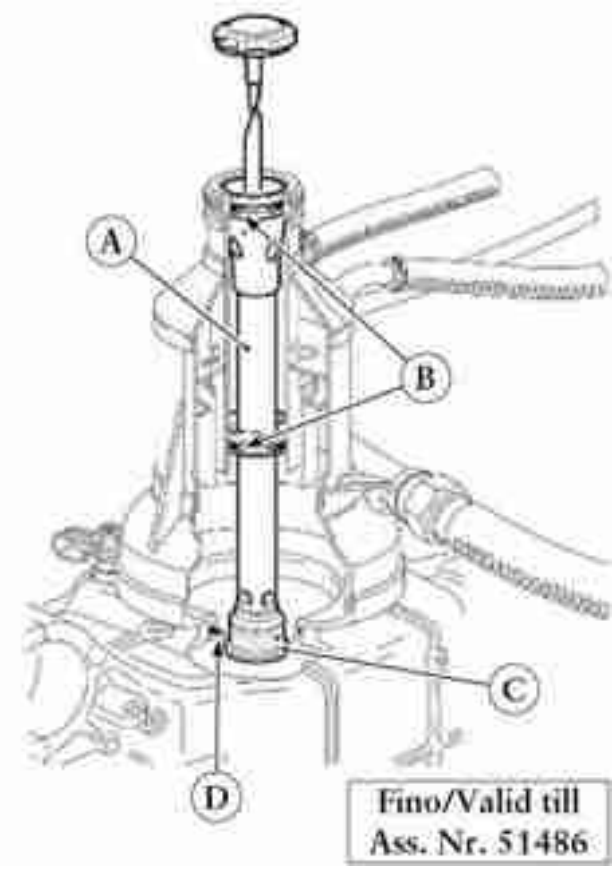
IMPORTANT
Use filters made by the suggested manufacturers only.

The oil filter should be replaced at regular intervals, as prescribed in the "PROGRAMMED MAINTENANCE PLAN" (_____).

B4.03 OIL TANK

The oil tank is incorporated in the gearbox housing, in the front interspace. The blow-by system (B 4.05), is situated on the upper lip of the tank and consists of a cylindrical body, whose lower part completes the capacity of the tank.
The upper part of the blow-by stem is fitted with a filler including a cap and dipstick for checking the oil level *(*A 3.01*).*

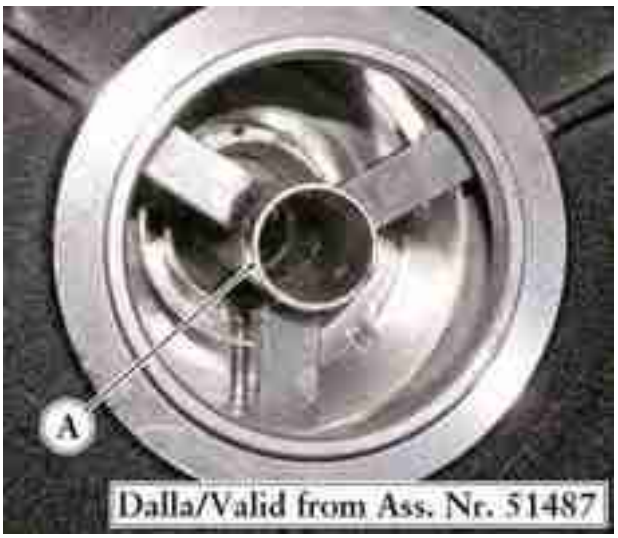
UP TO Ass.ly No. 51486
A tube **(A)** is fitted inside the blow-by system. This is equipped with two external O-rings **(B)** and a rubber bottom **(C)** resting on the gearbox housing's interspace.



FROM Ass.ly No. 51487

The new separator, as well as having a lager capacity, is also built as a single piece which holds the pipe **(A)** for the dipstick.

When there is excessive fluid in the system, this device prevents the level of intake oil rising, thereby avoiding a "flooding" which could cause engine failure.



A retaining split pin **(B)** has been fitted on the cap to prevent it being unscrewed accidentally. To unscrew the cap, the said retainer must be pulled out slightly; Once the cap has been screwed back on, push the split pin towards the cap, ensuring it is fitted completely.

Tightening torques	Nm	Category
Radiator pipe union	**78**	**B**

Disassembly

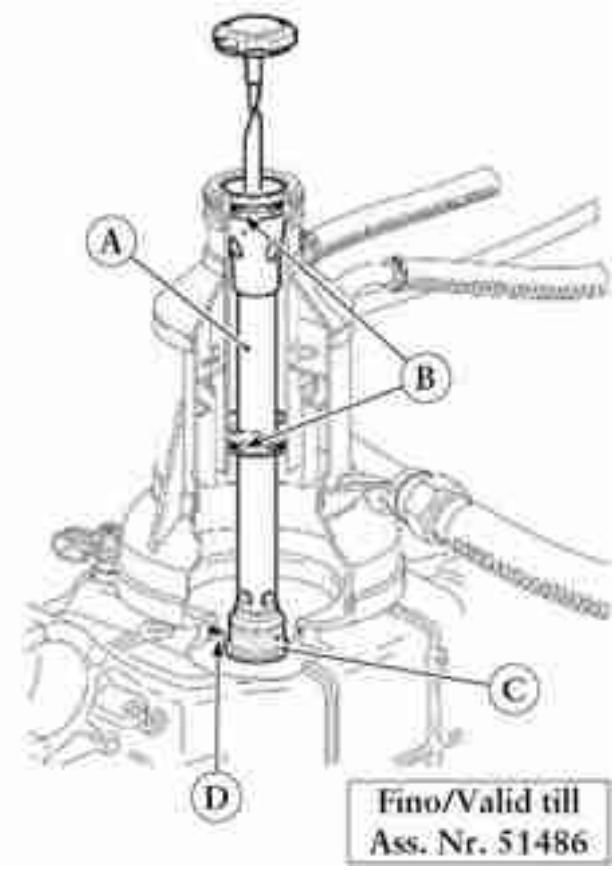
NOTES

The separator can be removed without draining the entire system. In the event of replacement, refill with the same amount of oil that was present in the blow-by system and check the oil level (A 3.01).

- Detach all pipelines connecting the blow-by system to the head vapour recirculation system.
- Detach the union on the radiator connection pipe and plug it.
- Unscrew the nuts **(1)** fastening the blow-by system to the gearbox unit.

- Remove the complete blow-by system unit.

- Prior to re-assembly, check the conditions of the O-Ring **(D)**, on the lower end of the blow-by system and the surfaces it rests on.
- On vehicles **UP TO Ass.ly No. 51486**, check that the inner pipe **(A)** is fitted, complete with gaskets **(B)** and base **(C)**.



Re-assembly Notes

- Lightly lubricate the O-Ring **(D)** to facilitate assembly and to avoid tearing.
- Fit the supporting brackets **(2)** for the pipes supplying the exchanger, under the left-hand nut **(1)**.

- Tighten the radiator pipe union to the prescribed tightening torque.

- Reconnect all the lines connecting the separator to the heads’ vapour recirculation system.

B4.04 OIL RADIATOR

The oil radiator is located over the right-hand rear wheelhouse and it is directly affected by the flow of outside air, which is distributed on it by a specific air flow duct.

Tightening torques	Nm	Category
Pipe unions on the radiator	**78**	**B**

Disassembly

NOTES

The radiator can be removed without draining the system completely. In the event of replacement, the radiator must be refilled with the same amount of oil that was present in it previously and the oil level must be checked (A 3.01).

- Remove the right-hand side shield from the engine compartment (M 2.13).
- Remove the outer part of the right-hand wheelhouse (M 2.05).
- Loosen the unions on the pipe **(1)** delivering oil to the radiator and the pipe **(2)** returning oil to the blow-by system.

- Unscrew the nuts **(3)** fastening the front of the radiator to the chassis.

- Unscrew screws **(4)** fastening the rear support and detach the brackets **(5)** for the vacuum tank and the activated charcoal filter from the support.

- Unscrew the nuts **(6)** fastening the rear part of the radiator to the support.
- Detach the pipes **(1)** and **(2)** and remove the radiator complete with the duct.

Re-assembly Notes

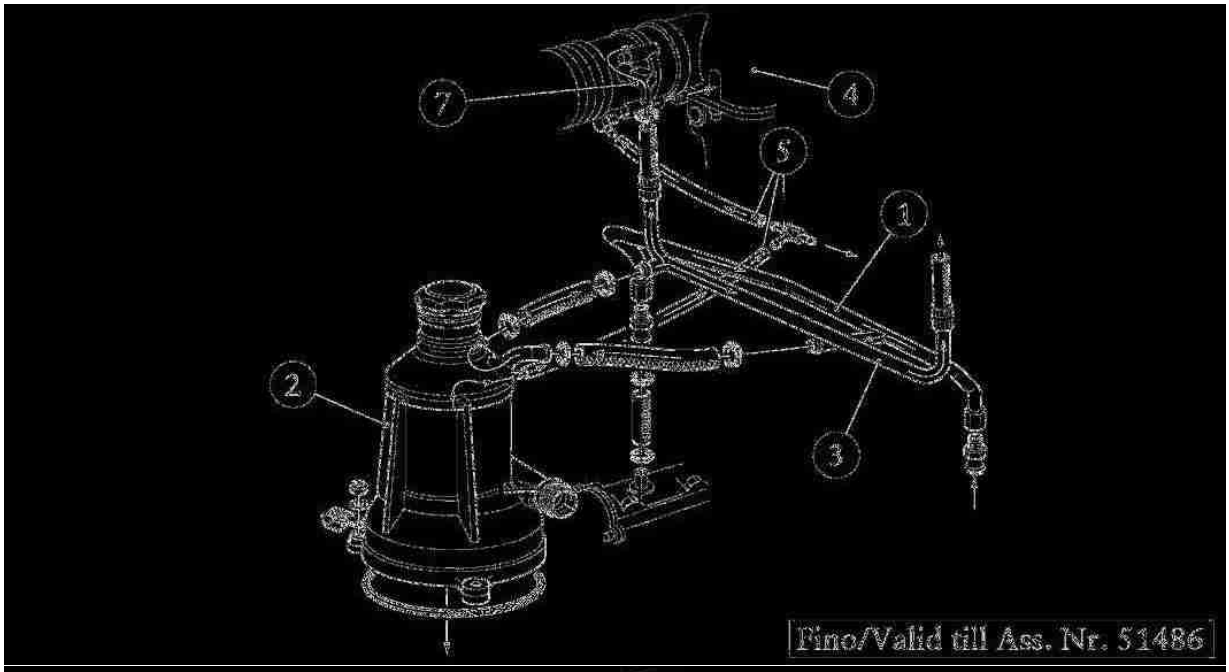
- After the radiator has been re-positioned and secured, connect the oil hoses **(1)** and **(2)** and tighten the unions to the prescribed torque.
- Refit the components removed for the operation, top up and check the oil level *(*A 3.01*)*.

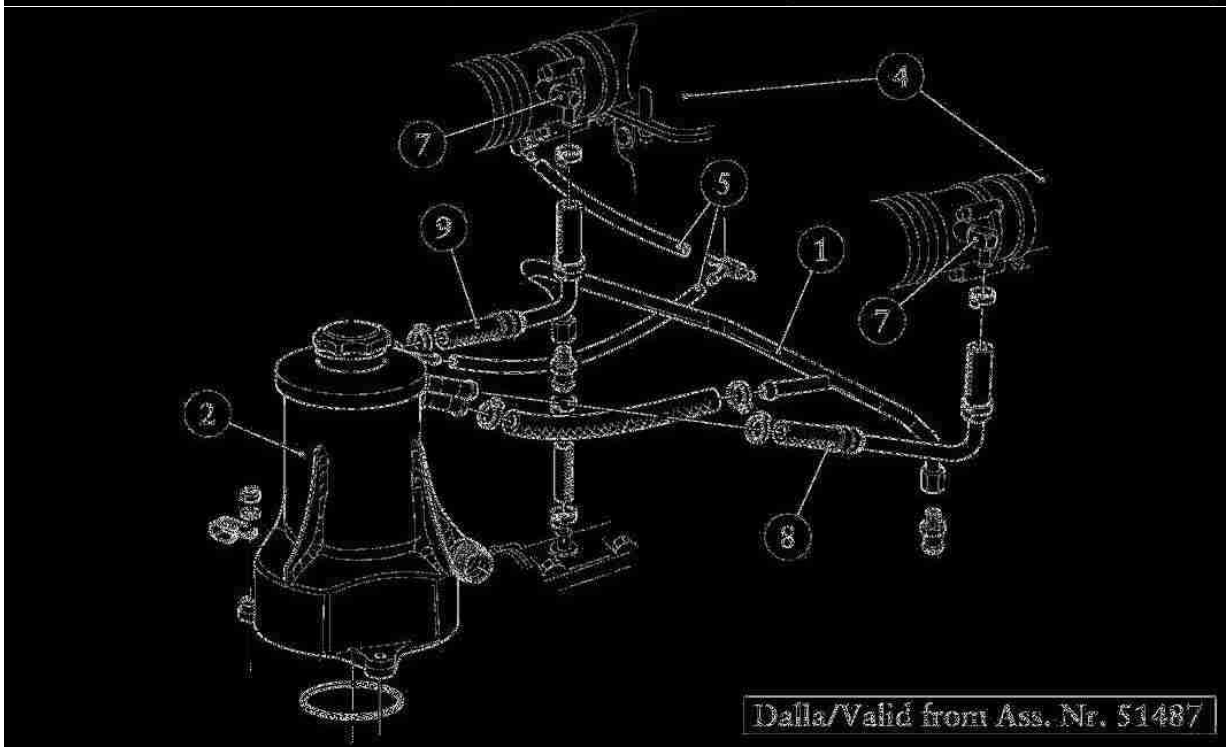
Replacing the radiator connection pipes

- Remove the right-hand side shield from the engine compartment (M 2.13).
- Remove the outer part of the right-hand wheelhouse (M 2.05).
- Detach the delivery pipe **(1)** unions from the radiator and from the engine pipe.
- Detach the return pipe **(2)** unions from the radiator and from the separator
- Slide the pipes off of the movable frame support bracket **(7)**.

- When re-assembling, position the pipes correctly (see figure), inserting them in the support stand **(7)** and tightening the unions to the prescribed torque.
- Refit the components removed for the operation, top up and check the oil level *(*A 3.01*)*.

B4.05 OIL AND GAS VAPOUR RECIRCULATION





The oil and gas vapour circulation device is of the closed-circuit type.
The oil gas and vapours coming from the heads are channeled into a pipe **(1)** that is connected to the blow-by system **(2)**.
From there, part of the vapour condenses and flows into the underlying oil tank.
Owing to the vacuum created by the engine, the remaining vapour is suctioned through the connection pipe **(3, valid UP TO Ass.ly No. 51486)** and channeled into the plenum chambers **(4)**.
FROM Ass.ly No. 51487, there are two output unions **(8)** and **(9)** on the separator for the lines that carry the vapours to the plenum chambers **(4)**.
The pipeline **(5)** serves to release the accumulation of pressure inside the oil tank.

Piping replacement

Valid UP TO Ass.ly No. 51486

- In order to replace the pipe **(3)** it is necessary to detach the sleeve **(6)** from the blow-by system and from the unions **(7)** on the throttle bodies.
- Remove the pipe **(3)** and separate it from the sleeve **(6)**.

Valid FROM Ass.ly No. 51487

- To replace the lines **(8)** and **(9)**, they must be detached from the separator and the unions **(7)** on the throttle bodies, by opening the clamps on the end of the said lines.

B5.01 SYSTEM OUTLINE

Cooling cycle

Fill the system as described (B 5.07). Before reaching **77°C - 170.6°F** (B 5.03), the thermostatic valve is closed and the radiator circuit is temporarily cut out. The cooling mixture flows out from the engine through the water outlet manifolds **(14)** and cools the cylinders and heads through the special slits and channels. The coolant then flows through the exchanger **(15)** and into the centrifugal pump **(1)**.

Over the **79°C - 174.2°F** threshold (B 5.03), the thermostatic starts opening, thereby allowing the mixture to pass and flow to the radiators. The mixture then flows through the line **(9A)** and into the radiators **(6)** and **(5)**. Once cooled down, it will flow into the engine through the line **(9B)**: the cycle will be so repeated.

System

The engine is cooled by a pressurised circuit system **(0.98 bar)** through circulation of an anti-freeze mixture.

CAUTION

The high temperature and the pressure of the mixture contained in the circuit can lead to severe burning. Always work with the engine cool and with extreme caution.

120°C – 248°F.

IMPORTANT

*The system must be checked if the thermometer indicates a temperature that exceeds **120 °C – 248°F** (the warning light will light up on the instrument panel).*

The circulation of the coolant is activated by a centrifugal pump **(1)** that is driven by the crankcase by means of a belt that, in turn, transmits motion to the alternator as well.

A thermostat unit **(2)** is assembled on the pump and it includes a bleed screw **(3)** for breathing air present in the system when the circuit is being filled or in the event of problems with circulation. Furthermore, the rear side is fitted with a duct **(12)**, connected to the expansion tank for the pump/engine self-bleeding.

The thermostatic valve **(4)** starts opening when the temperature of the mixture reaches **77÷81 °C** (**170.6-177.8° F**), thereby permitting passage to the radiators.

The radiators are positioned in the front part of the car in order to improve thermal exchange. The right-hand radiator **(5)** includes standard assembly with the air-conditioning condenser. The cooling coil for the power steering system is assembled on the left-hand radiator **(6)**.

Each radiator is equipped with an electric fan **(7)** to facilitate heat dispersion. The radiators have a parallel connection and they include a duct **(8)**, which is connected to the expansion tank for self-bleeding of the system.

The connection lines **(9A)** and **(9B)** between the pump and the radiators are made of light alloy and they run longitudinally across the underfloor of the car.

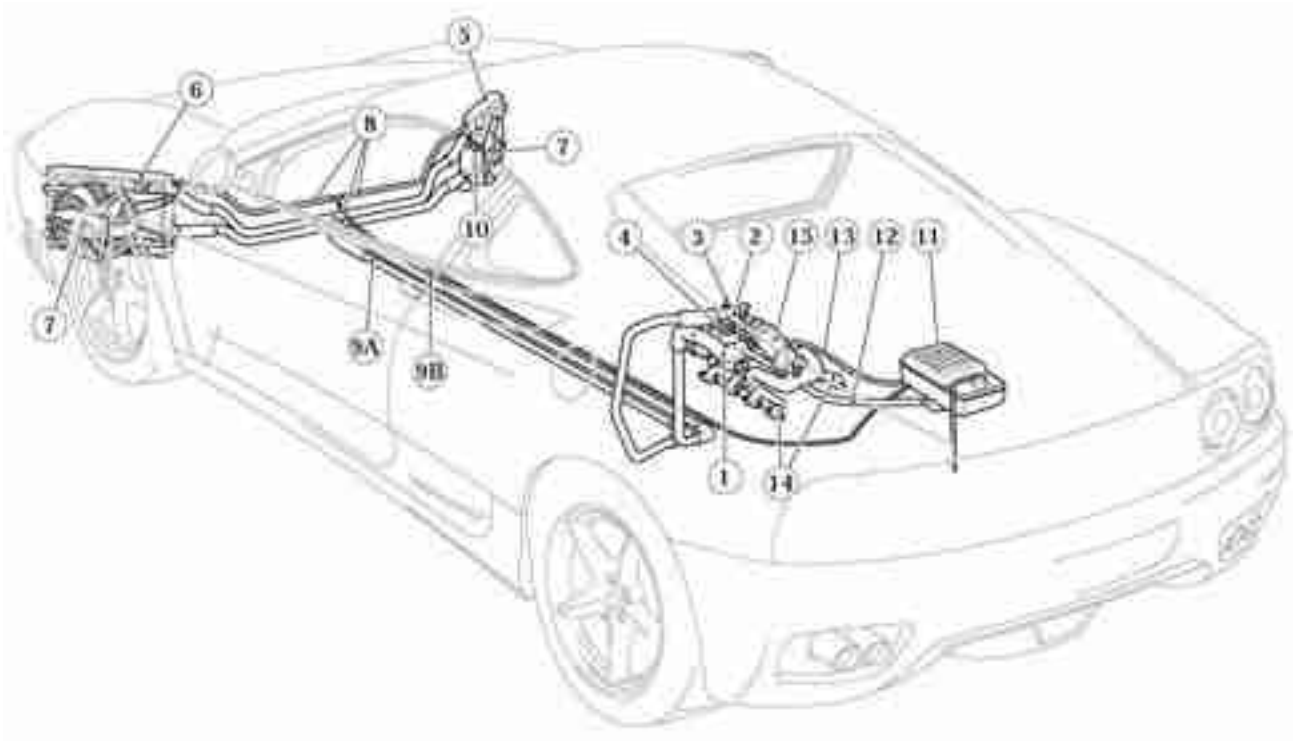
There is a twin contact switch **(10)** fitted on the right-hand radiator. It serves for automatic engagement of the electric fan/s when the temperature reaches a given point.

	1st contact	2nd contact
Closes	**92 ±2 °C (197.6±35.6°F)**	**97 ±2 °C (206.6±35.6°F)**
Open	**87 ±2 °C (188.6±35.6°F)**	**92 ±2 °C (197.6±35.6°F)**

CAUTION

Do not place hands or clothing near the electric fan as the latter could start up automatically and cause serious injury to the operator.

An expansion tank **(11)** positioned on the air intake compensates for fluctuations in the volume and pressure of the coolant caused by engine temperature fluctuations.

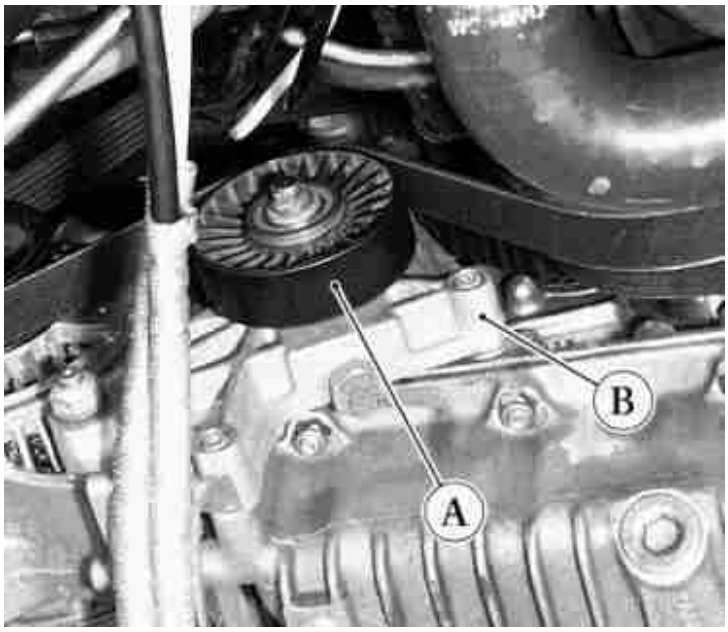


1 - Centrifugal pump
2 - Thermostat unit
3 - Bleed screw
4 - Thermostatic valve
5 - Right-hand radiator
6 - Left-hand radiator
7 - Electric fan
8 - Duct
9A - Delivery line
9B - Return line
10 - Twin contact swich
11 - Expansion tank (nourice)
12 - Nourice-engine connection duct
13 - Pump-engine self-bleeding duct
14 - Water outlet manifolds
15 - Gearbox oil exchanger

B5.02 WATER PUMP

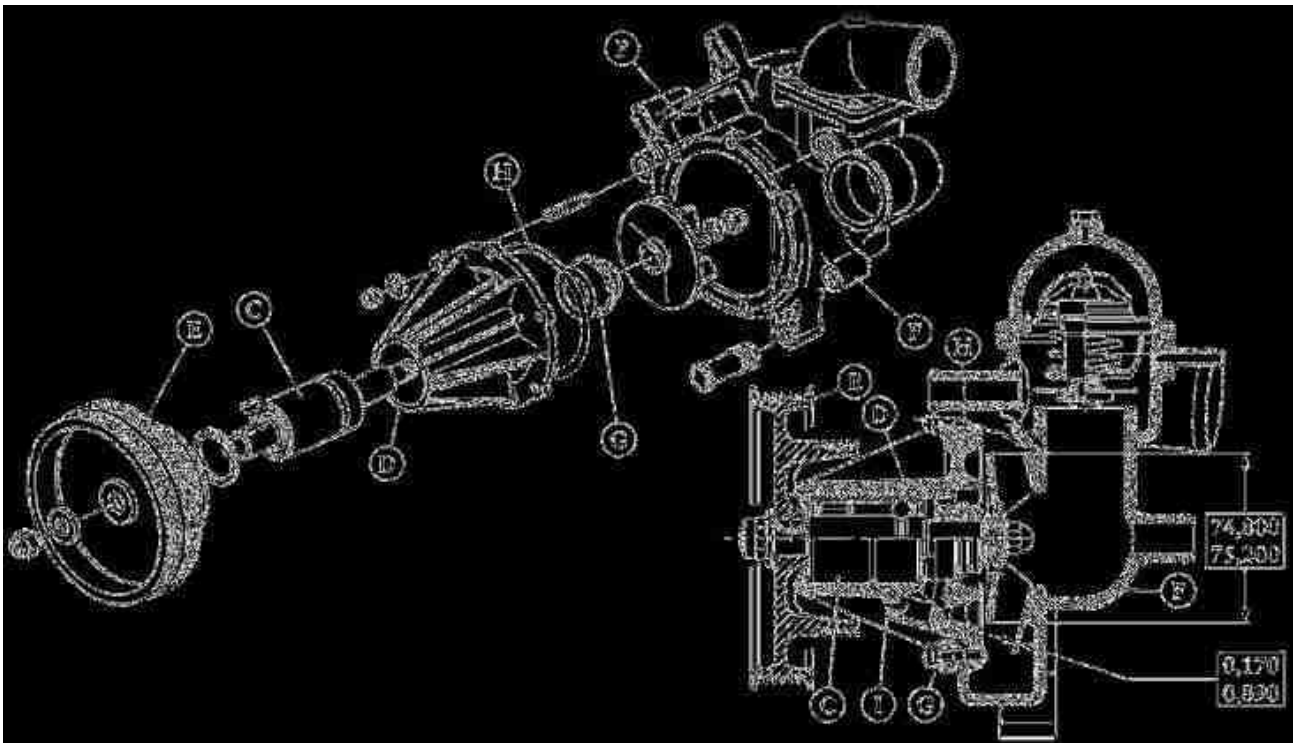
The pump is of the centrifugal type and is driven by the crankcase by means of a driving belt that, in turn, also activates the alternator simultaneously. A second belt assembled on the water pump pulley drives the power steering pump.

Proper tension of the water pump driving belt is determined by the position of the belt-tensioner roller **(A)**, which is secured to the alternator **(B)** support.



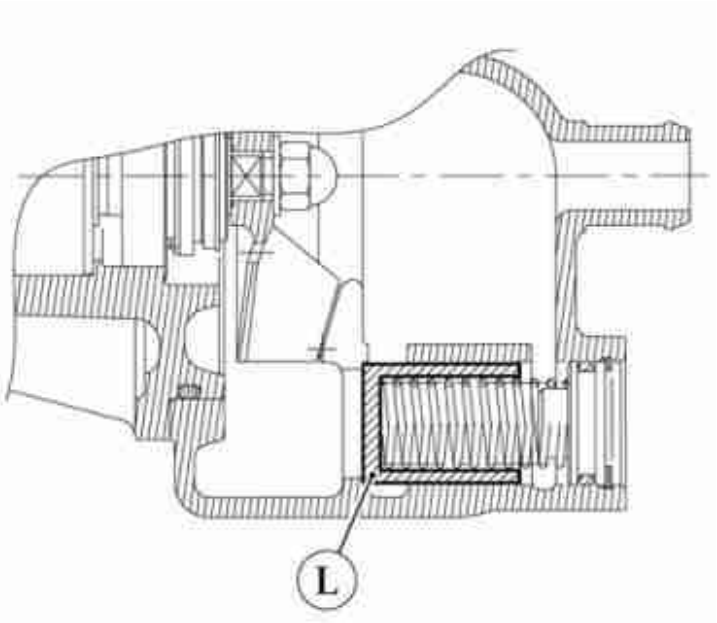
See Paragraph (A 3.04) for information on tension adjustment and/or replacement of the water pump driving belt. After removing the belt, perform the following checks:

- check for leakage of liquid from the bearing **(C)** on the cover **(D)**, pulley side **(E)**, or between the cover **(D)** and the pump body **(F)**, and from the drainage hole **(I)**. If leakage is present, the cover must be removed together with the impeller unit as described below. The inner seal ring **(G)** or the O-Ring **(H)** must be replaced as well.
- rotate the pulley **(E)** on the pump and check to ensure that the bearing **(C)** supporting the impeller does not show excessive radial clearance and that it is not noisy. If either one of these conditions is present, the bearing must be replaced.
- slowly rotate the pulley **(E)** while pulling and pushing it towards the pump body at the same time in order to check the end float of the bearing **(C)**. The bearing must be replaced if contact occurs or there is excessive end float.



The water pump body is fitted with a space to contain the thermostatic valve (B 5.03).

On the delivery line, the water pump is equipped with a by-pass valve which in the event of overpressure, cuts out the passage of the liquid. In the event of malfunctioning, the water pump cover must be removed and while pushing the diaphragm **(L)** in its seat, it must be checked to ensure that it slides freely without interference or excessive forcing.



The complete pump unit must be removed from the engine for valve replacement.

Tightening Torques

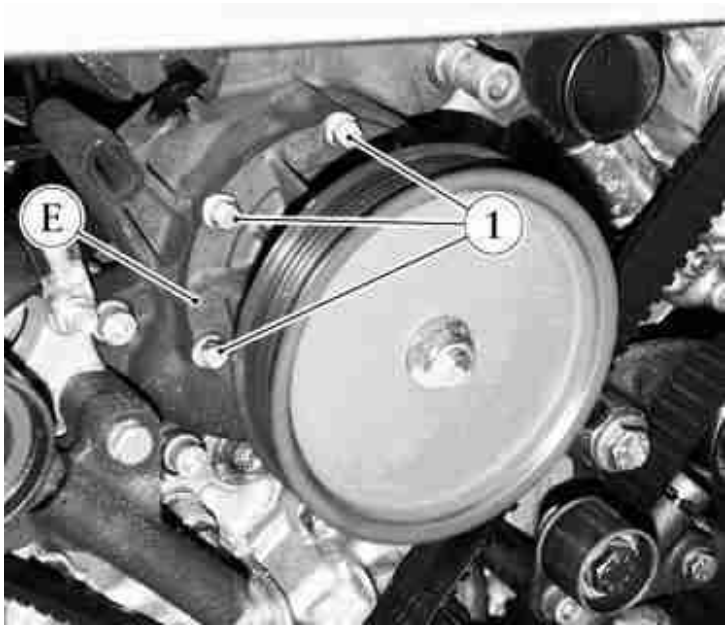
Nut fastening the pump cover	**11 Nm**
Nut fastening the impeller	**25 Nm**
Screw fastening the pump body	**25 Nm**

Disassembly of the Cover with the Impeller Unit and Inspection of the By-Pass Valve

NOTES

This procedure can also be performed with the engine installed in the car, working from the engine inspection lid (M 3.05).

- Drain the cooling system through the drain caps on the radiators (B 5.04).
- Remove the power steering pump driving belt (A 3.04).
- Remove the power steering pump (E 2.01).
- Unscrew the six nuts **(1)** fastening the cover **(D)** to the pump body.

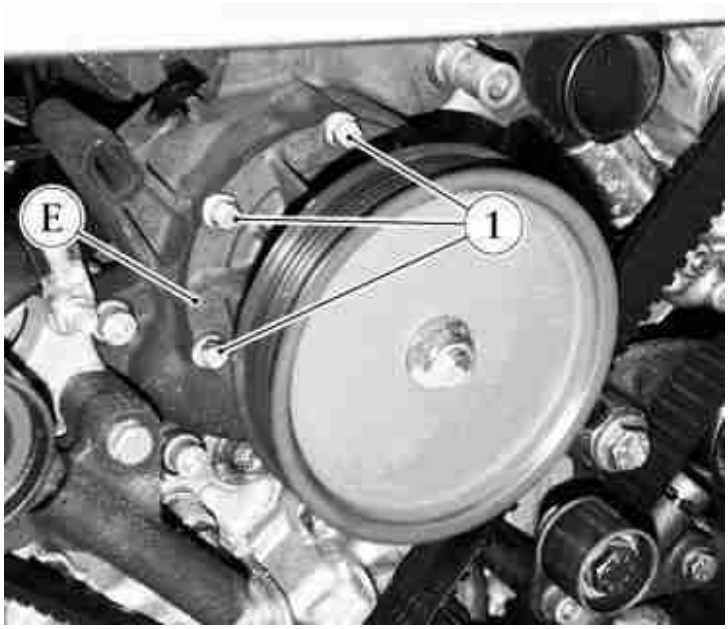


- Slide the cover with the complete impeller unit off of the pump body.
- Proceed with disassembly and/or replacement of the inner components.

NOTES

Under these conditions, the by-pass valve inside the pump body can be inspected and checked to ensure that it is running properly.

- Check the condition of the O-Ring **(H)** and if necessary, replace it, before re-assembly. Lubricate the new O-Ring with a thin layer of **MOLYKOTE** grease to facilitate insertion of the cover **(D)** in the pump body.
- Tighten the nuts **(1)** to the prescribed torque, proceeding crosswise.
- Rotate the pulley **(E)** and ensure that it moves freely, without interferences.

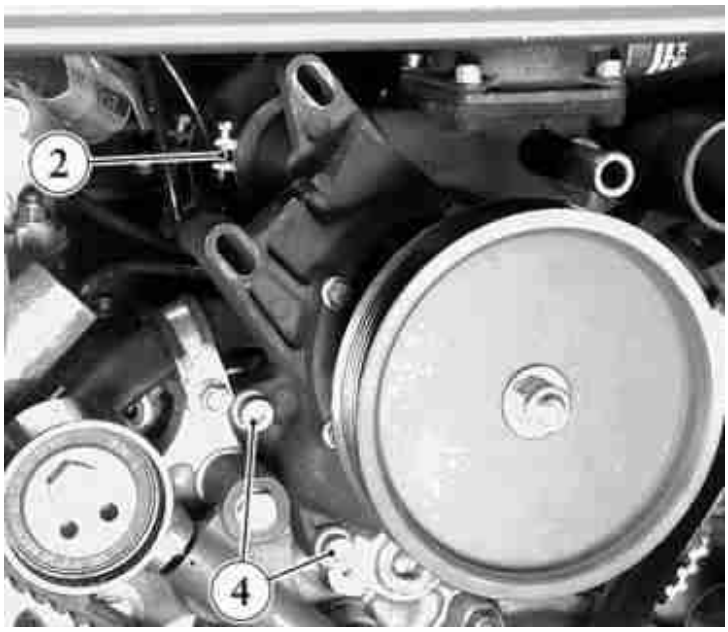


Disassembly of the Complete Water Pump

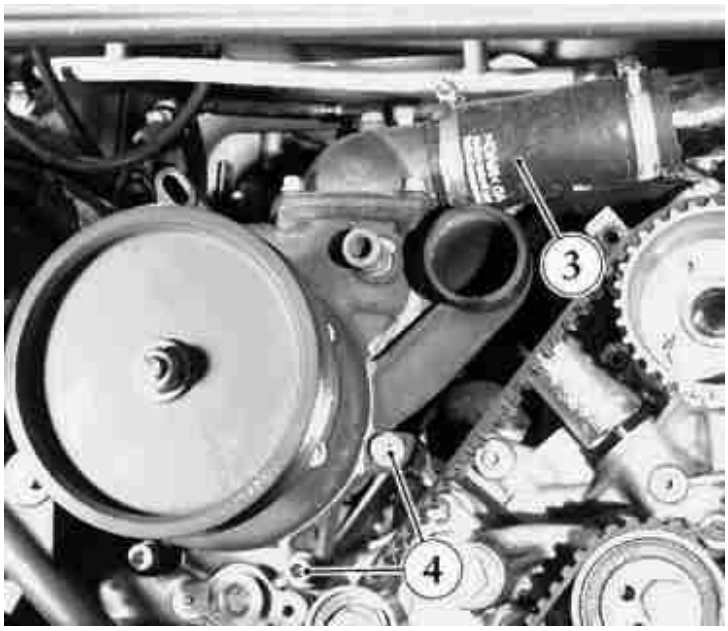
NOTES

This procedure can also be performed with the engine installed in the car and working through the engine inspection lid (M 3.05).

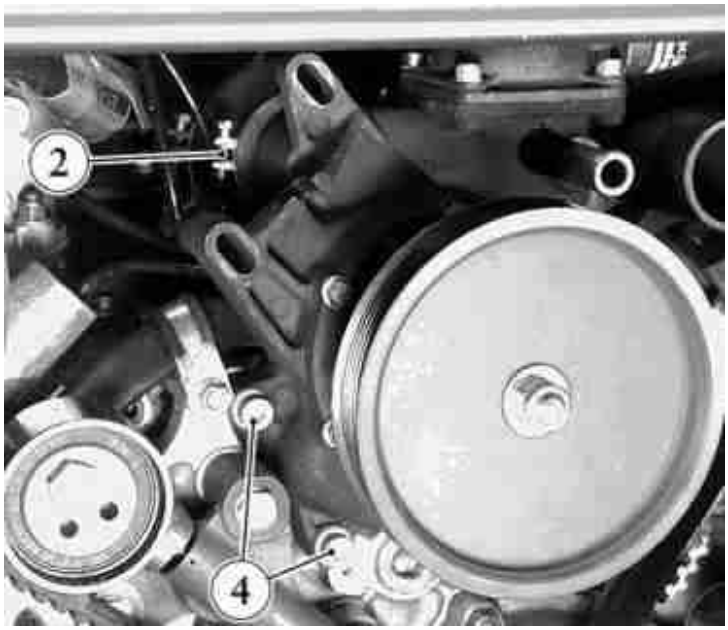
- Drain the cooling system through the radiator drain caps (B 5.04).
- Remove the power steering pump driving belt (A 3.04).
- Remove the power steering pump (E 2.01).
- Remove the return pipe union and the passenger compartment heating system pipe from the pump body.
- Loosen the clamp **(2)** on the oil-water exchanger and pump connection.

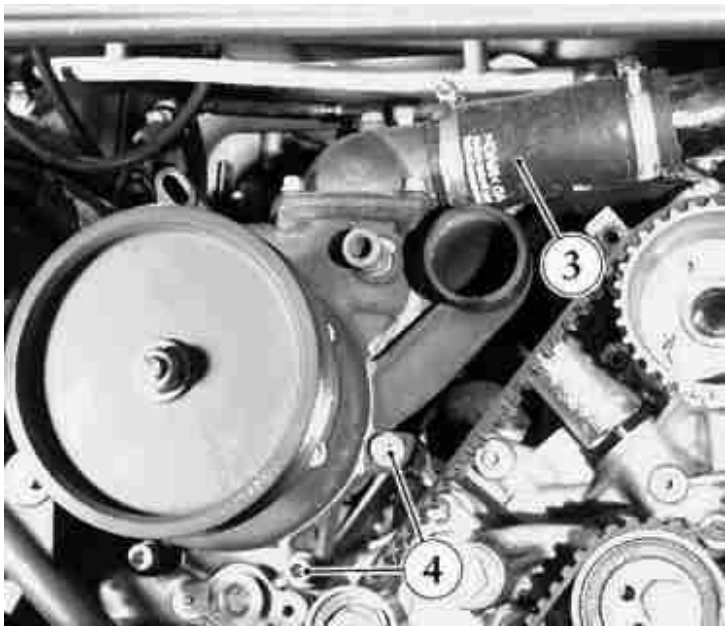


- Detach the union **(3)** on the pipe delivering water to the radiators from the thermostatic valve cover



- Detach the expansion tank from the device fastening it to the air intake, (B 5.05) but leave it connected to the system.
- Unscrew the four screws **(4)** fastening the pump body to the crankcase.





- Slide the pump off of the engine just enough to be able to detach the pipes connecting the expansion tank, from the rear of the pump.
- Remove the entire pump unit from the engine, being careful not to damage the O-Ring.
- Perform all of the overhauling or replacement procedures needed.
- Prior to re-assembly, ensure that all the contact surfaces on the pump body and on the crankcase are clean and perfectly level. Then lubricate the O-Ring with **MOLYKOTE** grease.
- After having connected all of the pipelines, tighten the screws to the prescribed torque.
- Refill the system (B 5.07).

B5.03 THERMOSTATIC VALVE

The thermostatic valve is found on the water pump body and its function is to open or close the coolant passage in the radiators, on the basis of the operating temperature.
Figure 1 shows the passage of the coolant inside the water pump, under the **closed valve** and **opened valve** conditions.

Keys to Fig. 1

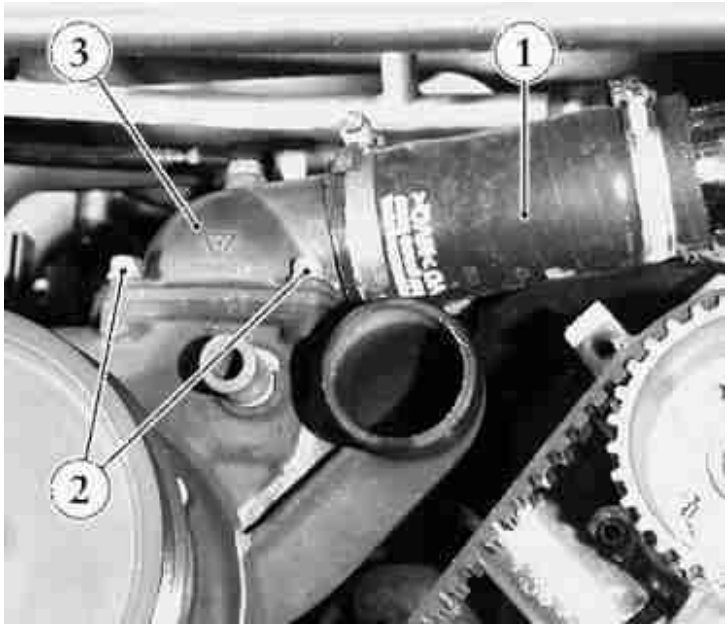
A - From the heads
B - To the radiators
C - From the radiators
D - To the engine

The temperature for the start of valve aperture is **79 ± 2°C**.
It is not advisable to eliminate the thermostatic valve as circulation would take place prevalently inside the engine, excluding the radiators a priori. This would inevitably lead to overheating of the engine.

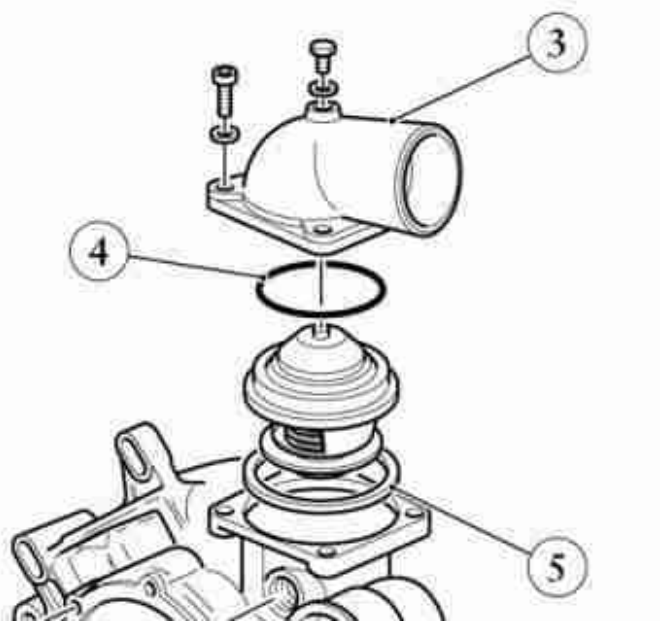
Disassembly and Overhaul

You must work through the engine inspection lid to remove the thermostatic valve from the pump body (M 3.05).

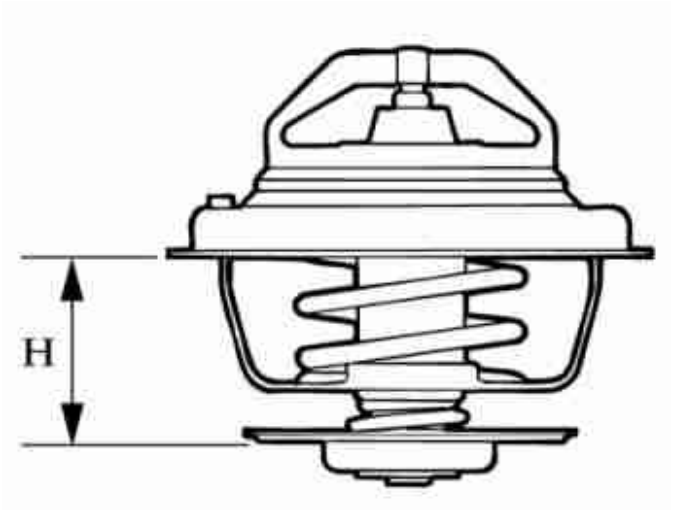
- Drain the cooling system through the drain caps on the radiators (B 5.04).
- Detach the union **(1)** on the pipe delivering water to the radiators from the thermostatic valve cover.
- Unscrew the four screws **(2)** fastening the cover **(3)** and remove it from the water pump body.



- Remove the O-Ring **(4)**. Slide off the thermostatic valve.

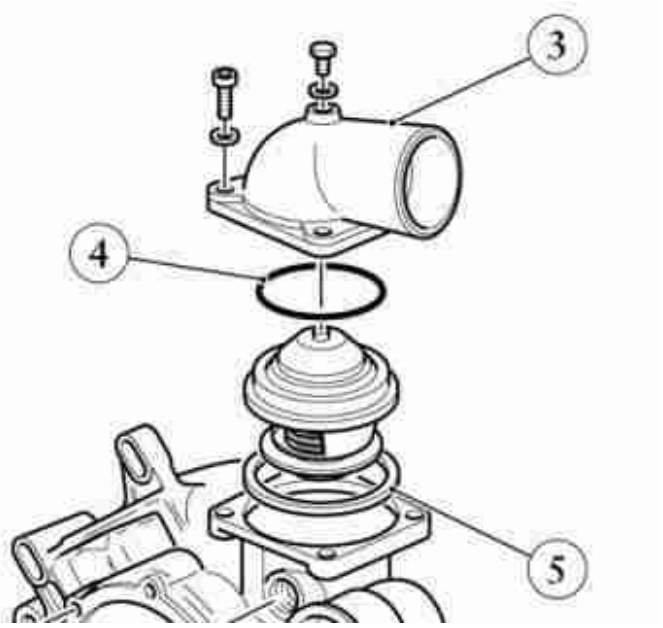


After removal of the valve, it can be checked for proper operation. Immerse it in a container full of water and heat the water up to the temperatures listed in the table. Ensure that the valve extension **(H)** matches the prescribed extension listed.



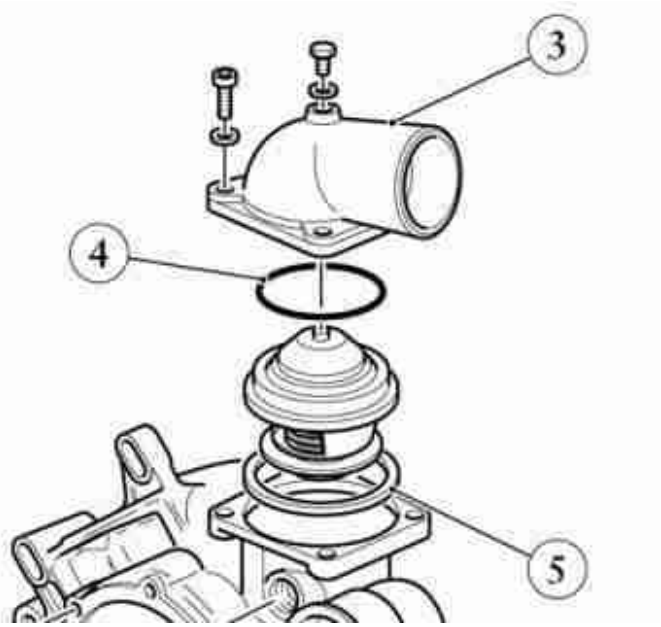
Fluid temperature		Extension (H)
°C	**°F**	**mm**
20	68	25
94	201	32
110	230	35,5

Prior to re-assembly, check the state of the rubber gasket **(5)** in the valve. Replace it if it is bent or torn.



Re-assembly Notes

- Remove any deposits from the valve housing and lubricate the rubber gasket **(5)** and the O-Ring **(4)** with a thin layer of **MOLYCOTE** grease.



- Fit the valve into the housing, pushing it until it is resting perfectly on the pump body seat.

B5.04 WATER RADIATORS

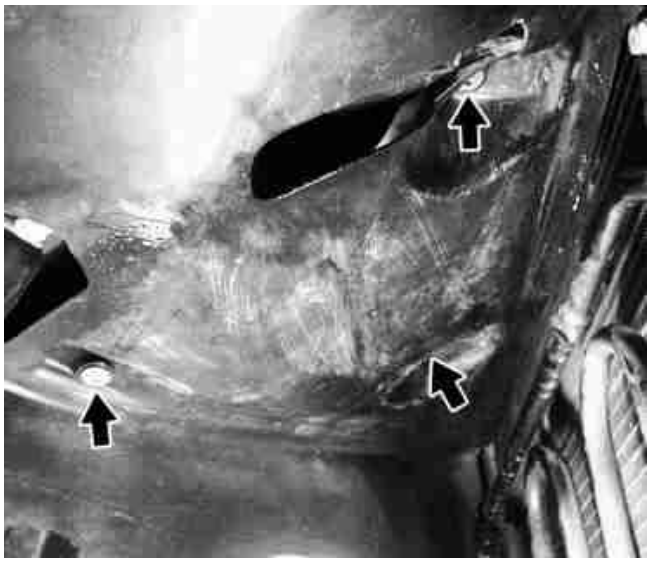
Tightening torques	Nm	Category
Pipe union on condenser	**16,2**	**A**
Thermometric switch	**39**	**B**
Screw fastening bracket to radiator	**12**	**B**
Screw fastening bracket to chassis	**7÷8**	**B**

Preliminary procedures

Check the state of the core of each radiator periodically. Remove any leaves, insects or impurities from the fins as they could obstruct air flow and cause overheating of the fluid. Straighten any bending present while being careful not to cause breakage of the radiator cores.
Replace the radiator if it proves to be in poor condition.
Check the conditions of the connection unions periodically (_____).

- Before removing the radiator or replacing cooling system parts, the circuit must be drained through the drain caps (1) found on the bottom side of each radiator.

- The front part of the underfloor must be removed to gain access to said cap (M 2.12).
- The front bumper must be removed to gain access to the radiators (M 2.03).
- Remove the liners around the perimeters of the air flow ducts and which keep them in place.
- Working inside each air flow duct, unscrew the three screws fastening the upper part to the chassis.



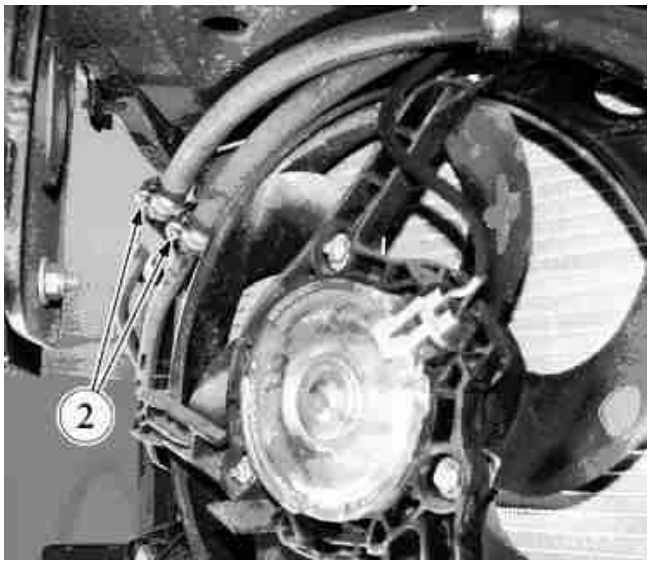
- Remove the air flow duct with gasket.

Removing the Left-Hand Water Radiator

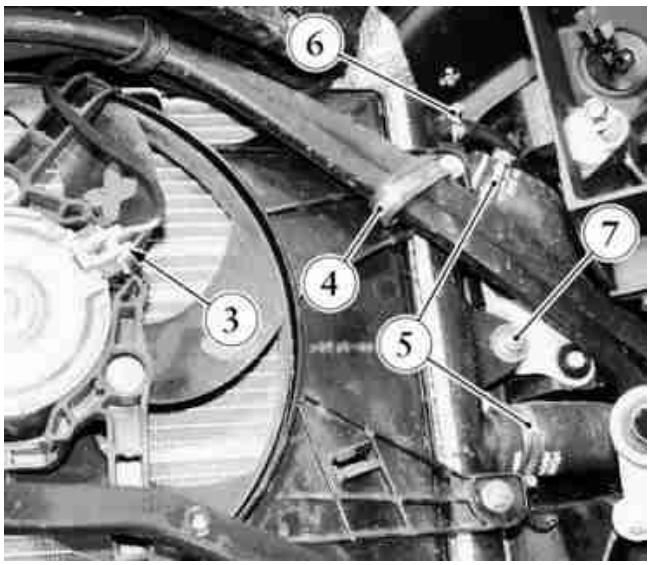
NOTES

The power steering system must be drained as described in (E 2.01) before you proceed to detach the connection lines to the coil.

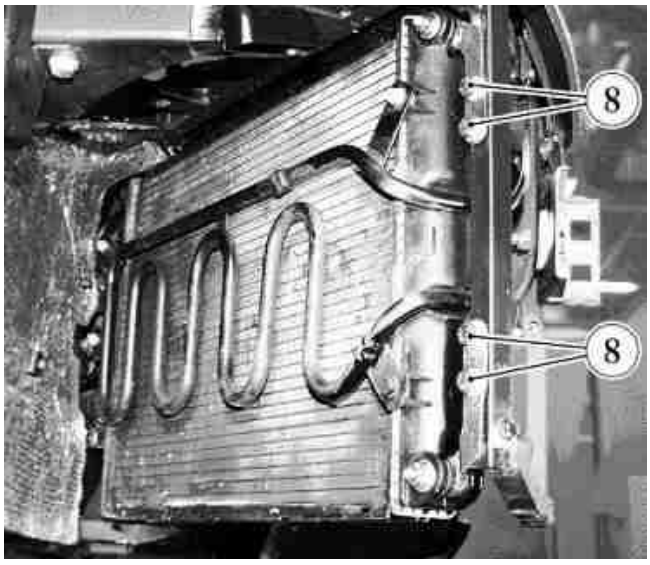
- Loosen the clamps **(2)** on the pipes connecting the power steering system to the coil.
- Slide the connection pipes off of the coil.



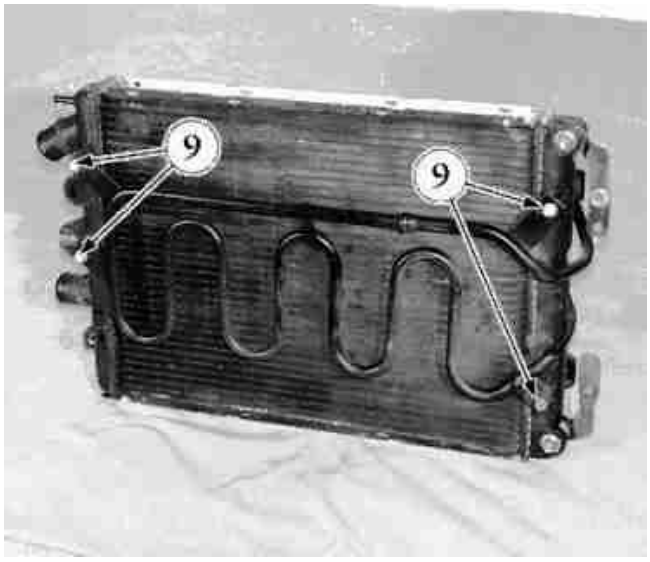
- Detach the electric fan connector **(3)** and the bracket **(4)** holding the power steering pipes on the radiator.
- Loosen the clamps **(5)** on the unions of the pipes delivering and returning water to and from the radiator and the bracket **(6)** on the breather pipe.
- Slide the unions and the breather pipe off of the radiator.
- Loosen the nut **(7)** fastening the inner face of the radiator to the chassis.



- Unscrew the screws **(8)** fastening the supporting brackets for the outer face of the radiator to the small front frame.



- Slide the radiator with the coil and electric fan off of the chassis.
- Unscrew the fastening screws **(9)** to remove the coil from the water radiator.

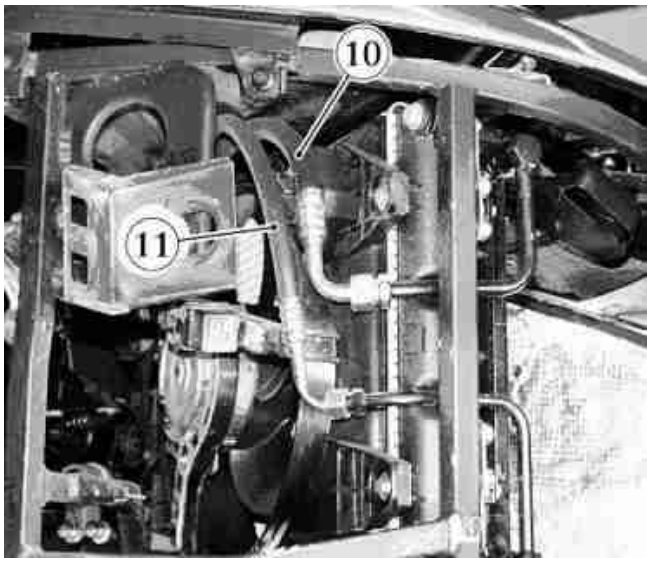


Removing the right-hand radiator

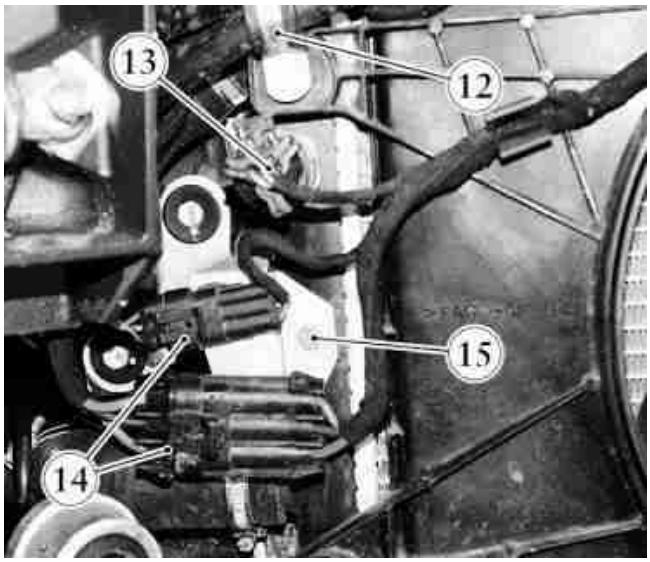
NOTES

The system must be drained as described in (I 3.01) before you proceed to detach the air-conditioning system lines from the condenser.

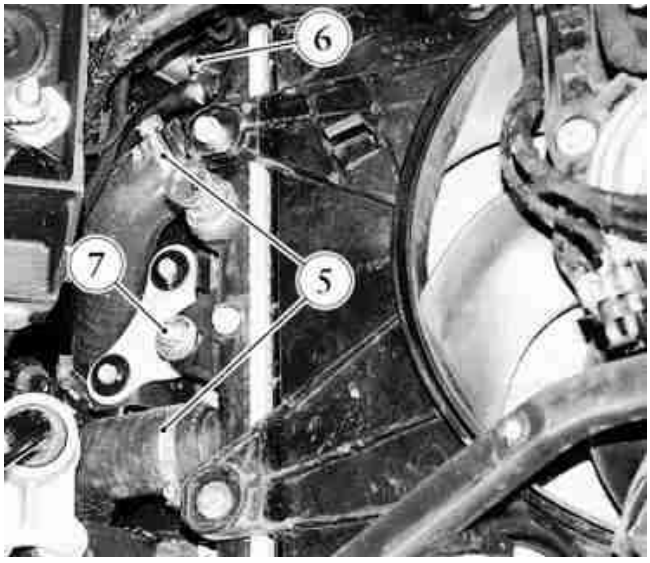
- Detach the delivery pipe **(10)** running from the compressor to the condenser and the return pipe **(11)** running from the condenser to the dehydrator filter.



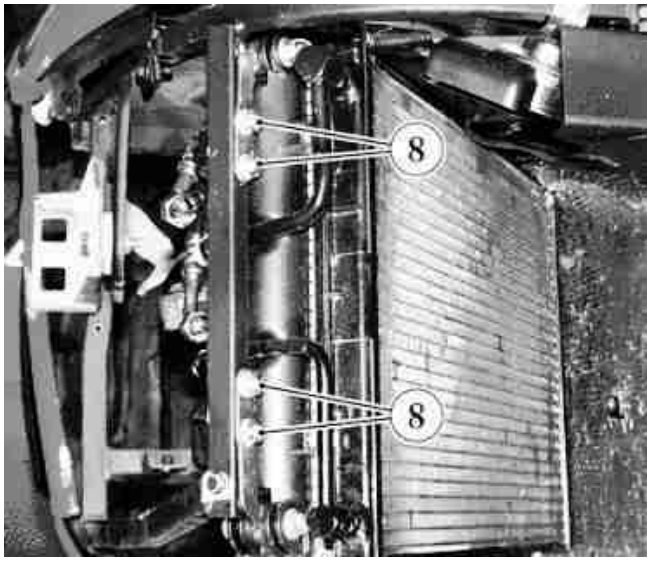
- Remove the small bracket **(12)** supporting said pipes from the radiator.
- Detach the connection **(13)** from the thermometric switch and the connections **(14)** from the electric fan harness.
- Detach the connector supporting bracket from the radiator by unscrewing the screw **(15)**.



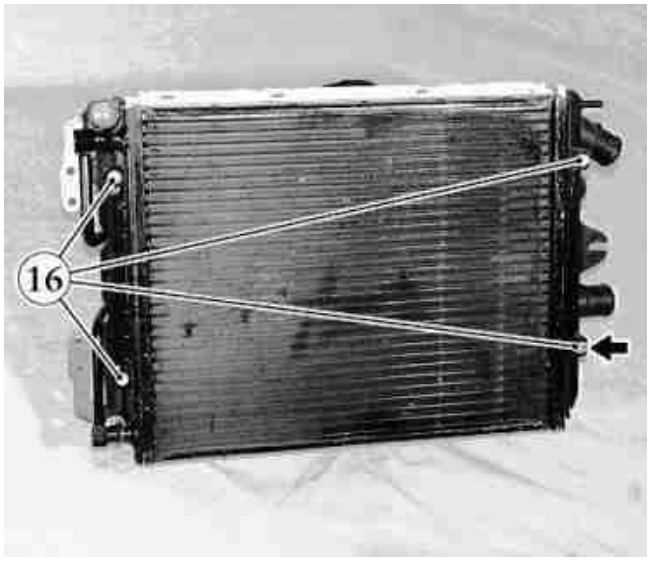
- Loosen the clamps **(5)** on the unions of the pipes delivering and returning water to and from the radiator and the bracket **(6)** on the breather pipe.
- Slide the unions and the breather pipe off of the radiator.
- Loosen the nut **(7)** fastening the inner face of the radiator to the chassis.



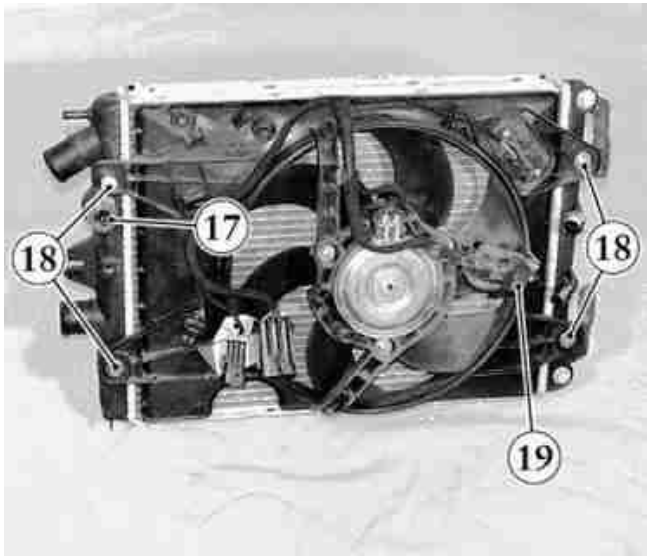
- Unscrew the screws **(8)** fastening the supporting brackets for the outer face of the radiator to the small front frame.



- Slide the radiator with the air-conditioning condenser (I 2.02) and the electric fan off of the chassis.
- Unscrew the 4 fastening screws **(16)** to detach the air-conditioning condenser from the water radiator.

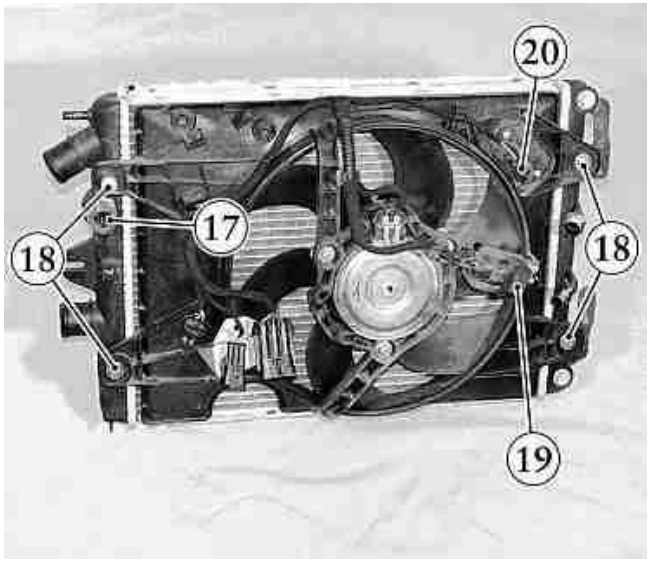


- There is a thermometer switch **(17)** assembled on this radiator. It serves for enabling the fans.



Removing the electric fan

The air flow duct with the respective electric fan is fastened on the rear part of each water radiator.
Unscrew the 4 fastening screws **(18)** to detach the electric fan from the radiator.
After removal of the duct, the fan and/or starter motor, which are shared by both radiators, can be replaced.
A harness for connecting the motor fan is fitted on the relay's **(19)** right-hand duct for controlling the fans and the reisitor **(20)**.

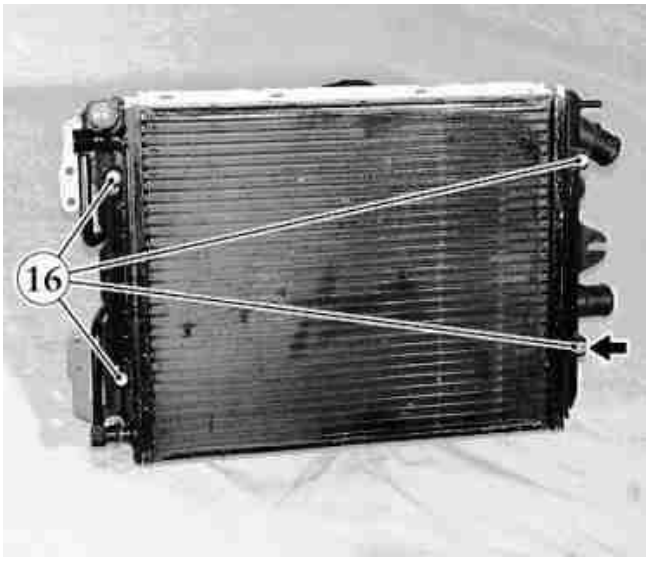


NOTES
The protection fuses for the electric-fans are positioned in the luggagge compartment, behind the fuse box and relays (L2.10).

Re-assembly Notes

Perform all of the procedures in reverse order, ensuring that:

- you are careful about not confusing the inputs when refitting the lines on the coil. The one coming from the steering box should be connected to the lower union (E 1.02);
- the convex-head screw **(16)** fastening the condenser to the right-hand water radiator, is fitted in the position indicated by the arrow.



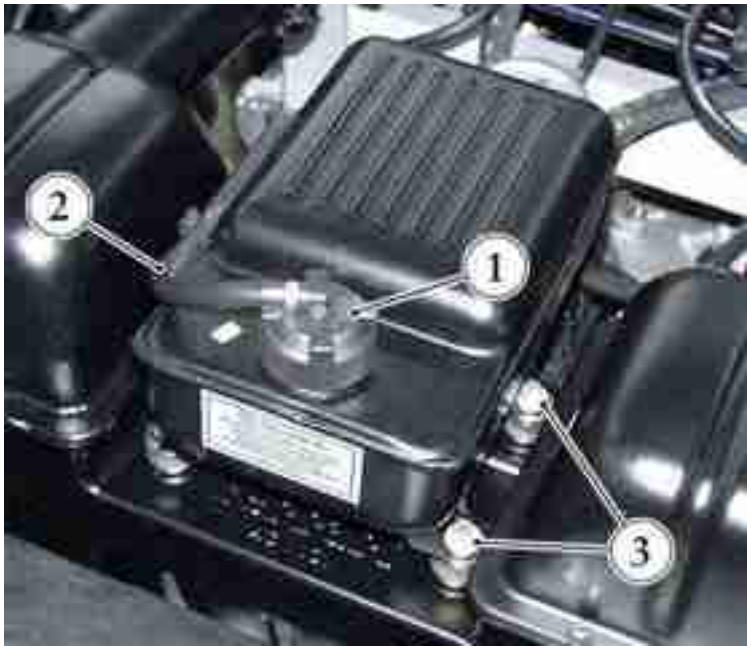
- tighten the delivery and return pipe unions on the air-conditioning condenser to the prescribed torque.

For connection to the system for the fan motors and the resistor(see Table A – ELECTRICAL SYSTEM).

- After completing the re-assembly procedures, fill the power steering system (E 3.02) or the air-conditioning system (I 3.02).
- Then fill the cooling system (B 5.07).

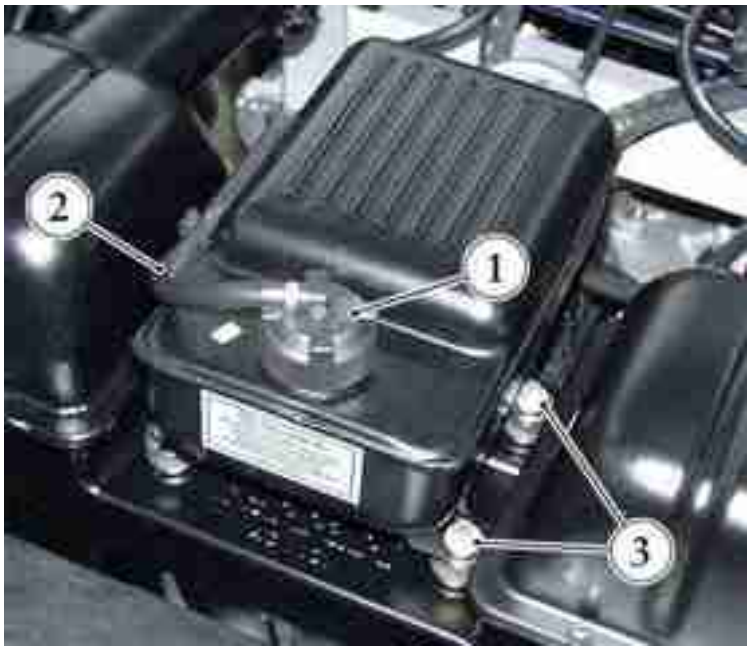
B5.05 EXPANSION TANK

The expansion tank compensates for fluctuations in the volume and pressure of the coolant, which are caused by variations in engine temperature.
The tank is connected to the water pump and to the radiator self-bleeding pipe (B 5.01).
The tank is fitted with a filler neck for filling the system (B 5.07).
The filler neck is closed with a plug **(1)**, which is equipped with a drainage valve set at **0.98 bar**.
The plug union is fitted with a pipe **(2)** that drains the coolant down to the ground when the pressure is excessive.



IMPORTANT
*Check the state of the pipe **(2)** periodically for possible blockage.*

- To remove the expansion tank it is necessary to detach it from the air intake by unscrewing the four nuts **(3)** fastening it to the anti-vibrating pads.
- Lift the tank and detach it from the connection piping, keep the liquid contained in it.



After reassembly, check the fluid level in the system (B 5.07).

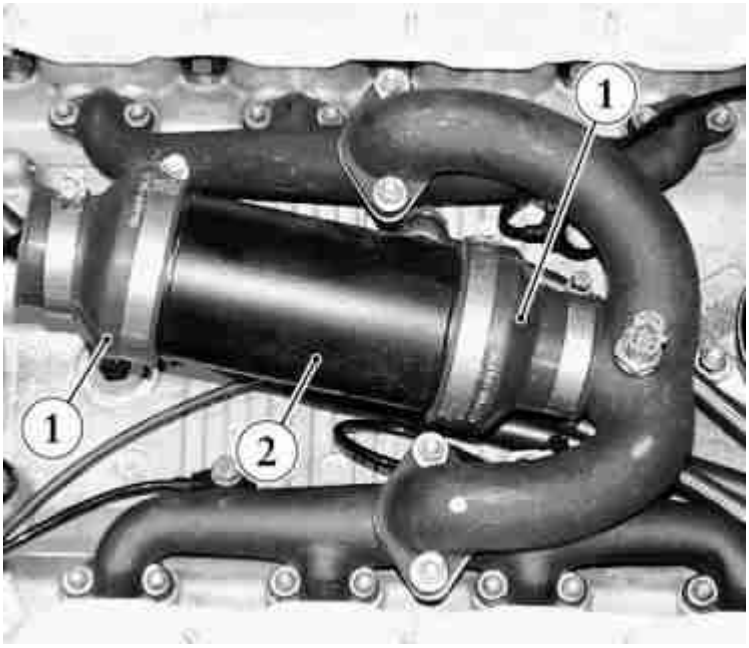
B5.06 OIL-WATER HEAT EXCHANGER

Tightening Torques

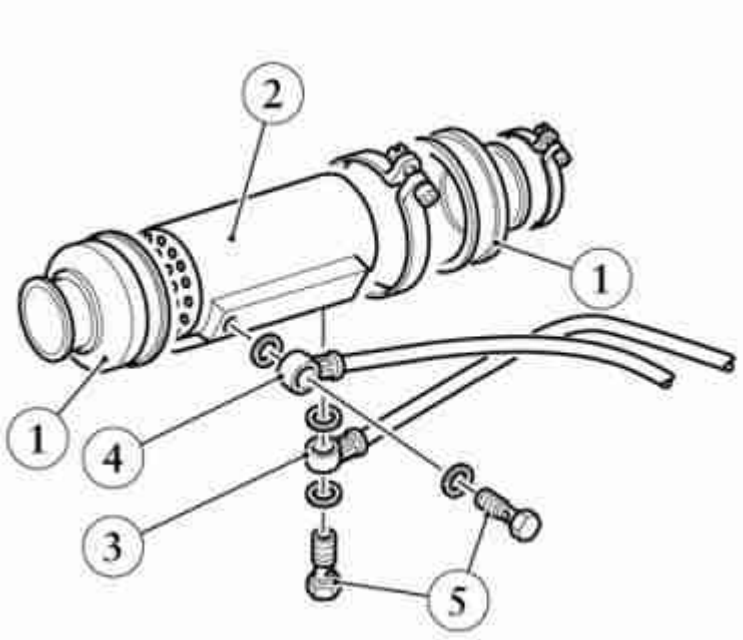
Union on the oil pipe **49 Nm**

Before it enters the water pump, the coolant exiting the heads passes internally through the exchanger. It thus stabilises the temperature of the oil in the gearbox lubrication circuit.
When overhauling the engine, it is advisable to check the coolant ducts for blockage.
After removing the complete water pump unit, (B 5.02), detach the rubber coupling **(1)** from the duct connecting the water outlet manifolds and remove the exchanger, leaving it connected to the gearbox lubrication circuit.

- Detach the rubber couplings **(1)** from the exchanger body **(2)** and perform all of the checks required.



- When re-assembling, position the exchanger with the union holes in the oil hoses towards the left-hand side and downwards, respectively.
- Position the pipes **(3)** and **(4)** as shown in the figure and tighten the unions **(5)** to the prescribed torque.



NOTES

The exchanger can be removed without having to remove the water pump, by working from the rear of the plenum chamber.

B5.07 FILLING THE SYSTEM

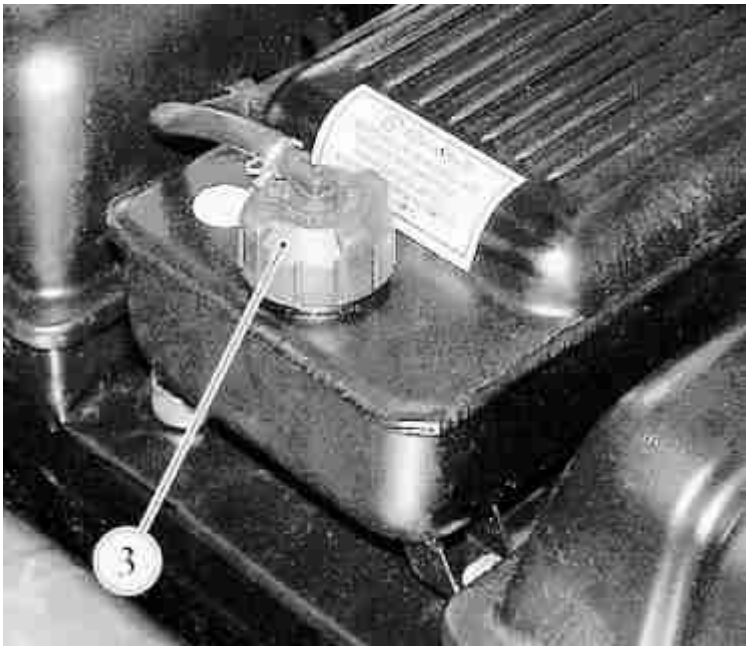
CAUTION

Perform this procedure only when the engine is cool.
If it is necessary to work when the engine is warm, take all of the necessary precautions to prevent burns caused by contact with fluid that may be overheated or under excessive pressure and which could drain or leak from the system

Before filling the circuit, ensure that all the clamps on the connection couplings are tightened and that the drain caps **(1)**, found under each radiator, are tightened securely.

- Set the passenger compartment heating system at the maximum temperature.
- Unscrew the bleeder screw **(2)** on the thermostat unit, to vent the air present in the system.

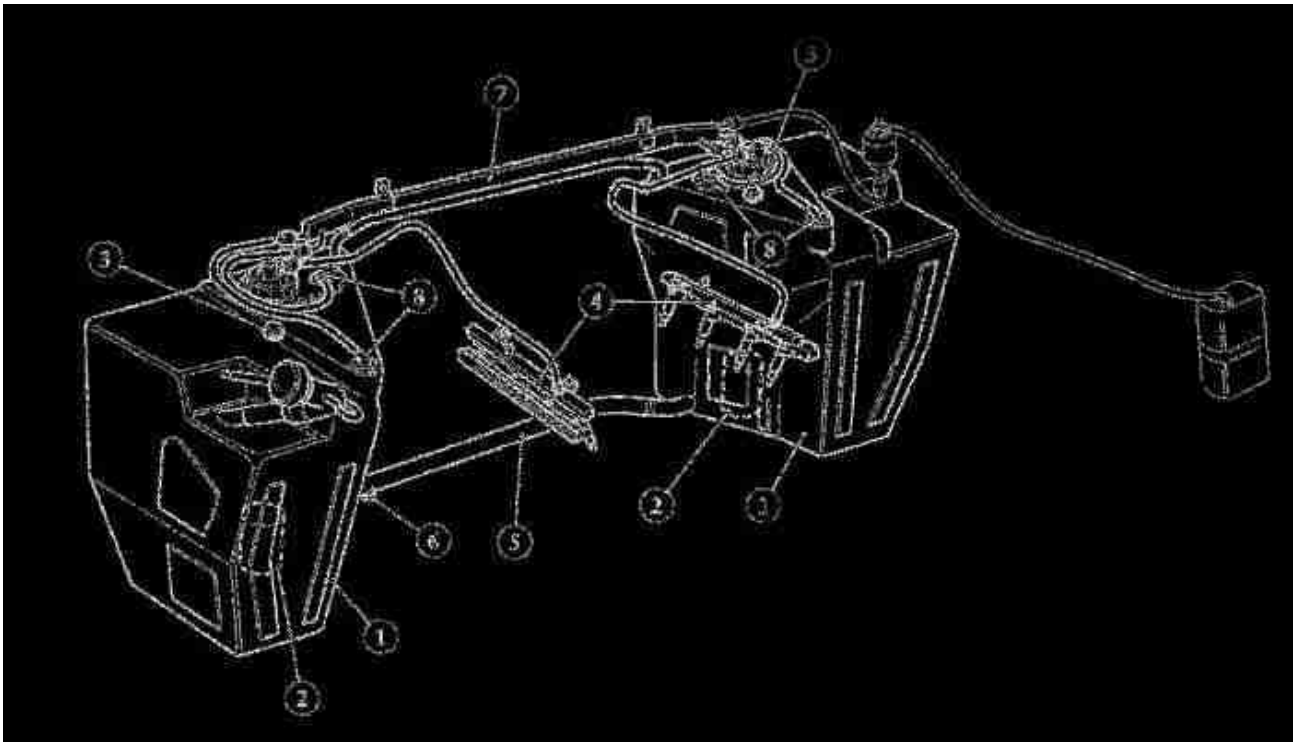
- After removing the filler plug **(3)** pour the prescribed antifreeze mixture (A 1.01) into the expansion tank until the system is completely filled.



- Refit the plug **(3)** and re-tighten the bleeder screw **(2)**.
- Start the engine and run it until it reachis the operating temperature, which causes the thermostatic valve to open.
- Under these conditions, loosen the bleeder screw **(2)** again and check for any release of air. Tighten the screw when only fluid begins to come out.
- Allow the engine to cool and check to ensure that the level of the fluid in the expansion tank is about **40 mm** from the top of the filler neck.
- If necessary, top up with more antifreeze mixture should the level prove to be too low in the expansion tank.

B6.01 FUEL SUPPLY SYSTEM OUTLINE

Each engine bank is supplied by its own system and each system is independent.
Each system is made up of a fuel tank **(1)** with an immersed electric pump **(2)** and a pressure regulator **(3)** set at **3,6 bar**.
The fuel coming from the pump reaches the flow or injector rail pipe **(4)** which distributes the fuel to the injectors of each bank.
The system is a "returnless" type, that is without the return of fuel to the tank.
The tanks are connected to each other, in the lower section by a line **(5)** equipped with a plug **(6)** used to drain the system and in the upper section by a separator **(7)** which collects and condenses the fuel vapours (B 6.02).
Two roll-over shut-off valves **(8)** are fitted on the top of each tank. They serve to prevent fuel leakage should the car roll over.

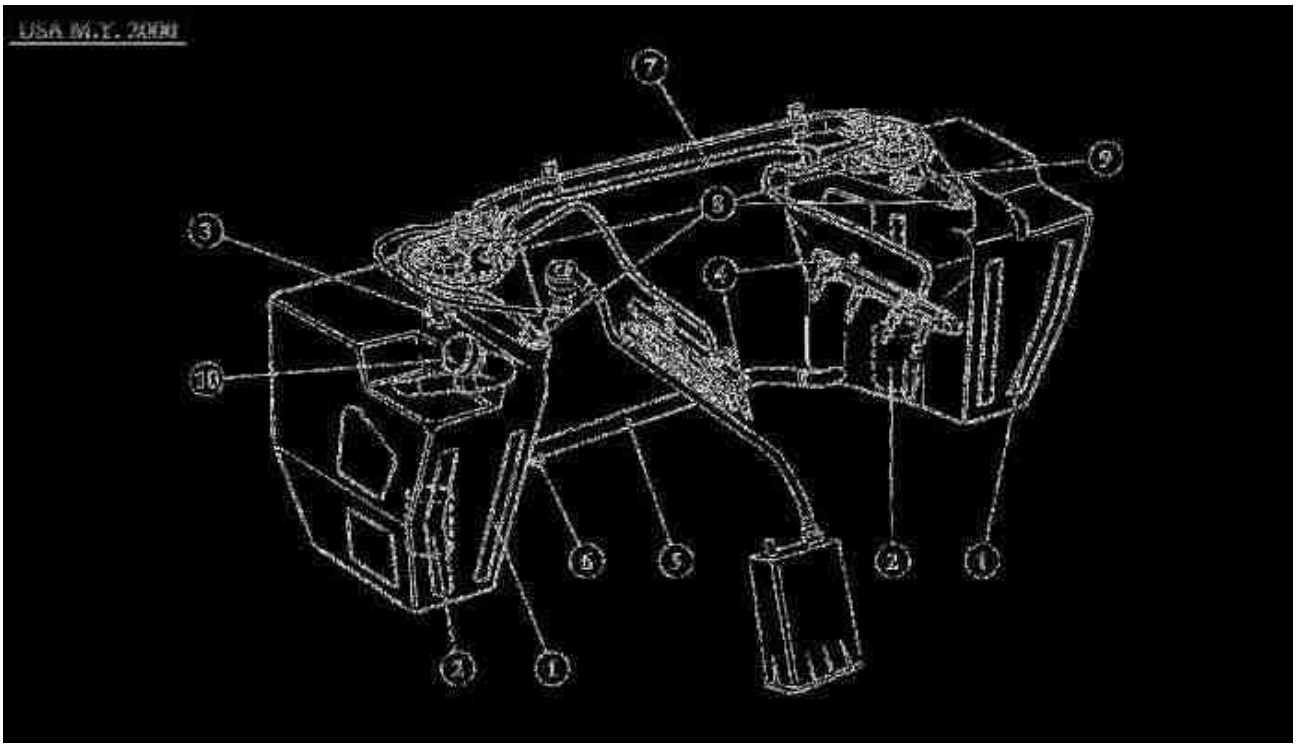


Besides these valves, the system also contains an inertia switch (H 3.04) whose purpose is to cut out the electrical supply for the fuel pumps, in the event that the car undergoes sudden deceleration (collision).
The left-hand tank has a control that transmits the signal to the level indicator on the instrument panel.

Note for the Euro 3 - US version

There is a pressure sensor on the right-hand reservoir **(9)** which is able to detect any eventual leakage from the system (C 2.09).

On **USA** version cars, from **M.Y.2000,** the filler neck **(10)** is equipped with a sealed plug, which is earthed to prevent sparks that may be ignited during re-filling.



B6.02 FUEL VAPOUR EMISSION OUTLINE

The evaporation control system is designed to prevent gas vapour leaking into the environment from the fuel circuit.

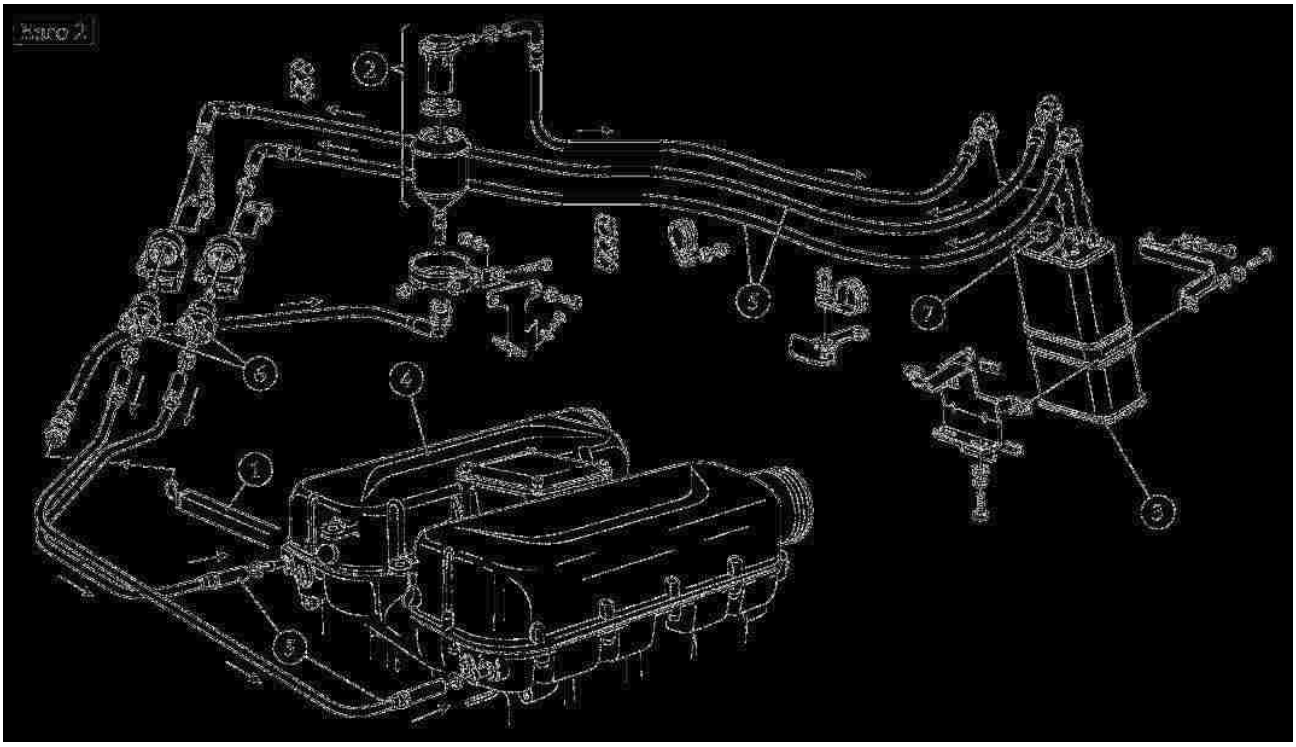
Vapours coming from the tanks are directed to a separator **(1)** where part of it condenses and is deposited in the tanks and another part reaches the multifunction valve **(2)** which unites the bleeder and roll-over shut-off devices to prevent fuel leakage in the event that the car overturns.

The vapour from the multifunction valve enters the activated charcoal filter **(3)** where it is absorbed and retained when the engine is stopped.

The activated charcoal filter outlet unions are connected to the plenum chamber **(4)** through two pipes **(5)**, with each one being controlled by a solenoid valve **(6)** (C3.10).

The Motronic ECU controls the purge solenoid valves when the engine is started and according to the use conditions.

When the solenoid valve is open (energised), the activated charcoal filter filters outside air that enters from the stack **(7)** the intake of which is made possible by the vacuum created by the engine. The fuel vapour is suctioned in together with the air and then reaches the plenum chamber.



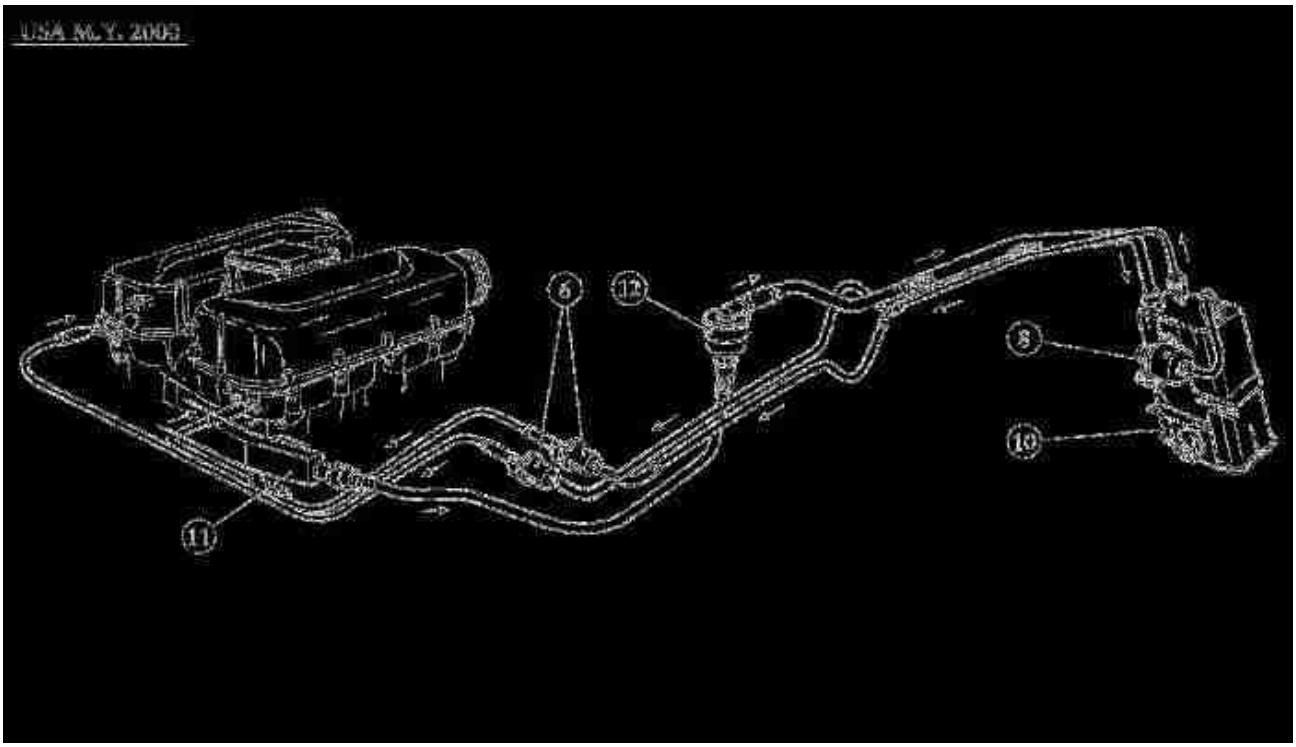
Euro 3 - US M.Y. 1999 version

The intake of external air into the active charcoal filter **(3)** takes place through an interception valve **(8)** which is usually open.

ECU closes the valve at regular intervals and, by detecting the vacuum which is made in the system, it is able to signal any eventual blow-bys. The system's control system for tightness of the system uses, besides the above mentioned valve, also a pressure sensor **(9)**, fastened on the top of the right-hand fuel tank (_____).

US M.Y. 2000 version

In this version, the components are positioned on the left-hand side of the engine compartment.
It has a specific active charcoal filter **(10)** and a single output union. Besides this, a specific anti-downflow valve **(12)** is fitted on the piping which connects the separator **(11)** to the charcoal filter. Unlike the valves on the other versions, this is not detachable.



Replacing the fuel vapour separator

- Remove the engine compartment side guards (_____).

CAUTION

The fuel contained in the tanks and in the fuel system is a highly inflammable product. Carry out the operation when the engine is cool and the tanks are empty, or with little fuel, to avoid fire risks.

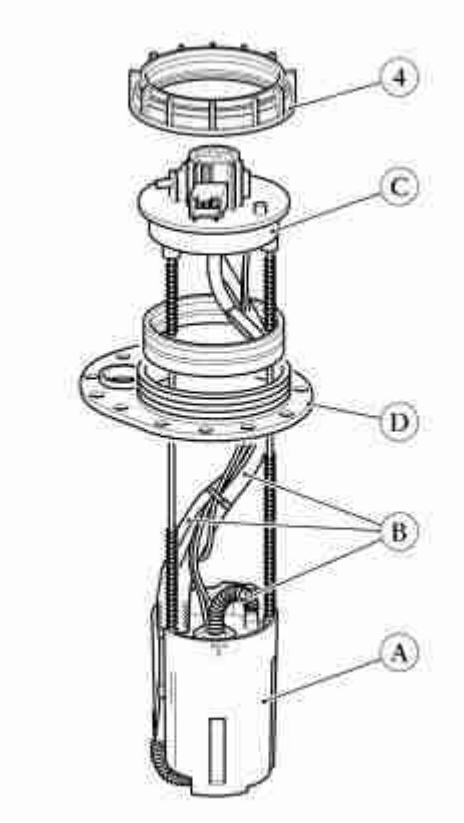
- Detach the unions (**13**) on the pipes connecting the tank's roll-over shut-off valves, as well as the union on the pipe for the multifunction or non-return valve, in the **USA M.Y. 2000** version.
- Loosen the clamp (**14**) and detach the tanks' upper connecting pipe couplings from the separator.
- Undo the fastening screws (**15**) and remove the separator's heat-resistant shield.
- Undo the two fastening screws and remove the entire separator from the car body.

B6.03 FUEL PUMP UNIT

The pumps supplying each engine bank are ftted inside a collecting pan, mounted on the fuel tank bottom.

NOTES
For information on the pump functioning and features (C 3.01).

The pump is supplied as a spare part together with the collecting pan **(A)**, pipes **(B)**, upper cap **(C)** and flange **(D)**. The pipes are hot-welded on the pump, cap and pan unions and they must not be separated.



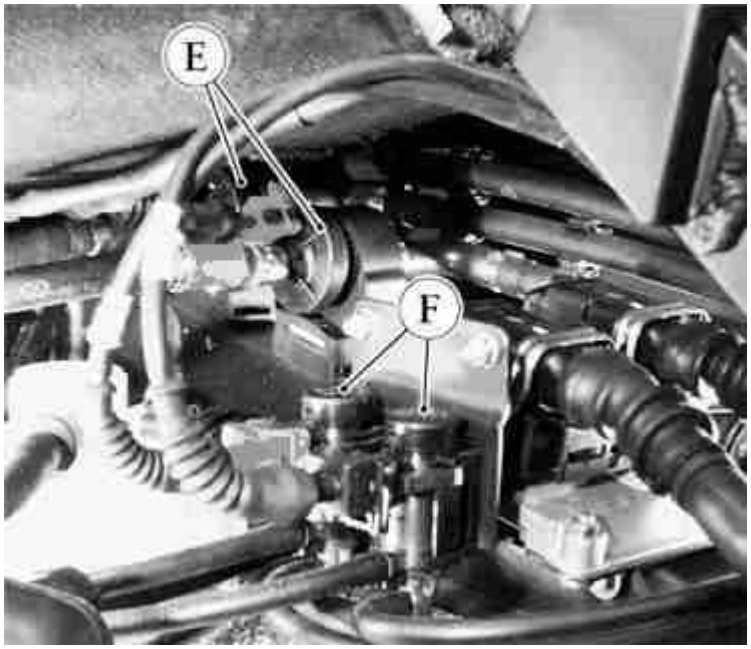
Disassembly

To work on the pump, the upper flange **(D)** must be removed from the tank, following the procedure described**.**

CAUTION

The fuel contained in the tanks and in the fuel supply system is a highly flammable product. To avoid the risk of fires, any maintenance shall be carried out when the engine is cool and with the tanks empty or containing very little fuel.

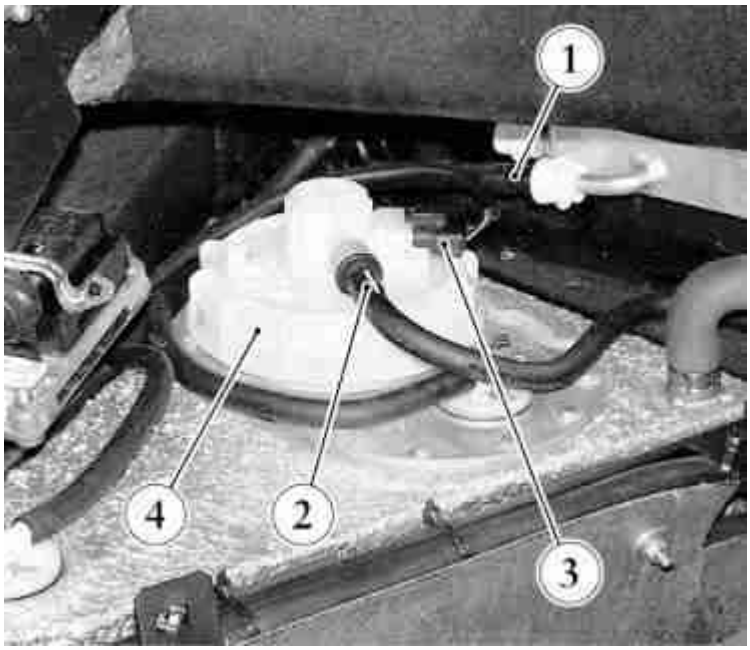
- Remove the side shields from the engine compartment (M 2.13).
- To work on the right-hand tank flange, first detach the elastic bases of the solenoid valves **(E)** from the support brackets and then remove the solenoid valve support **(F)** of the anti-evaporative emission system from the MOTRONIC control unit bracket.



NOTES

The figures refer to the removal of the left-hand tank's pump. The procedure for removing the right-hand tank's pump is identical. The right-hand tank differs in that it does not have a fuel level indicator.

- Detach the roll-over shut-off valve pipe **(1)** from the fuel vapour separator.
- Detach the union **(2)** for the pipe delivering fuel to the injector rail and the connector **(3)** from the cover.
- Using the Part No. **95971854** wrench, unscrew and remove the ring nut **(4)** so as to have access to the flange screws.



- Remove the screws fastening the flange **(D)** to the tank.
- Remove the entire pump unit from the tank, taking extreme care not to damage the level indicator float arm.

IMPORTANT
Protect the tank opening suitably to prevent the entrance of foreign matter.

The pressure regulator is installed within the upper cap (B 6.05) while the level indicator is mounted on the edge of left-hand pump collecting pan (B 6.04).

NOTES
The pressure regulator and/or the level indicator cannot be replaced individually, as they are an ingral part of the pump assembly, which is supplied as a spare part as a complete, single unit.

- During handling, protect the pump unit from bump and from any kind of pollution.
- The new units are supplied in a special plastic packages, which musta always be used for storage or handling.
- Store the new pump units in rooms protected from any outside or weather conditions.
- The storage period must not exceed four years. After this period, the proper working of the unit must be checked.

Re-assembly Notes

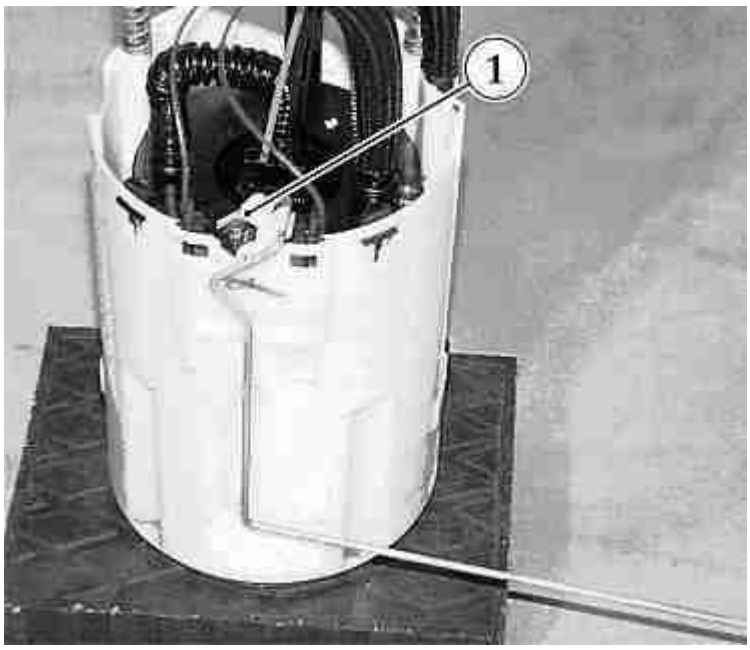
- Carefully clean all the parts that have been removed and dry them with compressed air.
- Check the state of the O-Ring **(5)**, as well as the tank and flange contact surfaces.

- Replace the O-Ring if damaged or crushed.
- To avoid bending and thus damaging the line when inserting the flange, position it perfectly with the tank holes before proceeding with fastening.
- Tighten the fastening screws to the **3,2÷4 Nm** torque, proceeding crosswise
- Using the Part No. **95971854** wrench, tighten the ring-nut to the **60Nm** torque.
- Re-assemble the parts that have been removed for the procedure.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

B6.04 FUEL LEVEL INDICATOR

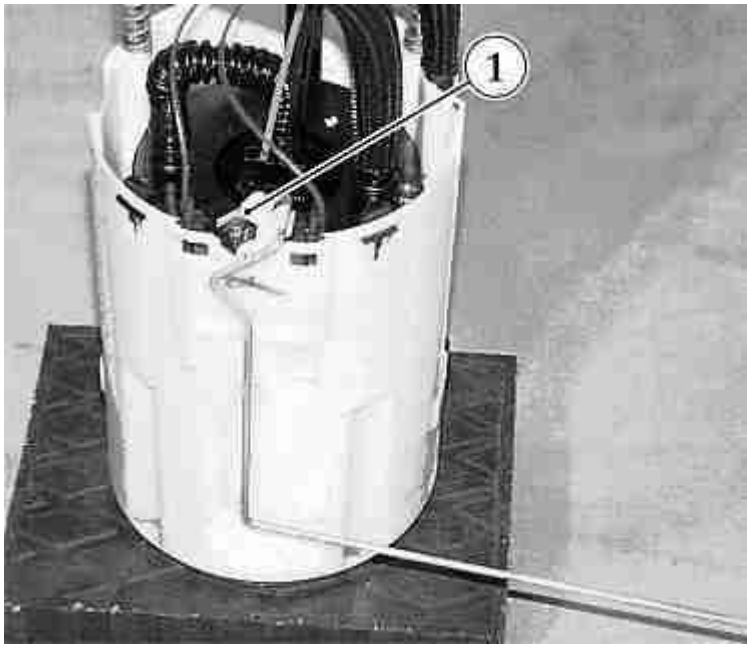
The level indicator **(1)** is secured to the fuel collector pan on the left-hand tank.



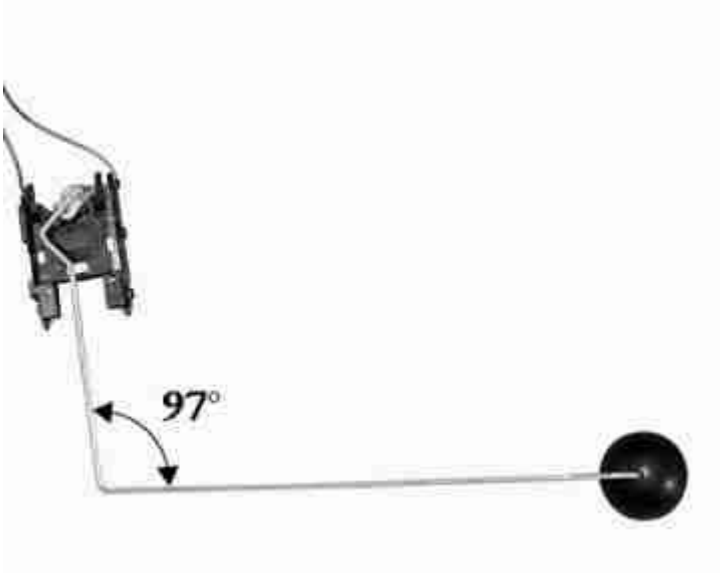
The indicator has a travelling arm, that is equipped with a float. Depending upon the position of the float, it transmits an electrical signal to the indicator instrument on the dashboard.

NOTES
The level indicator is supplied together with the complete pump unit.

- To gain access to the indicator, the flance and the pump unit must be removed (B 6.03).

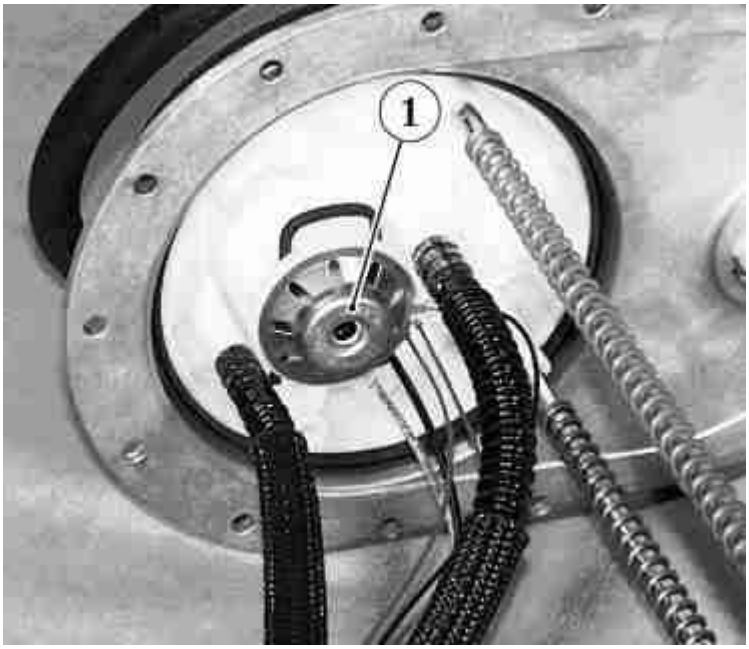


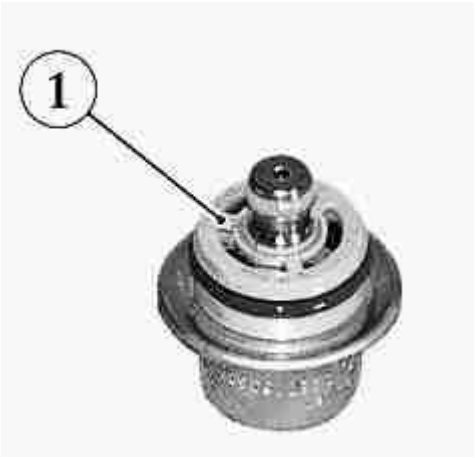
When re-assembling the pump unit, be careful not to bend the float supporting arm, as the refilling levels shown on the instrument panel will be affected.
The drawing illustrates the proper configuration of the float arm.


97°

B6.05 PRESSURE REGULATOR

The pressure regulator **(1)** is installed at the base of the pump cover. It serves to keep the difference between the fuel pressure and the atmospheric pressure constant.





Therefore, the amount of fuel delivered to the combustion chamber depends solely upon how long the electro-injectors are open. These intervals are established by the ECU.
The regulator used is a diaphragm type regulator with a pressure retaining spring set at **3,6 bar**.

NOTES
The pressure regulator is supplied together with the complete pump unit.

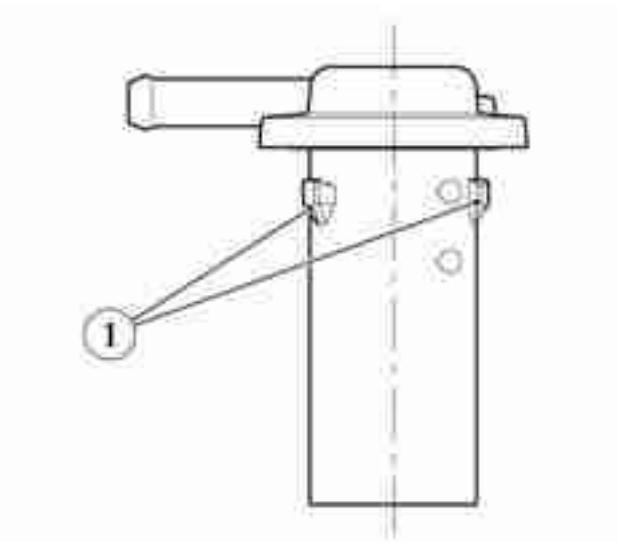
- To gain access to the regulator the flange and the pump unit must be removed (B 6.03).

B6.06 ROLL-OVER SHUT-OFF VALVE

The purpose of the valve is to prevent fuel leakage from the tanks and the fuel supply system in the event that the car overturns.
Each tank is fitted with two valves, one positioned on the pump unit support flange and the other on the rear part.
There is also a roll-over shut-off valve on the anti-evaporative emission system. It is inserted inside an outer container.
For these valves to work well, it is important to fit them in a vertical position because a tilted position can cause them to close.

Disassembly

- To remove the valve from its seating, rotate it using wrench **AV 3601** in an anti-clockwise direction in order to release it from the fastening inserts **(1)** and slide it out together with the gasket.



B6.07 FUEL TANK

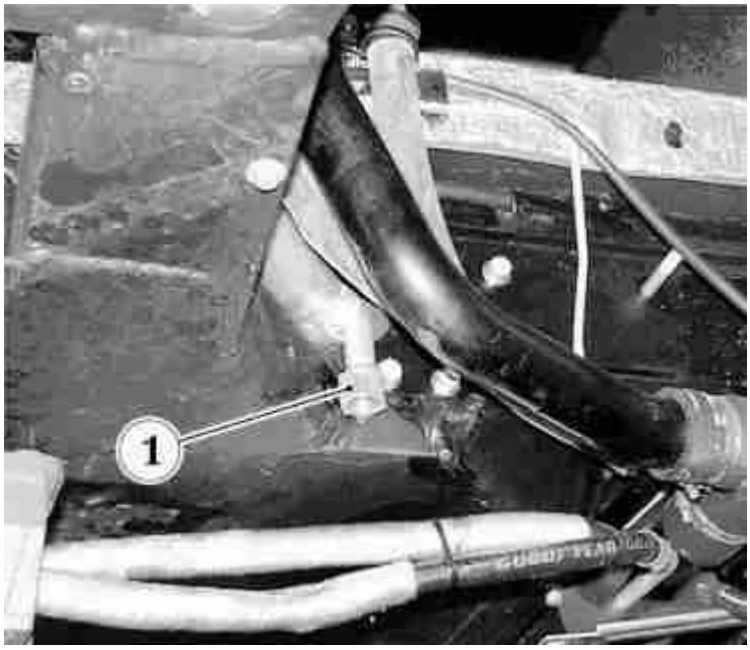
The fuel tank consists of two elements that are interconnected (B 6.01) and fitted in the structures of the chassis, in the front part of the engine compartment.
Each element is equipped with a support flange for the pump-filter unit for each bank. The pan inside the left-hand tank is fitted with a level indicator control.
A heat protection shield is positioned between the tank and engine to insulate the fuel against heat.

CAUTION
The fuel contained in the fuel tank and throughout the engine fuel supply system is a highly flammable product and under certain conditions it is also explosive.
Do not smoke, cause sparking or use flames near the work area or in the immediate vicinity.

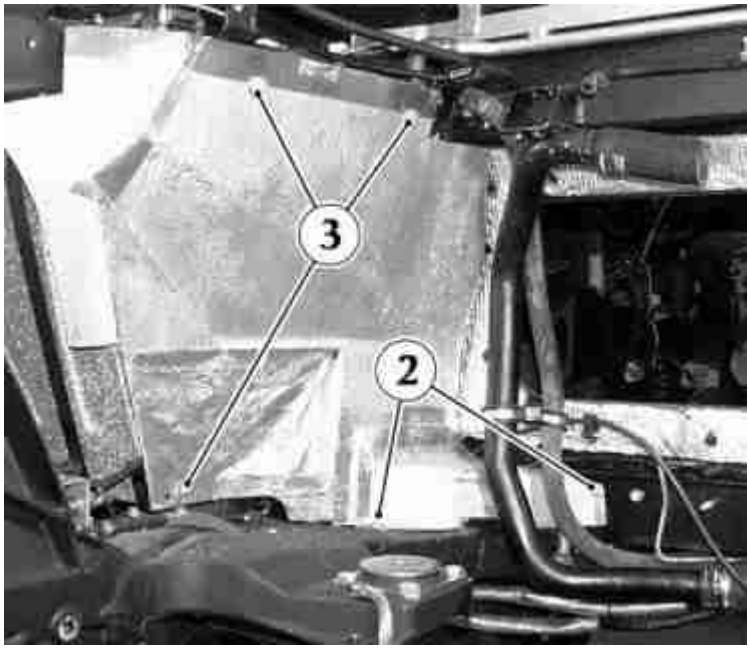
Disassembly

NOTES
The right-hand tank is symmetrically opposite the one described, therefore, the disassembly procedures are the same with the exception of the connection with the filler neck.

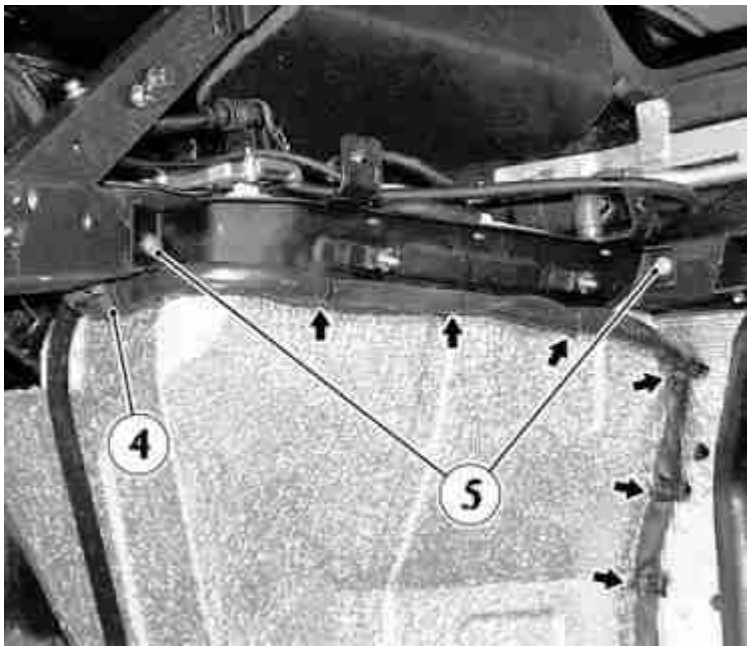
- Remove the engine-gearbox unit (B 2.01).
- Drain out the fuel contained in the tanks by removing the cap **(1)** on the lower connection pipe.



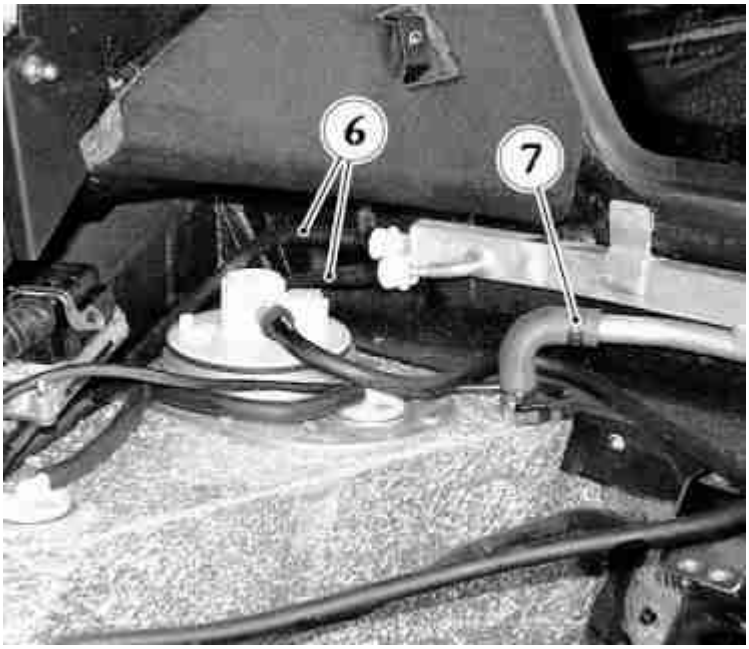
- Remove the heat protection shield by unscrewing the 2 lower screws **(2)** and the 3 nuts **(3)** fastening it to the supporting structures.



- Detach the bracket **(4)** and free the engine compartment cable from the clamps fastening it to the upper bracket and to the engine compartment-passenger compartment partition panel.
- Remove the upper bracket by unscrewing the 2 screws **(5)**.



- Detach the roll-over shut-off valve lines **(6)** from the fuel vapour separator.
- Open the clamp **(7)** on the union connecting the tank to the separator.

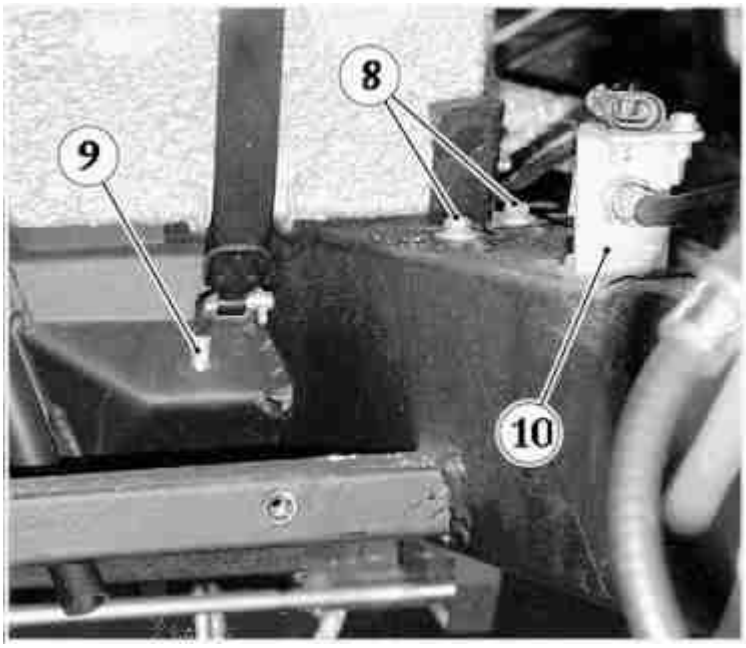


- Detach the fuel pump connector from the cover.

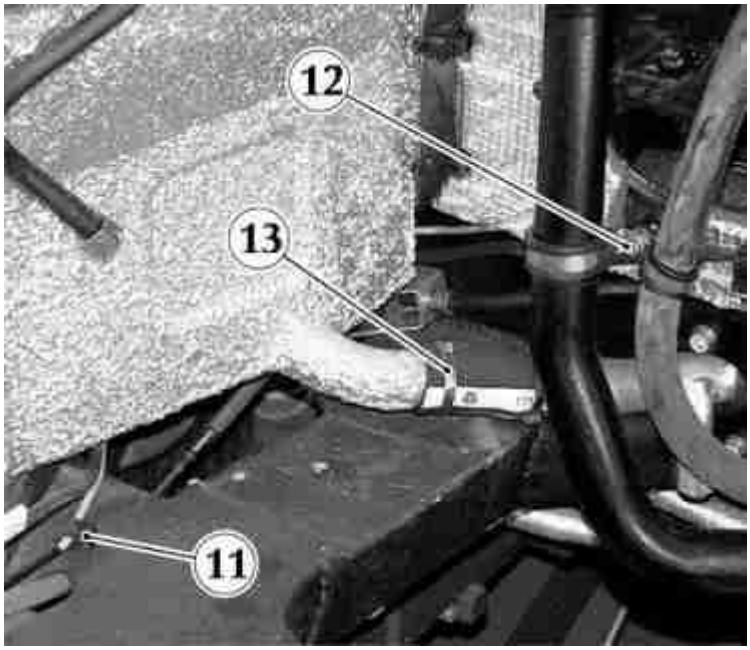
NOTES

When removing the RH tank it is necessary to detach the pressure sensor's connection to the system (C2.09).

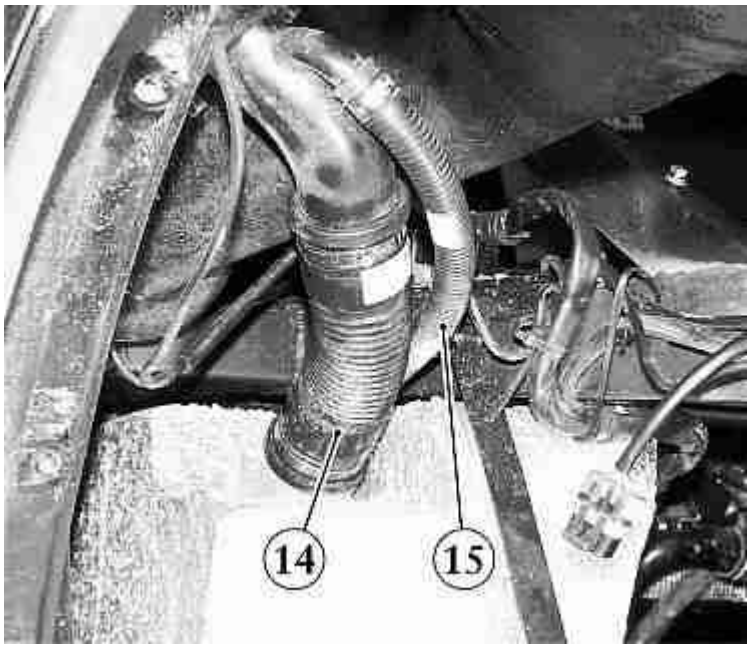
- Remove the lower bracket on the tank by unscrewing the 2 screws **(8)**.
- Free the threaded stay bolt **(9)** for the band securing the tank to the chassis.
- It is advisable to detach the supporting bracket **(10)** from the chassis to avoid the risk of damaging the ABS sensor cable and/or crushing the brake pipe.



- Slide the pipe off of the block **(11)**.
- Unscrew the nut **(12)** fastening the bracket that supports the water pipe and shift the pipe towards the centre of the car.
- Open the clamp **(13)** on the tank connecting pipe union and detach the union from the tank.

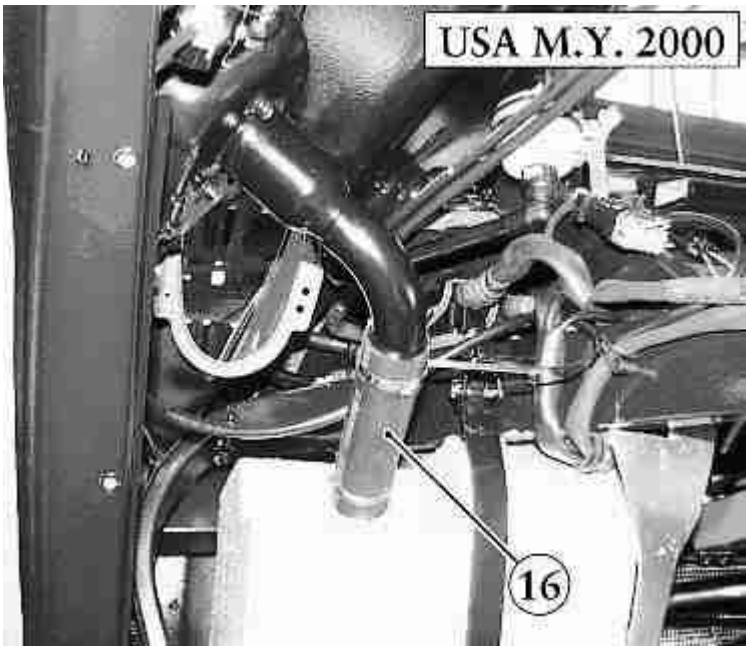


- From the tank side, open the clamps on the pipes **(14)** and **(15)** connecting to the filler neck and slide them off of the tank.



Note for the US M.Y. 2000 version

This version has only one connection tube **(16)** between the filler neck and the tank.



For disassembly of the filler neck (M 2.16).

- Remove the complete tank unit from the chassis, lifting the front end and turning it towards the centre of the car.

Remove the pump-holder flange (B 6.03) and proceed with replacement or inspection procedures.

Replacing the lower pipe connection for the tanks

After having removed the tank's protection shields it is possible to replace the pipe (**17**) which connects the tanks in the lower part.

- If still installed, remove the impact energy absorber housing (**18**) from the chassis' lower cross member.
- Undo the fastening screws and the stud bolts which also fasten the underfloor line brackets; then remove the guard (**19**) covering the pipe (**17**) on the chassis' lower cross member.
- After having detached the two sleeves (**20**) connecting to the tanks, remove the pipe (**17**) by pulling it upwards.

Re-Assembly Notes

- Refit the tank following the same procedures described in reverse order and always use new clamps for fastening the pipes and unions.
- Refit the engine-gearbox unit (B 2.02).

B6.08 MOTOR-DRIVEN THROTTLE BODY

The motor-driven throttle body **(BOSCH DV-E5)** is installed between the air flow meter and the engine plenum chamber.
This device is also internally supplied with a throttle valve, a direct current motor and angular throttle position sensor (potentiometer).
See Paragraph (C2.05) for information on the operation of the potentiometer.

*Key for **Fig. 1***
1 - Throttle
2 - Potentiometers
3 - Electric motor
4 - Gears

The engine is directly controlled by the ECU and it acts upon the throttle **(A)** shaft **(B)** by means of a two-stage gear system (see **fig. 1**) which makes it possible to obtain high torque levels with low power consumption.
As the motor-driven throttle body is very sensitive to vibrations, it is connected to the plenum chamber with a special rubber coupling **(C)** of a defined hardness and length.

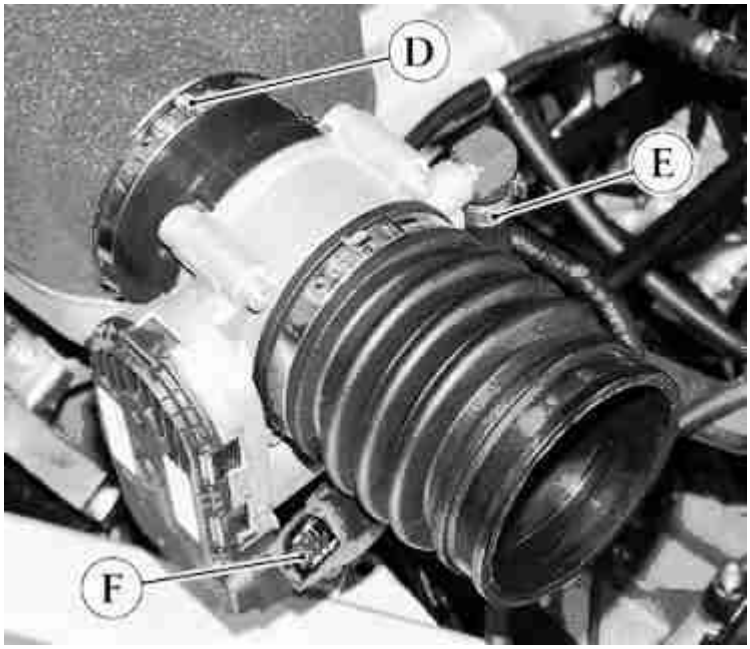
The throttle has been designed to be controlled by the MOTORONIC ECU, according to precise speed principles.

IMPORTANT
Do not supply power to the throttle by means of different systems as this could damage the device.

If the throttle breaks down, the engine is brought to the recovery mode, which corresponds to idling.
Two throttles, one per bank, are present in the system.

Disassembly

- Detach the air flow meter (C 2.03).
- Release the clamp **(1)** on the union connecting to the plenum chamber cover.
- Release the clamp **(2)** and slide off the pipe connecting to the blow-by system.
- Disconnect the injection cable connection **(3)**.



- Remove the complete throttle body unit.

IMPORTANT

Do not place the device on any elements that could cause vibrations.
*To ensure proper operation, the device should be installed so that the throttle shaft **(B)** is in a horizontal position (permissible tolerance **±20°**).*
After replacing the motor-driven throttle body, the self-learning cycle must be performed (C 6.05).

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

B6.09 CHECKING THEFUEL SUPPLY SYSTEM PRESSURE SEAL

Specific Equipment

Precision pressure gauge **95971243**

The fuel supply pressure is determined in each bank, by the pump immersed in the fuel tank.
To check fuel supply pressure, proceed as follows:

- Turn the ignition key to the **"STOP"** position.
- Remove the cap on the injector rail union.
- Connect the precision pressure gauge **95971243** union **(A)** onto the injector rail**.**

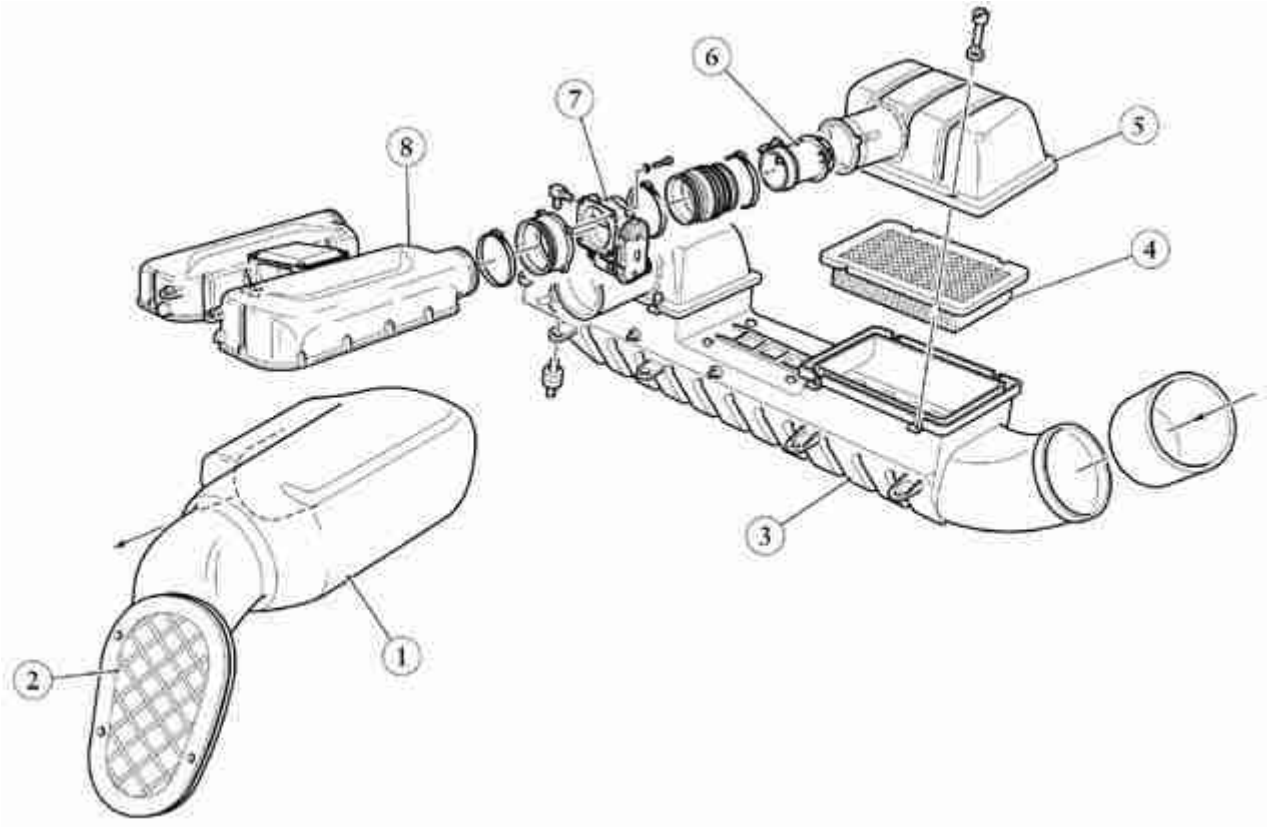
- Start the engine and allow it to idle.
- Check whether the pressure read on the pressure gauge is **3.45 bar**.
- Turn off the engine and check to ensure that the pressure drops and remains steady at **2.7 ± 0.3 bar**, **for at least one hour.**

NOTES
As the fuel supply circuits are separate for each bank, the pressure test must be performed on both circuits.

Should the values prove to be beyond the tolerance limits, check the pipes for leaks and/or replace the fuel pump (B 6.03).

B7.01 AIR INTAKE SYSTEM OUTLINE

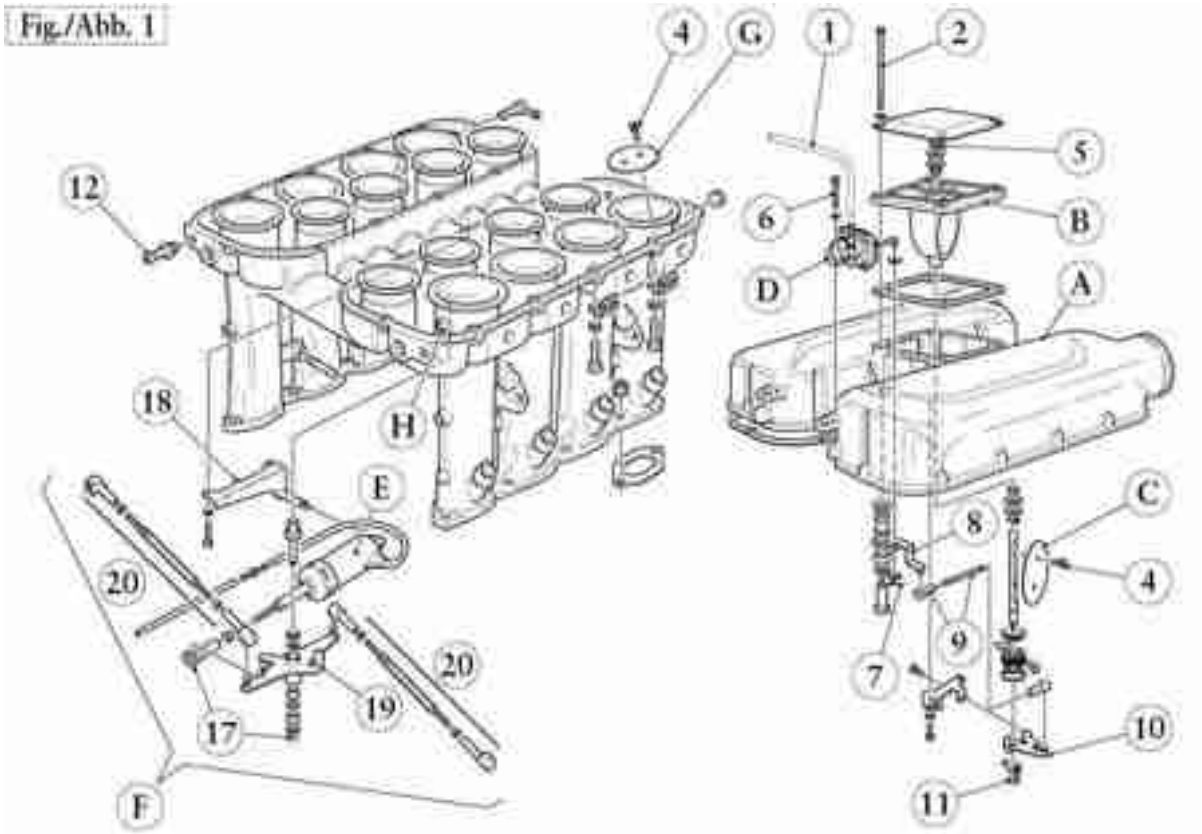
Outside air flows into the engine compartment through an air flow duct-resonator **(1)**, found above the left-hand rear wheelhouse. It is equipped with a protective grill **(2)**. From the air flow duct-resounder, the air enters into the air intake **(3)** and is directed towards the filter cartridges **(4)**.
All filtered air flow reaches the air flow meter **(6)** through a duct in the cover **(5)** and the meter transmits a signal to the Motronic control unit regarding the air mass intake.
The motor-driven throttle body **(7)** is connected to the meter for all air flow. The opening of this device is electrically controlled by the Motronic control unit.
The two metered air flows enter the plenum chamber **(8)** where they are fractionated and directed to the intake manifold, and then mixed with the fuel. The throttle devices in the plenum chamber are moved by the actuators, which are controlled by solenoid valves (B 7.04).



IMPORTANT
To ensure that the engine runs well, it is essential that the air filter cartridges be replaced in accordance with the intervals prescribed in the "PROGRAMMED MAINTENANCE PLAN".

B7.02 INTAKE MANIFOLD

The engine intake manifold is equipped with an upper cover **(A,** Fig**. 1)** with a support **(B)** for the air compensating throttle **(C)** and the pneumatic capsule **(D)**.
The actuator **(E)** is secured underneath the manifold, along with the device **(F)** for the opening of the throttles **(G)** inside the inlet lines for the mixture in the cylinders.
The intake manifold throttles are secured in pairs on shafts **(H)** that rotate on the manifold body bushings. Each bank is equipped with a screw for the synchronisation of the two shafts.
The throttles are supplied "factory-adjusted" and their positioning should not be changed except in the case of replacement of a component of the control system (tie-rods, levers, pivots, etc.) or when the idling rpm is being set.

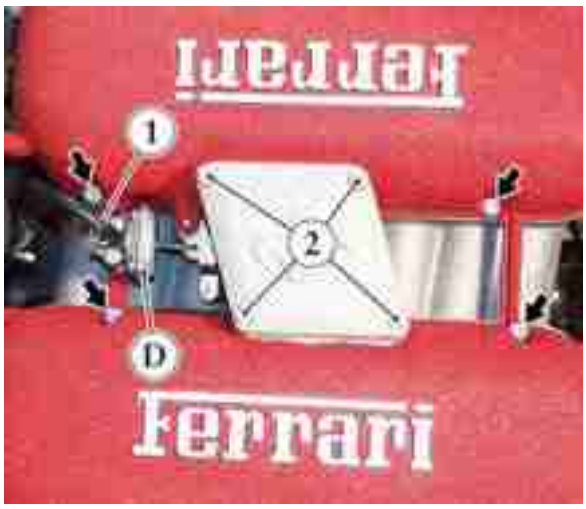


The injectors (C 3. 02) connected to the MOTRONIC control unit for the injection-ignition system and to the fuel supply system distributor (injector rail) (B 6. 01) are installed on the inlet lines of each bank.

Tightening torques	Nm	Product
Screw fastening the cover	**5÷10**	
Screw fastening the throttle support	**5÷6,5**	
Screw fastening the pneumatic capsule	**3,4÷4,6**	Thread lock **Loxeal 24-18**
Screw fastening the throttle	**2,1÷2,8**	
Nut fastening the lever on the throttle shaft	**3,4÷4,6**	
Screw fastening pipe union	**40÷50**	

Removing the manifold cover

- Detach the motor-driven throttle bodies from the cover (B 6. 08).
- Detach the vacuum pipe **(1)** from the pneumatic capsule **(D)**.
- Unscrew the four screws **(2)** fastening the cover and the throttle support.
- Unscrew the four inner screws on the two banks.



- Open the clamps **(3)** on the outer sides of the manifold and slide out the fuel pipes from each bank.
- Unscrew the fastening screws on the outer perimeter of the manifold body cover.

- Remove the entire cover including the gasket.

IMPORTANT

Protect the manifold with a clean cloth to prevent foreign matter from coming into contact with the throttles and thereby affecting their closure.

Re-assembly notes

- Clean the contact surface on the cover and the manifold and mount a new gasket.
- Tighten the screws **(2)** to the prescribed torque.

Replacing cover parts

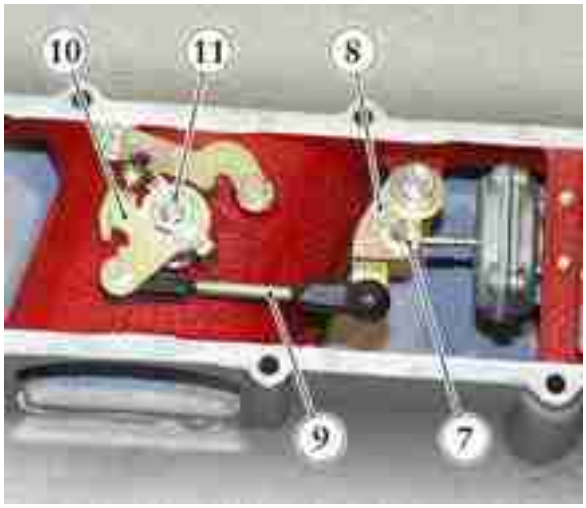
The compensating throttle **(C)** can be replaced when the cover has been removed from the manifold.

- Turn the cover over and unscrew the screws **(4)** fastening it to the small control shaft. Then remove the throttle.

Proceed as follows for replacement of the parts supporting and moving the throttle.

- Remove the throttle shaft stop ring **(5)**.
- Unscrew the screws **(6)** fastening the pneumatic capsule to the cover.

- Remove the split pin **(7)** and slide off the pneumatic capsule control pin from the idler arm **(8)**. Then remove the pneumatic capsule.
- Detach the stay rod **(9)** from the throttle shaft control lever **(10)**.
- Slide out the shaft including the lever and check spring and remove the shims. Special seal rings are installed on the support **(B**, Fig. **1)**. They maintain the required lubrication in the throttle shaft contact zones.
- Unscrew the nut **(11)** and slide off the control lever to replace the throttle shaft.



Re-assembly notes

- Tighten the screws **(6)** and **(4)** to the prescribed torque and bevel them on the throttle shaft.
- Tighten the nut **(11)** to the prescribed torque.
- Bend one tab on the safety washer.

Removing the complete intake manifold unit

NOTES

The complete manifold unit can also be removed with the engine installed in the car. The figures show an engine on a work bench to provide a better understanding of the procedure.

- Detach the motor-driven throttle bodies from the cover (B 6. 08).
- Detach the vacuum pipes from the pneumatic capsule **(D**, Fig. **1)**, from the unions **(12)** on the front and rear parts of the manifold and from the servo brake pipeline **(13)**.

- To facilitate disassembly, it is advisable to disconnect the injection harness connectors from the injectors and remove the latter together with the rails (C 3. 02).

- Open the clamps **(3)** on the outer faces of the manifold and slide out the bank cables.
- Unscrew the nuts fastening the manifold to the heads.

- Detach the brackets supporting the injection cables and the connector linking the two banks, from the rear part of the manifold.
- Detach the detonation sensor connectors **(14, white** colour**),** the head phase sensors connectors **(15, black** colour**)** and the solenoid valve connectors **(16)** for the timing variator from the injection cables and release them from the fastening clamps.

- Detach the right-hand injection cable connector from the temperature sensor on the connecting duct for the water manifolds.
- Remove the complete manifold unit from the heads and keep the gaskets.

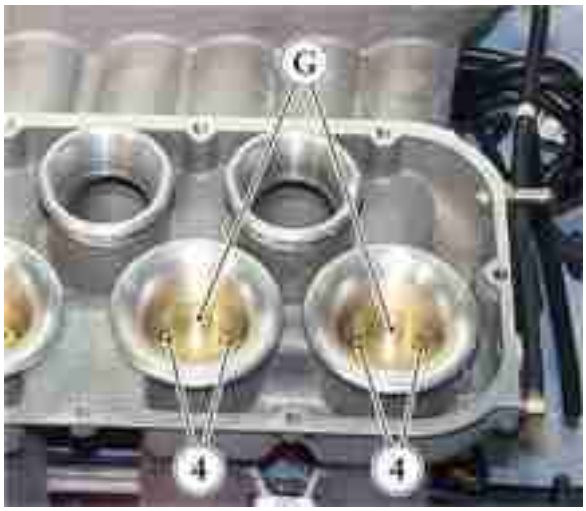
IMPORTANT
Protect the head intake ducts with a clean cloth to prevent foreign matter from entering the combustion chambers.

Re-assembly notes
- Clean the contact surfaces on the manifold and on the heads and fit new gaskets.
- Secure the sensor connectors for the injection cables in their original positions.

Replacing manifold parts

- To remove the actuator **(E)**, slide out the lock ring **(17)** on the idler arm pin and detach it from the support **(18)**.
- To disassemble the idler arm **(19)**, detach the tie rods **(20)**, remove the lock ring **(17)** and slide all the parts out.

- After having removed the cover, the manifold throttles **(G)** can be replaced by unscrewing the screws **(4)** fastening them to the small drive shaft **(H)**.



Valid UP TO Ass.ly No. 49527

There is a rigid pipe **(21)** from the brake servo system fitted on the manifold. This pipe is connected, by means of two sleeves, to the pipe unions **(22)** for each of the manifold's delivery line.

On the pipe unions **(22)** for each delivery line, there is a check valve **(23)** fitted.

- To remove the pipe **(21)**, complete with the sleeves, the pipe unions must be detached from the manifold and the clamps **(24)** must be opened.

Valid FROM Ass.ly No. 49528

There is a rigid pipe **(25)** from the brake servo system fitted on the manifold. This pipe is connected to the manifold's right-hand delivery line with a pipe union **(22)**.

The only check valve on the circuit is fitted in position with the brake servo (G 2.01).

- To remove the pipe **(25)**, the pipe union must be detached from the manifold and the clamp **(24)** opened.

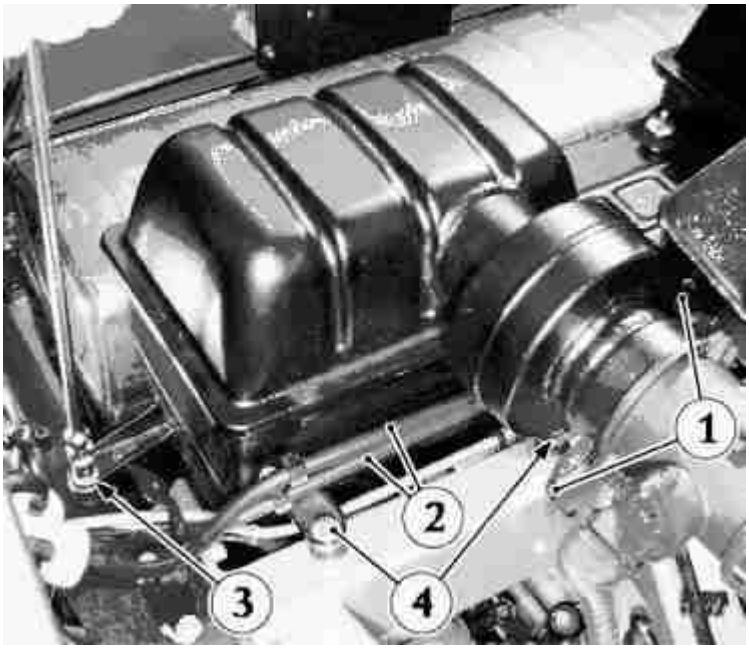
Re-assembly notes

- Tighten the screws **(4)** to the prescribed torque and bevel them on the small drive shaft.
- Lock the pipe union screws **(22)** on the manifold to the prescribed tightening torque, placing new copper gaskets in between the parts.

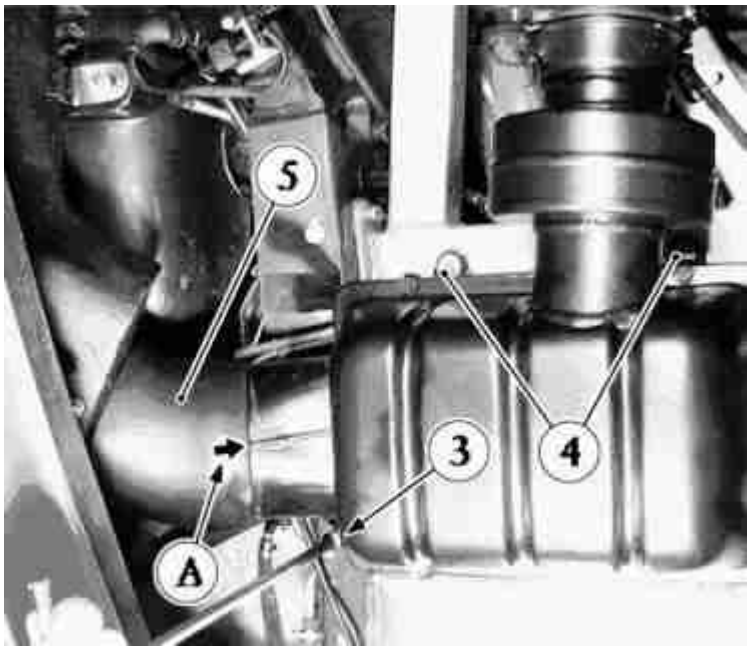
B7.03 AIR INTAKE

Detaching the intake

- Detach the expansion tank, (B 5.05) lasciandolo but leave it connected to the system.
- Release the air flow meter locks **(1)**.
- Detach the vacuum pipes from the supporting blocks **(2)**.
- Unscrew the two nuts **(3)** fastening the side of the air intake to the chassis and the four fastening nuts **(4)** for the gearbox supporting frame.
- In the electronically-controlled version, the supporting brackets (**6**) for the F1 system device cables are fitted under the two nuts on the right-hand side.



- Remove the complete air intake unit including filter cartridges and covers, by sliding it out of the rubber coupling **(5)**.
- During re-assembly, be careful to position the coupling with the arrow **(A)** pointing towards the air intake.


5
3
4
A

B7.04 OUTLINE OF THE PNEUMATIC ACTUATING SYSTEM

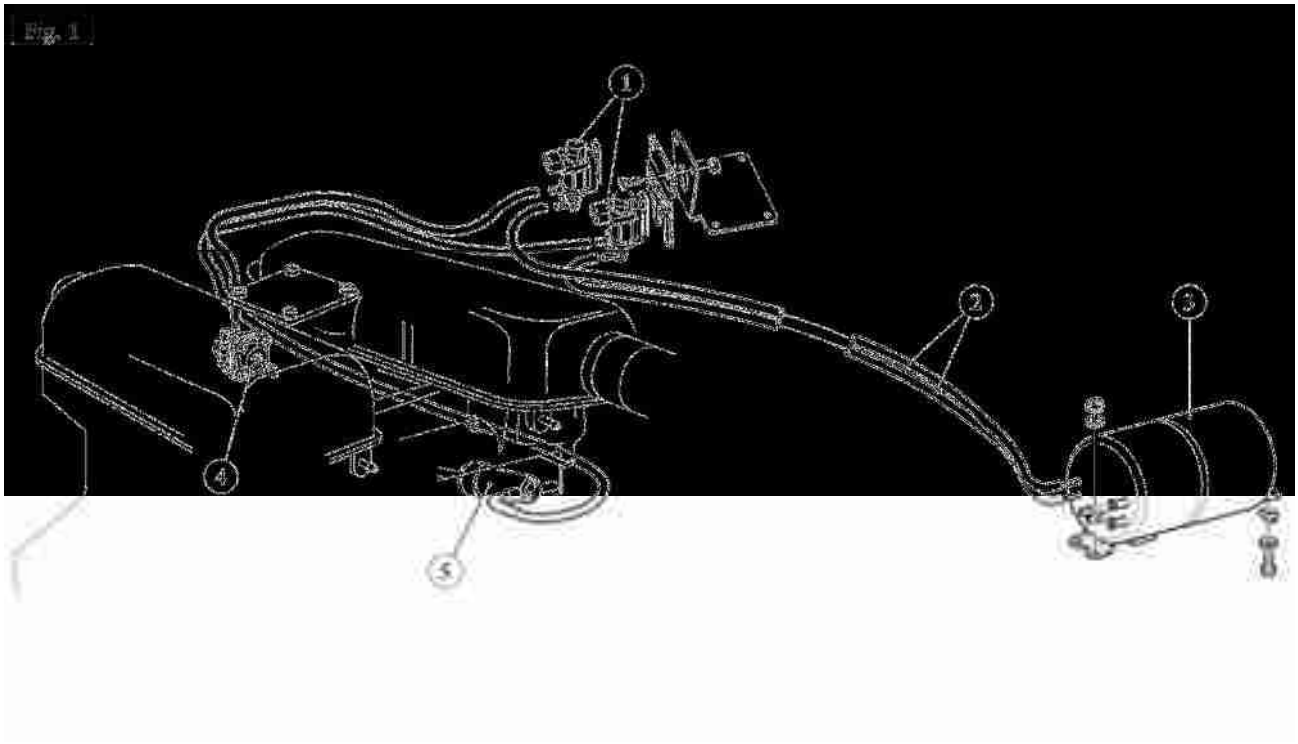
IMPORTANT

The connecting pipelines must be in good condition - without excessive bends, blockage or tears – to ensure the system proper functioning.

Modular Manifold (Fig. 1)

The system is made up of two solenoid valves **(1)**. They are secured to the Motronic supporting bracket and connected, by means of pipes **(2)**, to the vacuum tank **(3)** which is found under the right-hand rear mudguard. The engine ECU determines the opening of the solenoid valves, which, in turn, control the pneumatic capsule **(4)** and the actuator **(5)**, both of which are positioned on the plenum chamber (C3.06).

The pneumatic capsule **(4)** controls the compensating throttle through a system of levers. The actuator **(5)** activates the intake manifold throttles, (B 7.02) using an idler arm and ball-jointed stay rods.



Exhaust b -pass system (Fig. 2)

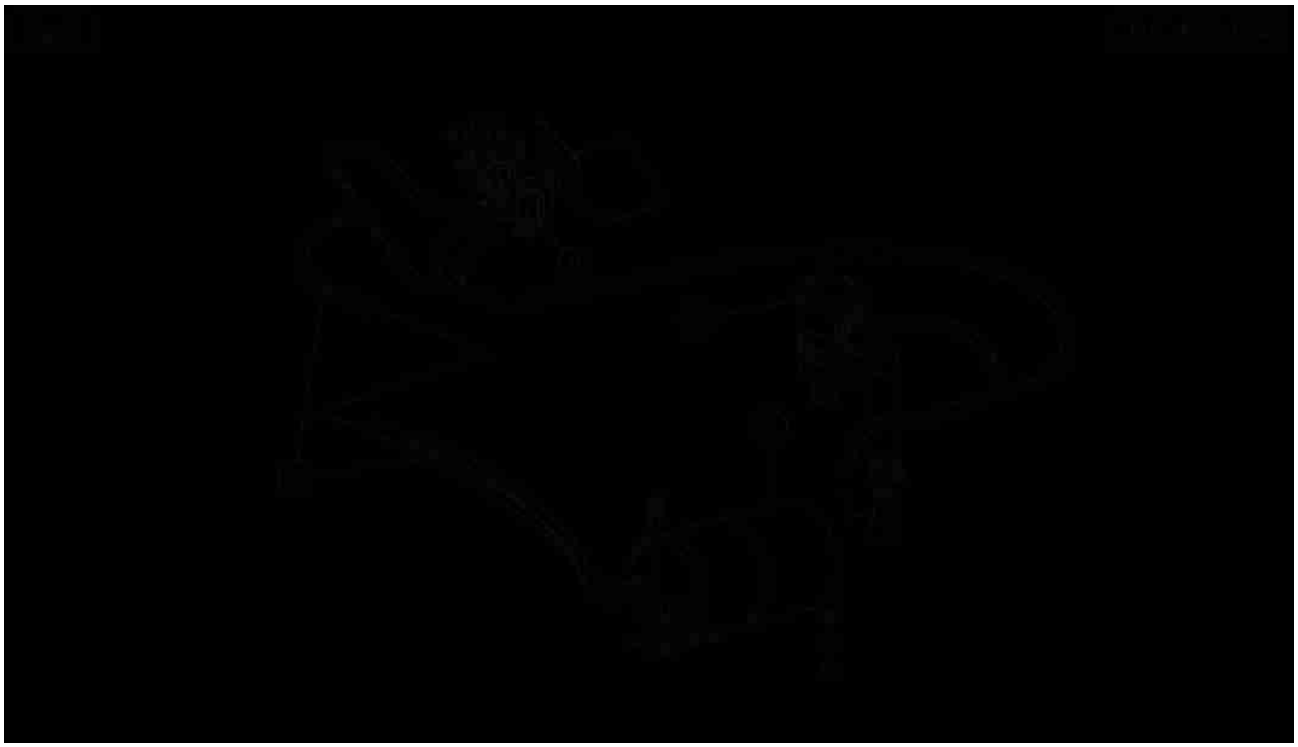
The system is composed of two solenoid valves (**6**) fastened to the chassis, on the rear part of the engine compartment. These solenoid valves are both connected to a pneumatic throttle valve (**7**), fitted on the exhaust terminal, and to the vacuum tank (**3**).

The Motronic ECU for bank 1-4 determines the opening of the solenoid valve according to the engine revolutions and the engaged gear (_____).

Secondary air injection, (Fig. 3) (US M.Y. 2000 version)

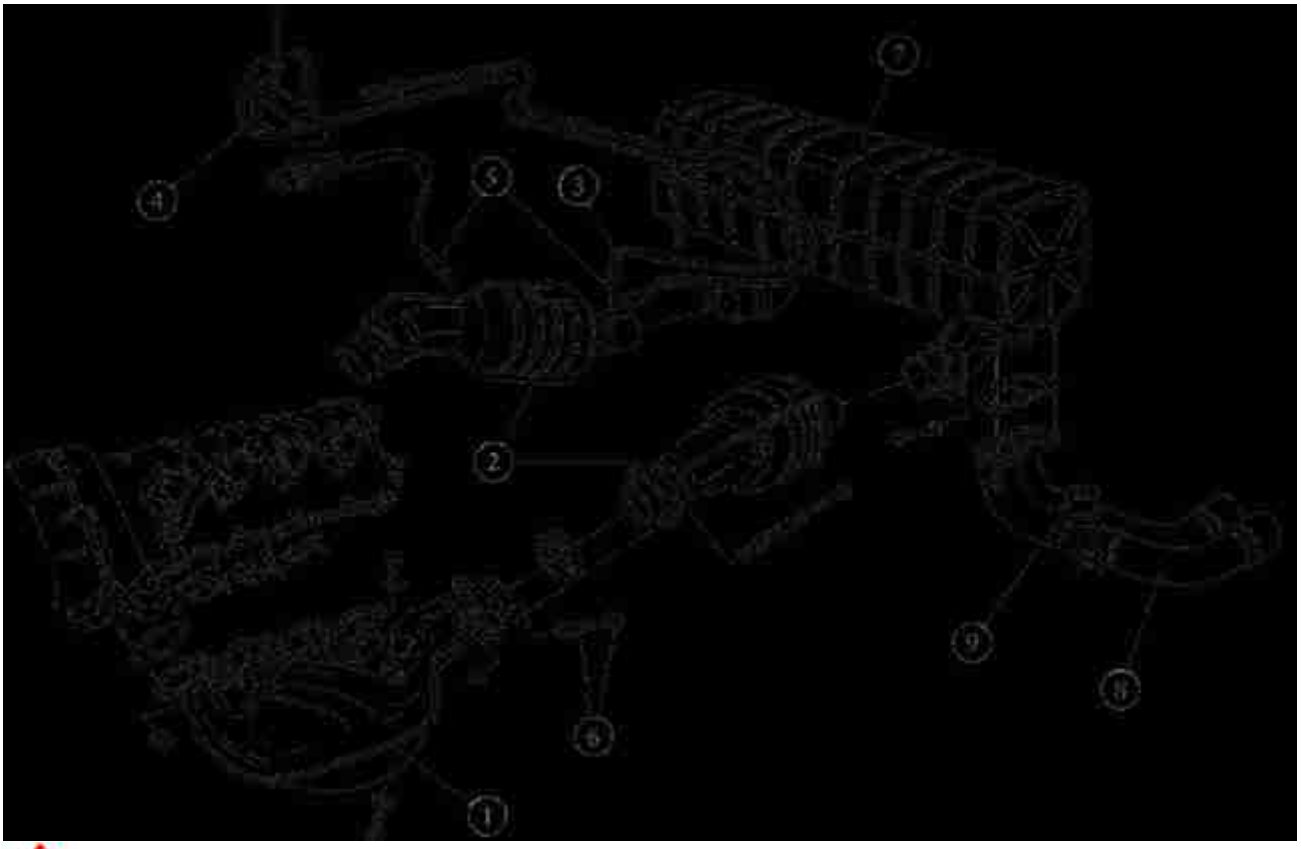
The solenoid valve **(8)**, fitted next to those of the modular manifold, is controlled by the Motronic for opening/closing the two pneumatic valves **(9)** which effect the injection of secondary air into the exhaust manifolds.

The piping **(10)**, which connects the vacuum tank **(3)** to the solenoid valve **(8)**, is connected by a 3-way union also to the solenoid valve which controls the actuator (**5**, **Fig. 1**) positioned under the modular intake manifold.



B7.05 EXHAUST SYSTEM OUTLINE

The exhaust gases leaving each head are channelled by a manifold **(1)** found inside a catalytic converter **(2)**.
The function of the catalytic converter is to reduce emission into the atmosphere of HC,CO and NOx. The converter is equipped with a thermocouple **(3)** that signals the temperature of the catalytic converter to an ECU **(4)**. In the event that the engine is not operating properly, resulting in a rise in temperature in the exhaust system as detected by the thermocouple, the MOTRONIC control unit transmits a signal to the multifunction display, with the latter resulting in the slow down symbol switching on (C 3.07).
The input and output of each catalytic converter are fitted with two oxygen sensors **(5)** which measure the oxygen content in the exhaust gases. The output signal from the two oxygen sensors is transmitted to the MOTRONIC control unit, which controls the adjustment of the air-fuel mixture. The purpose of this adjustment process is to maintain the stoichiometric ratio as close as possible to the theoretical levels (C 2.06).
Each manifold has a union **(6)** serving for CO sampling upstream of the catalytic converter.
From the catalytic converters the exhaust gases reach the silencer **(7)** and are then released into the atmosphere through the outlets **(8)** (B 7.07).
Each outlet is fitted with a by-pass pneumatic throttle valve **(9)**, which is connected to the vacuum tank (B7.04) and is controlled by the by-pass system's solenoid valve. For its functioning (C 3.05).



CAUTION

The exhaust system components reach very high operating temperatures. Avoid direct contact with these components.
Do not park the car on surfaces where there is grass or dry leaves, paper or inflammable materials.

US M.Y. 2000 Version

This version has a system which supplies supplementary air to the exhaust manifolds in order to reduce the HC and CO emissions during the catalytic converter warm-up stage.
The air drawn through a special filter **(11)** (C 3.09), is delivered into the circuit, also in high volumes by an electric pump, controlled by each individual ECU.
In this way any residual hydrocarbons present in the exhaust gases are burnt-off.
The pump and the secondary air solenoid valve **(12)** are controlled, after engine ignition, when the temperature of the coolant fluid ranges between **–10 °C** and **40 °C**. Its function remains active for about **80 seconds**, it then turns off for about **60 seconds** and is then activated once again for a further **10 seconds**.
In this last stage, the tightness of the secondary air valves **(10)** is tested. The oxygen sensor **(5)** is disenabled for the entire length of the cycle.

B7.06 CATALYTIC CONVERTER

Tightening torques	Nm	Category
Thermocouple	**10**	**B**
"Torx" clamp nut	**43**	**B**

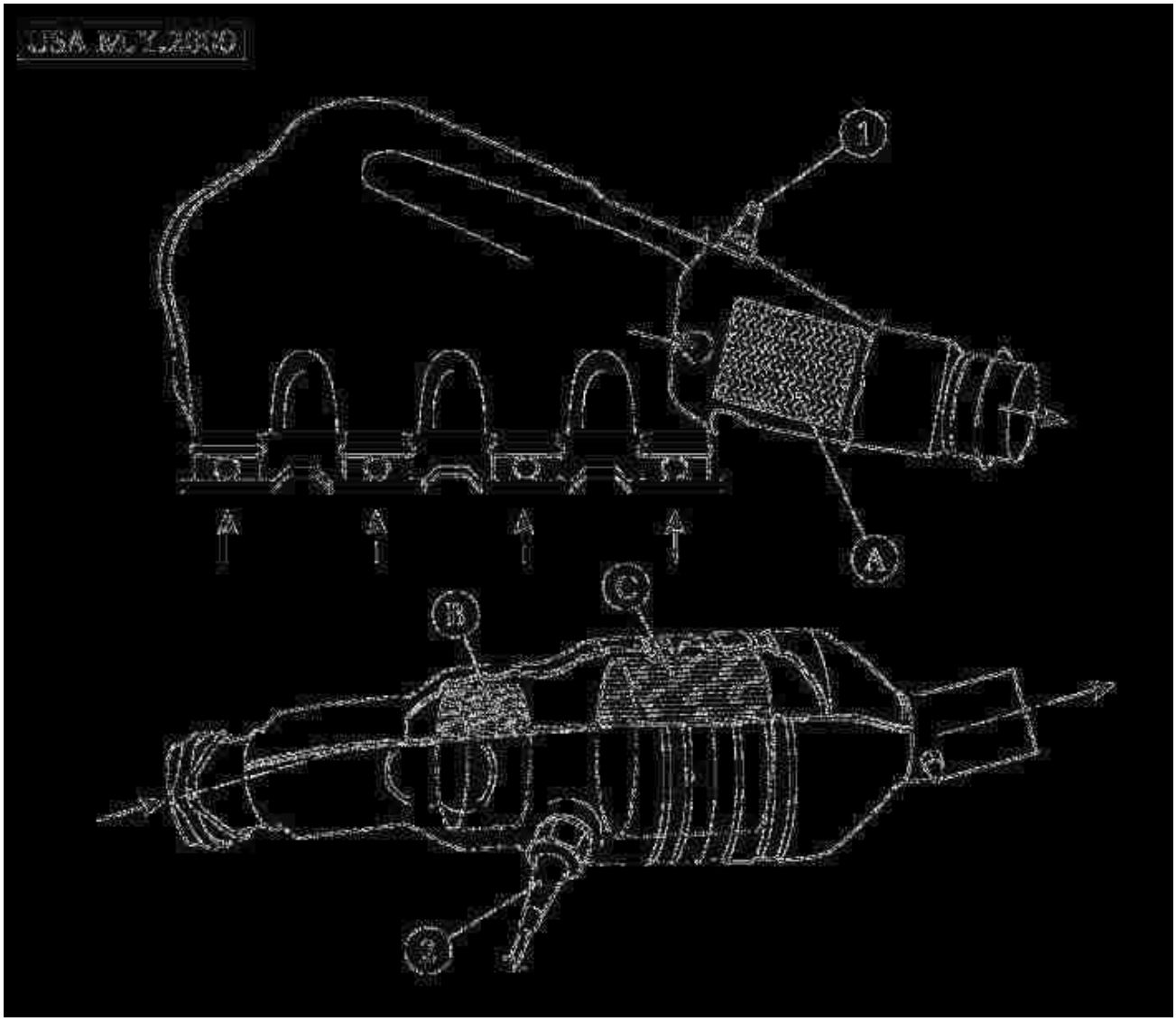
Metallic 3-way catalytic convertors are used.
When they reach the operating temperature **(400÷800 °C)**, they reduce emission into the atmosphere of HC, CO and Nox, with performance approaching **95 %** in efficiency, converting the emissions into water, CO_2 and N_2.

IMPORTANT
To avoid damaging the catalytic converters, it is essential to use unleaded 95 RON fuel only.

The converters have two seats (one at the intake and one at the outlet) serving for fastening the front **(1)** and rear **(2)** oxygen sensors. There is also a seat for fitting the thermocouple **(3)**.

Note for the US M.Y. 2000 version

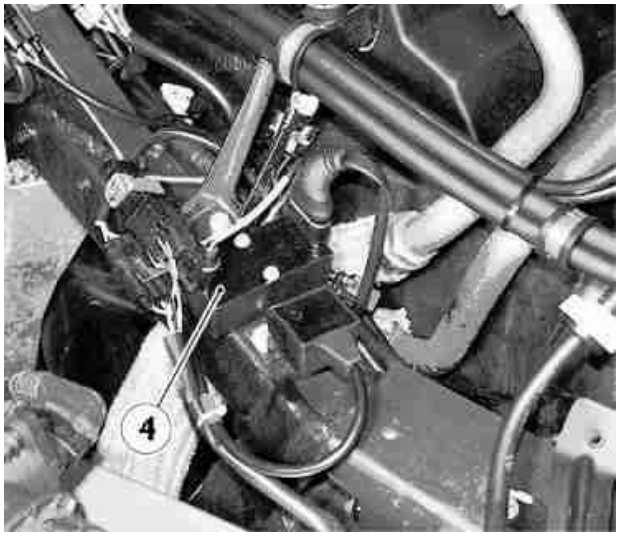
Trivalent, 3 stadium catalytic converters are used on these cars. The first stadium **(A)** is positioned on the exhaust manifold's output, while the other two stadiums **(B)** and **(C)** are fitted on the main catalytic converter's inlet. The front oxygen sensor **(1)** is positioned on the exhaust manifold just in front of the first stadium (pre-catalytic converter). The rear oxygen sensor **(2)** is fitted between the two stadiums of the main catalytic converter.



These parts supply information to the MOTRONIC control unit, which ensures a metering of the air-fuel mixture that approaches the stoichiometric ratio under all engine operating conditions for which that ratio is required. This condition is indispensable for ensuring proper and long-lasting operation of the catalytic converters.

The oxygen sensor informs the MOTRONIC control unit as to the oxygen content of the exhaust gas and enables the control unit to control the adjustment of the mixture titre should the latter prove to deviate from the stechiometric ratio. These adjustments are virtually continuous (about every 10 ms) and they provide for metering of the amount of fuel to be injected from one moment to the next (C 2.06).

The thermocouple is connected to a control unit **(4)** and it informs the MOTRONIC unit as to the temperature of the catalytic converter on which it is fitted.

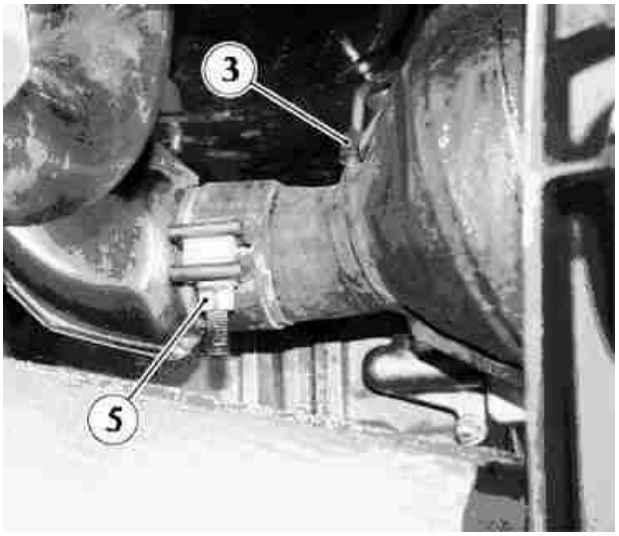


CAUTION

To limit the emission of pollutants into the atmosphere, it is essential that the catalytic converters, the oxygen sensors, the thermocouples and the respective control circuits are in perfect condition. Consult the "PROGRAMMED MAINTENANCE PLAN" to determine the repair work, checks and inspections to be performed.

Removing the Catalytic Converter

- Remove the rear wheels (F 3.06).
- Remove the rear gravel guards (M 2.05).
- Remove the rear element of the underfloor (M 2.12).
- Remove the exhaust manifold (B 7.08).
- Remove the oxygen sensors **(1)** and **(2)**, but leave them connected to the system (A 3.12).
- Remove the thermocouple **(3)** from the catalytic converter, but leave it connected to its respective control unit.
- Loosen the nut **(5)** on the "torx" clamp fastening the silencer on the catalytic converter.



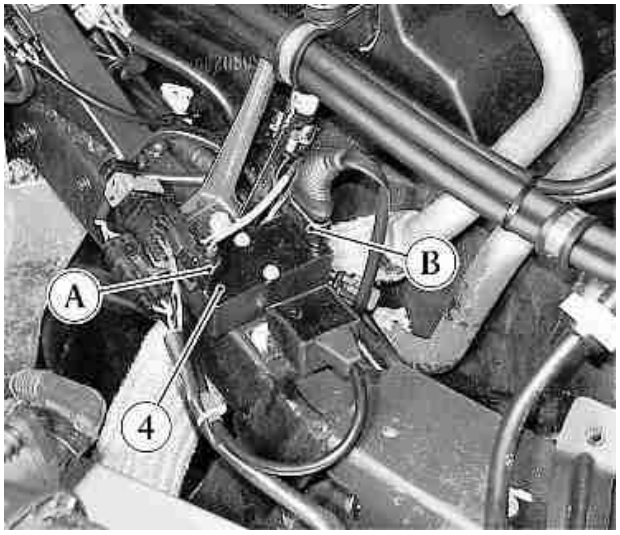
- Mark all parts in order to have a reference for re-assembly with proper positioning.
- Slide the catalytic converter off of the silencer.

Re-assembly notes

- When re-installing the catalytic converter in the silencer, position it correctly, using the reference marks made during the removal phase. If you are fitting a new catalytic converter, the thermocouple seat must be found in the upper part, in a vertical position.
- Tighten the thermocouple to the prescribed torque.
- Re-fit the exhaust manifold, (B7.08), before tightening the nut **(5)** on the "torx" clamp.

ECU for catalytic converter temperature control

The ECU **(4)** which controls the catalytic converter's temperature is positioned on the side panels of the engine compartment. It is connected to the thermocouple (connector **A**) and to the engine compartment harness (connector **B**). The ECU has a 2 pole filter on the output signal to make sure that a brief, insufficient contact with the thermocouple does not cause significant variations in the output signal.



For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

B7.07 SILENCER

Tightening torques	Nm	Category
"Torx" clamp nut	**43**	**B**
Terminal fastening nut	**25**	**B**

The rear part of the exhaust silencer is supported by a bracket **(1)** incorporated in a support **(2)** that is secured to the gearbox housing. In addition to serving as support for the silencer, this support is used to absorb striking energy and thus as protection for the gearbox in the event of a collision.
The left-hand **(3)** and right-hand exhaust gas terminals are located on the lateral ends of the silencer.

Each terminal is fitted with a pneumatic throttle valve **(4)**, which is controlled by the by-pass solenoid valve. This valve operates by means of the vacuum generated in the accumulation tank (B7.04). The control rod **(5)** is connected to the diaphragm inside the valve and activates the throttle inside the exhaust terminal by means of a ball joint **(6)**.

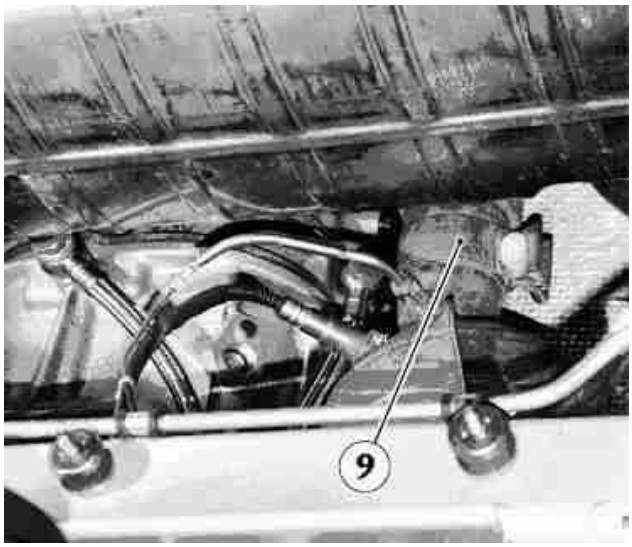
Test rod movement to ensure there is no blockage. If it is not working properly, the entire terminal must be replaced.

Removing the Terminals and Silencer

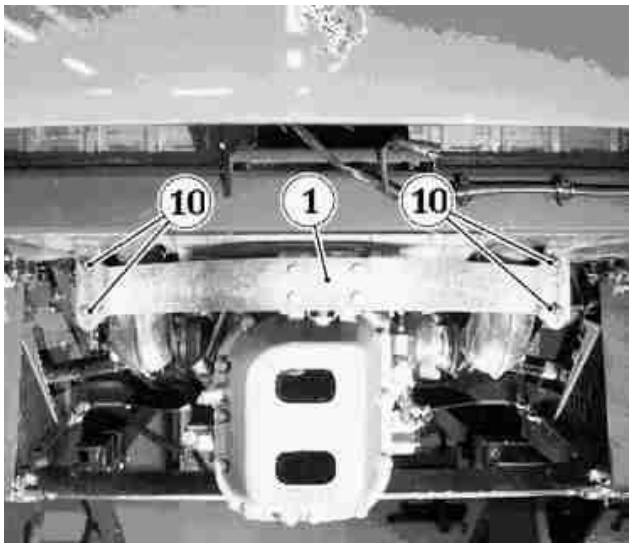
- Remove the rear wheels (F 3.06).
- Remove the rear gravel guards (M 2.05).
- Remove the rear element of the underfloor (_____).
- Remove the rear bumper (M 2.04).
- Remove the exhaust terminals **(3)** from the silencer by unscrewing the fastening nuts **(7)**. Remember to keep the gaskets **(8**, **Fig. 1)**.

- Loosen the nuts on the "torx" clamps **(9)** on the connection with the catalytic converters.

IMPORTANT
Every time the torx clamp is loosened, it must be replaced.



- Unscrew the 4 nuts **(10)** fastening the bracket **(1)** supporting the silencer.



- Slide out the silencer from overhead.

Re-assembly notes

- When installing a new silencer, it must be fitted in a position that is equidistant from the chassis structures.
- Fit new torx clamps **(9)** on the exhaust tailpipes and fit them on the catalytic converters, tightening the nuts to the prescribed torque.
- Lubricate the terminal attachment flange stud bolts with molybdenum bisulphide grease.

B7.08 EXHAUST MANIFOLD

The exhaust manifolds (**Fig. 1**) are equipped with a union that is closed with a cap nut **(A)** for sampling the exhaust gases, upstream from the catalytic converters. In addition, a cap **(B)** with a gasket is fitted on each exhaust pipe. The cap permits CO sampling to detect any malfunctioning of the valves in each cylinder (the **US M.Y. 2000** version does not have these caps).

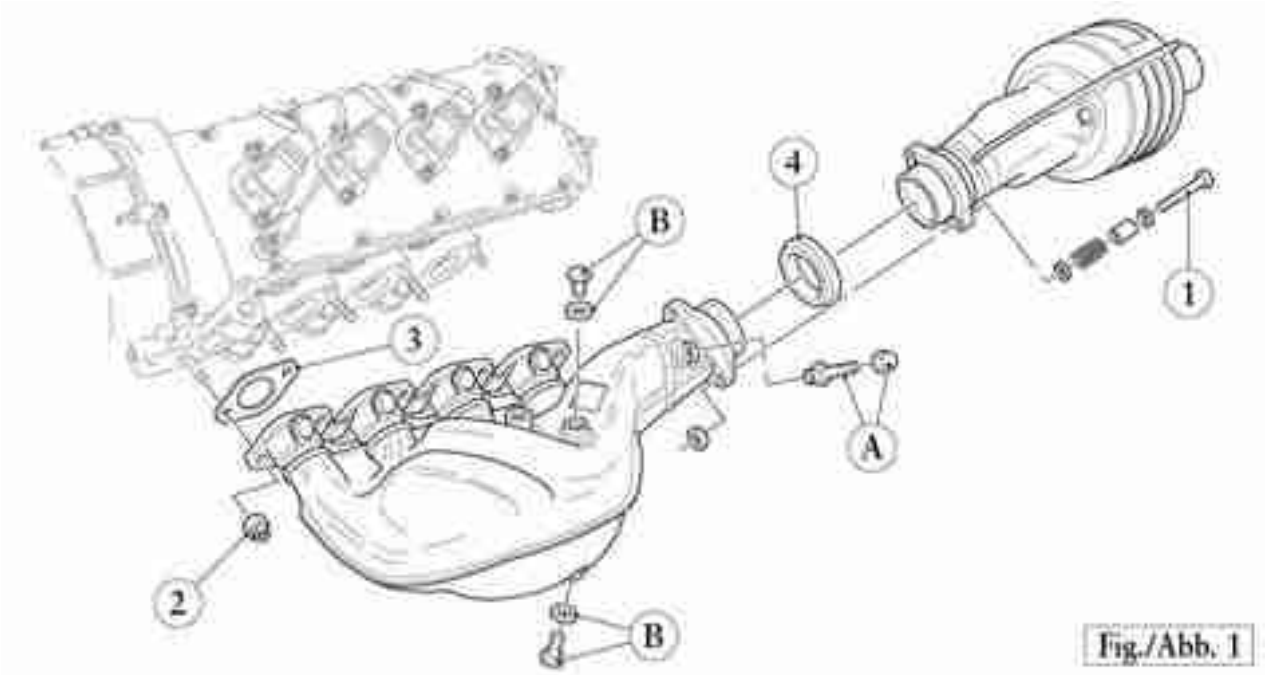
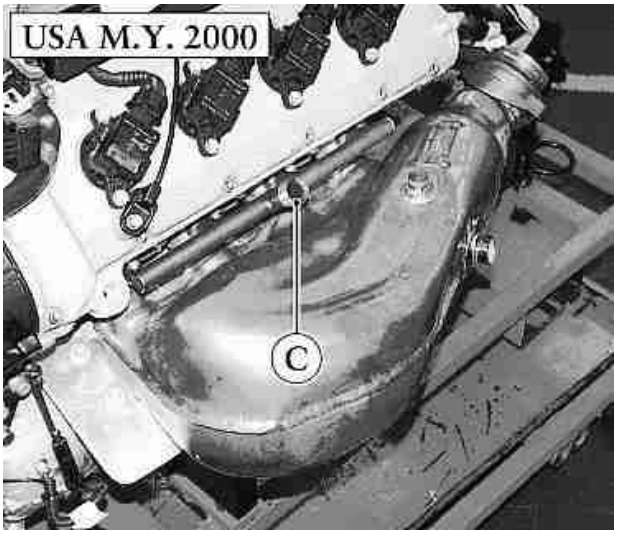
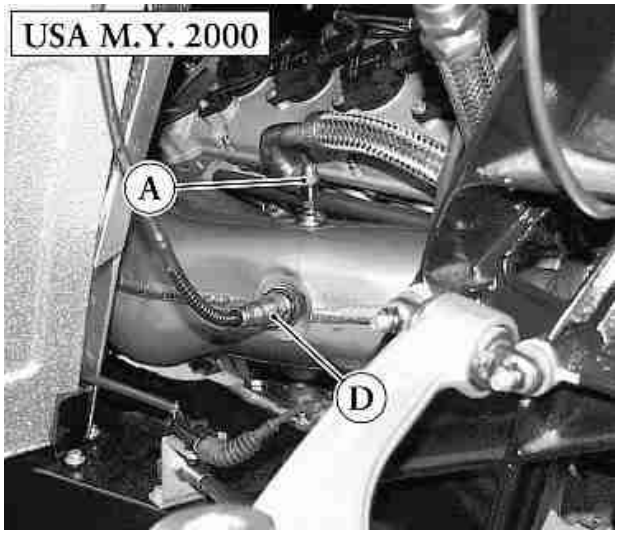


Fig./Abb. 1

Note for the US M.Y. 2000 version

Besides having a cap nut union **(A)**, the exhaust manifolds for these cars also have a union **(C)** for secondary air intake and distribution to the output of each exhaust duct (B 7.05).
A pre-catalytic converter is fitted on the manifold's output. The front oxygen sensor is fitted upstream of this converter **(D)** (B 7.06).

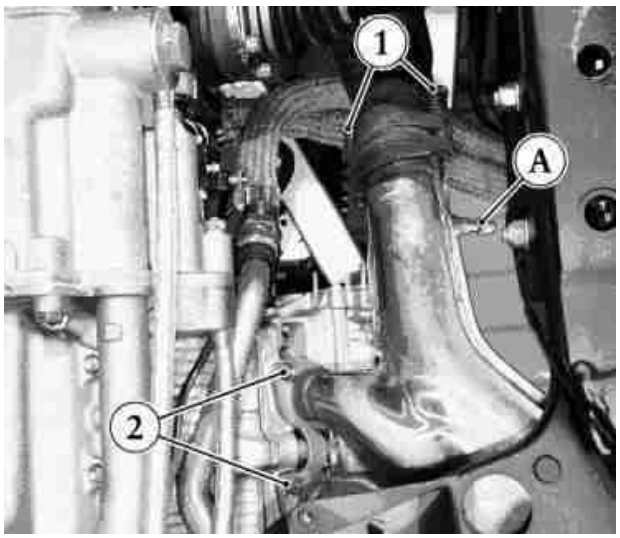




Tightening torques	Nm	Category
Manifold clamp nut	**25**	**B**
Screw fastening manifold/catalytic converter	**16**	**B**

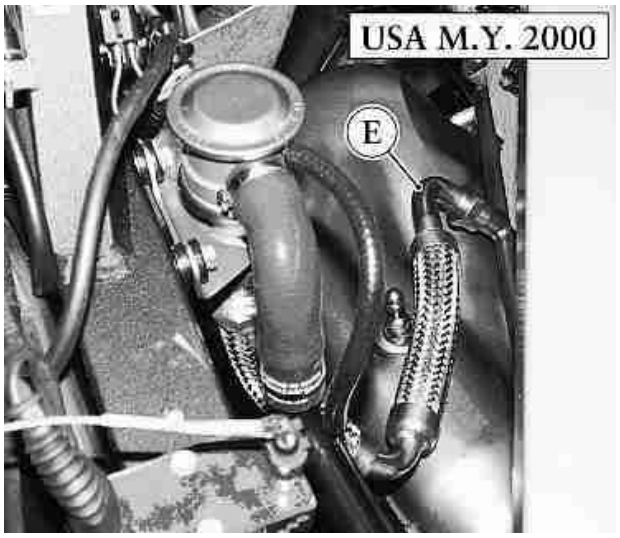
Removing the Exhaust Manifold

- Remove the rear wheels (F 3.06).
- Remove the rear gravel guards (M 2.05).
- Remove the rear element on the underfloor (M 2.12).
- Unscrew and remove the screws **(1)** fastening the flanges on the manifold - catalytic converter connection with all the fastening elements.
- Unscrew and remove the nuts **(2)** fastening the manifold to the head.

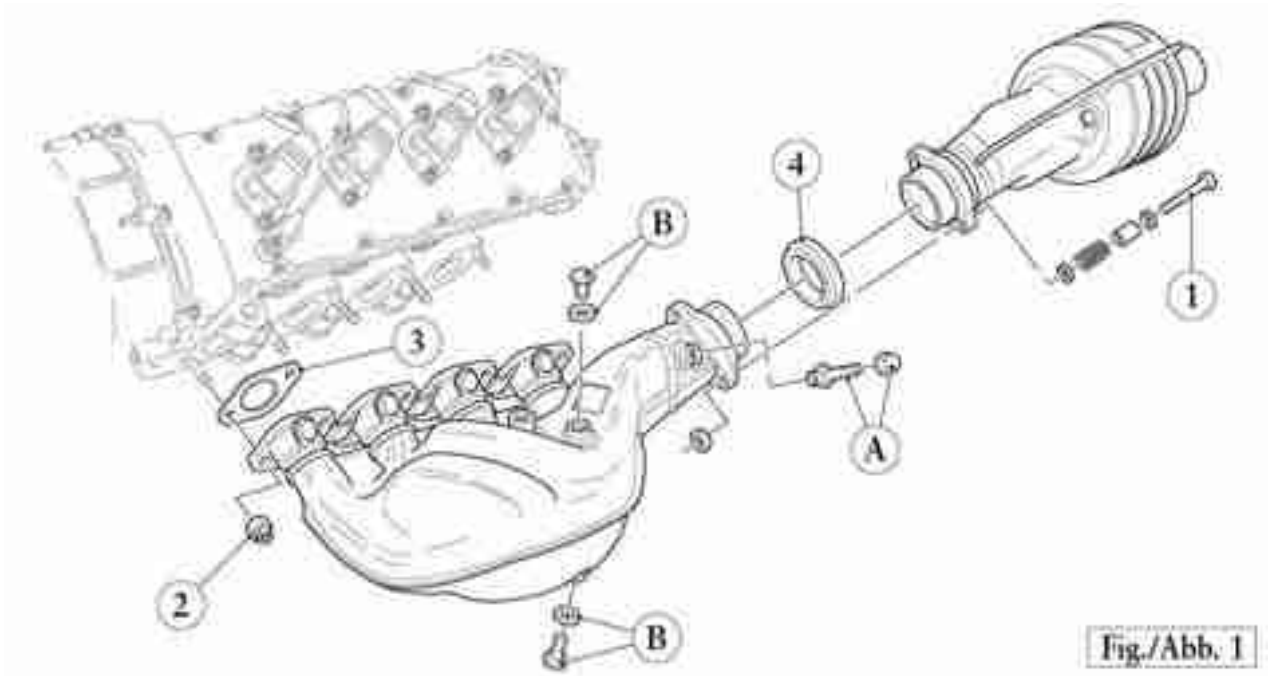


Note for the U.S. M.Y. 2000 version

Unscrew the union on the pipe **(E)** connecting the exhaust manifold to the secondary air system valve (B 7.05) and remove the front Lambda sensor (A 3.12).

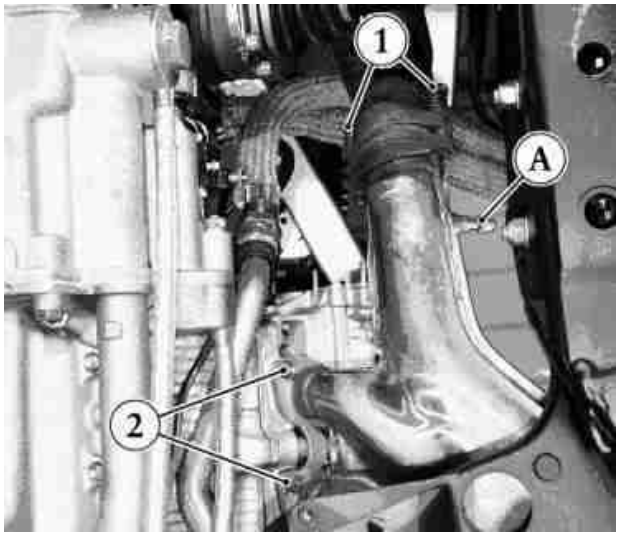


- Remove the exhaust manifold and keep the gaskets **(3)** on the head and the trapezoidal gasket **(4)** on the catalytic converter.



Re-assembly notes

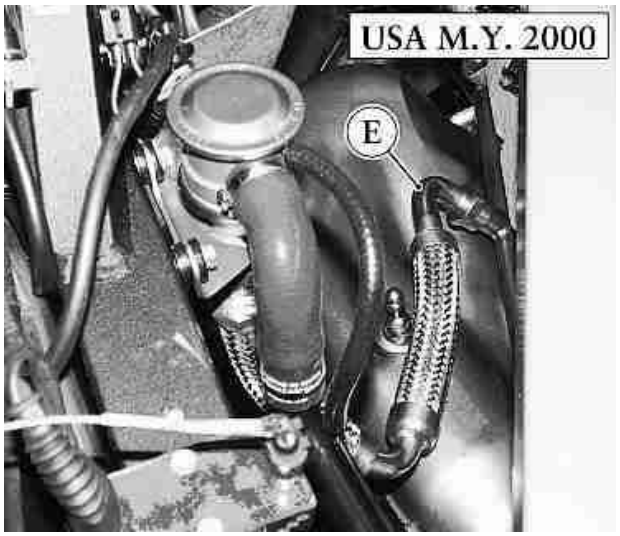
- Check to ensure that the gasket seat surfaces **(3)** on the head and the manifold are perfectly level. Eliminate any deposits or gasket residue. It is a good rule to replace the head gaskets with each overhaul.
- Lubricate the head stud bolts and the screws **(1)** with molybdenum bisulphide.
- Tighten the nuts **(2)** and the screws **(1)** to the prescribed torque, following the sequence 1-2-1.



Note for the U.S. M.Y. 2000 version

Tighten the tube's union **(E)** on the manifold by positioning the tubing as illustrated in the photo.

- Refit the front Lambda on the manifold (A 3.12).



C1.01 SPECIFICATIONS

Injection

Type:	**BOSCH ME 7.3**
ECU:	**BOSCH SG-ME7-3H**

Ignition

Static ignition	
Ignition order:	**1-8-3-6-4-5-2-7**
Initial spark advance, idling (1050 revsmin):	**6° ±3**
Single ignition coil:	**BOSCH ZS-K-1X1**
Spark plugs:	**NGK PMR8B**

The injection/ignition system control is integrated in a single microprocessor Electronic Control Unit (ECU, one per bank).
In this way, both the engine performance and the fuel consumption are enhanced, improving the car's handling and optimising the engine operation with partial loads.

IMPORTANT
The system which controls the injection/ignition is self-adjusting and does not require any regulation.

The system is made up of the following systems:
- ELECTRIC/ELECTRONIC system;
- AIR INTAKE system;
- FUEL SUPPLY system;
- EMISSION CONTROL system;
- exhaust temperature control system.

The system sensors transmit the following signals:
- engine revolution speed and position (in relation to the TDC);
- intake air temperature and volume;
- throttle opening position and speed;
- accelerator pedal position;
- coolant temperature;
- catalytic converter internal temperature;
- mixture titre;
- detonation;
- car speed;
- ignition key in running position;
- battery voltage;
- braking system activated;
- clutch activation;
- compressor activated;
- air conditioning system activated;
- engine supply cut-off;
- parameters communicated via CAN and parameters from other systems (ABS, ASR, electronically-controlled gearbox, etc...).

C1.02 SYSTEM DESCRIPTION

Each of the two engine banks has its own ignition system governed by a microprocessor-controlled **ECU** which receives the signals related to the use the car from the sensors positioned on the engine. It also directly controls the actuators which manage the engine operation. The components of the two systems are interchangeable.
The ECUs communicate with each other, and with other systems, via the **CAN** (**C**ontroller **A**rea **N**etwork) line, to optimise the running of the engine.
Each system therefore, basically consists of an ECU and a set of sensors and actuators.

Sensors

- Engine timing sensor
- Angular velocity sensors
- Air flow meter
- Coolant fluid temperature sensor
- Throttle potentiometer (integrated into the motor-driven throttle body)
- Oxygen sensor
- Detonation sensor
- Accelerator pedal position sensor
- Air temperature sensor (integrated into the air flow meter)
- Pressure sensor (only for the **Euro 3** - **US** version)

Actuators

- Fuel pump
- Electro-injectors
- Motor-driven throttle (B 6.08)
- Coil
- Timing variator check solenoid valve
- Exhaust by-pass solenoid valve
- Compensating solenoid valve; modular manifold; canister cleaning; vapour on-off valves (only for the **US** version)
- Tank tightness check solenoid valve (**Euro 3** - **US** version only).
- Secondary air solenoid valve (**US M.Y. 2000** version only)
- **"Check engine"** or **"Engine control system faults"** and **"Slow-Down"** lights
- Relay
- Secondary air pump relay (**US M.Y. 2000** version only)

All these components, together with the ECU, supply the Motronic ME 7.3 system with all the features of the:
EGAS (**E**lectronic **GAS** pedal)
This is a checking system for the engine which detects every situation as a torque requirement. The main element which determines the torque requirement is the accelerator pedal.
OBD II (**O**n **B**oard Detection and **D**iagnostic system)
This system identifies operative malfunctions, inside the engine checking system, in compliance with the regulations concerning emission checks.
RLFS (**R**eturn **L**ess **F**uel **S**ystem)
This system prevents the fuel supply flowing back into the tank.

C1.03 OPERATING PRINCIPLE

The ECU which controls the functioning of the engine calculates the output values according to the signals received from the system sensors. In particular, it determines the injection time **tj** and the **S.A.** (Spark-Advance).

Calculating the Injection Time

The injection time **tj** is given by the sum of the following factors: **tj = (t1 + t2 + t3 + t4) x t5**

t1 This datum, which is the most important, is a function of the number of revolutions and the engine air intake.
t2 The factor **t2** depends on the throttle position and the coolant temperature.
t3 This last factor corrects the **tj** according to the battery voltage.
As the battery voltage decreases, it is necessary to increase the opening time of the electro-injectors in order to deliver the correct quantity of fuel to the cylinders.
t4 depends on the intake temperature.
t5 This factor is worth 1 when the system is functioning with an **"open loop"** while it can be worth from **0.8 to 1.2** when the system is functioning with a closed loop and corrects **tj** on the basis of the oxygen sensor, in order to bring the air/fuel mix ratio to the stoichiometric value.

NOTES
*The Motronic system ECUs can work with battery voltages of up to **6V**.*

Closed Loop Operation

The closed loop control system guarantees the accuracy of the mixture composition which is essential to maximise the efficiency of the trivalent catalytic converter.
During standard operation, the signal generated by the oxygen sensors is compared with a predetermined threshold, in order to establish how the ECU will work to bring the mixture to the stoichiometric value.

NOTES
The oxygen sensors are mounted in the exhaust while the air/fuel ratio correction takes place in the intake system: this means that there is a time delay in the system's checking logic.

Open loop Operation

The system is controlled by the ECU according to pre-set values, without any corrective action resulting from the oxygen sensor signals, therefore regardless of the oxygen content in the exhaust gases.
In conditions of normal use, this mode functions when:
1 - The oxygen sensor is insufficiently hot (sensor temperature below approximately **300 °C**).
2 - The engine coolant temperature is below **50 °C** (but above **–7 °C**).

NOTES
*In analogous conditions (**–10 °C < T° < 40 °C**), the ECU for the **US M.Y. 2000** cars activates the injection of secondary air to the exhaust.*

3 - Accelerator in fully-open position (throttle open **72°**).
4 - Engine revolution speed **> 4000 ± 200** rpm.

Open loop Mode for Checks and Diagnosis

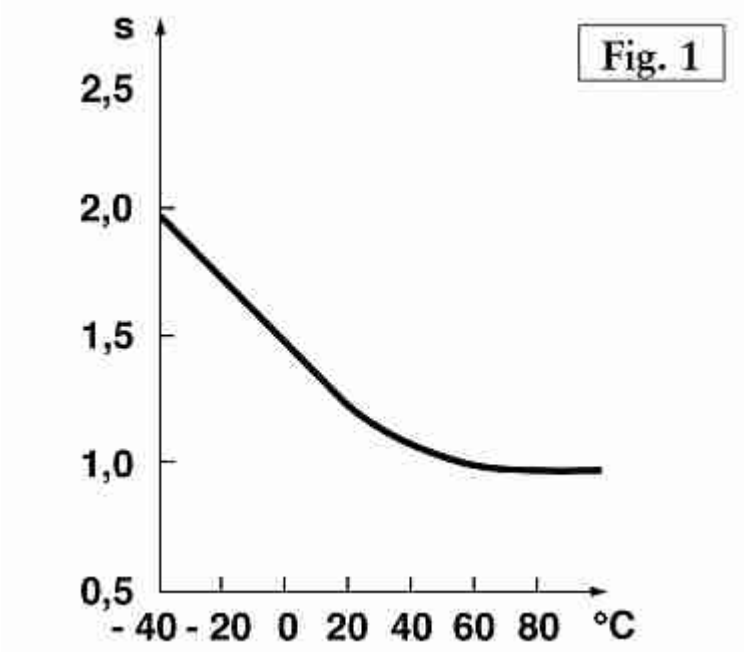
The open loop mode can also be simulated to check the engine operation when the motor is warm, leaving the oxygen sensors disconnected.

Self-Learning Cycle

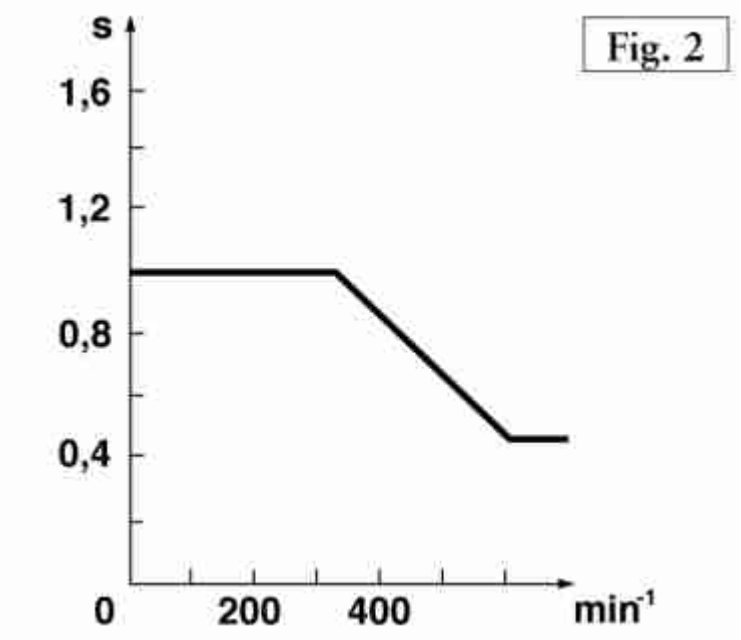
The ECU also performs the so-called **"self-learning cycle"** for the various engine conditions, which means it is capable of permanently storing the last correction made on the basis of the oxygen sensor signal.
If, for example, an unmeasured amount of air enters the intake circuit, thereby rendering the mixture too lean, the ECU will change the peculiar values accordingly, thus enriching the air/fuel mixture.
This correction is then stored and used the next time the engine runs.
By means of the self-learning cycle, it is possible to recover infiltration, losses or ageing of the components which provoke a movement of **±20%** of the value λ **= 1**.
If the battery is disconnected, the ECU must be allowed to re-learn the data relating to the engine condition, leaving the car running for at least **10 minutes**.

Start-up

As the engine turns, the ECU must recognise the engine timing by the sequence of signals which are transmitted by the revolution and timing sensors to synchronise the injection and ignition.
During this phase, when the engine revolution speed is higher than **30 rpm**, to make starting up the car easier, the ECU controls all the electro-injectors simultaneously and for a time that only depends on the coolant temperature.
After the first injection, and once the engine timing has been recognised, the sequential and timed check of the injection starts and the electro-injectors are controlled for the injection time calculated by the ECU.
The said enrichment follows the trend indicated in the graph in **Fig. 1** and is active until the coolant temperature reaches **60°C**.



As well as this enrichment, still during the starting-up phase, the ECU also corrects the injection time according to the number of engine revolutions.
As the graph in **Fig. 2** shows, as the number of revolutions increases, the injection time decreases to prevent an excessive quantity of fuel being delivered to the cylinders.



NOTES
*The start-up phase is recognised by the ECU in the presence of revolution speeds between **30** and **640 rpm**.*

Post Start-Up

Once the start-up phase is complete, the ECU calculates the value and the duration of the enrichment factor for the phase after starting-up.
As the graph in **Fig. 3-4** shows, the lower the engine temperature is the higher the value and duration of this factor are.

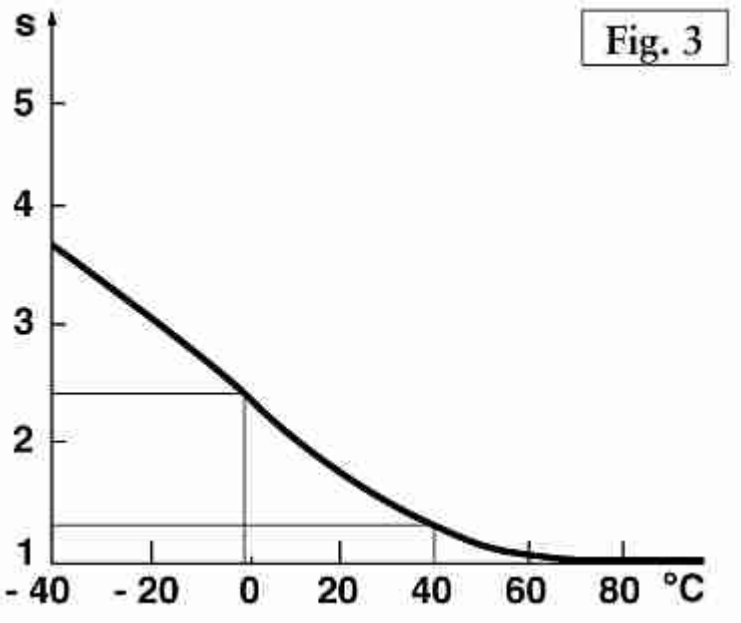
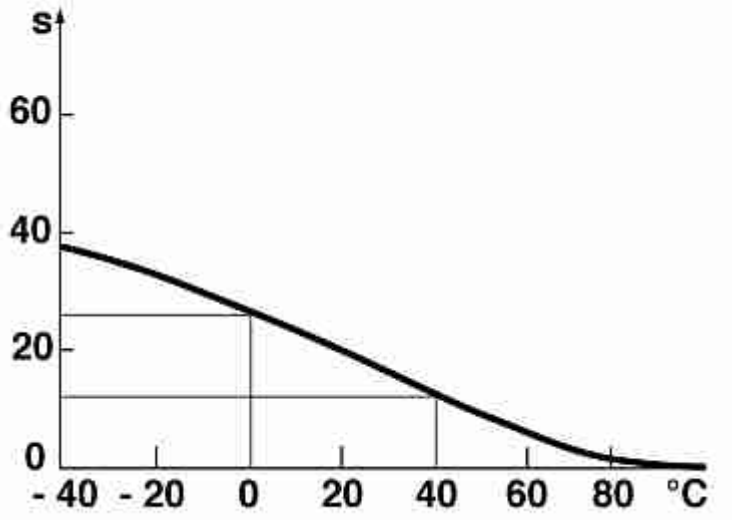


Fig. 4

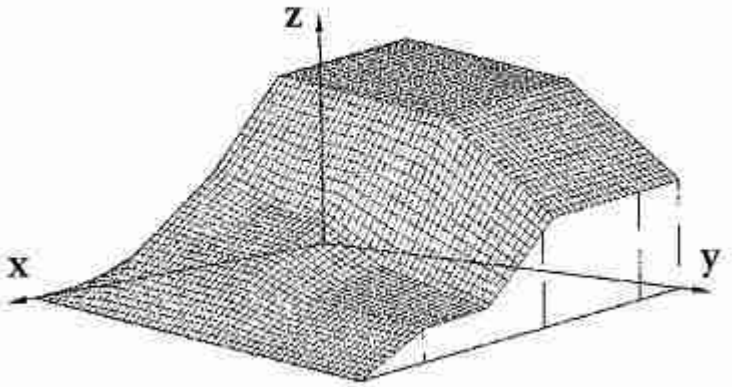


The duration of the post start-up phase is inversely proportional to the engine temperature.

Engine Warming-Up

The graph in **Fig. 5** shows the trend of the so-called warm-up enrichment factor, applied by the ECU until the engine reaches the operating temperature.

Fig. 5



*Keys to **Fig. 5***
X - Engine revolutions
Y - Engine load
Z - Enrichment factor

This enrichment factor depends on the load and the number of engine revolutions.
When the engine is up to temperature, all the enrichment factors described are cancelled and the electro-injectors are controlled by the time **tj** (described previously) only.

Full Power Enrichment

The injection time is also corrected according to the throttle opening.
When the throttle body potentiometer signals the **"full opening"**, the ECU will ensure a supplementary

quantity of fuel is delivered to the cylinders in order to maximise the engine performance.
This enrichment is also linked to the engine load and revolution speed.
As well as influencing the injection time, the throttle position also affects the spark advance. In fact, the Motronic ECU selects various advance mappings depending on whether the engine is idling, running at full or intermediate rpm.
The Motronic ECUs also control the revolutions limit, in order to safeguard the engine.

- The upper limit is set at **8500 rpm**.

The Motronic ECU intervenes by cutting off the electro-injectors' control.

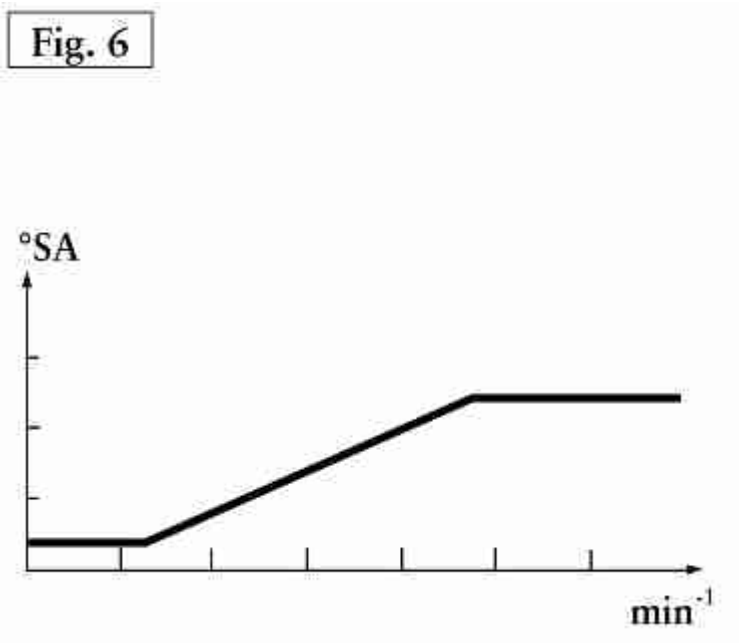
Calculating the S.A. (Spark Advance)

Various spark advance curves are stored in the ECU for a different numbers of engine revolutions, air flow rate and throttle position. The ECU microprocessor calculates the spark advance needed according to the values assumed by these input figures.
The advance curves are improved during the design and experimentation phase and once they have been entered in the memory they cannot be altered.
The ECU also corrects the spark advance according to the engine conditions of use.

Start-up Phase

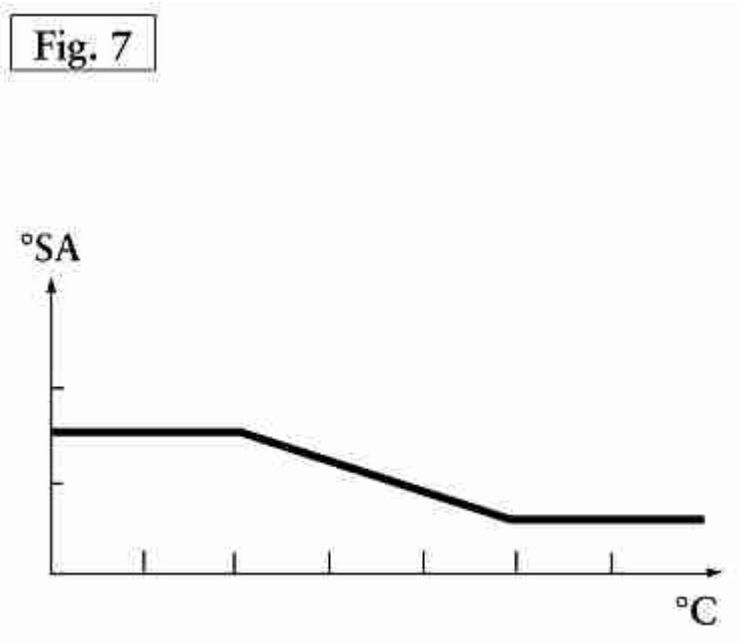
During the start-up phase, which is recognised, like the injection phase, on the basis of the number of engine revolutions, the spark advance is corrected according to a graph such as the one indicated in **Fig. 6**.

Fig. 6



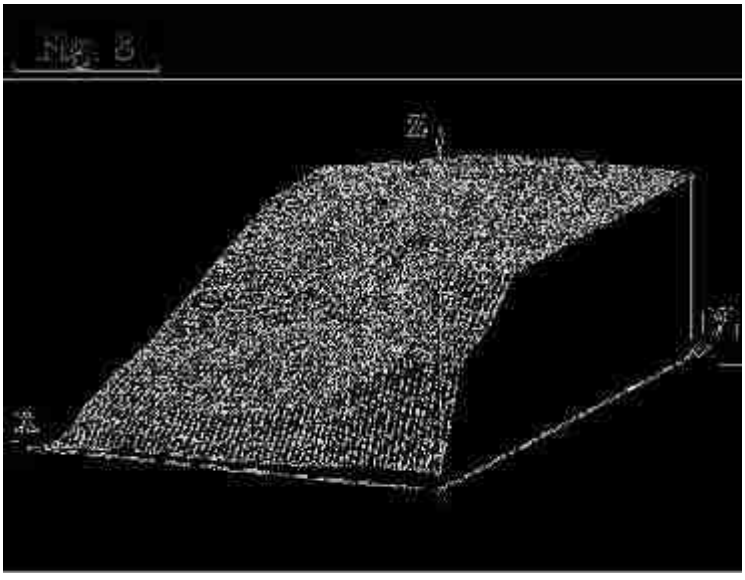
°SA – Spark advance temperature in degrees

On the other hand, the graph in **Fig. 7** shows the trend of the spark advance according to the coolant temperature.



°SA – Spark advance temperature in degrees

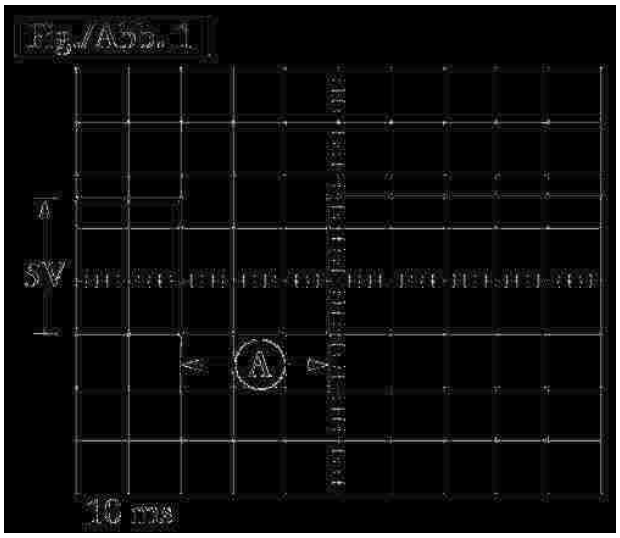
As the temperature increases, the spark advance is gradually decreased.
The ECU of the Motronic system is capable of controlling the coil charge time, generating a control signal for the power module.
To optimise the coil functioning using the maximum current value, the ECU sets the charge time according to the engine revolution speed and the battery voltage.
The graph in **Fig. 8** shows the trend of the closing angle or the running time for the power module according to the number of revolutions and the battery voltage.



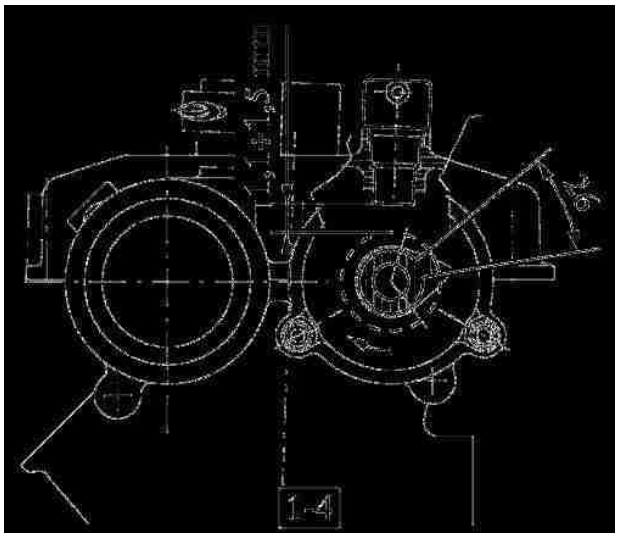
*Keys to **Fig. 8***
X - Battery voltage
Y - Engine revolutions
Z - Closing angle

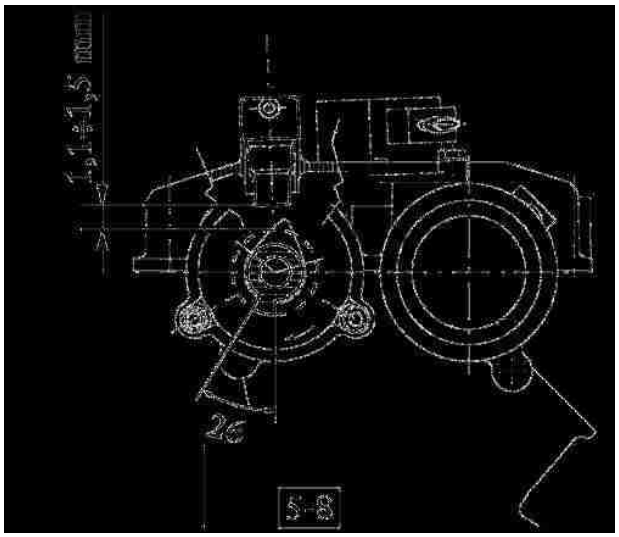
C2.01 TIMING SENSOR

The timing sensors are mounted on each head cover, facing the camshafts, on the exhaust side.
The output signal is generated by the Hall effect.
This principle is based on the fact that if a current is passed along a semiconductor immersed in a magnetic field which is perpendicular to the current itself, every time the magnetic field is altered, this will generate a voltage variation.
In the specific case of timing sensors, this is supplied by the ECU at **12 Volt**.
Each time the rotor (**26°** projection on the camshaft) passes in front of the sensor, the Hall effect causes a variation in the sensor output voltage; this variation occurs throughout the duration of the rotor's passage in front of the sensor. After this passage, the signal returns to the initial value **(5 V)**.



The sensor output voltage is indicated in **Fig. 1** and the amplitude of the signal has a duration **(A)** which corresponds to a **90°** rotation of the crankshaft (**15** teeth) which is equivalent to a **45°** rotation of the camshaft.
The distance between the sensor and the projecting camshaft must be between **1.1 and 1.5 mm**.





Replacement

- Working below the intake manifold, detach the sensor's (black) connector from the injection wiring harness.
- Remove the sensor by unscrewing the screw **(1)** fastening the head cover.

- Before reassembling the part, lubricate the O-ring on the sensor with a thin layer of **MOLYCOTE** grease and tighten the screw **(1)** to a torque of **8 Nm** (Category **B**).
- Reconnect the connector and fix it to the cable of the corresponding bank with a tear-off clamp.

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

C2.02 ANGULAR VELOCITY SENSOR

This is a variable reluctance sensor which generates an electric signal by detecting the movement of a toothed wheel – featuring 60 teeth and intervals equalling 2 teeth - mounted on the rear part of the crankshaft.
The intervals equal to 2 teeth on the toothed wheel permit to recognise the cylinders' top dead centre **(TDC)**.
The graph in **Fig. 1** shows the sensor's output signal with respect to the horizontal development of the toothed wheel. As it can be seen, the signal's trend differs in correspondence with the intervals (halved frequency), with respect to the frequency generated by the teeth of the wheel itself.

*LKeys to **Fig. 1***
1 - Toothed wheel profile
2 - Engine revolutions sensor signal
3 - Reference tooth
4 - Measurement point for TDC recognition

Furthermore, the ECU counts the number of pulses which correspond to the wheel teeth, in order to determine the subsequent moment at which the halved frequency signal is expected, and so to recognise any interference which may occur.

$$fs = \frac{rpm \times teeth\ no.}{60}$$

fs: detected signal frequency
rpm: number of engine revolutions per minute

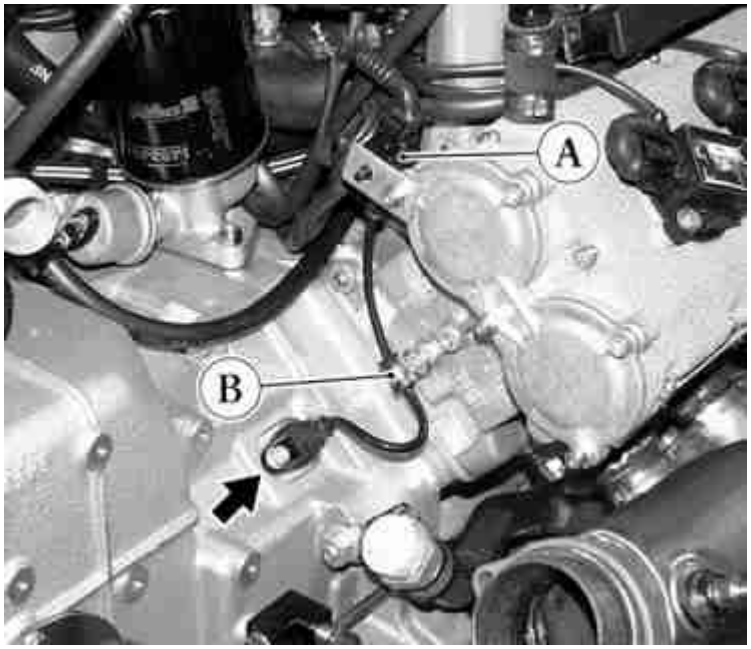
The ECU recognises the timing by analysing the signal and it injects fuel, according to a fixed advance, when cylinder **1** intake valve opens.
Once the system has recognised the TDC which corresponds with the cylinder **1** intake phase, the ECU injects fuel into the other cylinders, according to the pre-set combustion order.
For this reason, the timing sensor signal is no longer analysed, unless the ECU loses its synchronism because of interference etc.
If the ECU loses its synchronism, it will analyse the timing sensor to find the correct fuel injection order with respect to the intake phases of the various cylinders once again.
The sensor connector is a two-way plaited cable, since this type reduces the electromagnetic interference.

Replacement

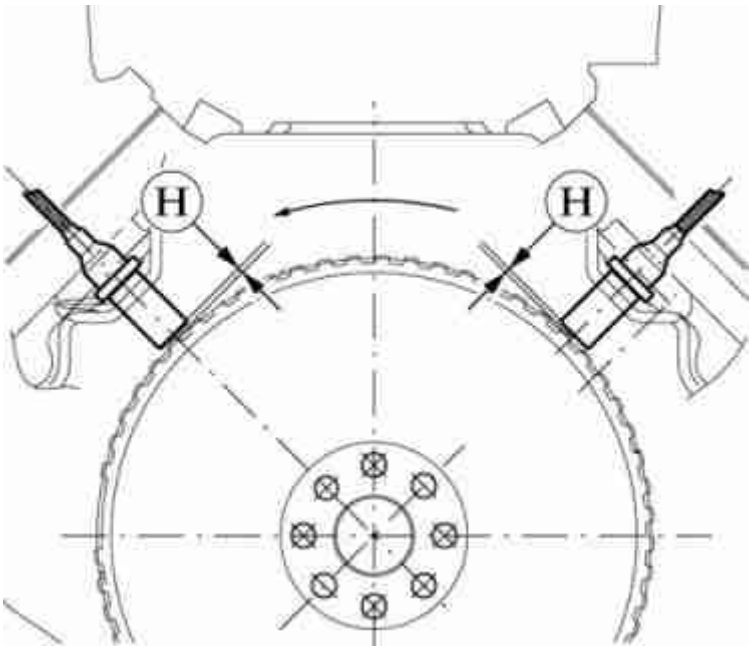
- Detach the sensor connector **(A** which secures the fastening bracket to the rear head cover and

disconnect it from the injection wiring harness.

- Take off the cable support clamp **(B)** and remove the sensor's fastening screws.



- Remove the sensor from the gearbox.
- When reassembling, the distance **(H)** between the sensor and the toothed wheel must be between **1.1** and **1.5 mm**.

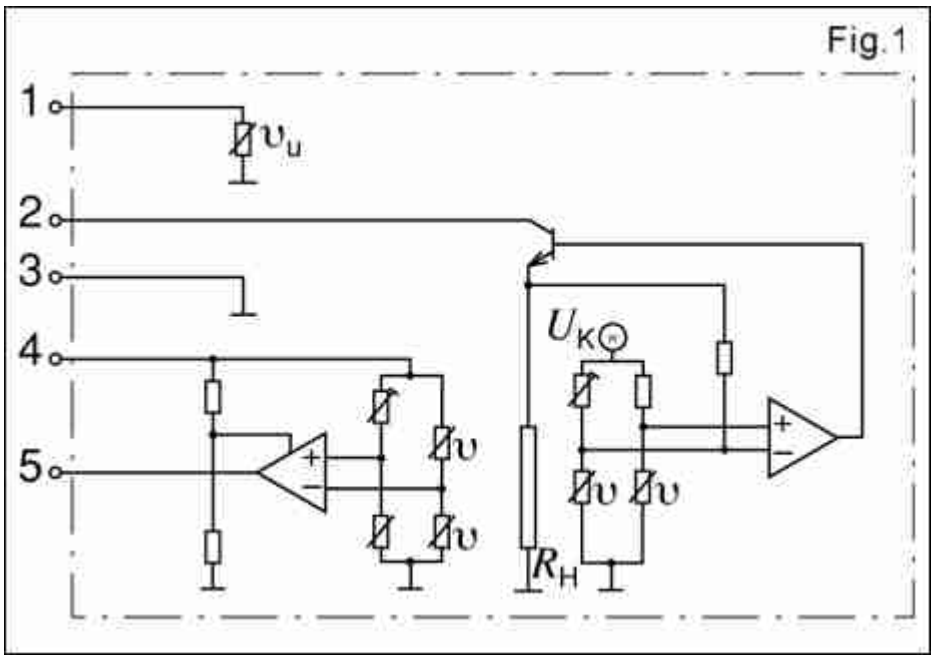


- Tighten the fastening screws to a torque of **8 Nm**.

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

C2.03 AIR FLOW METER

The identification of the engine load, and so the air-intake volume (needed to distribute the correct quantity of fuel), is carried out by means of the signal generated by the air flow meter.
The air taken in by the engine passes through the flow meter hitting the hot-film sensor located inside the air flow duct.
Fig. 1 shows a block diagram of the air flow meter.



The platinum hot film sensor is a PTC (positive temperature coefficient) type thermo-resistance that is, a resistance whose value increases as the temperature increases.
As the air intake increases, the heat taken off of the sensor increases, and hence the resistance of the sensor itself decreases. Since the sensor is installed within a **"bridge"** measuring electric circuit, it causes an increase in the output voltage, which is detected by the ECU to meter the quantity of air taken in by the engine.

The air flow meter can also identify the air flow direction, and consequently the information related to the actual quantity of air taken in by the engine, if no turbulence occur.
The air temperature sensor is also integrated with the air flow meter.
On the external body of the meter there is an arrow (see **Fig. 2**) which indicates the air flow direction.

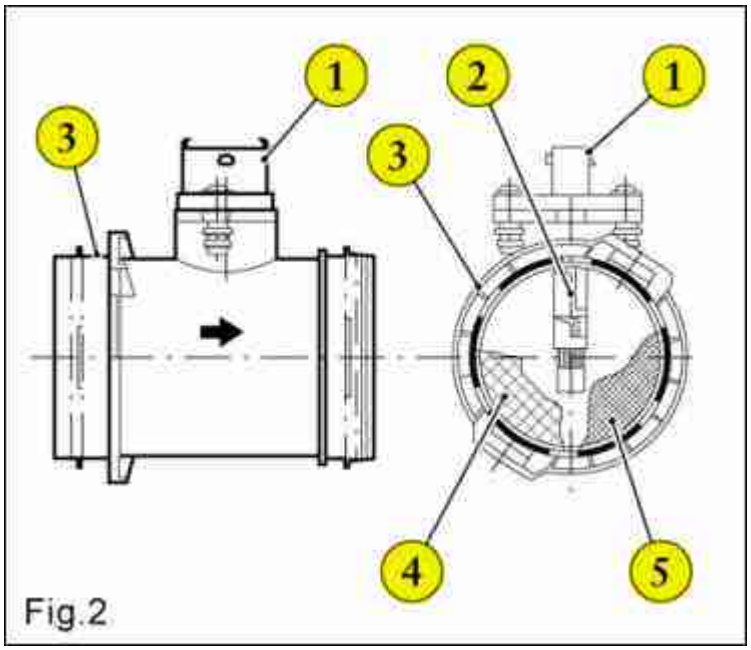


Fig.2

*Keys to **Fig. 2***
1 - Electrical connector
2 - Hot-film sensor
3 - External body
4 - Griglia di protezione
5 - Metallic screen

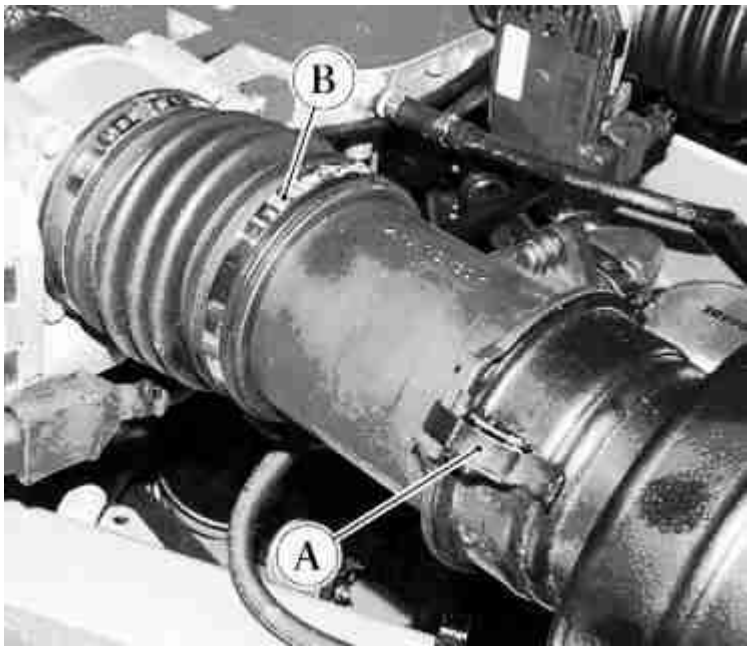
If the air flow meter fails and produces wrong information or information which the E.C.U does not recognise as plausible, the **"recovery"** procedure is activated. This analyses the signal coming from the potentiometer, located on the throttle body, to determine the opening of the throttle valve and consequently the quantity of air taken in by the engine. The adjustment in this case, is much more approximate than the one obtained using the air flow meter but, it is sufficient to keep the car running efficiently and to prevent its stopping.

Replacement

- Detach the injection harness connector from the meter.

For connection to the system, see Table **S** - ELECTRICAL SYSTEM.

- Release the fasteners **(A)** on the air filter housing cover.
- Undo the clamp **(B)** on the motor-driven throttle body bellows.



- Remove the meter.

The spare air flow rate meter is supplied as a whole and must not be disassembled.

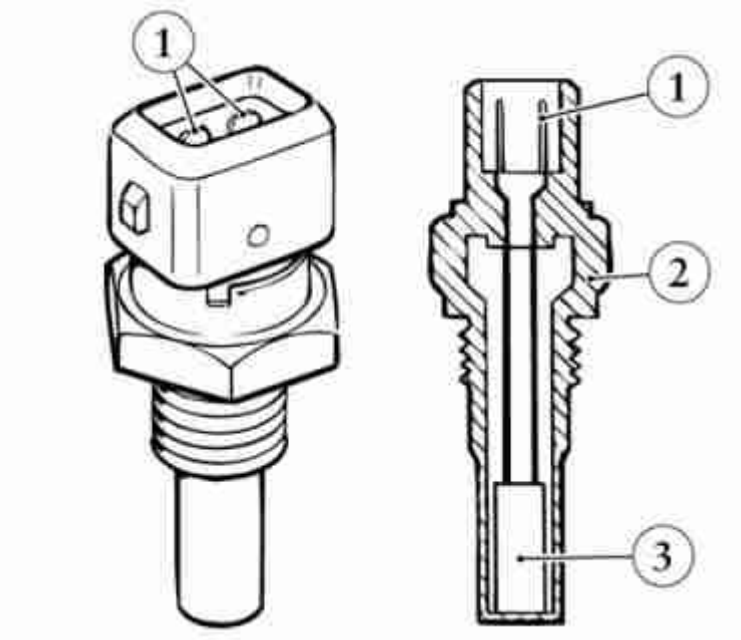
C2.04 COOLANT TEMPERATURE SENSOR

This **NTC** (Negative Temperature Coefficient) type sensor, is located on the connection duct for the head water outlet manifolds.
The sensor is mounted so that the sensitive part comes into contact with the coolant and it is fitted with gold-plated contacts.

IMPORTANT

Never connect the sensor using connectors of any other type.

It is composed of a metallic body **(2)** with an internal negative temperature coefficient resistance **(3)**, on which the leads **(1)** are terminated.

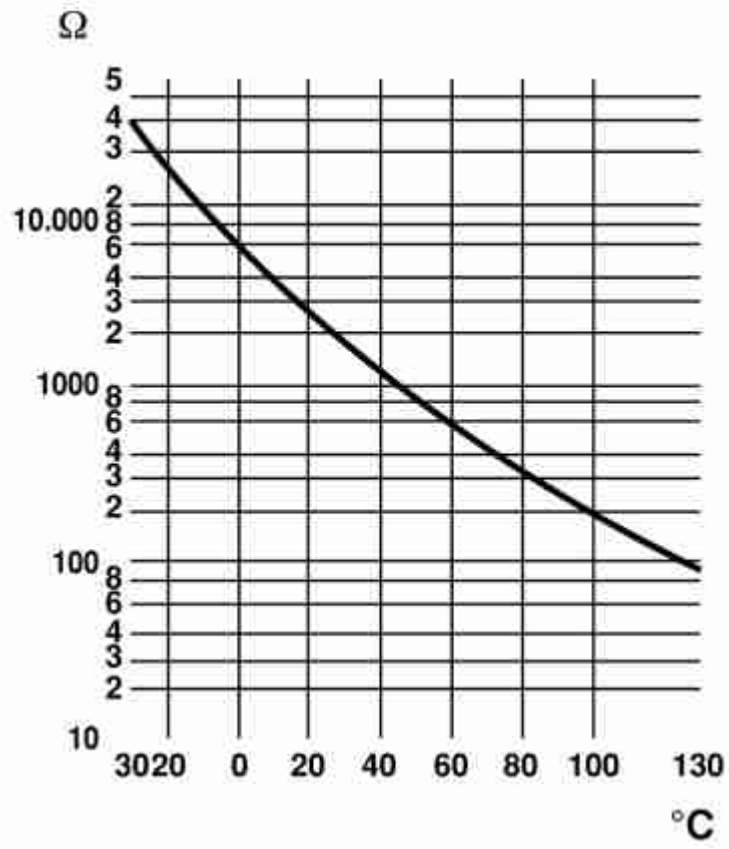


The graph shows the curve direction.

- Measurement range: from **–30/40°C** to **130°C**
- Tollerance at 20°C **1.2°C**
- Tollerance at 100°C **3.4°C**

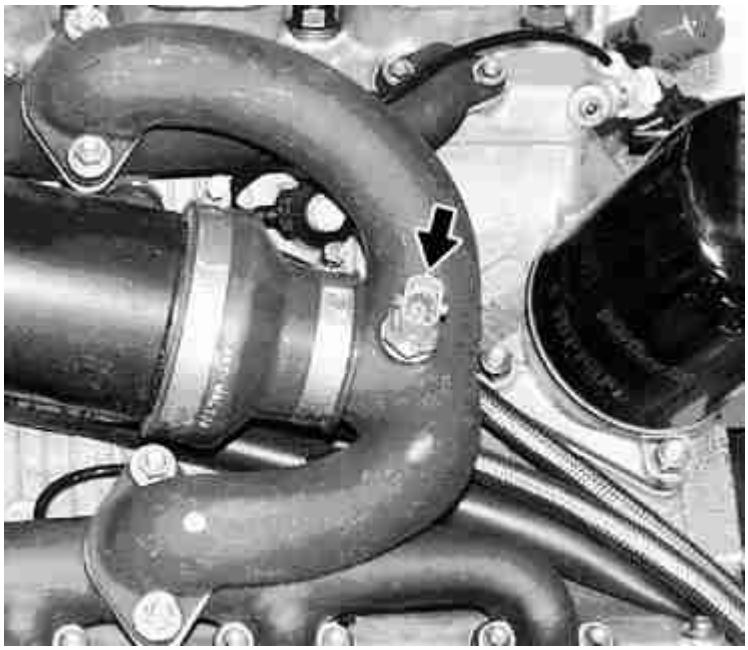
-Nominal resistance at 20°C: **2.5 kΩ±5%**

-Nominal voltage: **≤ 5V**



Replacement

- Working from below the intake manifold, disconnect the sensor from the right-hand injection harness.
- Unscrew and remove the sensor from the duct.



- When reassembling, tighten the sensor to a **16 Nm** torque.

For connection to the system, see Table **S** - ELECTRICAL SYSTEM.

C2.05 THROTTLE POTENTIOMETER

It is fitted inside the motor-driven throttle body of each bank.
The potentiometer is located on the axis of the throttle shaft and it keeps the ECU constantly informed about the opening of the throttle valve in proportion to the support shaft rotation angle.
From the principle wiring diagram for the motor-driven throttle (Fig. **1** and **2**), it can be seen that there are actually two parallel potentiometers; this allows the ECU to carry out a plausibility check.

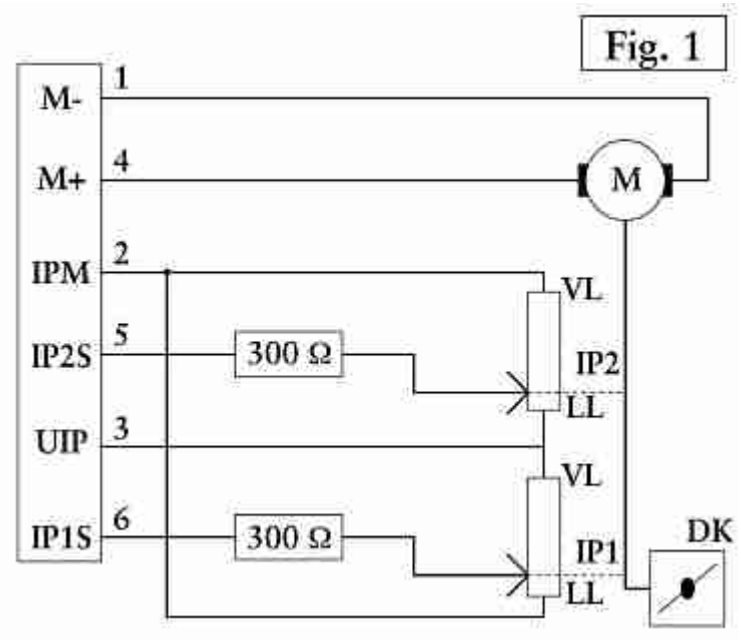
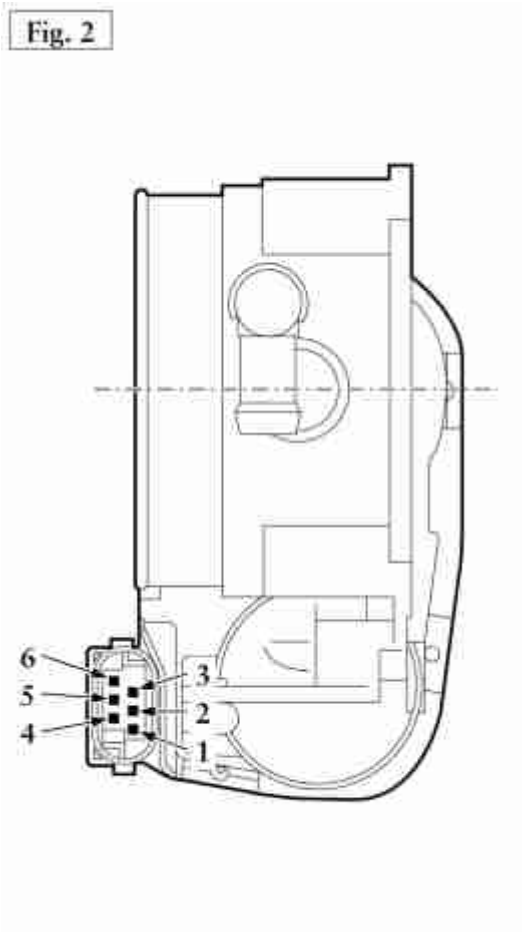


Fig. 2



IThe values can be checked by means of the SD-2 tester and they are opposing values (when the output voltage of one decreases, the voltage of the other one increases proportionally).

Activation threshold
- **10 minutes** of self-learning
- Idling position = **2÷3%**
- Recovery position (1500 revs max.) = **8%**
- Self-learning counter: in the new part this is positioned at **9**

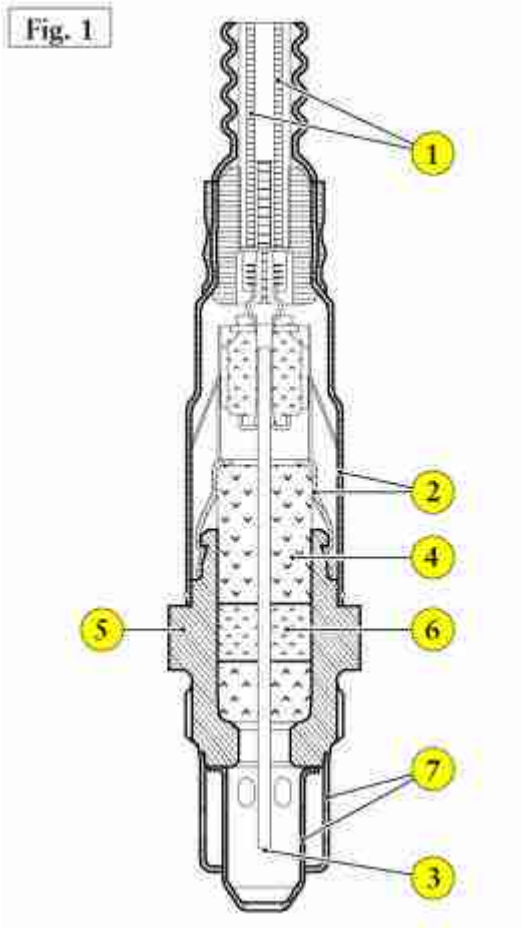
Every time the engine is started, the ECU resets itself on the idle position.
The accelerator pedal must not be pressed therefore while the engine is being started.

NOTES
It is not possible to replace the potentiometer alone since it is an integral part of the motor-driven throttle body (B 6.08).

C2.06 OXYGEN SENSORS (LAMBDA SENSOR)

The oxygen sensors are mounted onto the outlet and outlet of the catalytic converter and they detect the exhaust gas composition.
These oxygen sensors feature the earth reference on the outlet.

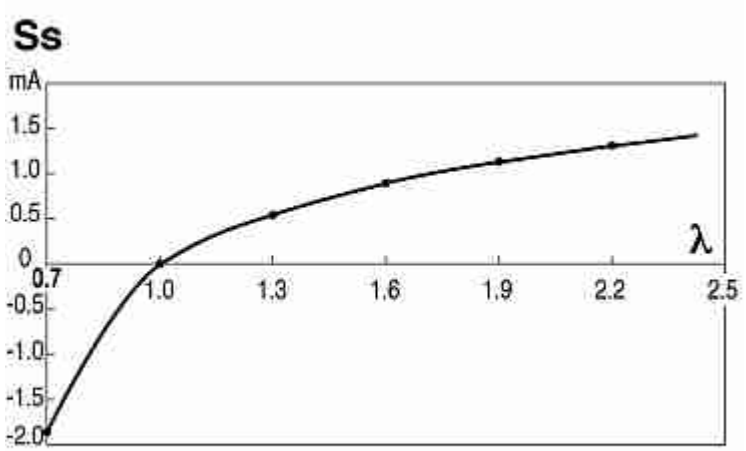
Front BOSCH LSU 4 Oxygen Sensor (Fig. 1)



*Keys to **Fig. 1***
1 - Connection cable
2 - External protective covering
3 - Sensor planar element
4 - Ceramic support
5 - Sensor body
6 - Ceramic gasket
7 - Protective terminal

This is a linear sensor generating a voltage signal which depends on the concentration of unburnt oxygen in the exhaust gases. This latter is very closely related to the air/fuel ratio in the intake manifold or to the excess air factor in the air/fuel mixture (excess air factor = λ Lambda).
The main feature of this sensor is its linearity which is maintained even when the λ value is not equal to **1** (see **Fig. 2**).

Fig. 2



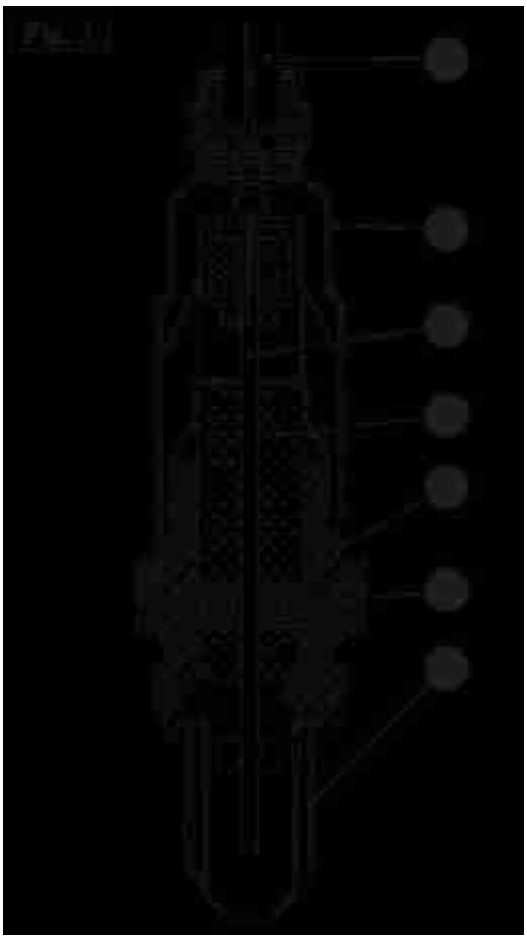
*Keys to **Fig. 2***
Ss - Sensor signals
λ - Excess Lambda factor

In fact, the sensor output is a clean signal which is continuous for **0,7 < λ > 1,6**.
This signal, when transmitted to the ECU input, makes it possible for the control unit to regulate the injection system, in order to keep the stoichometric value at **λ = 1**.

IMPORTANT
The oxygen sensor is active at all engine revolution speeds.
*In the **US M.Y. 2000** cars, the Lambda function is disenabled (oxygen sensor is **OFF**) for the entire time taken by the secondary air pump and solenoid valve to complete the ON-OFF-ON cycle* (C 3.09).

There is also an internal heating element integrated with the sensor, (see **Fig. 1**) which ensures the correct working temperature of (**700÷800 °C**) is maintained in all conditions.

Rear BOSCH LSF 4 Oxygen Sensor (Fig. 3)



Keys to ***Fig. 3***
1 - Connection cable
2 - External protective covering
3 - Sensor planar element
4 - Ceramic support
5 - Sensor body
6 - Ceramic gasket
7 - Protective terminal

This sensor has a double function:
- it reveals ageing of the catalytic converter by comparing it with the signal from the front oxygen sensor;
- in the event of ageing of the front oxygen sensor, it adjusts the mixture accordingly.

At low temperatures, (below **350 °C**), the sensor's internal resistance (above **1 MΩ**), prevents the generation of an useful signal.
For this reason, to accelerate the initial warm-up time when the car is started up with the engine cool, and to maintain the sensor's efficiency if the engine is left inactive for prolonged periods, as well as being heated by the exhaust gas, the oxygen sensor is also heated internally by modulated wave resistance. The sensor output signal depends on the air/fuel λ ratio and its has a **"step-by-step"** trend when the value is **λ = 1**. The amplitude of the sensor's signal is approximately **400 mV**, centred on **450 mV** (see Fig. **4**).

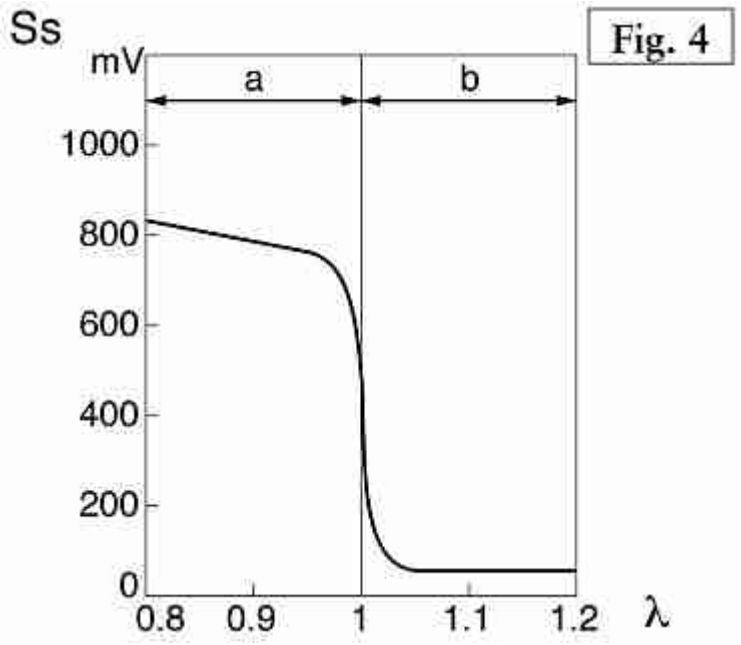


Fig. 4

*Keys to **Fig. 4***
Ss - Sensor signals
λ - Excess Lambda factor
a - Rich mixture
b - Lean mixture

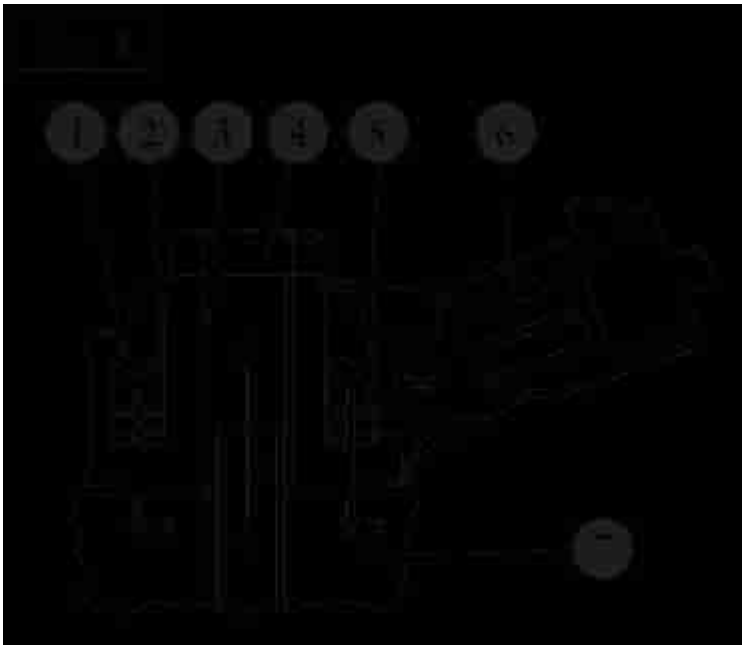
Replacement

- For replacing the oxygen sensor (A 3.12).

C2.07 DETONATION SENSOR

These sensors are fitted on the upper surface of the engine crankcase in a symmetrical position with respect to the transversal centre line. This positioning is determined by the need to detect when detonation starts in an identical way for all the cylinders.

The sensors (**BOSCH KS-1-K**) are piezoelectric type (see **Fig. 1**): when the engine knocks, vibrations of a certain frequency are produced in the crankcase; these are transformed by the sensor into a voltage signal, which is proportional to their intensity.

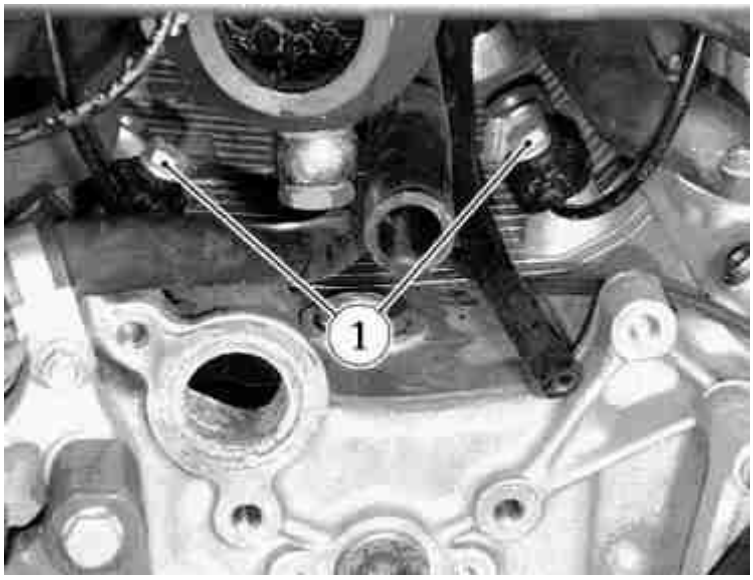


*Keys to **Fig. 1***
1 - Vibrating core with compression force F
2 - Body
3 - Ceramic body
4 - Fastening screws
5 - Contact
6 - Electrical connection
7 - Crankcase
V - Vibrations

This signal is transmitted via a braided cable (to reduce the effects of any electrical interference that may occur) to the ECU, which subsequently operates on the ignition accordingly.

Replacement

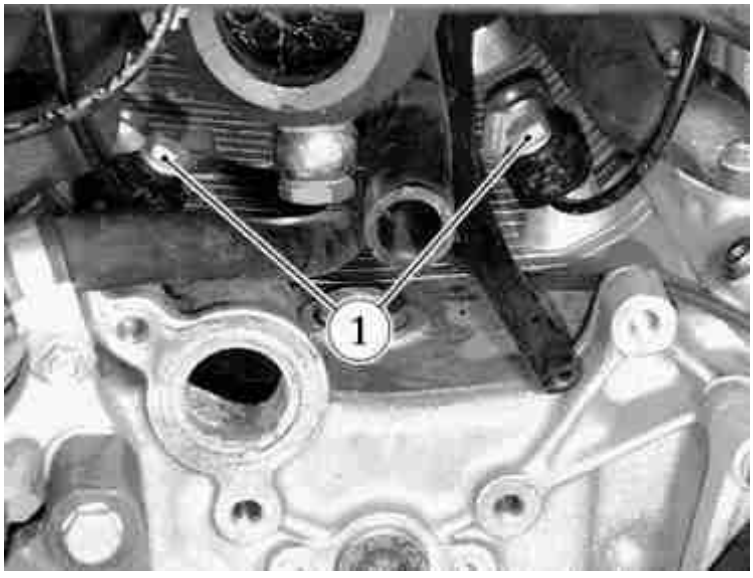
- To gain access to the front sensors, it is necessary to work from the engine inspection hatch (M 3.05).
- Remove the entire water pump (B 5.02).
- Detach the white connector from the injection wiring harness.
- Remove the fastening screw **(1)** and the crankcase sensor.



- To gain access to the rear detonation sensors, it is advisable to detach the lines which may get in the way during the operation and remove the oil filter cartridge (A 3.01).
- Detach the white connector from the injection harness.
- Unscrew and remove the sensor from the crankcase.

Re-Assembly Note

- Place the sensor in direct contact with the crankcase.
- Position the sensors with the cable outlet turned towards the front and rear ends of the engine and tighten the screws **(1)** to a torque of **20 Nm**.



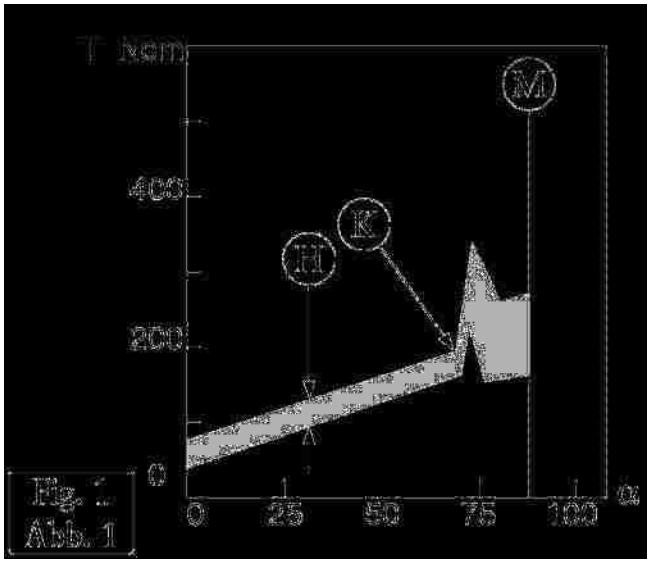
- Connect the harness and fix it in place on the injection cable with a tear clamp.

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

- Reassemble the parts removed for the procedure.

C2.08 ACCELERATOR PEDAL POSITION SENSOR

This extremely robust and reliable element is fastened to the accelerator pedal mechanically (H 2.16).
This sensor serves to detect the exact position of the pedal and to transmit this information (via an electrical signal) to the ECU which is informed about the torque required by the user (see **Fig. 1**).



*Keys to **Fig. 1***
T - Torque applied to the sensor's arm (example)
α - Rotation angle
H - Hysteresis
K - Kickdown
M - Mechanical stop

The sensor is an angular type sensor (**BOSCH PWG 3**) and it is fitted with two potentiometers (for improved operational safety), each one with its own electrical circuit to identify the signal (see **Fig. 2**).

*Keys to **Fig. 2***
P1-P2 - Potentiometers

If during this redundancy check, the ECU identifies a malfunction, it signals the error and sets the system into a recovery state: maximum operation speed of **1500 revsmin**.

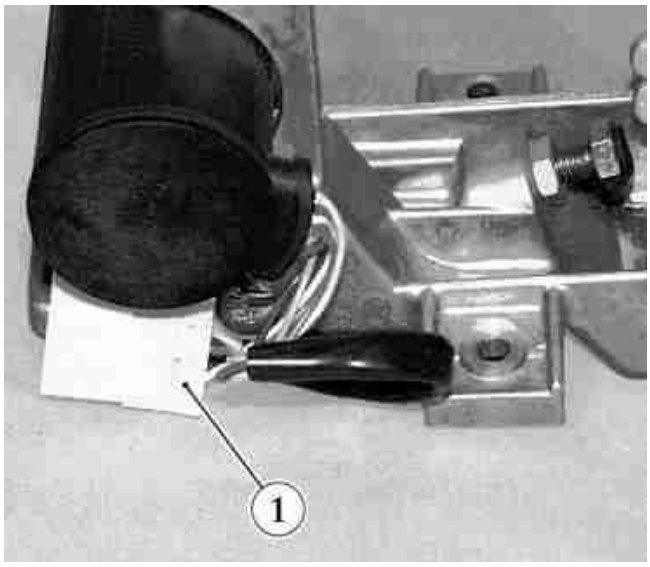
Reference values

Potentiometer (P1)
- Resting position = **0,65÷0,85 V**
- Max position. = **3,7÷3,9 V**

Potentiometer (P2)
- Resting position = **0,33÷0,42 V**
- Max position. = **1,85÷1,95 V**

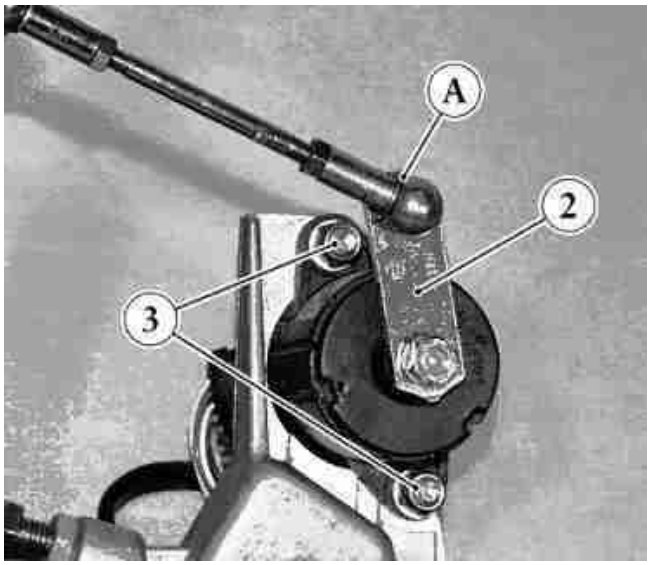
Disassembly

- Remove the pedal unit (H 2.16).
- Detach the sensor connector **(1)** from the fastening bracket on the pedal support.



For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

- Detach the ball joint from the control lever **(2)**, sliding off the clip **(A)**.
- Unscrew the nuts **(3)** and remove the sensor from the support.

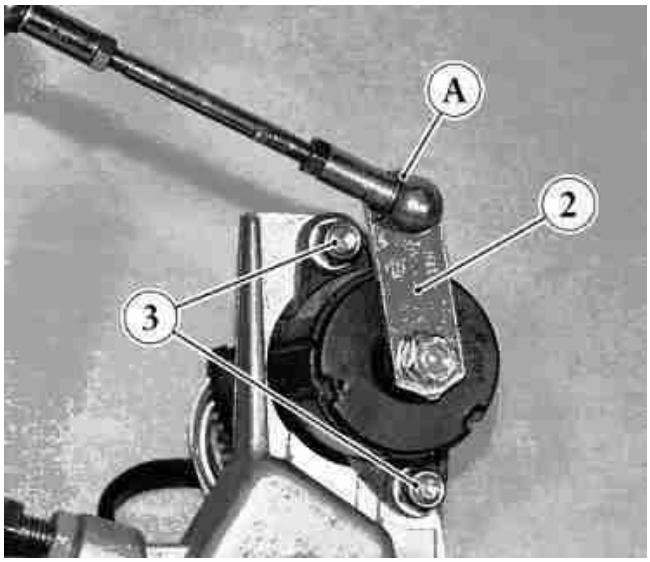


NOTES

To adjust the pedal stroke limit, (H 2.16).

Re-Assembly Notes

- Lubricate the spherical head on the control lever **(2)**.
- Tighten the nuts **(3)** on the support to a torque of **8,7 Nm**.

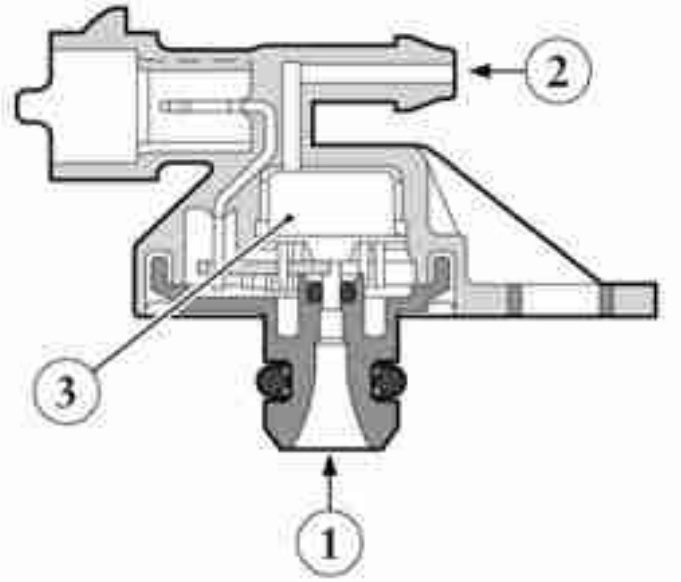


C2.09 TANK PRESSURE SENSOR AND VAPOUR INTERCEPTION VALVE (Euro 3 - US version)

The system carries out the tightness diagnosis for the fuel tanks and the anti-evaporation system using these components.

Pressure sensor (A)

This sensor, mounted in the fuel tank, is a differential sensor which detects the difference between the pressure in the two inlets used.

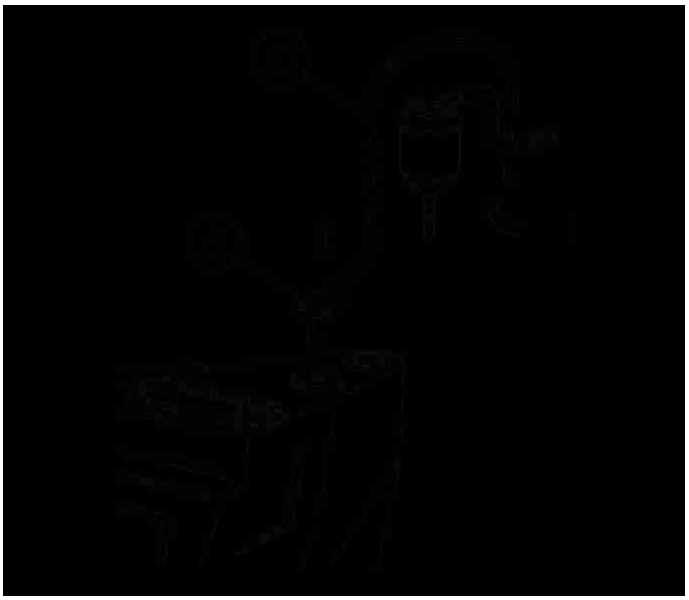


The inlet **(1)** is located inside the fuel tank, while the inlet **(2)** draws on the room pressure: the two inlets converge in a single central chamber, where there is a piezo-resistive element **(3)** which generates an electric signal that is proportional to the pressure difference at its two ends.
The tightness diagnosis for the anti-evaporation system is carried out by the ECU autonomously, by activating the tank-lock valve and the fuel pump accordingly, in order to create a vacuum inside the tank. By observing the time trend of the signal transmitted by the sensor, the ECU can identify any leakage of up to **1mm** column of water.

NOTES FOR REPLACING THE SENSOR
- Fix the sensor to the tank, tightening the fastening screws to a torque of **6 Nm**.
- It is very important that no impurities enter via the inlet **(2)**.

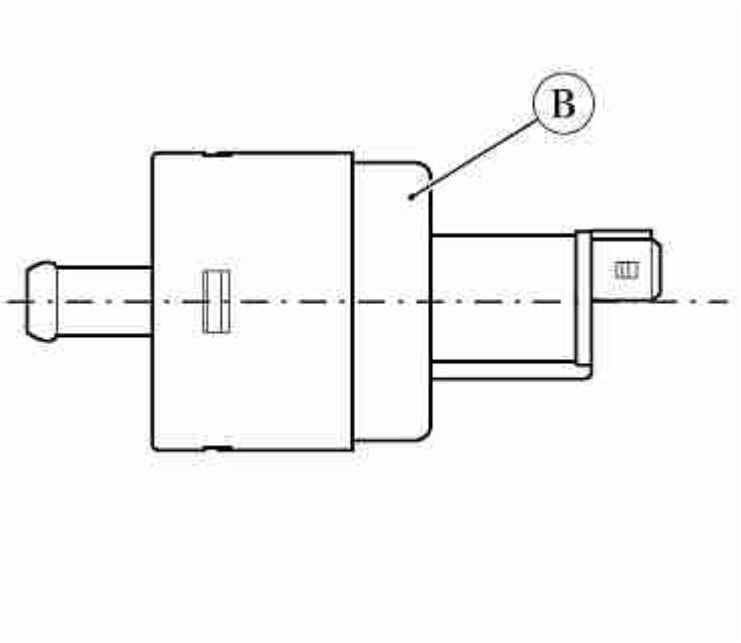
IMPORTANT

*The pipe **(C)** used to detect the external pressure must be located in a position protected from possible impurities or water infiltrations.*



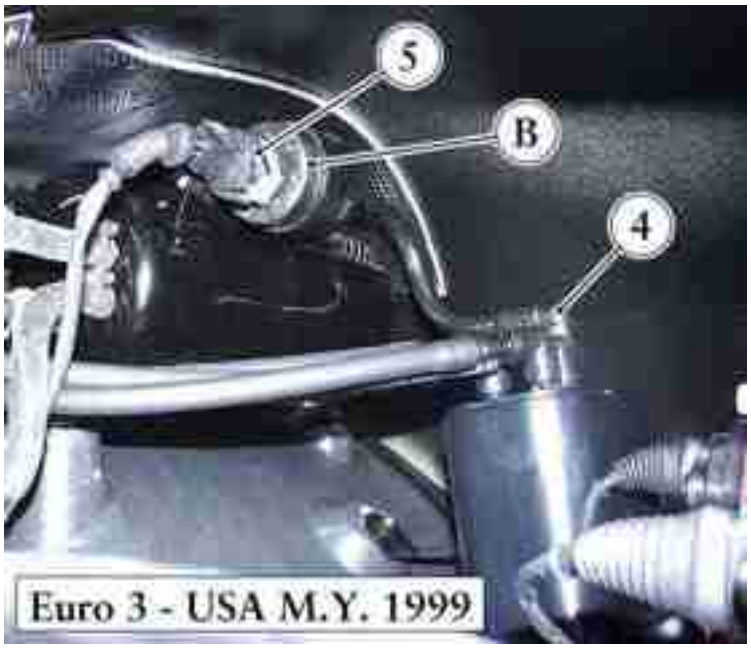
Vapour interception valve (B)

-

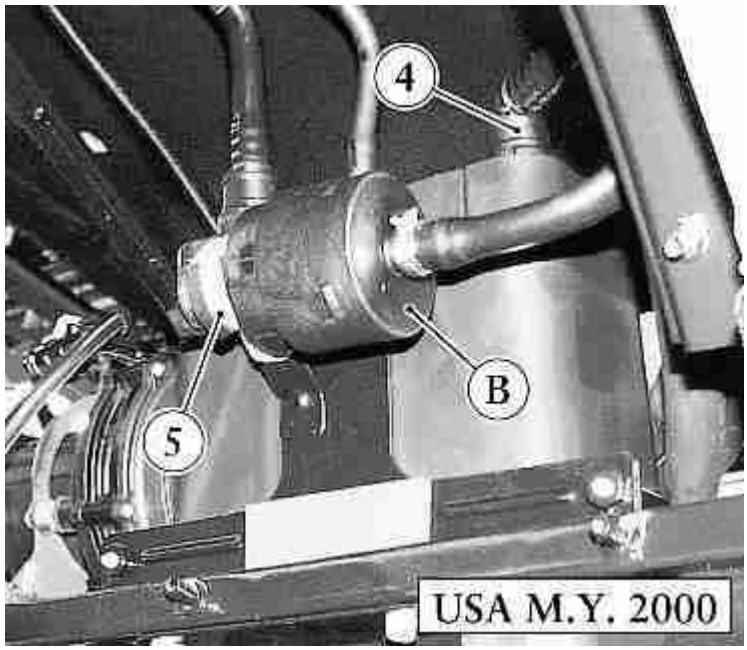


-

This is connected to the active carbon filter through a flexible tube.
In the **Euro 3** - **US M.Y. 1999** version it is fastened to the vacuum tank, housed on the right-hand side of the engine compartment.



In the **US M.Y. 2000** version it is fastened to the active carbon filter's support bracket, fitted on the right-hand side of the engine compartment.



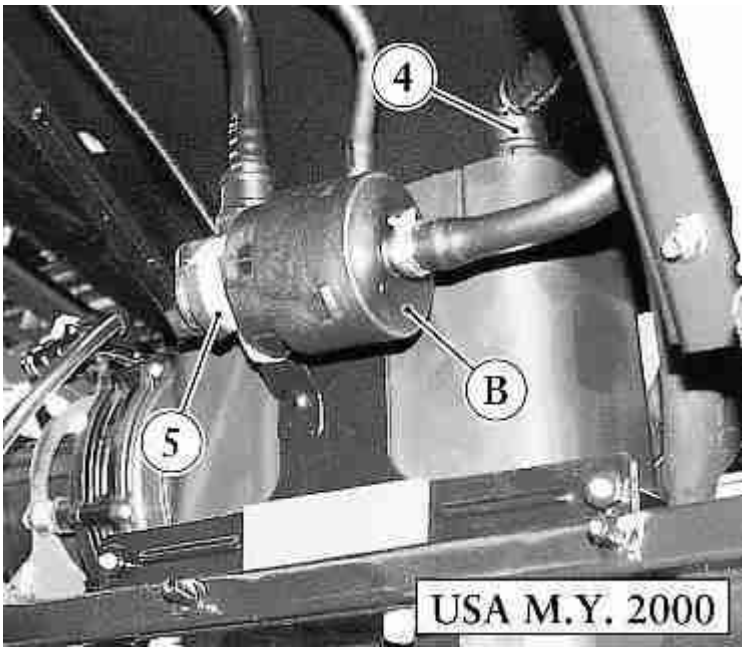
In normal conditions the valve is open and allows the intake of external air into the filter.
With the car at a standstill, with the engine running at a minimum, the ECU controls the valve to effect a diagnosis on the system's tightness, at prescribed intervals.

NOTES FOR REPLACEMENT
- Remove the right-hand side protection of the engine compartment (M 2.13), for the **Euro 3** - **US M.Y. 1999** version, or the lower edge of the rear left-hand side wheelhouse (M 2.05), for the **US M.Y. 2000** version.
- Detach the connection from the system.

For connection to the system, see Tables **L** and **T** - ELECTRICAL SYSTEM.
- Detach the Victaulic coupling **(4)** from the carbon filter.
- Release the valve from the support bracket **(5)**.
- Remove the valve together with the pipe.

5
B
4
Euro 3 - USA M.Y. 1999

-


4
B
5
USA M.Y. 2000

C3.01 FUEL PUMP

The pump (**BOSCH EKP 13.5**) is a suction pump with rollers, and it is activated by a permanent magnet electric motor (see Fig. **1**).

*Keys to **Fig. 1***

- Inlet plate
2 - Impeller
3 - Outlet plate
4 - Spring
5 - Magnets
6 - Engine body
7 - Bearing support

8 - External support
9 - Terminal cover
a - Intake side
b - Rotating disk
c - Roller
d - Roller track
e - Pressurised outlet side

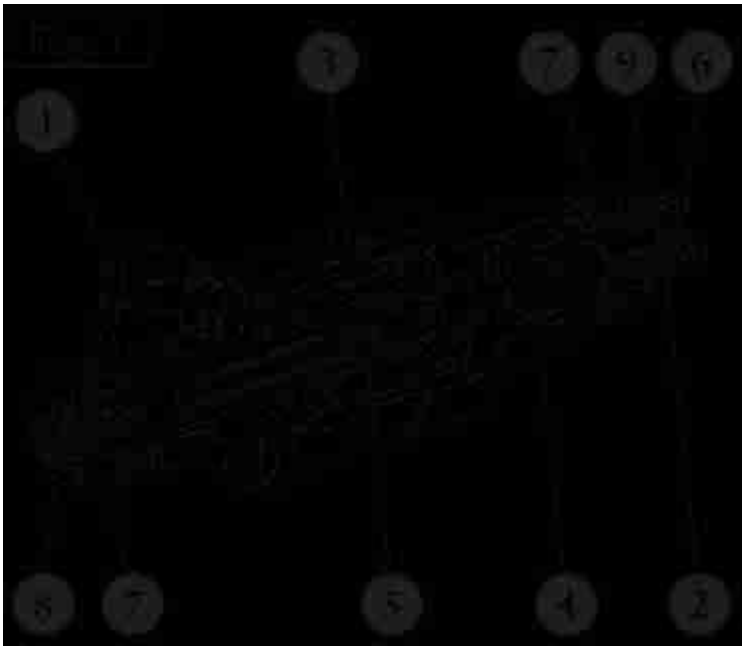
There is one located in each tank, inside a special casing **(A)** which also contains the fuel filter, at the pump inlet. On the lower end there is a meshed suction screen **(B)**.

The pump control motor is activated when the speed of the engine/motor exceeds **40 revs/min** and it remains constantly active when the engine/motor is started.
If the injection is activated when the engine is not running, a safety circuit locks the fuel supply pump.
The pump can function with low power supply voltages and at low temperatures, which makes it particularly efficient for starting up when the engine is cool.
The pump has a pressure relief valve which short-circuits the delivery to the intake chamber when the pressure exceeds **8 bar**, as in the case of clogging. Furthermore, it is fitted with a check valve which opens at a pressure of **1,5 bar** and closes with the pump stopped, to keep the operating pressure at approximately **3,6 bar**.

IMPORTANT
The pump is connected to the tank flange cover by means of pipes and electrical cables which must never be disconnected.
*To replace the pump (*B 6.03*).*

C3.02 ELECTRO-INJECTORS

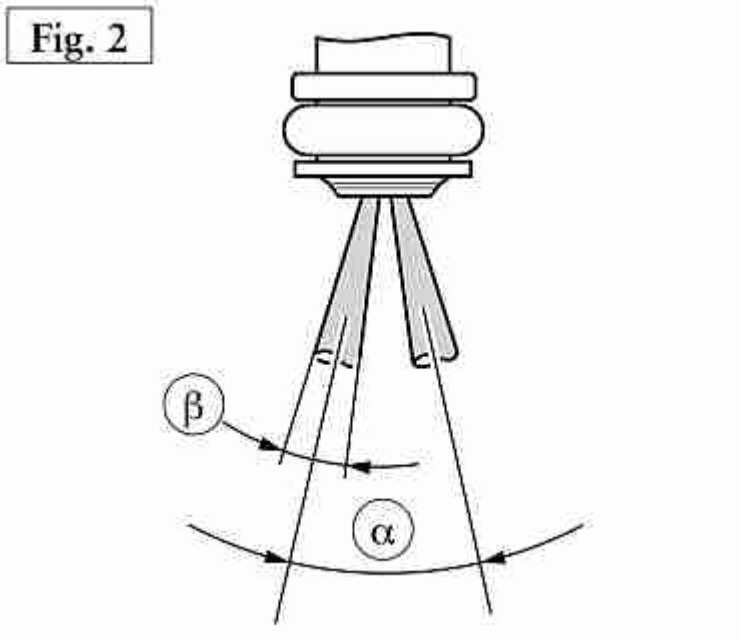
The electro-injectors (**BOSCH EV 6-E**) are controlled directly by the ECU and they can be fully open or fully closed.
The command sent by the ECU is sequential and timed, that is the electro-injectors are activated according to the engine combustion order (sequential). The moment opening begins and its duration depend on the timing of the each cylinder (timed).
The electro-injector is composed of a body (see **Fig. 1**) and a needle nozzle with a magnetic inductor placed over it.



*Keys to **Fig. 1***
1 - Injector body
2 - Needle nozzle
3 - Magnetic winding
4 - Needle guide
5 - Helical spring
6 - Nozzle pin
7 - O rings
8 - Meshed filter
9 - Heat resistant bushing

The injector body houses a magnetic winding and the guide for the nozzle needle.
When the magnetic winding is disconnected from the power supply, the helical spring presses the nozzle needle onto the seal seat next to the injector exhaust.
As soon as the helical winding has been triggered, the nozzle needle moves away from its seating by approximately **0,1 mm,** allowing the fuel to be injected through a gauged hole.
On the front end of the needle there is sharpened nozzle pin which atomises the fuel finely and generates a double spray (see **Fig. 2**) which makes the distribution of the fuel in the combustion chamber more uniform

Fig. 2



*Keys to **Fig. 2***
α - Spraying angle (50% of the fuel injected is included in this angle)
β - Spraying angle (70 of the fuel injected is included in this angle)

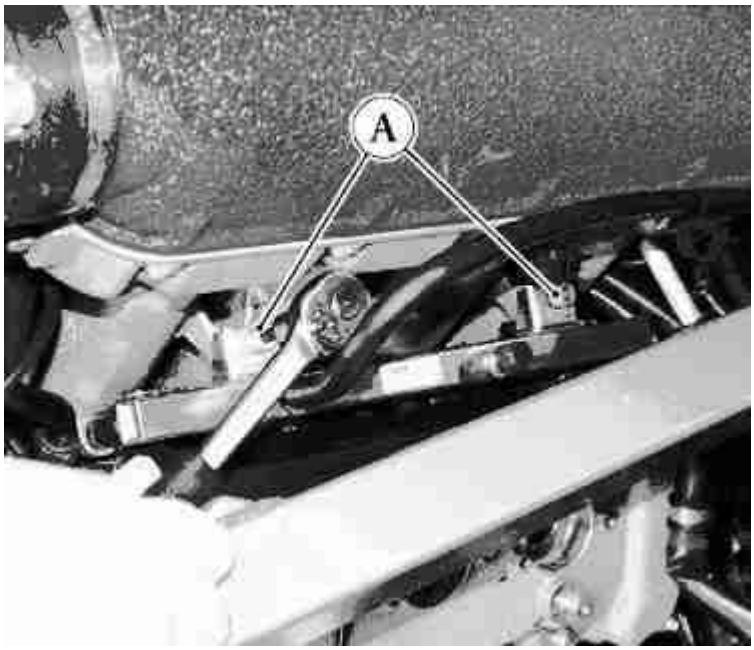
On the external body there are two O-rings which seal the rail and the intake manifold, and a meshed filter to retain the fuel impurities.
The end of the electro-injector is also fitted with a teflon thermal protective bushing in order to prevent the fuel evaporation and the consequent crystallisation of the dry residue on the needle. That is why the said sleeve must never be removed when the electro-injector is being assembled.
- The electro-injector triggering and drop times range between **1** and **1,5 ms.**

Replacement

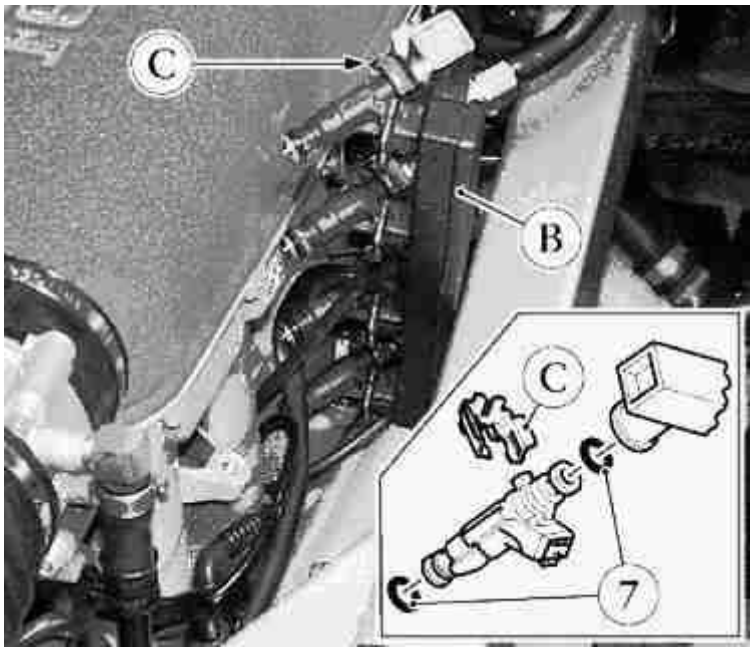
CAUTION

If it is necessary to disconnect any of the fuel supply system's pipelines, remember that they may be pressurised, and so there is a risk that the worker may be sprayed with fuel. Take special care then when carrying out this operation and keep any naked flames clear of the work area.

- Remove the injector rail fastening screws **(A)**.



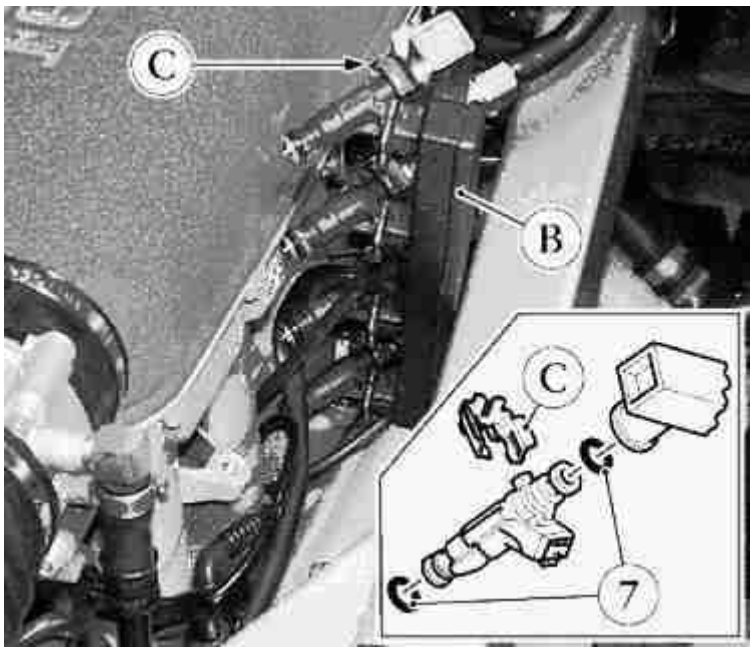
- Remove the rail, taking care not to let the injector ends hit any parts of the vehicle.
- Plug the injector seat on the manifold to prevent foreign bodies entering the combustion chamber.
- Remove the injector from the connector-holder support **(B)** and remove it from the rail, sliding off the clamp **(C)**.



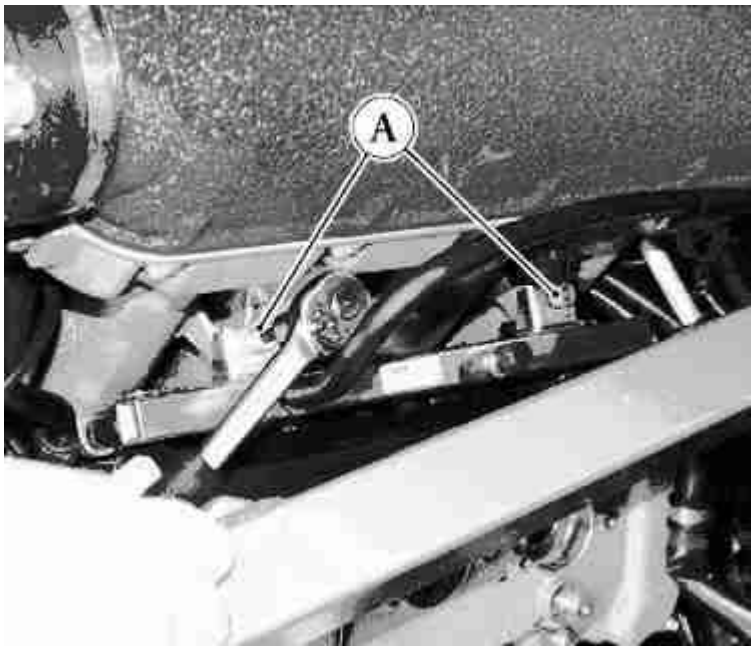
Reassembly

- If the original injectors are to be remounted, make sure that the O rings **(7)** are in a good condition. Lubricate them, using products that do not contain silicon to avoid damaging the oxygen sensors.
- Install the injector on the rail, holding it in place with the special clamp **(C** and mount the connector-holder

support **(B)**.



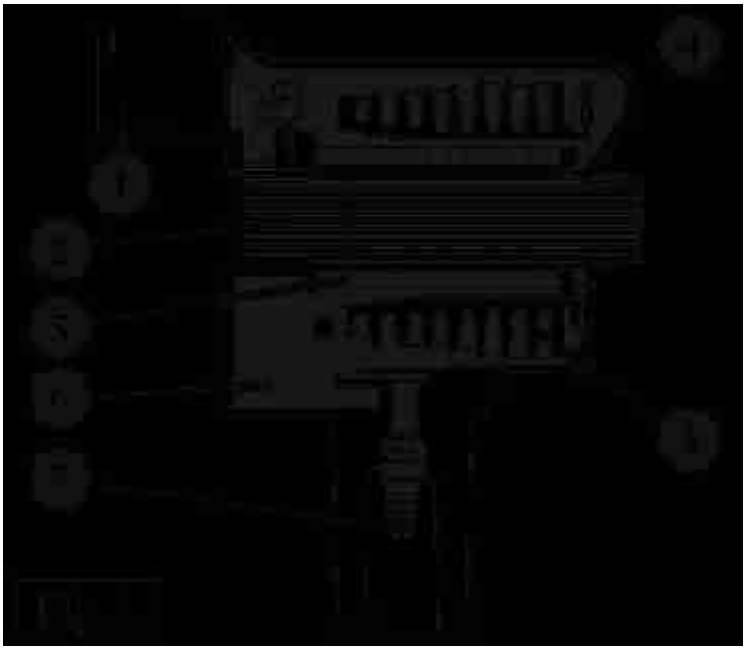
- Insert the unit just assembled in the manifold seatings and tighten the screws **(A)** to a **25 Nm** torque.



IMPORTANT
After replacing the injectors it is necessary to carry out a self-learning cycle (C 6.05).

C3.03 COIL

The car is endowed with a static inductive exhaust ignition.
The coil used is a magnetic closed circuit one. The windings are contained in a plastic body, immersed in epoxy resin and laid out one on top of the other, around a central iron core (see **Fig. 1**).



*Keys to **Fig. 1***
1 - Primary connector
2 - Core
3 - Secondary winding
4 - Body
5 - Primary winding
6 - Plastic compound
7 - Terminal

Each coil is connected to the respective spark plug by means of an extension cable made of a silicon-type material with high dielectric strength.

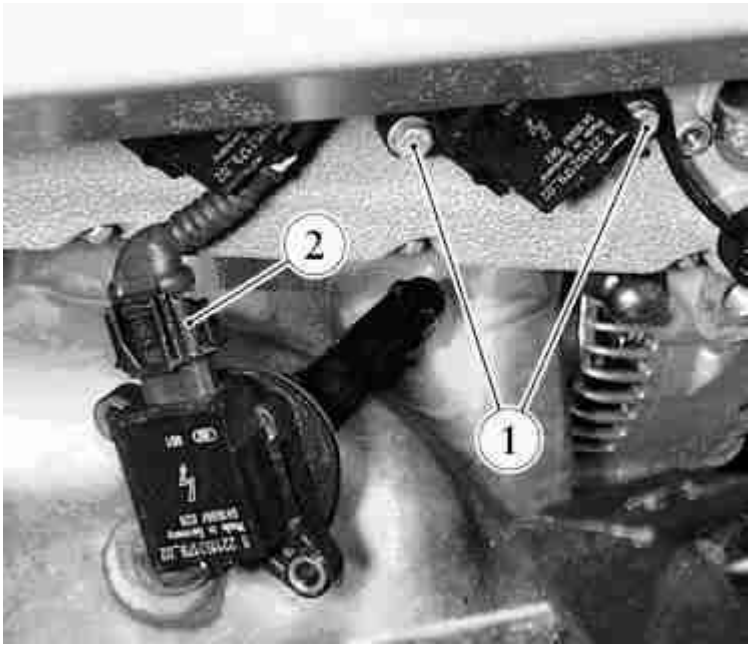
IMPORTANT
Avoid disconnecting the coil for long periods of time, as it might not be possible to obtain a good contact when re-fitting it.

The single coil has the advantage of generating a single spark, unlike the previous models in which the coil controlled two spark plugs at the same time and one of the two sparks generated was dispersed at the end of the exhaust stroke.
The power modules which transmit the control signal to the coils are located inside the Motronic ECU which, depending on the peculiar values stored in the memory, calculates the coil opening and closing angles, in accordance with the operating conditions (speed, battery voltage etc...).

Replacement

- Remove the two fastening screws **(1)**.
- Slide off the coil and detach the connector **(2)** from the injection wiring harness.

For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.



IMPORTANT

After replacing the coil it is necessary to carry out a self-learning cycle (C 6.05).

C3.04 TIMING VARIATOR CONTROL SOLENOID VALVE

Mounted on the front part of each head, this valve is governed by the ECU and hydraulically controls the timing variator, on the exhaust side of the camshaft.
The solenoid valve is controlled by the timing adjusting ECU, in accordance with the thresholds related to the engine revolutions and load stored in the memory.

Activation threshold

Active low → variator actuated by **20°** (exhaust closing delay)
From **1000** to **2920 rpm** → NOT ACTUATED
From **2920** to **8600 rpm** loaded **>35%** → ACTUATED

Replacement

- To gain access to the solenoid valve, it is necessary to open the engine inspection lid (_____).
- To insert the disassembling tool into the solenoid valve for bank **1-4**, it is necessary to remove the hydraulic steering pump (E 2.01)) while, for the solenoid valve for bank **5-8**, it is necessary to remove the water pump as well (B 5.02).
- Detach the blue solenoid valve connector from the injection wiring harness of the respective bank.
- Insert the dismounting tool **AV 3058** and remove it from the head.

- Plug the seat to prevent foreign bodies entering the head channels.
- When re-fitting the valve, apply **AREXONS 4740 SYSTEM 56 A38** sealant on the thread and tighten the solenoid valve to a **43 Nm** torque, using the disassembling tool.
- Reassemble all the parts removed for the procedure.

IMPORTANT
After replacing the timing variator control solenoid valve it is necessary to carry out a self-learning cycle (C 6.05).

For connection to the system, see Table **S** - ELECTRICAL SYSTEM.

C3.05 EXHAUST BY-PASS SOLENOID VALVE

The solenoid valves **(A)** are installed on the frame structures, in the engine compartment area, behind the rear lights, one per side.

The ECU of each bank controls the solenoid valve which determines the opening of the by-pass throttle on the exhaust terminal. The by-pass valve is vacuum-operated (B 7.04 and B 7.07).
The opening of the solenoid valve depends on the rpm and on the gear engaged, but only when the vehicle is in a full power condition. This system allows the engine power to be increased by an adjustment of the discharge counter-pressure.

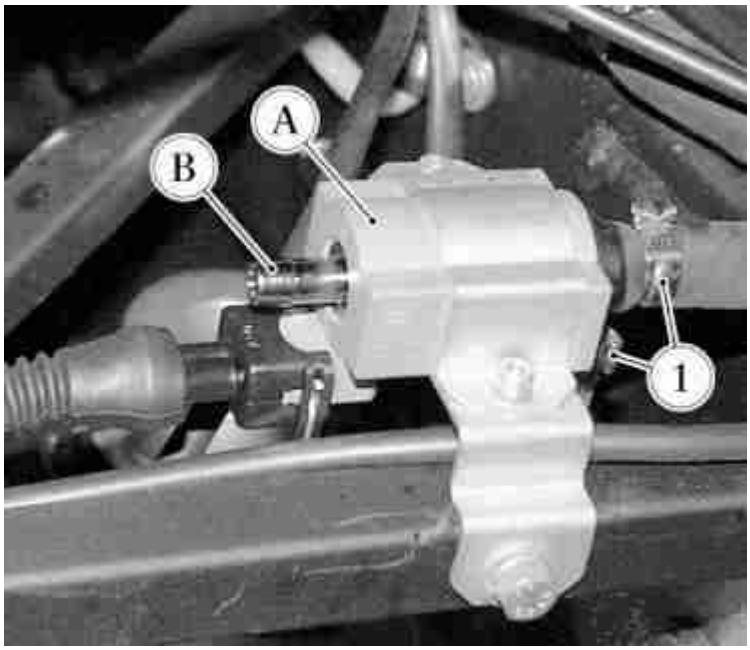
Activation thresholds

Active low → by-pass closed
- **EU** version
  From **1000** to **2920 rpm** → CLOSED
  From **2920** to **8600 rpm** loaded **>70% 1**,**2**,**3**,**4**,**5**,**6** gear → OPEN

- **USA** version
  From **1000** to **2920 rpm** → CLOSED
  From **2920** to **8600 rpm** loaded **>70% 1**,**3**,**4**,**5**,**6** gear → OPEN

Replacement

- Detach the valve connection pipe and the pipe connected to the vacuum tank, by opening the clamps **(1)**.



- Detach the injection wiring harness connector and remove the solenoid valve from the fastening bracket.
- When re-fitting the valve in its original position, always leave the union **(B)** above the connector free.

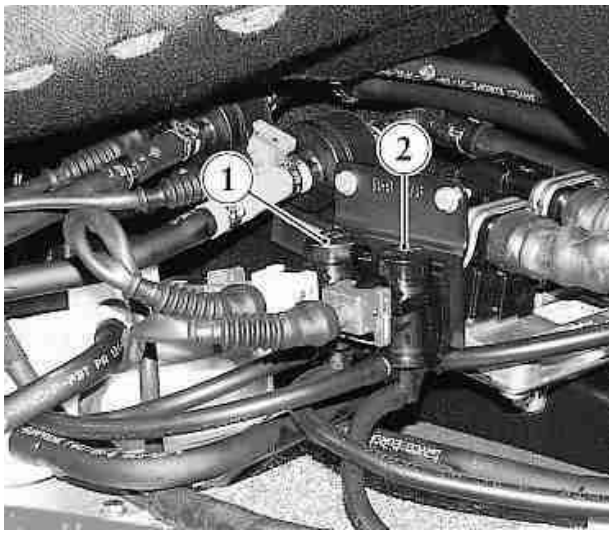
For connection to the system, see Table **S** and **T** - ELECTRICAL SYSTEM.

IMPORTANT

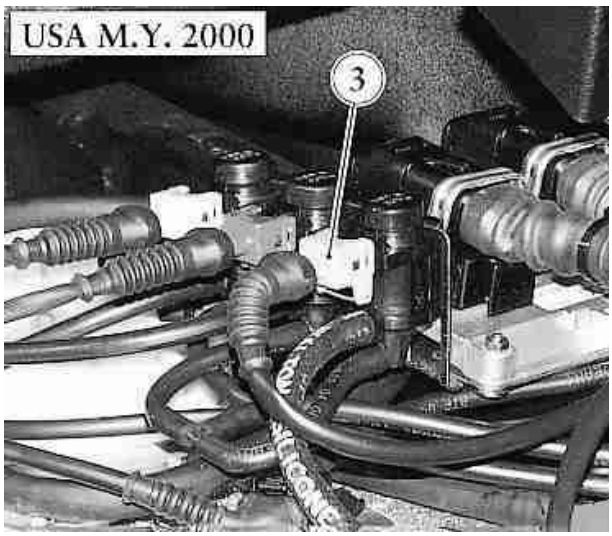
After replacing the by-pass solenoid valve, it is necessary to carry out a self-learning cycle (C 6.05).

C3.06 PNEUMATIC ACTUATION SYSTEM SOLENOID VALVES

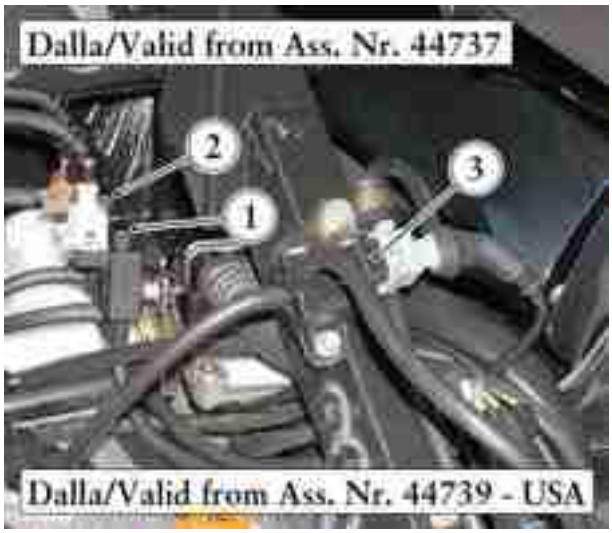
These are attached to the support bracket of the MOTRONIC ECU, over the right-hand fuel tank.
The solenoid valve **(1)** controls the pneumatic capsule of the intake manifold cover, determining the opening of the flow rate balance throttle valve.
The solenoid valve **(2)** controls the actuator located under the intake manifold, determining the opening of the throttles on the fuel supply lines.



The solenoid valve **(3)**, available in the **US** version, controls the pneumatic valves which enable the injection of air into the exhaust manifolds.



Vehicles **FROM Ass. No. 44737** (**NOT** for **USA**) and **FROM Ass. No. 44739** (**Valid** for **USA**), are equipped with new solenoid valves featuring double-screw fastening supports. This modification also concerns the support plate, which must be replaced if the new solenoid valves are fitted.
With this new modification, the solenoid valve **(3)**, available only starting from the **USA M.Y. 2000** version, is no longer positioned next to the other valves, but it is secured on the chassis RH pillar, by means of a special support plate.



The actuators are vacuum-operated and are part of the pneumatic actuating system (B 7.04).
The solenoid valves are controlled by the ECU by means of an **ON/OFF** control, in accordance with the engine conditions of use.
The diagnosis system can detect a short circuit (sc) or open circuit (oc) in the solenoid valve.

Activation thresholds

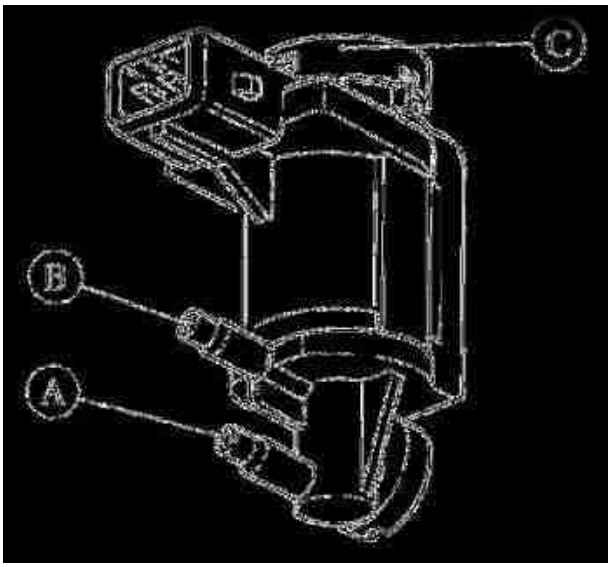
(1) COMPENSATION
Active low → throttle compensation valve closed
From **1000** to **2680 rpm** → CLOSED
From **2680** to **3960 rpm** loaded **>56%** → OPEN
From **3960** to **5080 rpm** loaded **>6o%** → CLOSED
From **5080** to **6240 rpm** loaded **>60%** → OPEN
From **6240** to **8600 rpm** loaded **>60%** → CLOSED

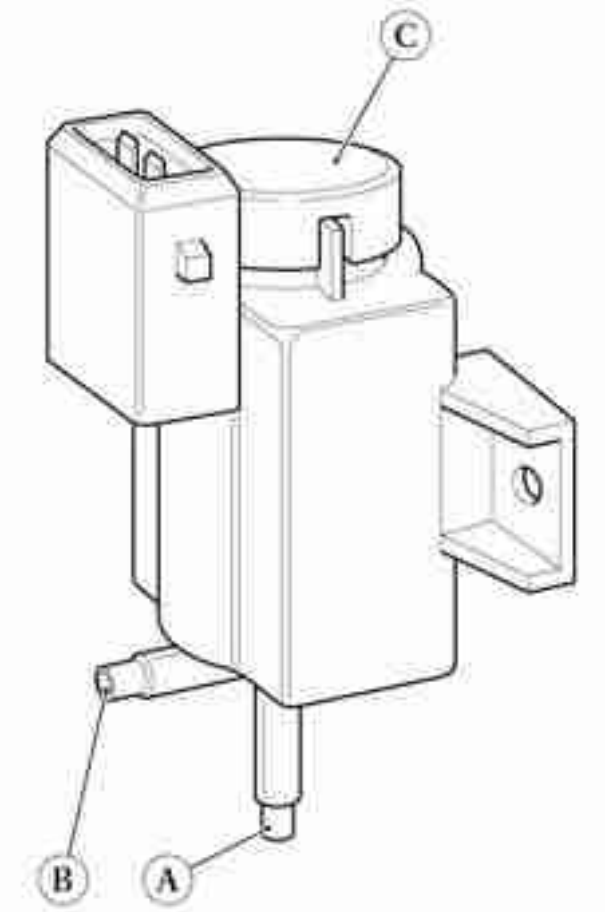
(2) MODULAR INTAKE
Actve low → short manifolds
Da **1000** a **5520 rpm** → LONG MANIFOLDS
Da **5520** a **8600 rpm** carico **>46%** → SHORT MANIFOLDS

(2) MODULAR INTAKE
- **Open:** from **5500 rpm** to **8500 rpm**

(3) SECONDARY AIR INJECTION
The secondary air pump and solenoid valve are controlled after the engine is running and when the coolant fluid is **–10°<T°mot<40°**.
This function is active for about **80** seconds, it is then disenabled for about **60** seconds and is active once again for a further **10** seconds. The tightness of the pneumatic valves is tested during the last **10** seconds. For the entire length of the ON-OFF-ON function, the Lambda function is disenabled (oxygen sensor **OFF**).

Each solenoid valve is fitted with:
A - a vacuum plug (connection to the storage tank);
B - a union for connection to actuators
C - an atmospheric pressure plug.

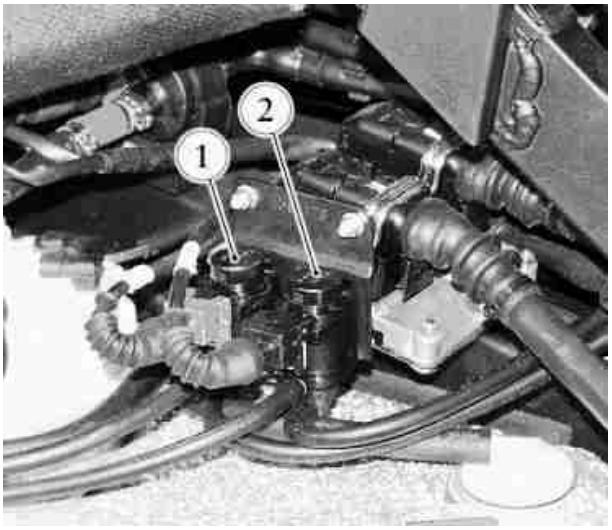


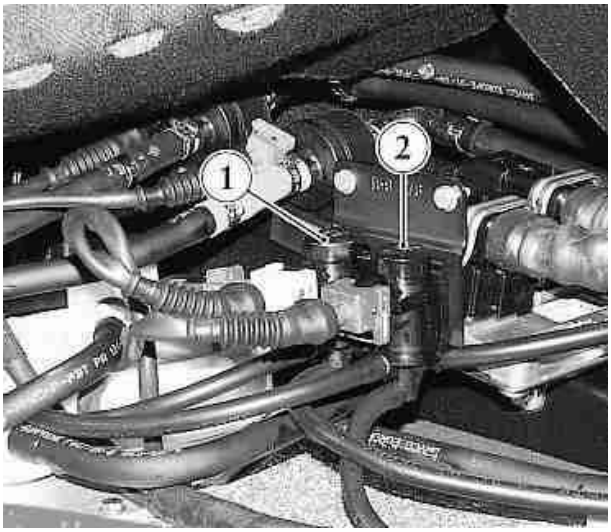


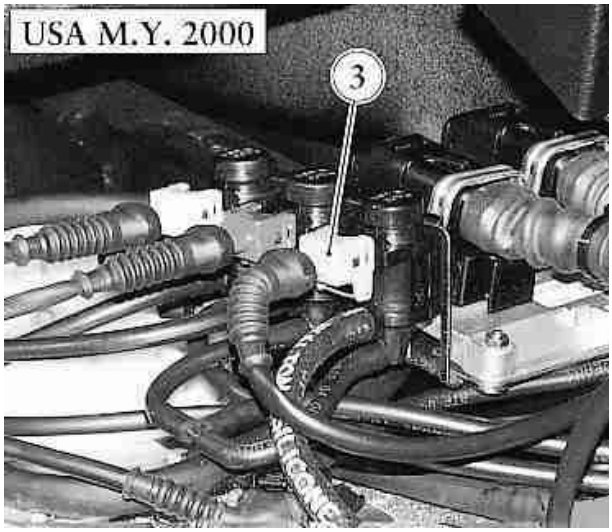
Replacement

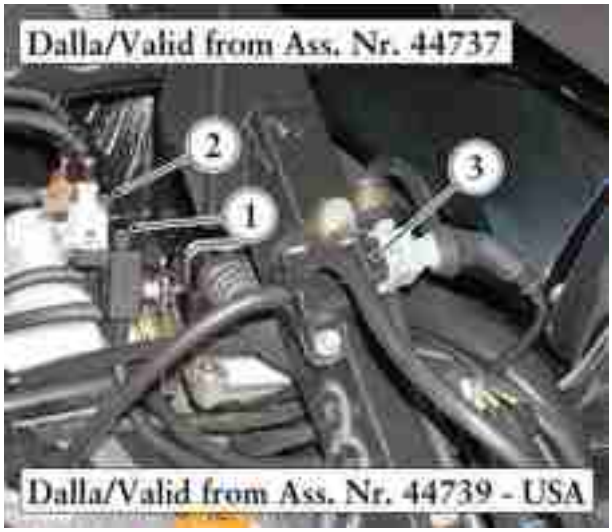
- Detach the connector from the injection wiring harness and the connecting pipes.
- Slide the solenoid valve off the support bracket.
- When re-fitting the valve, the WHITE connector (BLUE in the first cars) must be linked to the solenoid valve **(1)**, which controls the pneumatic capsule, and the BROWN connector (BLACK in the first cars), to the other solenoid valve **(2)**.

In the **US** version, the GREY connector must be connected to the solenoid valve **(3)** which controls the secondary air valve.









For connection to the system, see Table **S** - ELECTRICAL SYSTEM.

IMPORTANT

After replacing the solenoid valves, it is necessary to carry out a self-learning cycle (C 6.05)

C3.07 CHECK ENGINE" OR “ENGINE CONTROL SYSTEM FAULTS” AND "SLOW-DOWN" WARNING LIGHTS

"Check Engine" or “Engine Control System Faults” warning light and Ignition Strategy

This warning light (**amber** colour) is located on the instrument panel (H 1.02) and indicates the errors found on all of the sensors/actuators and that can be identified by means of the **SD-2** tester.

-

The engine ECU has a self testing system which recognises all the errors relating to the engine management sensors and actuators.

When a malfunction is detected, the ECU stores the error and the engine data related to the moment at which the error was identified.

The warning light starts to flash as soon as any misfiring errors are recognised or remains permamently lit to indicate a malfunction in the emission control system and in the injection/ignition system.

"Slow-Down" Warning Light

The thermocouple signal is linearised by an ECU and transmitted to the ECU which turns on the **SLOW-DOWN** ideogram (colour **red**), on the instrument panel multifunction display (H 1.03), and ensures the catalytic converter is protected in the following way.

If the light is flashing, the temperature of the catalytic converter is too high, i.e. it has reached a level of **$960^{\pm 15}$ °C**.

In this case, slow down immediately and act as necessary to remove the cause of the malfunction.

If the light is lit constantly, the temperature of the catalytic converter has reached a level of **$970^{\pm 15}$ °C** and it could rise still further, greatly increasing the risk of damage.

In this case, stop the car immediately and proceed as necessary to remove the cause of the malfunction.

If the temperature reaches **$980^{\pm 15}$ °C** for more than half a second, the ECU will cut off the fuel supply to the injectors.

C3.08 RELAYS AND HARNESS

Relays

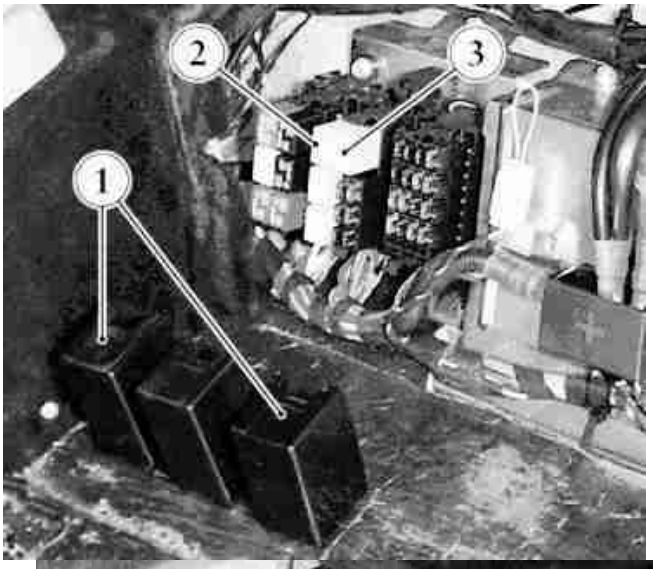
The injection/ignition system of each bank uses standard motor vehicle relays to control the power supply to the ECU, the electro-injectors and the electric fuel pump.

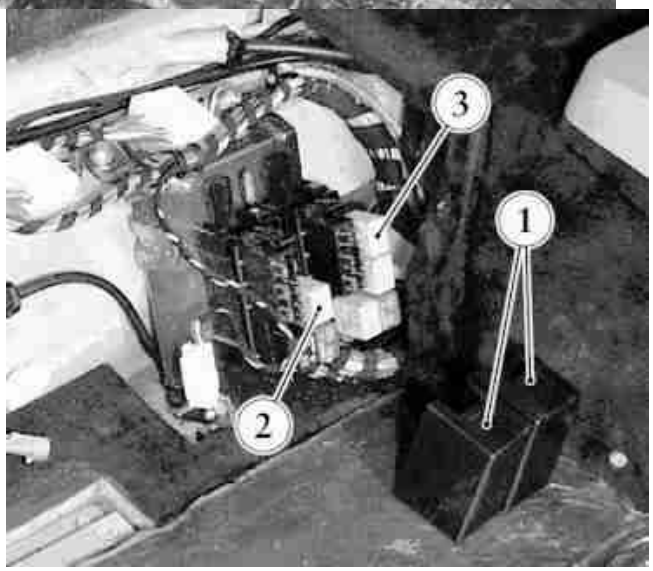
The control relays of the right-hand Motronic (bank 1-4) are located in the two relay and fuse-holding boxes, behind the passenger's seat. The left-hand Motronic ones (bank 5-8), are located in the box behind the driver's seat.

- To gain access to the boxes, first remove the lower ECU covering (M 3.04).
- Once the cover **(1)**, bearing the diagram for the relays and fuses contained in the box has been removed, replace the faulty part.

The relay **(2)** supplies the power for the sensors/actuators as well as the reference voltage (battery voltage) to the ECU.

The relay **(3)** supplies the fuel pump and the oxygen sensor heating.





To follow the route of the cables in order to identify the position of the connectors linking the systems' devices, see Section - ELECTRICAL SYSTEM.

Harness

The injection/ignition system wiring harness is composed of a specific bundle of cables, fitted with connectors

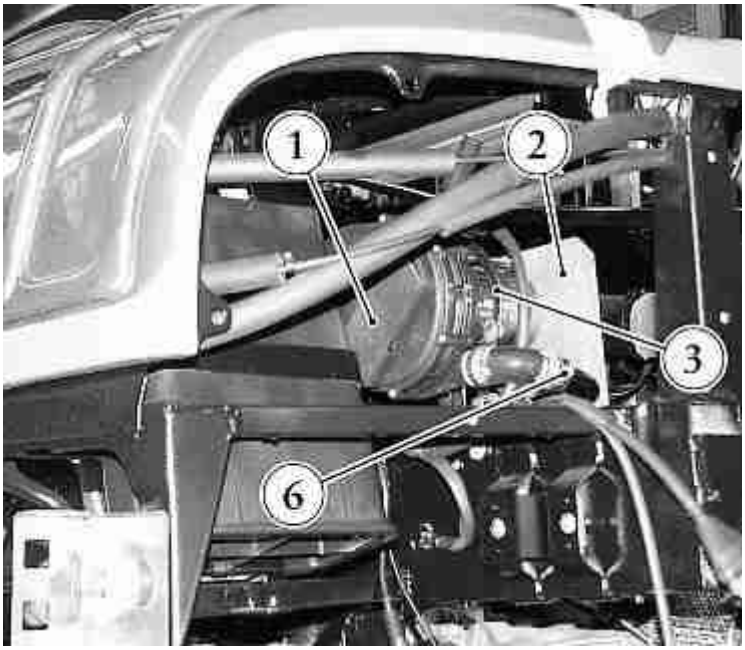
of various types and colours, and it has reduced section insulating material (see Section - ELECTRICAL SYSTEM).
L'alimentazione dell'impianto viene prelevata dalla batteria ed i ritorni di massa sono effettuati sul motore.

The system's power is supplied by the battery and the earth returns take place through the engine.

IMPORTANT
Always check that the system components feature a good earth contact with the engine, as the sensor and actuator signals refer to the engine's earth.

C3.09 SECONDARY AIR PUMP (US M.Y. 2000 version)

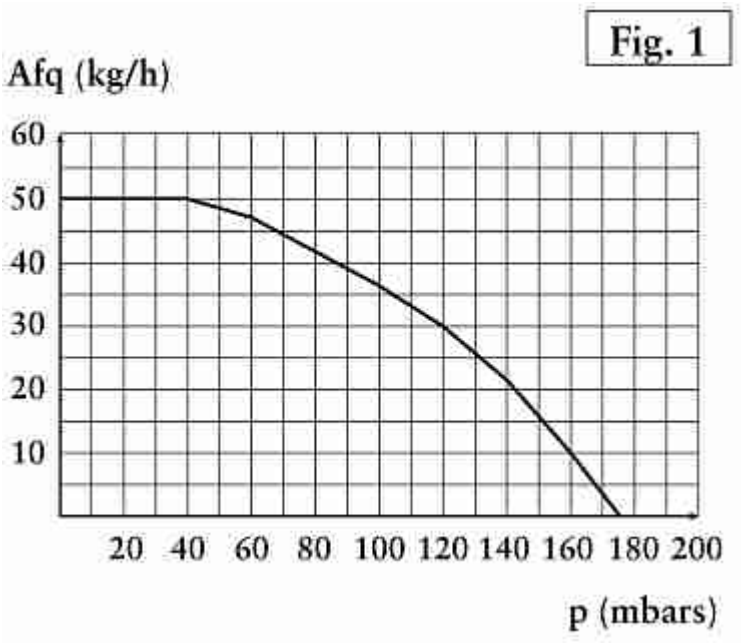
The air pump **(1)** is positioned on the left-hand side of the engine compartment, under the rear mud-guard. It is protected by a shield **(2)** from the heat produced by the exhaust silencer fastened to the pump bracket support **(3)**.



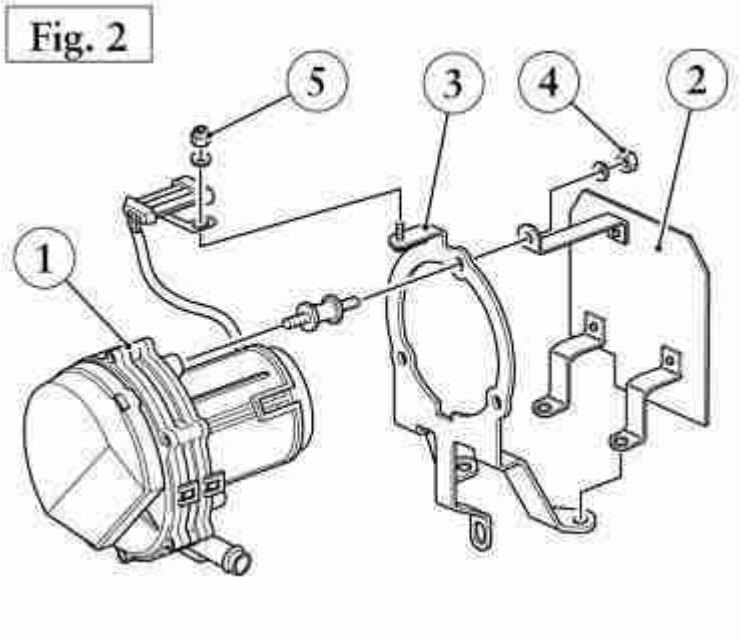
The air drawn-in by a filter incorporated in the pump, is sent, through a series of rigid tubing and pipe couplings, to the secondary air valves (B 7.05).

In certain engine functioning conditions, the comand for the secondary air pump and the solenoid valve is activated by the Motoronic in order to lower the level of harmful emissions into the environment (C 3.06).

The graph for Fig. **1** shows the characteristic curve of the air flow produced by the pump depending on the overpressure.



*Keys for **Fig. 1***
Afq – Quantity of air flow
p - Pressure



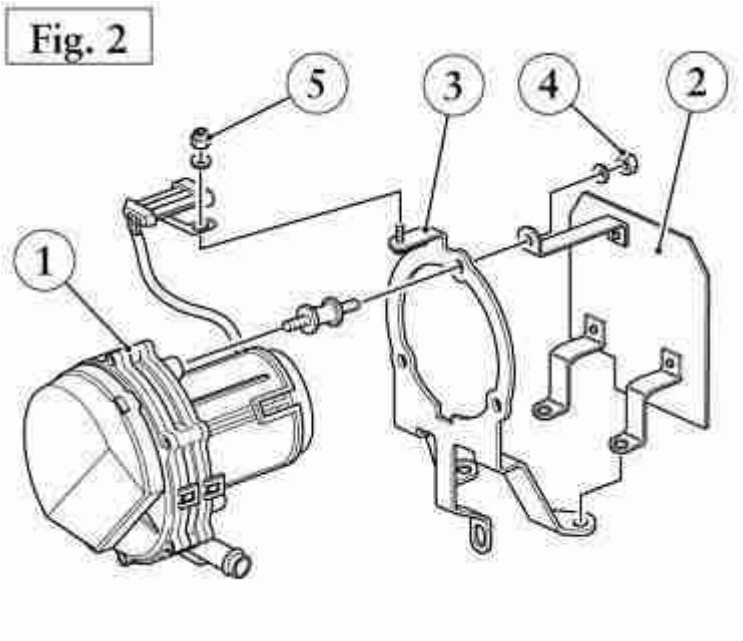
Replacement

-

- To access the air pump it is necessary to remove the lower edge of the rear, left-hand side wheelhouse (M 2.05) as well as the active carbon filter (A 3.10).
- Unscrew the three nuts (**4**, Fig. **2**) fastening the air pump's flexible inserts **(1)** to the support bracket **(3)** and to the anti-heat shield **(2)**.
- Unscrew the nut **(5)** which fastens the pump connector on the support bracket and remove the connection from the engine compartment system.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

Fig. 2



- Loosen the clamp **(6)** on the tubing which connects to the pneumatic valves and separate it from the pump.
- Remove the air pump by detaching it from under the wheelhouse.

C3.10 ANTI-EVAPORATION SOLENOID VALVE

The anti-evaporation or canister purge solenoid valves control the flow of vapours which arrive at the intake manifold (B 6.02).
They are controlled by the MOTRONIC ECU by means of a duty-cycle piloting and are usually closed. In this condition the solenoid valve also effects an anti-return function.

- Frequency control: **30 Hz**
- Absorption current (at 13,5 V): **0.5 A**
- Resistance at 20°C: **26 Ω**
- Working voltage: **9÷16 V**
- Operating temperature: from **–30°C** to **120°C**

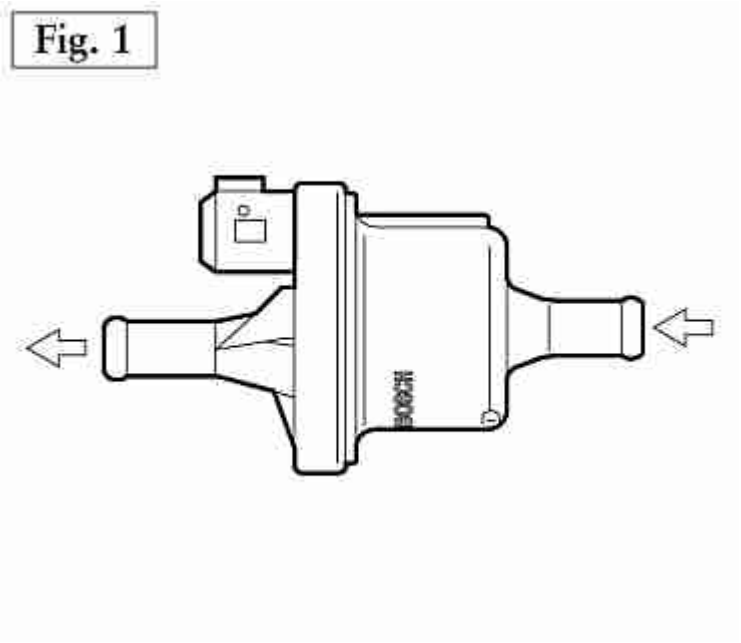
Notes for replacing

-

- Remove the right-hand side protection from the engine compartment (M 2.13)
- Detach the system's connection.
- Remove the solenoid valve **(1)** with flexible terminal strip from the support bracket.
- Loosen the clamps on the connection pipes and remove them from the solenoid valve.

- When reassembling the solenoid valve, position it as in Fig. **1**.

Fig. 1

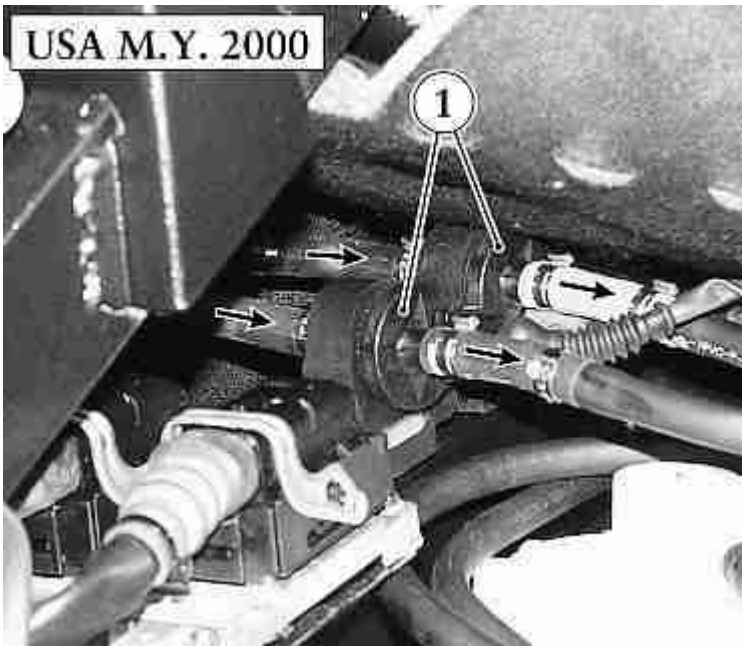


For connection to the system, see Tables **L** and **T** - ELECTRICAL SYSTEM.

Nota per versione USA M.Y. 2000

In this car, the two solenoid valves **(1)** are positioned on the left-hand side of the engine compartment, under the rear mud-guard.

For connection to the system, see Table **T** - ELECTRICAL SYSTEM.



C4.01 AIR CONDITIONING SYSTEM ENGAGED

The ECU needs information concerning the air conditioning system and the compressor electromagnetic joint in order to set the idling speed correctly.

C4.02 CATALYTIC CONVERTER TEMPERATURE

The signal from the thermocouple is linearised by the catalytic converter ECU and transmitted to the ECU which controls the strategy to safeguard the catalytic converters and the "Slow-Down" light.
In this system, therefore, the "Slow-Down" lamp is controlled directly by the ECU (via CAN).

C4.03 CAR SPEED

This signal is used by the ECU in conjunction with the throttle potentiometer signal. This is integrated with the motor-driven throttle body and it serves to distinguish between the conditions of the car when it is stopped from the "released" conditions.

The signal read is the one that the speed sensor on the right-hand rear wheel transmits (via CAN) to the ABS/ASR ECU.

C4.04 KEY "ON"

This signal informs the ECU of the intention to start the car (key turned to the ON position).
In this case the ECU controls the power supply relay , supplying the ignition/injection system's sensors/actuators.

NOTES
All the actuators are controlled by the ECU in negative.

When the car is stopped (key turned to the OFF position) the ECU cuts off the power supply to the fuel pump, the sensors and the actuators.
The ECU stores all the errors which have been identified while the car was in use in the "Eprom". Even if the battery is disconnected, the ECU keeps these errors stored in the memory as it uses an "Eprom flash".

C4.05 FUEL WARNING LIGHT

This informs the ECU of the fuel level so that any difficulties with the engine are not stored as misfiring errors.

C4.06 BATTERY VOLTAGE

This informs the ECU of any voltage drops. If the voltage level should fall, the Motronic ECU intervenes by activating a strategy to raise the engine idling speed so that the alternator can charge up the battery.

C4.07 ALARM SYSTEM START-UP

The alarm system communicates with the ECU of the bank 1-4 to activate the ignition/injection.
In its turn, the ECU of the bank 1-4 activates the ECU of the other bank via CAN line.

C4.08 OTHER INLETS

- **Clutch pedal switch**

Used in the gear shift strategy (diagnosis carried out during gear shifting)

- **Brake pedal switch**

Used in the accelerator check strategy (torque modulation for engine braking)

- **Inertia switch**

Used by the Motronic to cut off the fuel supply in the event of a collision urto (H3.04)

- **Fuel tank pressure (Euro 3 - US version only)**

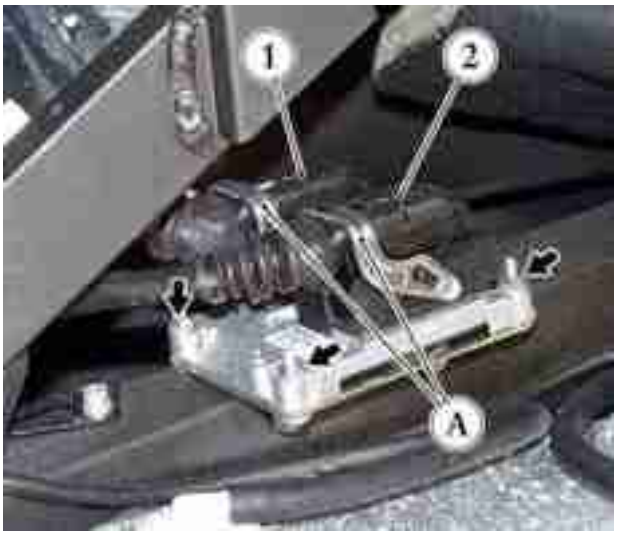
Used to identify fuel tank leakages.

C5.01 REPLACING THE MOTRONIC ECU

The MOTRONIC ECU of each bank is installed on the top chassis, in the area above the fuel tank.

IMPORTANT
Do not detach or plug the connectors in the ECU with the ignition key in the ON position.
*Avoid starting up the engine with an auxiliary **"steering wheel"** ECU which is only connected to the system temporarily, but not installed in its seat. Since there is no earth connection, the ECU cannot function and therefore it can be damaged.*

- To replace the ECU, remove the side engine compartment shield (M 2. 13).
- Detach the injection harness connector 1 (**1T**, see Table **T** / **1S**, see Table **S** - ELECTRICAL SYSTEM) and the engine compartment harness connector 2 (**1L** / **26L**, see Table **L** - ELECTRICAL SYSTEM).



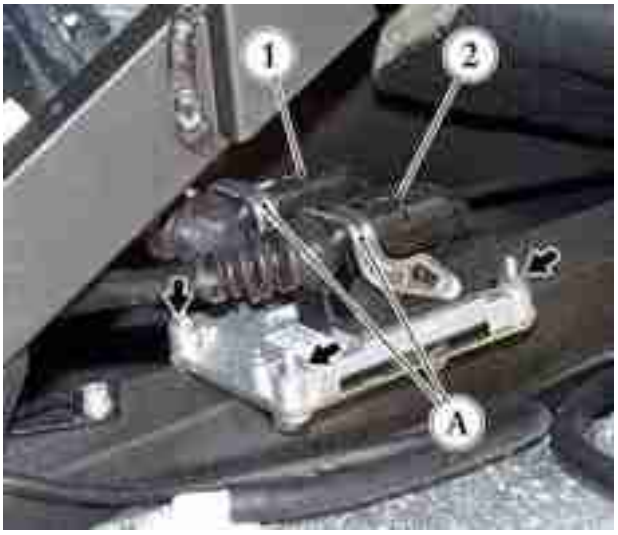
- Unscrew the four nuts and remove the ECU from the support bracket.

NOTES
The Motronic ECUs on the two banks are identical.
These, therefore, can be inverted, but they cannot be replaced with those from another car since the Motronics are interfaced with the alarm system.

Re-Assembly Notes

- After installing the new ECU, re-attach the connectors **(1)** and **(2)** very carefully to avoid bending and damaging the ECU pins irreparably.

Proceed as follows:
- raise the guide slider **(A)** on the connector;
- place the connector in line with the ECU counter-unit;
- press the slider **(A)** down into the position as shown in the figure: if you notice excessive resistance when fitting it, start the operation again from the beginning.



- After replacing the ECU, it is necessary to carry out an automatic self-testing cycle with the SD-2 tester (C 6. 05).

Self-learning

The throttle position self-learning procedure which is run at “key ON”, after each battery removal, must be performed within an outside temperature range of **+5 °C and +100 °C**.

Therefore, to prevent the risk of engine malfunctions, the self-learning procedure must be carried out in areas in which the temperature is **above +5 °C**.

C6.01 DIAGNOSIS WITH SD-2 TESTER

The BOSCH ME 7.3 injection/ignition system uses two Motronic ECUs, one for each bank. The identification of the right-hand ECU or the left-hand ECU, is carried out by the **S_sga** signal, by means of the **F11** pin. According to this signal, the ECU is recognised as either "right-hand ECU", when **B_sga = 1** (open) or as "left-hand ECU ", when **B_sga = 0** (grounded). In this way the input/output controls are used for the actuators of both the ECU's or only for the "left-hand ECU" or for the "right-hand ECU".

NOTES

The ECU cannot be tested by means of the Ferrari SD-2 tester if the car alarm is in the "immobilizing" anti-theft condition (the injection/ignition system is disabled) (H 3. 01).

The ECU can test the system components and communicate with the testing system.
The testing system can be used for the following functions:

- Engine parameters display.
- Error signals.
- Active diagnosis.
- Guided diagnosis.
- Automatic cycle.
- Help messages.

NOTES

The connector for plugging-in the SD-2 tester is located on the left-hand side underneath the dashboard (L 2. 12).

C6.02 ENGINE PARAMETERS DISPLAY

The following data, related to the engine, can be displayed by the testing system:

- Engine revolutions;
- Engine temperature;
- Intake air temperature and pressure;
- Intake air flow rate;
- Spark advance;
- Injection time for left and right-hand banks;
- Intake manifold absolute pressure;
- Load;
- Absolute throttle angle;
- Battery voltage;
- Car speed;
- Front oxygen sensor voltage;
- Rear oxygen sensor voltage;
- Catalytic converter temperature;
- Idling rpm;
- Injection time correction;
- Accelerator pedal position (potentiometers 1 and 2);
- Position of angle between crankshaft and camshaft;
- Gearshift position;
- Clutch disk load;

The system can also display the following values for each parameter, if applicable:
- correction factor;
- addition values;
- multiplication values ;
- functioning mode.

C6.03 ERROR SIGNALS

The ECU can recognise and then transmit to the tester, a series of errors.
Each error is defined by a code made up of a prefix **P0** (reference: SAE J 2012) or **P1**(reference: Ferrari) followed by a three-figure number.
The SD-2 tester recognises the type of error which has been found and highlights the malfunction by displaying the relevant message, such as:

- short circuit towards + battery, or upper threshold (max) exceeded;
- short circuit towards ground, or lower threshold (min) exceeded;
- circuit interrupted (not always recognisable; an interruption at the input or output of an electronic device can be detected as a short circuit towards the + battery or towards the ground);
- Conflicting sensor values;
- Error currently found;
- Error currently not found;
- Engine state (n° of revolutions, load or battery temperature) when the error occurred.

NOTES
The errors memory is automatically updated every second time the engine is started up.

C6.04 ACTIVE DIAGNOSIS

The active tests, which can be carried out with the SD-2 testing system, are related to the following components:

- electro-injectors
- oxygen sensors
- variable intake manifold
- camshaft control
- canister cleaning valve
- A.C compressor relay
- fuel pump relay
- exhaust by-pass valve
- revolution counter

In addition to these, the system can also test systems (the anti-evaporation one), signal lights (Slow Down, MIL, etc..) and it can delete the self-learned values.

NOTES

*The Motronic ME 7.3 ECU does **NOT** allow the user to delete the parameters set during the self-learning cycle or to readjust them, by cutting off the power supply to the ECU. A testing step has been added to this phase, which makes it possible to reset the ECU. To ensure the engine functions properly, it is necessary therefore to delete the parameters set during the self-learning cycle, each time the actuators are replaced.*

Guided Diagnosis

The programmes needed to carry out "guided diagnosis" are stored in the SD-2 tester. This function allows the user to check the components are working correctly and to follow the route of the cables through the connector pin-out identification.

It is possible to enter the "guided diagnosis" function, either following an error signal from the ECU, or autonomously, by selecting the parameters required in the **Errors** page of the menu and then pressing **Enter**.

NOTES

Before commencing testing, the errors must be printed out.

Through the diagnosis system it is possible to display the progress of one or more of the parameters as graphic figures, which can be printed out if necessary. This print-out should help in problem-solving and engine debugging.

C6.05 AUTOMATIC CYCLE

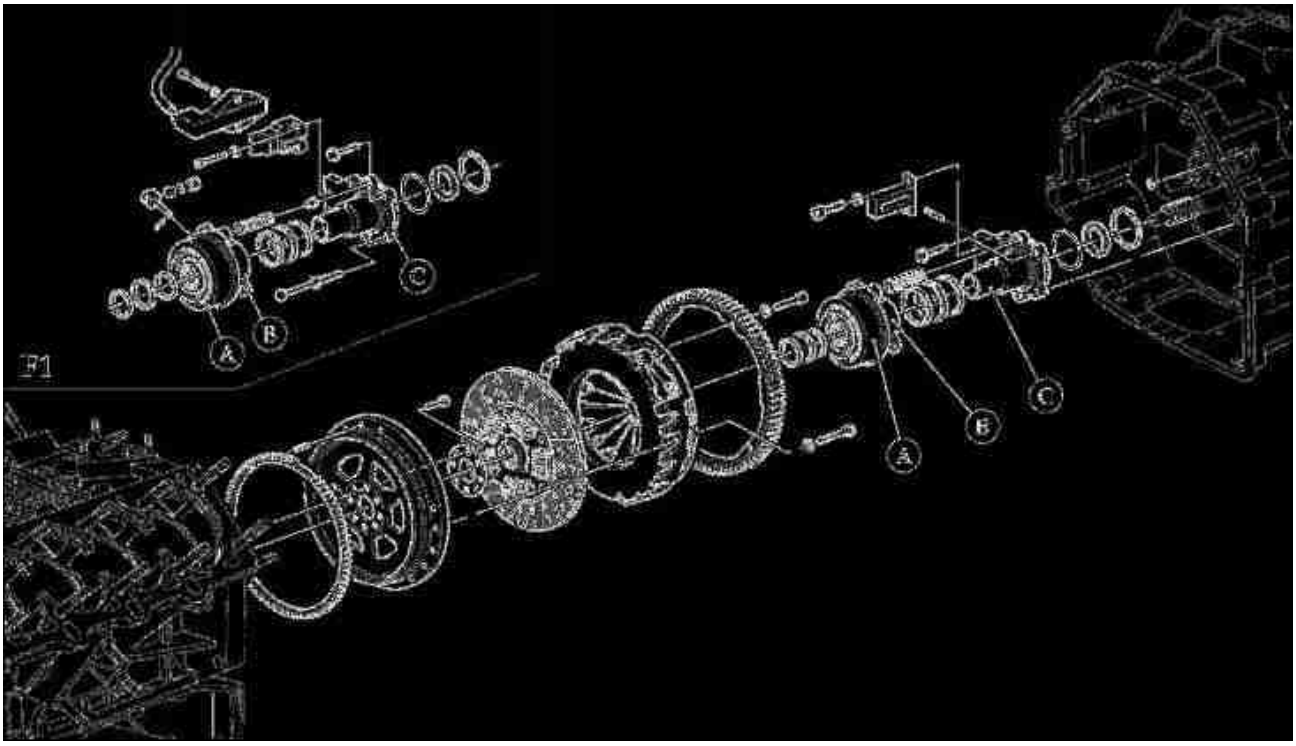
The automatic cycle, must be carried out in the event that a system must be checked after a component, a wiring harness or the ECU itself has been replaced.
Following a precise procedure, the cycle checks all the actuators in order to find any system problems.
If any faults are found which are difficult to identify correctly, it is important to carry out the thorough cycle in order to check the Motronic system and any possible adjustments to be made following a functional and progressive method.
Once the cycle has been completed, the tester will check all the errors found and it will print out all the reports of the phases executed, with the relative results.

Help Messages

Each time the word **Help** appears in the lower part of the screen, help messages can be displayed by pressing the **F1** button. These messages are related to the operations in progress, the window in use or the parameter reference values.

D1.01 TECHNICAL FEATURES

Longitudinal mechanical transmission with synchronized six gears and reverse gear.
The manual control lever is situated in the centre of the tunnel. In the electrically controlled version, the equalizer control levers are situated behind the steering wheel.
The gearbox housing, besides the main and lay shafts and the coupling forks, also contains the bevel gear pair and the self-locking lamellar differential.
The engine oil tank is machined in the gearbox housing's monolithic cast.
The synchronisers for **1st** and **2nd** speeds have a triple cone while the others have a double cone.
The lubrication of the gearbox gearing, which is the same as for the differential's, is carried out by a volumetric pump with concentric gears, operated by the auxiliary mechanism of the reverse gear.
The temperature of the gearbox/differential oil is adjusted by an oil/water heat exchanger, placed between the water head outlet manifold and the water pump.
The clutch is the dry monodisk type, with flexible couplings and diaphragm springs.
The clutch is released by using a self-adjusting thrust bearing **(A)**. The thrust of the fluid within the hydraulic circuit makes the bush bearing holder **(B)** slide onto the flange's sleeve **(C)**, until the clutch is released.



Gearbox Ratios

Gears	*Gear ratios*	*Final reduction ratio (engine rpm/wheel rev.)*
1a	**46/14 = 3,286**	**14,603**
2a	**41/19 = 2,158**	**9,591**
3a	**37/23 = 1,609**	**7,150**
4a	**33/26 = 1,269**	**5,641**
5a	**30/29 = 1,034**	**4,598**
6a	**28/33 = 0,848**	**3,771**
RM	**41/16 = 2,565**	**11,389**

Bevel gear differential ratio: **40/9 = 4,444**

Gearbox features

End float:

– main shaft neutral gears	**0.10÷0.30 mm**
– lay shaft 1st and 2nd speed gear	**0.15÷0.25 mm**
– between seeger and lay shaft bearing, on the plate	**0.03÷0.05 mm**
– Reverse idle gear	**0.125÷0.325 mm**
Backlash	**0.08 mm**
Pinion bearings' rolling torque	**1.5÷2.3 Nm (before assembling on housing)**
Interference of double gear assembly on lay shaft:	
– 3rd and 4th	**0.04÷0.06 mm**
– 5th and 6th	**0.03÷0.05 mm**

Gearbox/differential rolling torque (detected on clutch shaft with completely assembled gearbox):

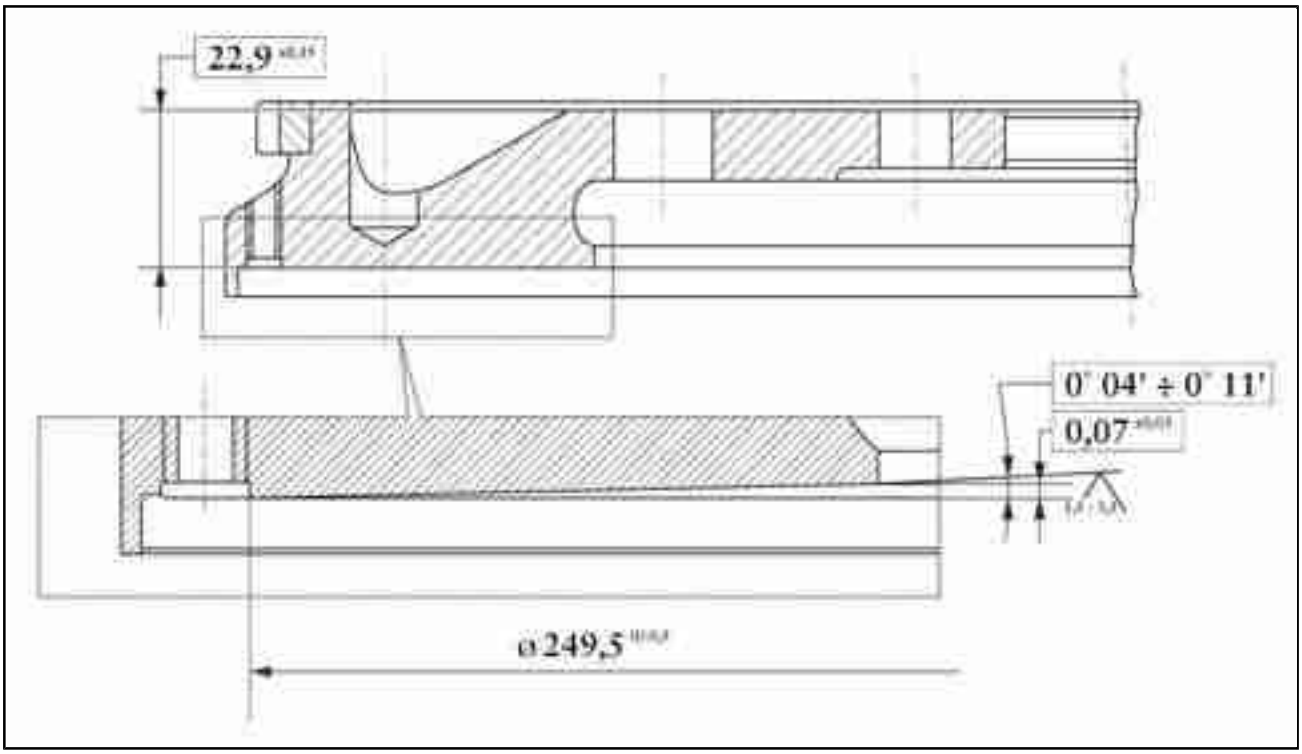
Engaged gear	*Rolling torque [Nm]*	
	from	*to*
N	**0,6**	**0,8**
1st	**1,8**	**2,1**
2nd	**2,5**	**2,7**
3rd	**2,8**	**3,4**
4th	**3,6**	**4,5**
5th	**4,4**	**4,8**
6th	**5,7**	**6,2**
Reverse	**2,7**	**3**

Clutch Specifications

Brand	**VALEO**
External diameter of gasket	**247 mm**
Internal diameter of gasket	**165 mm**
Thickness of clutch disk loaded (7400N)	**8,3 ± 0,3 mm**
Clutch disk wearing limit	**0,8 mm**

Flywheel Specifications

Distance of working surface to clutch disk/keying surface to crankshaft	**22,9±0,15 mm**
Maximum reduction in working surface thickness	**1,0 mm**
Surface roughness	**1,5 – 3,5 µ**
Maximum flatness deviation on working surface	**0,05 mm**



Hydraulic Thrust Bearing Specifications

Working surface	**709,2 mm^2**
Maximum stroke	**14,6 mm**
Auxiliary spring pre-load	**73,5±3,9 N**

Differential features

Differential type	**Self-locking, lamellar**
Reduction bevel gear pair	**Spiral (GLEASON)**
Reduction ratio	**9 : 40**
Pre-load adjustment	**By spacing washers**
Support bearing type	**Tapered roller**
Differential slipping torque	**48÷75 Nm**
Differential housing rolling torque	**3÷4 Nm**
Pinion/Crown backlash (on 3 points at 120°)	**0.13÷0.18 mm**
Self-locking percentage in tension	**30 %**
Locking percentage when released	**50 %**

D1.02 SPECIFIC TOOLING

Tool n°	*Description*
AV 2714	Extracting tool
AV 3045	Pins for extracting tool
AV 3048	Box wrench for hydraulic clutch control's stud bolt
AV 3070	Tool for clutch disengagement
AV 3075	Punch for driving flexible pins onto the bearing holding bushing
AV 3079	Punch for centering complete thrust bearings
AV 3080	Thrust bearing centering tool
AV 3218	Tool for fitting the seal ring (3 pieces)
AV 3219	Tool for replacing the gearbox housing's upper flexible bushing (4 pieces)
AV 3375	Tool for replacing the gearbox housing's upper flexible bushing
AV 3234	Tool for replacing the gearbox housing's lower punch (8 pieces)
AV 3243	Tool for fitting assembled gearbox shafts (5 pieces)
AV 3244	Gearbox housing's closing flange for checking the rolling torque
AV 3245	Key for fastening the main shaft ring nut and check ring nut
AV 3246	Key for fastening the main shaft shoulder ring nut
AV 3247	Key for ring nut retaining the lay shaft's bearings
AV 3248	Support for gearbox housing
AV 3251	Centering screws for forked shaft-rod cluster
AV 3252	Tool for disassembling/assembling the main shaft (4 pieces)
AV 3255	Tool for assembling double gearings and bearing on the lay shaft (4 pieces)
AV 3257	Kickback tool for lay shaft ring-nut tightening
AV 3258	Tool for fitting the clutch shaft's ball bearing
AV 3259	Tool for fitting the roller bearing's outer ring
AV 3260	Tool for extracting/inserting the gearbox housing's bearing (2 pieces)
AV 3261	Tool for fitting the clutch shaft's bearing
AV 3262	Tool for fitting the spacer and the 1st and 2nd speed synchroniser body
AV 3263	Tool for various fittings on the lay shaft
AV 3264	Tool for fitting the ball bearing on the main shaft
AV 3265	Tool for fitting the bearing and the bushing on the intermediate plate (4 pieces)
AV 3266	Tool for testing the pinion play
AV 3267	Tool for fitting the ball bushing
AV 3268	Punch for fitting the retaining washer (Ø 14 mm)
AV 3269	Punch for fitting the retaining washer (Ø 18 mm)
AV 3270	Puncher for fitting the retaining washer (Ø 25 mm)
AV 3271	Tool for positioning the gear shift control lever on the rod
AV 3272	Extractor for 3ª - 4ª speed synchroniser on the main shaft
AV 3273	Tool for extracting the forked shaft-rod cluster
AV 3274	Bushing with bearing dimension
AV 3275	Tool for fitting the ball bearing's outer ring on the differential cover (2 pieces)
AV 3276	Tool for fitting the bearing on the differential's semi-shaft with right-hand side flange (2 pieces)
AV 3277	Tool for fitting the bearing on the differential's semi-shaft with left-hand side flange
AV 3278	Tool for fitting the differential's tapered bearings (2 pieces)
AV 3283	Union for gearbox pressing
AV 3284	Tool for testing the envelope between the bevel gear pinion and the bearing's seat
AM 106121	Tool for fitting the synchroniser components
AM 106628	Tool for locking the differential
CS 106524 01	Tool for checking the distance between the pinion and the bearing's seat
USAG 815 F	Electric torque wrench with controlled grip
AV 3536	Locking plate for pressure seal test

WARNING
Tools without hand protection must only be used with the press.

D1.03 COMMERCIAL TOOLING

Article	*Description*	*Manufacturer*
FACOM U.53J2	Set of bearing extractors	**FACOM**
FACOM R.250A	Torque wrench End of scale: **2÷9 Nm**	
1000 BULLES	Leakage detector of gases	**AIR LIQUIDE**
USAG 454N/2	Armed extractor	**USAG**
USAG 815 F	Torque wrench End of scale: **250 Nm**	
USAG 454N/3	Armed extractor	
USAG 468S11	Boxed assortment	
Art. 154	Press Capacity: **10.000 Kg**	**CORADE S.p.A.** **via Pietro Toselli, 81** **50144 (FI)** **Tel. 055 32271**
ZO-PW 470	Calibrated blocks	**ATS FAAR** **via Camporicchio, 1** **20060 Vignate (MI)** **Tel. 02 95360013 r.a.**
Series 460	Electronic surface gauge	
Art. 5184TC500	Usable length: **500 mm** Reading: **1/50 mm** Precision: **0,05 mm**	
F250	Forced ventilation kiln	

D1.04 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category	Product
Nut and screw fastening gearbox to engine	**56**	**A**	
Nut for screw fastening lower part of gearbox	**75**	**B**	
Clutch pipe union	**21**	**A**	
Screw fastening r.p.m. sensor	**8**	**B**	
Gearbox oil cooling pipe union	**49**		
Screw fastening crown wheel	**18**	**A**	
Screw fastening pressure plate	**18**	**A**	
Screw fastening flywheel	**91**	**A**	
Nut fastening clutch cylinder	**20**	**B**	
Pipe union for clutch pump	**18**	**A**	
Screw for flange supporting thrust bearing bush	**25**	**A**	
Support screw with anti-rotation pin guide	**1,2**	**A**	**Arexon 4706 System 52A 43**
Stud bolt fastening flange for thrust bearing bushing support	**18**	**A**	
Union for oil pipes on box	**18**	**A**	
Union on oil pipes	**21**	**B**	
Bleeding union	**18**	**A**	
Fastening screw on union block	**15**	**A**	
Screw fastening right flange cover	**10**		
Screw fastening differential cover	**30**		
Screw fastening gear-selection and shift lever	**27**	**A**	
Lock-nut on ball joint	**7,4**	**B**	
Screws fastening gearbox turret	**25**	**B**	
Screws for fastening cross member to frame	**9,8**		
Screws for fastening frame to chassis	**28,5**		
Screws for fastening frame to gearbox	**98**	**B**	
Screw fastening axle shaft (preload **40Nm**)	**78**	**A**	**MOLYKOTE 1000 grease**
Screw fastening gearshift lever onto the rod	**32**		
Nut fastening cover with control rod	**7,4**	**A**	
Nut fastening gearshift/selection actuator	**10**		
Nut fastening ball joint to gear selection and engagement levers	**7,4**	**B**	
Fastening screws for lubricating nozzle	**10**		**LOCTITE 270**
Screw fastening bushing bearing holder	**30**		**LOCTITE 270**
Screw fastening rear cover	**30**		**LOCTITE 242**
Ring nut and check-ring nut on main shaft	**100**		**LOCTITE 242**
Shoulder ring-nut on main shaft	**70**		**LOCTITE 242**
Bushing fastening screw	**8**		**LOCTITE 270**
Oil pump fastening screw	**4**		
Screws fastening bearing plate holder	**30**		**LOCTITE 242**
Rear ring nut for the main shaft	**100**		**LOCTITE 242**
Ring nut fastening tapered roller bearings on the lay shaft	**300**		
Nut and screw fastening actuator supporting bracket and guard	**24**	**B**	
Connecting pipe unions for the gearbox-actuator Power Unit	**22**		
Nut fastening oil pipe supporting bracket to gearbox housing	**24**	**B**	
Screw fastening pipe holder mount to framework	**7,4**	**B**	
Screw fastening clutch sensor to support	**0,9**	**B**	**Arexon 4706 System 52A 43**
Nut fastening Power Unit bracket to chassis	**7,4**	**B**	

Nut fastenign clutch locking block	**7,4**	**B**
Fastening nut supporting Bowden cables	**7,4**	**A**

D2.01 DISMANTLING

This paragraph describes the dismantling procedure of the entire gearbox-differential unit from the car. This procedure is necessary in case of overhaul or complete replacement of the gearbox or in case of repair work that cannot be carried out with the gearbox installed in the car.

NOTES

The procedure and the figures refer to the disassembly of a mechanical gearbox. In the Notes at the end of the paragraph, only the differences related to the disassembly of an electronically controlled gearbox with Power Unit are illustrated.

Procedures

The gearbox-differential unit must be lifted from the engine compartment. To carry out this procedure it is necessary to use a movable hydraulic hoist or a bridge crane with **200 kg** minimum capacity and two safety belts to sling the unit.

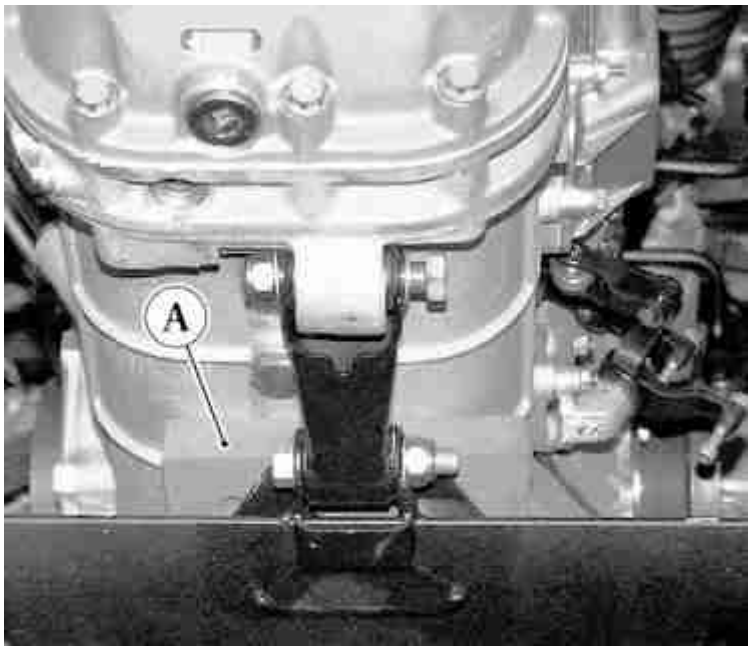
IMPORTANT

Before starting procedures within the engine compartment, adequately protect all the polished surfaces of the car body and chassis.

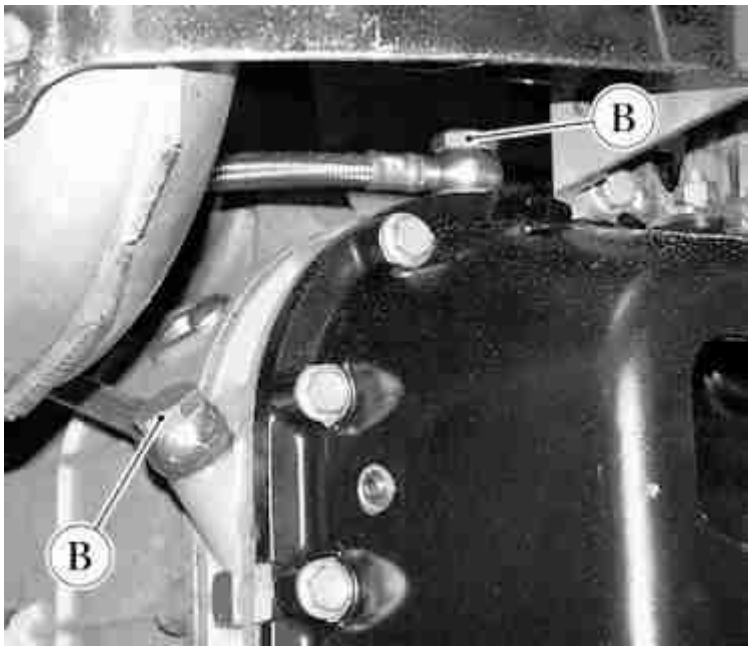
- Drain the engine oil (A 3.01).
- Remove:
  - the engine compartment boot(M 2.01);
  - the side protection guards of the engine compartment (M 2.13);
  - the rear part of the underfloor (M 2.12);
  - the rear bumpers (M 2.04);
  - the rear covering (M 2.15);
  - the rear wheels (F 3.06);
  - the rear wheelhouses (M 2.05);
  - the coolant expansion tank (B 5.05), keeping it connected to the system;
  - the air intake (B 7.03);
  - the exhaust silencer with its support and joints (B 7.07);
  - the catalytic converters (B 7.06);
  - the gearbox support frame (D 4.04).

NOTES

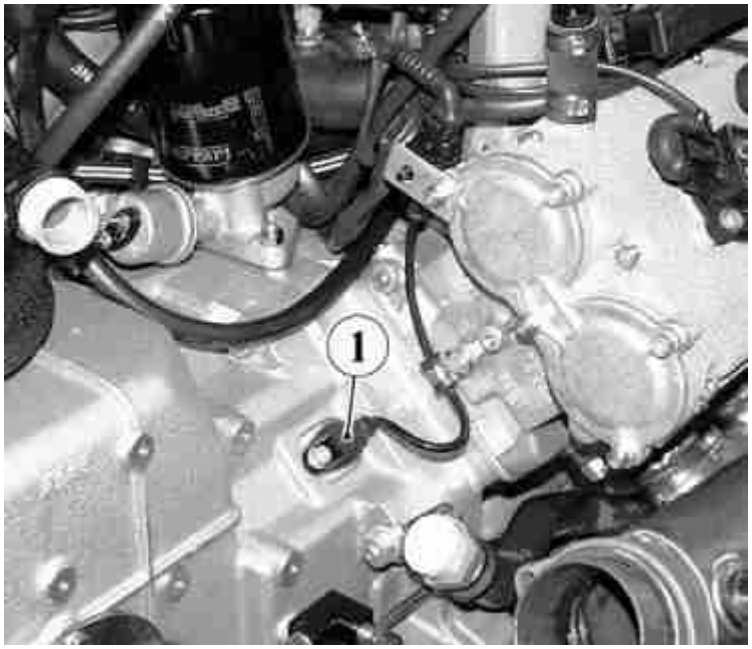
*To avoid excessively unbalancing the weight of the engine-gearbox unit towards the rear and straining the engine support pads, it is advisable to position a rubber pad **(A)** of the suitable thickness under the gearbox, between the box and the chassis beam*



- Remove the axle shafts from the gearbox (D 5.02).
- Detach the oil radiator pipes from the vapour separator and from the stiff pipe (B 4.04); Plug the stiff pipe onto the engine.
- Detach the oil pipes connecting the gearbox to the exchanger, unscrewing the screws **(B)** of the filler neck unions.



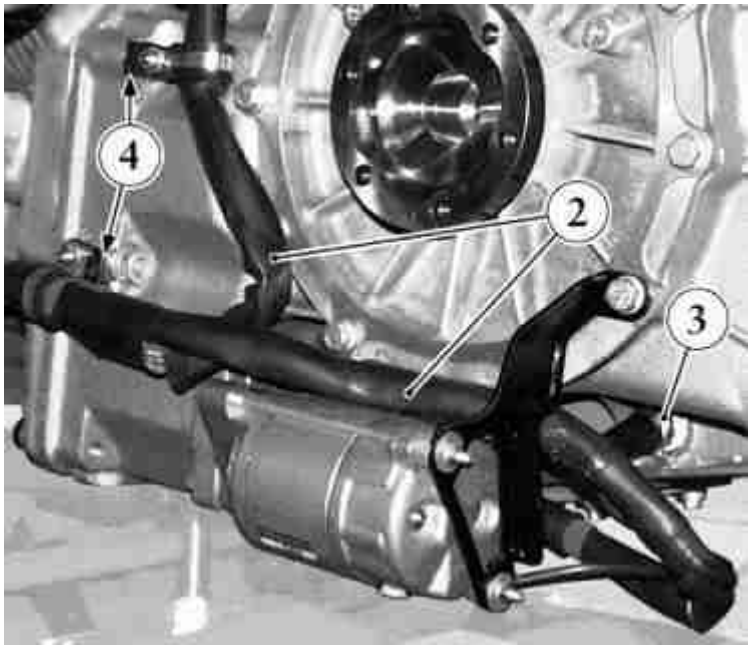
- Remove the r.p.m. sensors **(1)** on both sides of the gearbox (C 2.02), keeping the cable fastened to the head and connected to the injection harness.



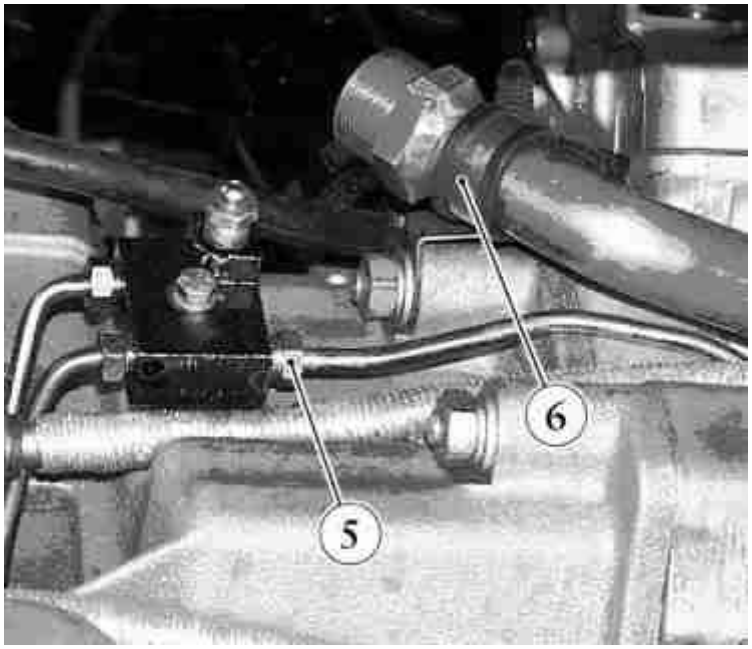
- Working from under the car, detach the engine service cable **(2)** from the starter motor, from the oil engine temperature sender **(3)** as well as from the brackets **(4)**.

NOTES

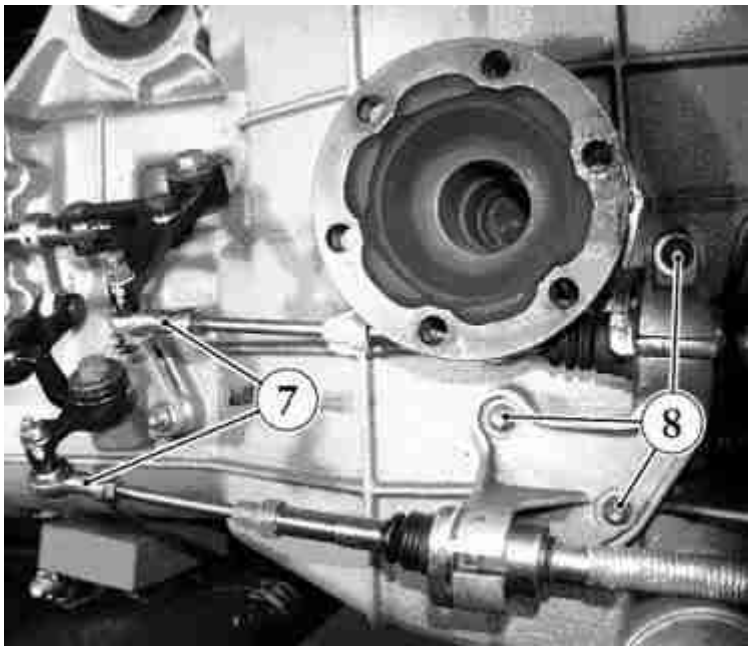
To avoid contact between the starter motor and the chassis rear cross member, it is advisable to also remove the motor (L 2.04).



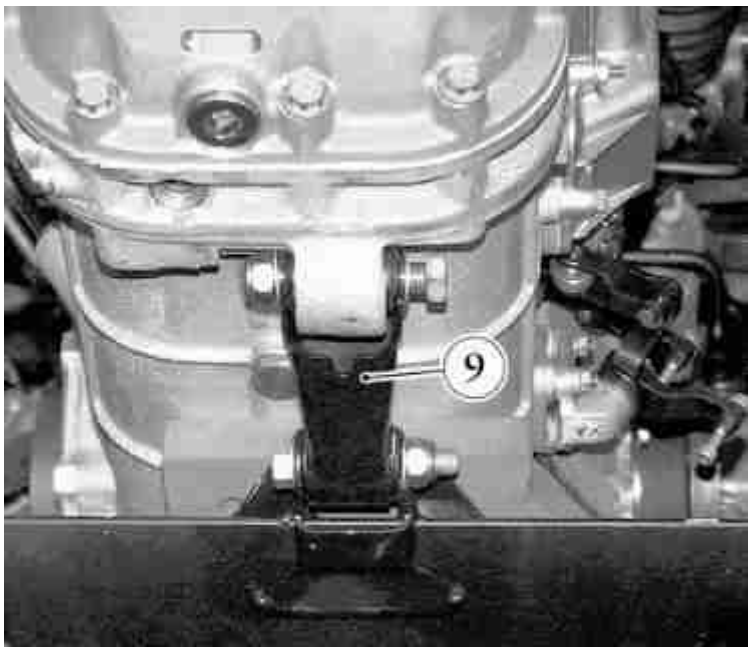
- Unscrew the clutch pipe union **(5)** from the block (mechanical gearbox only) and disconnect the support clamp **(6)** of the radiator oil delivery pipe from the bracket.



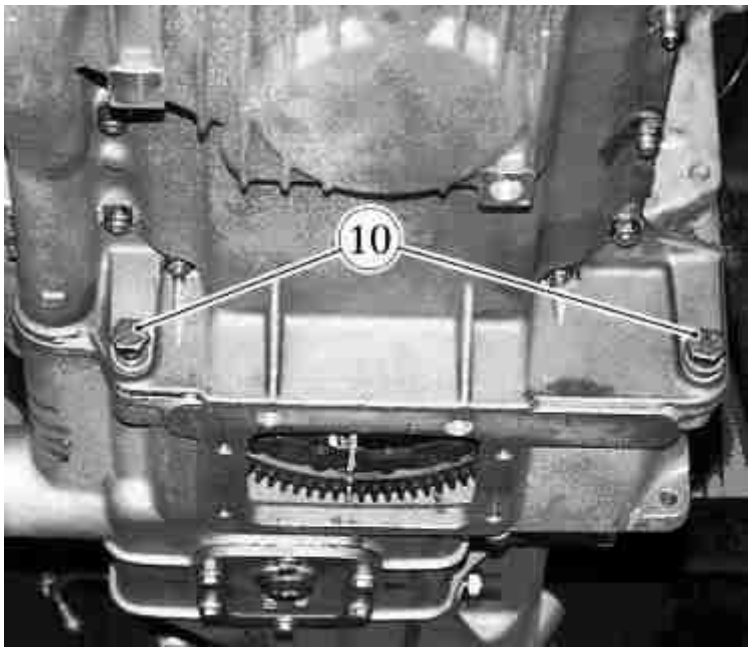
- Remove the joints **(7)** of the Bowden cables for the gearbox control from the transmission levers.
- Unscrew the nuts **(8)** fastening the cable support to the gearbox; remove the support and the cables from the gearbox.



- Detach the lower connecting rod **(9)** from its fastening on the gearbox.



- In the lower part of the engine, unscrew the screws **(10)** fastening the lower part of the gearbox to the engine.



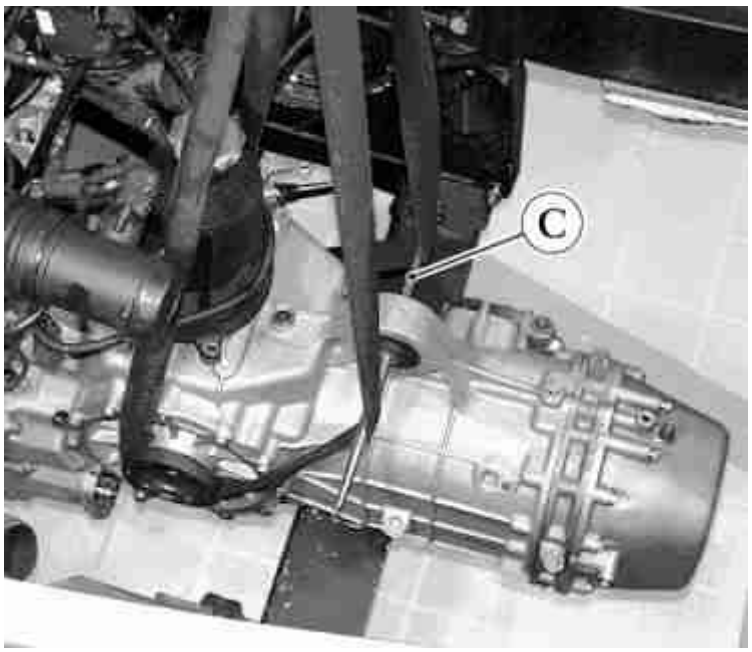
- Unscrew the six nuts fastening the gearbox to the engine, keeping the support brackets.

Lifting

IMPORTANT

*To keep the engine in its position, without straining the pads, it is necessary to use a hydraulic hoist to support the engine or to insert two **55 mm** shims between the exhaust manifold and the chassis.*

- Introduce a pivot **(C)** into the hole of the gearbox upper support.
- Pass each belt under the axle shaft flange connection and behind the pivot **(C)**.



- Fasten the ends of the belt onto the hoist hook.

ATTENZIONE

For safety reasons, the above-mentioned position of the belts must be respected.

- Lift the gearbox until the belts are tensioned.
- Pull back the gearbox by sliding it off of the engine stud bolts and of the shaft internal coupling on the clutch disk.

NOTES

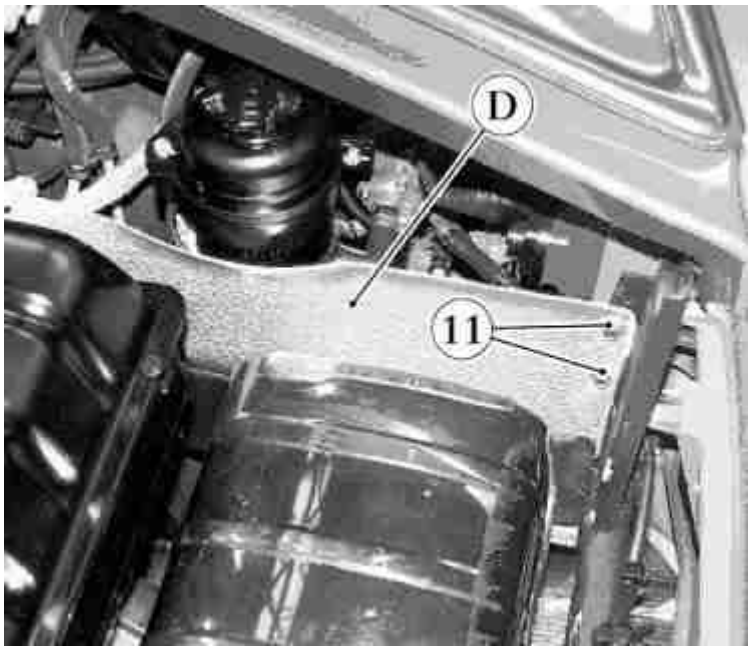
In case of difficulty in making the shaft spline come out of the clutch disk, pound the coupling area of the two cast-pieces with a rubber hammer. Absolutely avoid prizing the coupling surfaces with metal objects.

- Slowly raise the gearbox, avoiding contact with the chassis.
- Position the gearbox-differential unit onto an adequate support.

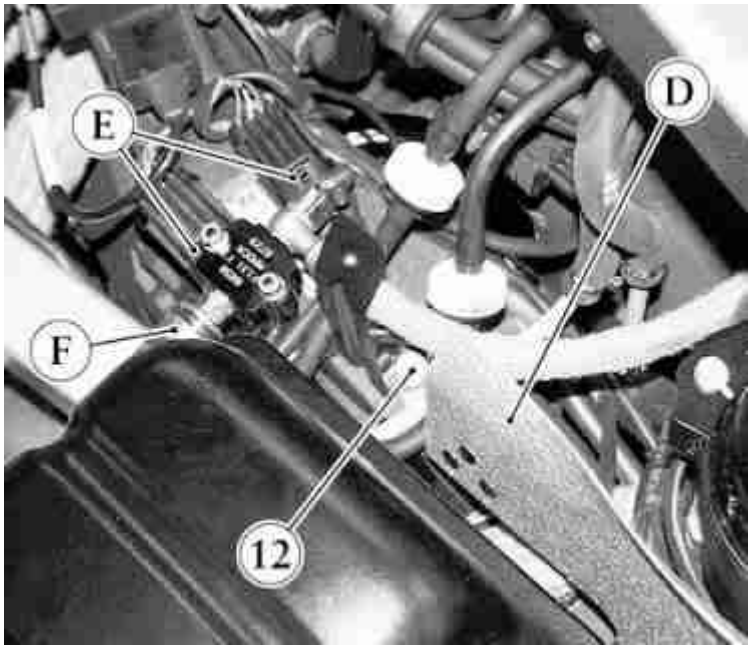
Specific Notes for Electronically Controlled Gearbox

During the preliminary operations it is necessary to:

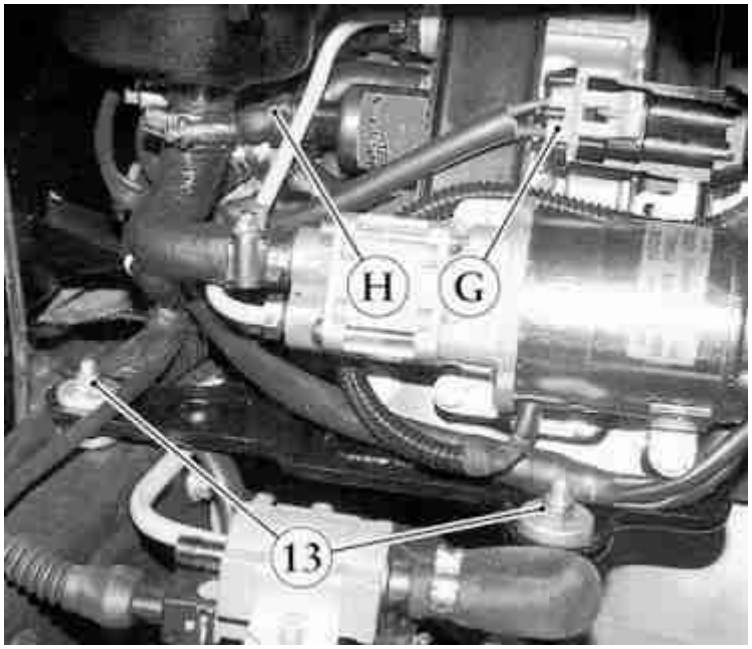
- remove the Power Unit protective shield **(D)**, unscrewing the rear screws **(11)** and the front one **(12)**;



- disconnect the actuator unit sensors' connections **(E)** from the electronically controlled gearbox harness;
- remove the clutch pipe rapid coupling **(F)** from the union block;

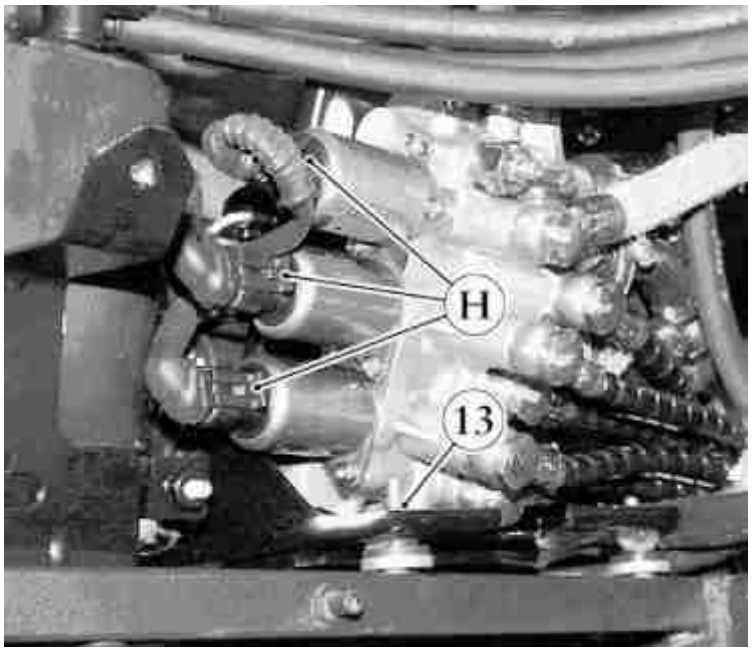


- detach the pump connector **(G)** and all the other connections **(H)** for the harness of the electronically controlled gearbox from the Power Unit;



NOTES
Each cable has a number printed on it to identify of the device which must be connected to it.

- detach the clutch and gearshift sensor connections from the gearbox;
- unscrew the nuts **(13)** connecting the four flexible supports and remove the Power Unit from the frame;



- to avoid hampering the hoisting of the gearbox unit, place the Power Unit on the gearbox, fastening it firmly to the blow-by system with a cable **(L)**.

NOTES

It is possible to remove the differential-gearbox unit by leaving the Power Unit on the chassis and removing the gearshift and selection actuator (D 6.07).

- Proceed by positioning the hoisting belts, following the previous instructions and taking care not to crush the piping or harness of the electronically controlled gearshift system.

D2.02 RE-ASSEMBLY

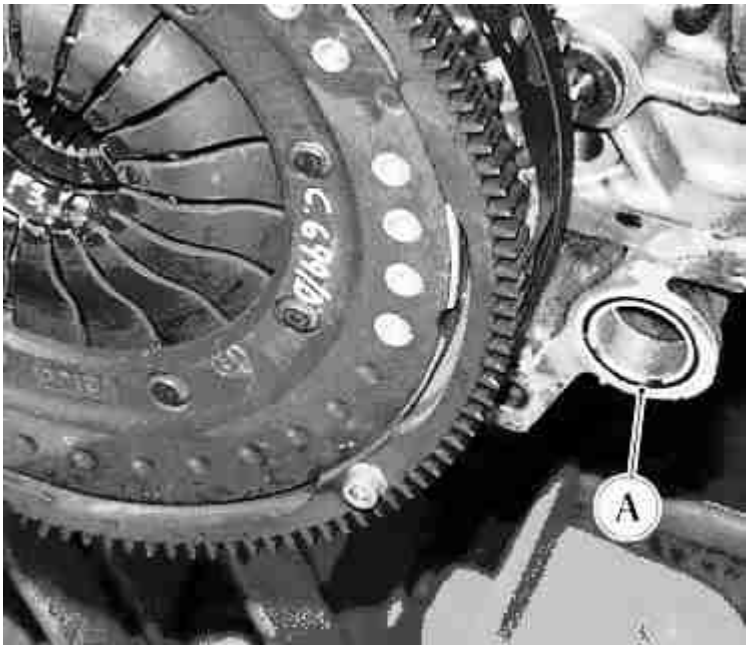
Tightening Torques

Nut and screw fastening gearbox to engine	**56 Nm**
Nut for screw fastening lower part of gearbox	**75 Nm**
Clutch pipe union (mechanical gearbox)	**21 Nm**
Screw fastening r.p.m. sensor	**8 Nm**
Gearbox oil cooling pipe union	**49 Nm**

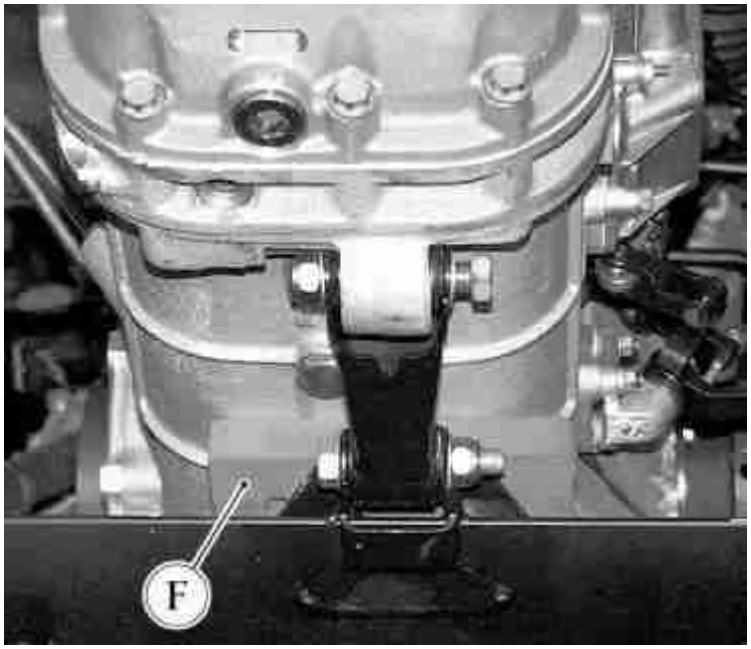
NOTES

The procedure and the figure refer to the re-assembly of a mechanical gearbox. In the Notes at the end of the paragraph, only the differences related to the re-assembly of an electronically controlled gearbox with Power Unit are illustrated.

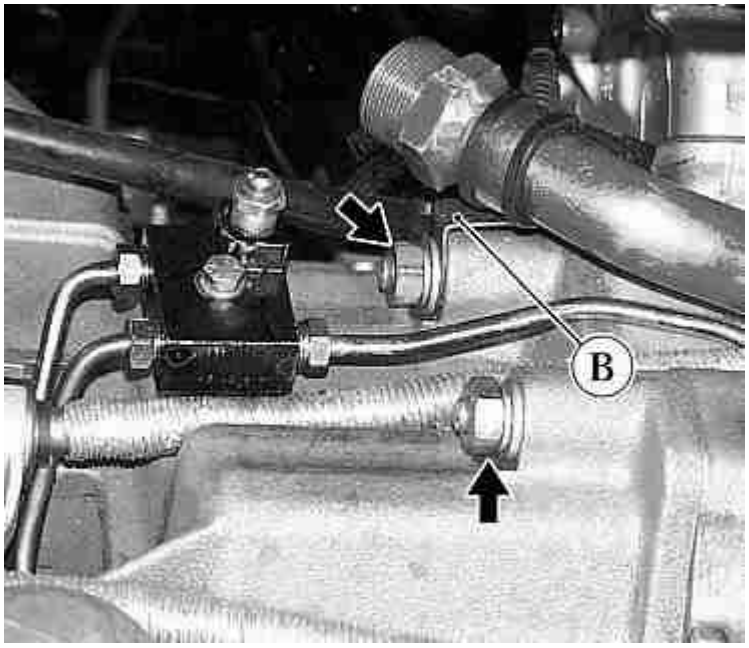
- Lubricate the end of the clutch shaft with **MOLYSLIP Copaslip** grease.
- Install the ORing **(A)** into the special seat in the oil sump applying a veil of grease to keep it in the correct position and check that the centering bushings are duly installed.



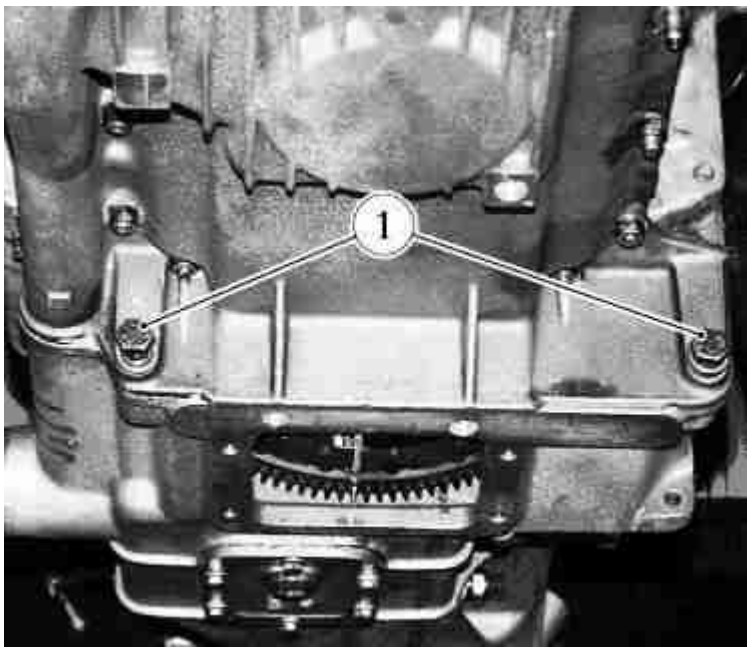
- Sling the gearbox as described in dismantling.
- Position a rubber pad **(F)** on the rear beam of the chassis to support the gearbox before fastening it.



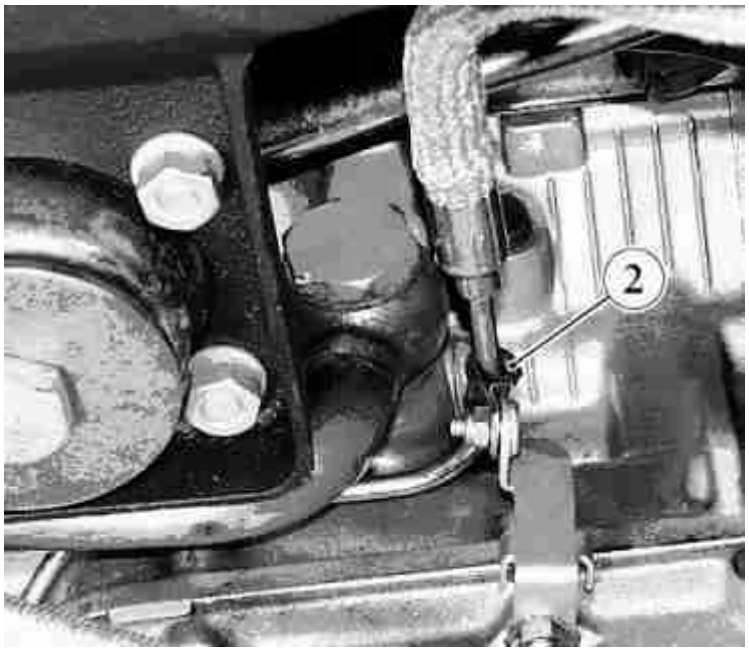
- Bring the gearbox onto the engine compartment and lower it, laying it on the pad.
- Push the unit against the engine, fitting it into the stud bolts and inserting the shaft into the clutch unit.
- Mount the engine service cable support brackets **(B)** onto the left side of the stud bolts and the oil pipe support bracket onto the right side.
- Fit the nuts onto the crankcase's stud-bolts.



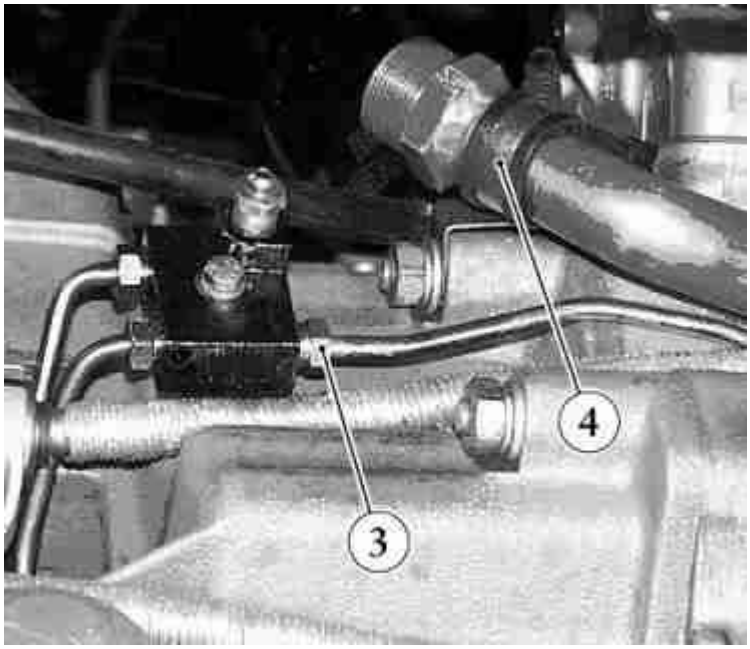
- Lock the six nuts and the two lower screws **(1)** to the prescribed torque.



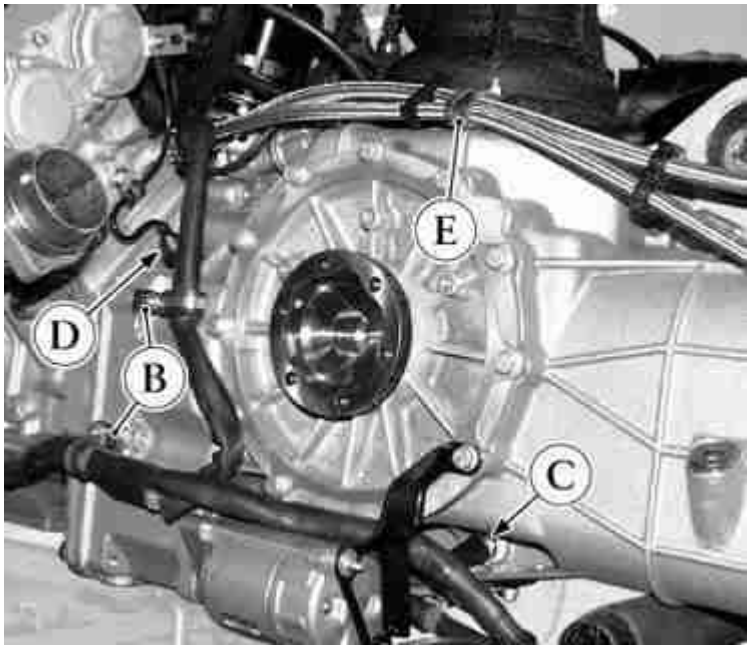
- To easily re-assemble the clutch pipe union onto the block, it is advisable to detach the pipe support clamp **(2)** from the oil sump bracket (mechanical gearbox only).



- Tighten the clutch pipe union **(3)** onto the block to the prescribed torque and re-assemble the clamp **(2)**.
- Fasten the oil pipe clamp **(4)** onto the support bracket.



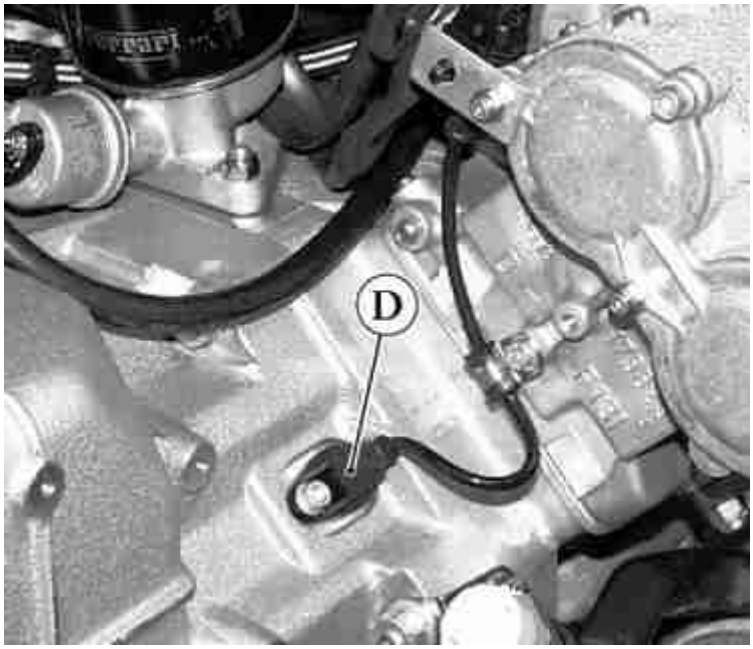
- Fasten the engine service cable to the brackets **(B)** and connect it to the starter motor and to the engine's oil temperature sender **(C)**.



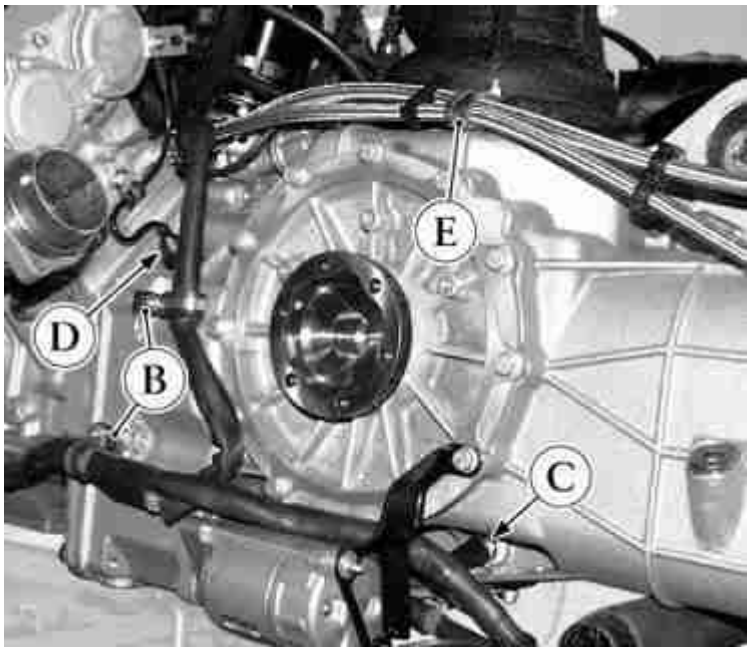
- Re-assemble the r.p.m. sensors **(D)** on the gearbox, tightening the fastening screws to the prescribed torque.

IMPORTANT

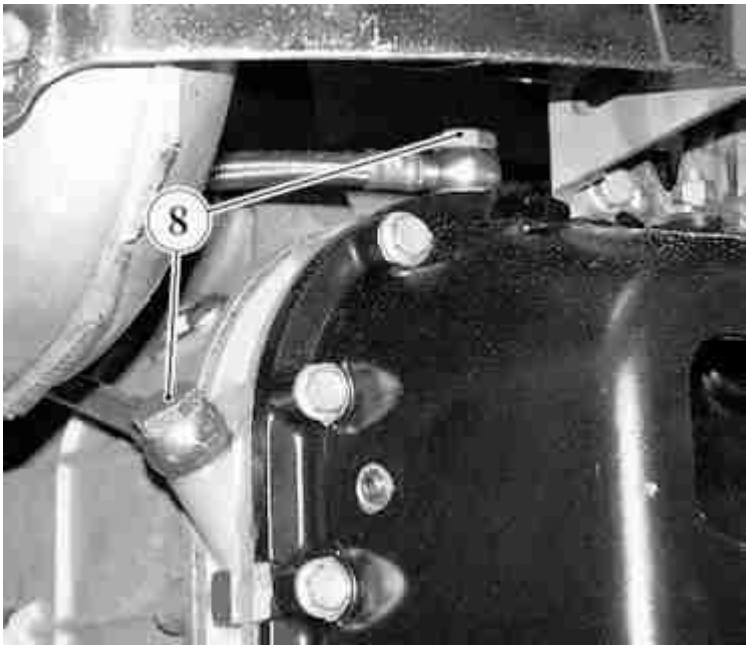
If the entire gearbox or the toothed flywheel is being replaced, check the distance between the end of the sensor and the toothed wheel when re-assembling the r.p.m. sensors (C 2.02).



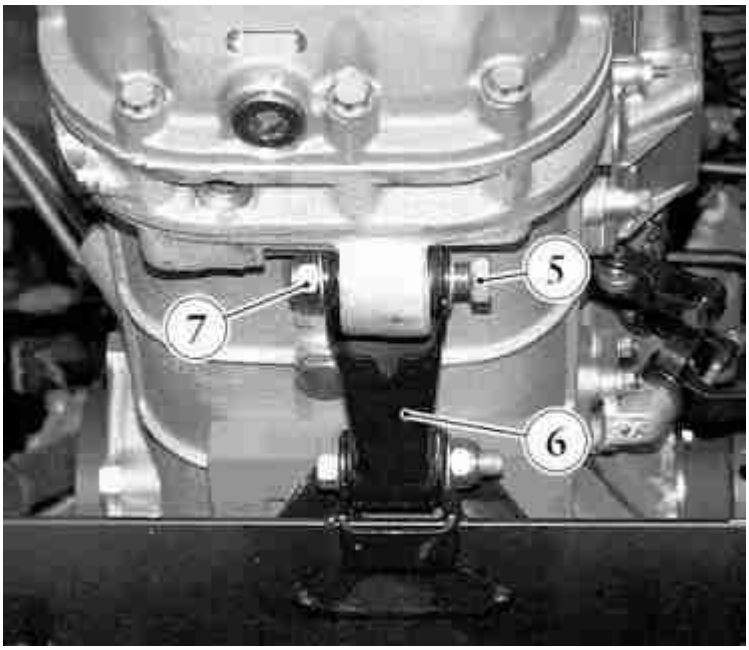
- Make sure that the pipe support clamp **(E)** is assembled in position with the oil vapour separator fastening.



- Re-assemble the oil coolant pipes onto the gearbox, re-utilizing the original gaskets and locking the unions **(8)** to the prescribed torque.



- Fasten the lower part of the gearbox to the torque rod.
- Insert the screw **(5)** fastening the gearbox to the connecting rod **(6)** and lock the nut **(7)** to the prescribed torque.



- Re-assemble the gearbox support frame (D 4.04).

NOTES

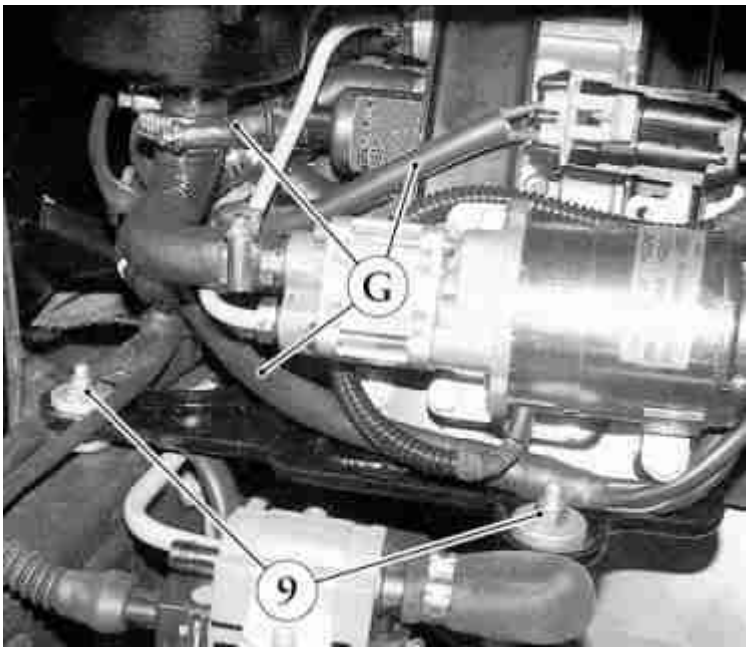
If the gearbox has been replaced, it may no longer be aligned to the torque rod as it was originally. In this case, it is necessary to proceed as described for the realignment of the gearbox-engine unit (B 2.02), respecting the indicated tightening sequence.

Re-assemble all the components previously removed (D 2.01).

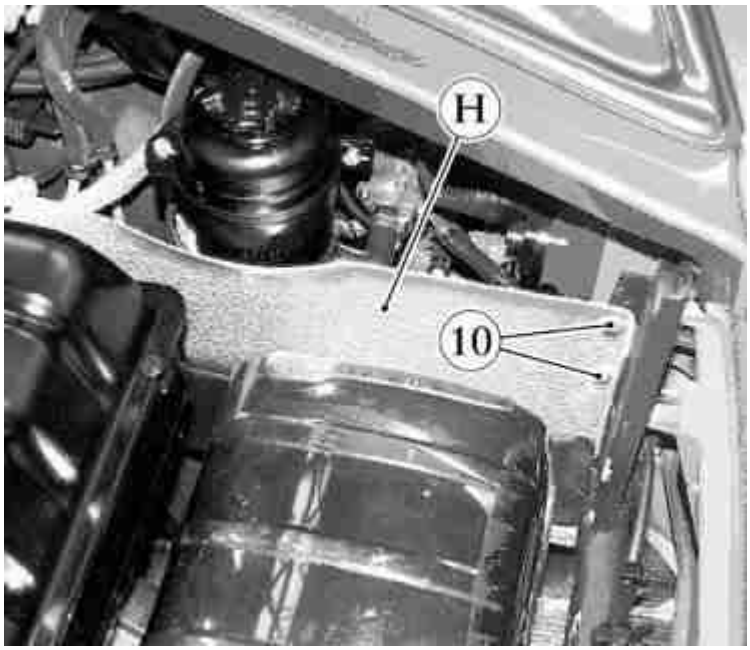
- Lay the cables and the piping in their original position.
- Replenish the engine oil (A 3.01) and the gearbox oil (A 3.02).

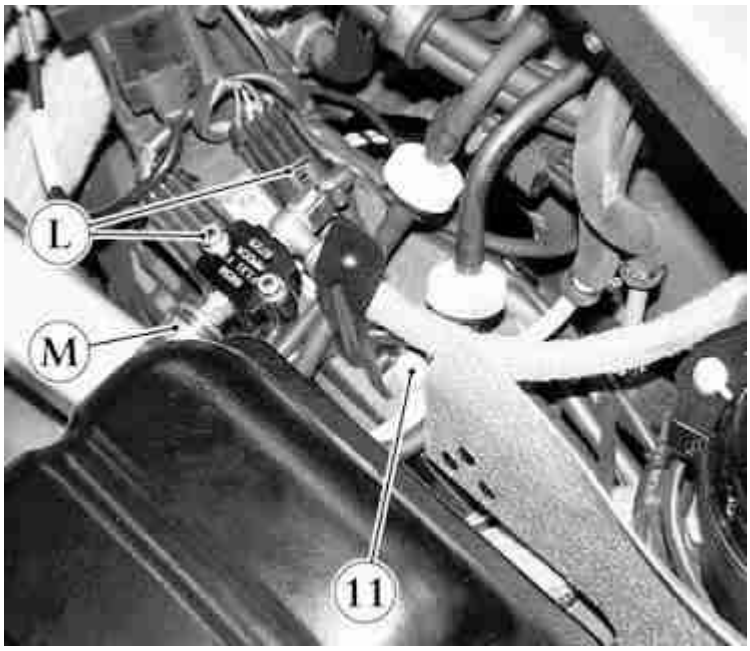
Specific Notes for Electronically Controlled gearbox

- After installing the gearshift unit in the engine compartment, to make working in the area where it is connected to the engine easier, you are advised to release the Power Unit from the engine support and position it on the flexible supports of the frame.
- Proceed by fastening the gearbox unit to the engine and then mounting the parts which have been disconnected or removed, as described beforehand.
- Fasten the Power Unit onto the chassis flexible supports, tightening the nuts **(9)** fully.
- Connect all the electronically controlled gearshift harness **(G)** connections on the Power Unit, matching up the reference numbers on the cables with those on the devices.



- Lay out the cables and piping in their original positions.
- After mounting the gearbox support frame (D 4.04), install the Power Unit protective shield **(H)**, fastening it to the frame, using the screws (10) for the rear part and the screw **(11)** for the front part.





- Reconnect the clutch and gearbox sensors and the actuator unit sensors to the electronically controlled gearshift, by means of the connectors **(L)**.
- Fit the rapid coupling of the clutch pipe **(M)** into the union block.

D3.01 REPLACING THE COMPONENTS

Tightening torques	Nm	Category	Product
Screw fastening crown wheel	**18**	**A**	
Screw fastening pressure plate	**18**	**A**	
Screw fastening flywheel	**18**	**A**	
Nut fastening clutch cylinder	**91**	**A**	
Clutch cylinder connector	**20**	**B**	
Screw for flange supporting thrust bearing bush	**25**	**B**	
Support screw with anti-rotation pin guide	**25**	**A**	
Union for oil pipes on box	**1,2**	**A**	**Arexon 4706 System 52A 43**
Union on oil pipes	**18**	**A**	
Fastening screw on union block	**21**	**A**	

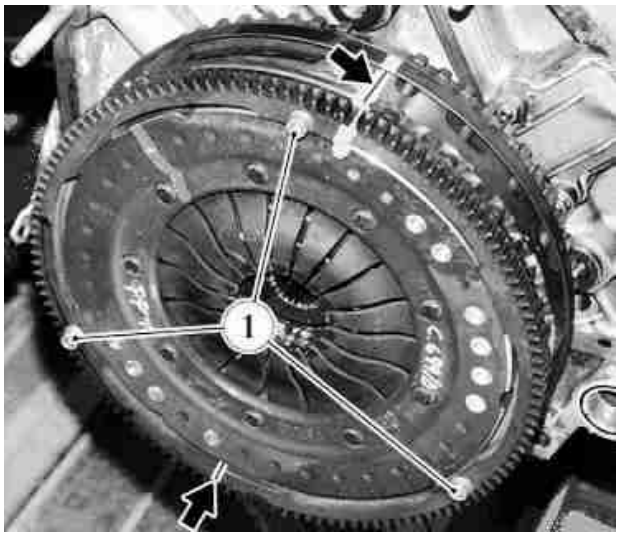
Access to clutch disengagement and flywheel parts is possible only after separating the gearbox unit from the engine (D 2.01).

IMPORTANT

The parts are marked with paint, indicating the residual unbalance point. When re-assembling the original parts, or if new parts are assembled, these marks (see arrows in the figure) must always be diametrically opposite.

Starter motor crown wheel

- During re-assembly, unscrew the screws **(1)** fastening the crown wheel to the pressure disk clutch cover.



Vehicles **with the N. 63614** (type F131B) **engine** or the **N. 7922** (cod. 177893) **gearbox**, have a toothed ring gear with a 1mm undersized centring diameter (Dc) fitted, and six fastening screws **(1)** instead of the three available on the part before the modification.

- Remove the crown wheel.

Check the wearing conditions of the crown wheel: in case of excessive wear or of tooth fracturing, replace the crown wheel.

- Lock the screws **(1)** to the prescribed torque.

Clutch disk

- Remove the crown wheel as described previously.
- Unscrew the fifteen screws fastening the pressure clutch disk **(B)**.

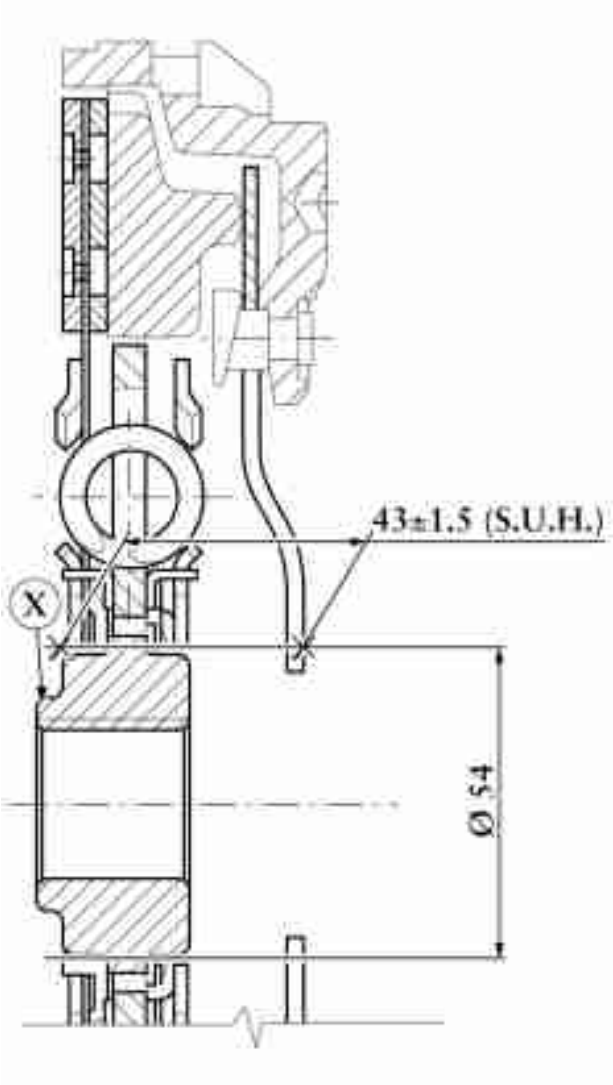
- Remove the plate and the clutch disk.

Check to see if the thickness of the disk falls within the prescribed limit (D 1.01): if not, replace the disk.

Each time the disk or the complete clutch is replaced, it is necessary to check the S.U.H. ratio to guarantee the proper functioning and long life of the clutch.

After having ensured that the thickness of the flywheel falls within the tolerated values, replace the complete clutch if the S.U.H ratio does not lie within the prescribed values.

- When re-assembling, install a new disk with the protruding side **(X)** of the hub facing the flywheel.

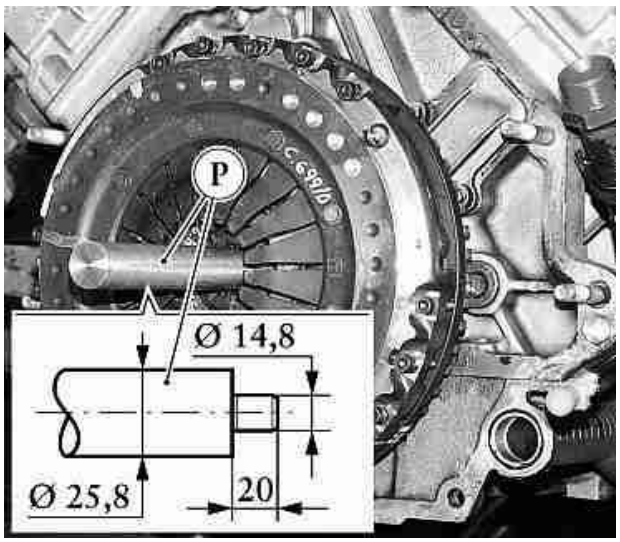


Starting from vehicle **Ass.ly No. 53588**, we have introduced a new clutch assembly, clutch disc and pressure plate (**Code 201680**) which is fully interchangeable with the previous one, but differs in that the clutch disc cannot be supplied as a separate, individual part.
Therefore, if the clutch disc needs to be replaced, the whole clutch disc and pressure plate assembly must be replaced.

IMPORTANT
If you need to replace the clutch assembly, the engine flywheel surface must be intact and not overheated.

- When re-assembling the screws, it is necessary to use a pivot **(P)** of the same size as per the drawing to be able to maintain the clutch centered with respect to the flywheel.

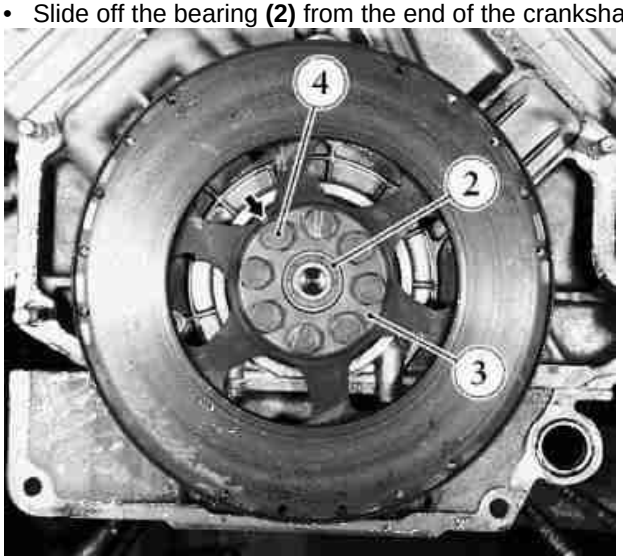
IMPORTANT
Use new screws for every reassembly.



- Lock the screws fastening the pressure disk to the prescribed torque, proceeding in crosswise.

Clutch shaft support bearing

- Remove the crown wheel as described previously.
- Slide off the bearing **(2)** from the end of the crankshaft. If this procedure is difficult, use a common bearing puller.



- Install a new bearing, bringing it onto the crankshaft.

Flywheel and toothed wheel

- Remove the crown wheel and the pressure plate with the clutch disk, as previously described.
- Unscrew and remove the eight screws fastening the flywheel to the crankshaft.
- Remove the washer **(3)** and the flywheel together with the toothed wheel.
- Detach the toothed wheel from the flywheel.

Check the work surface of the clutch disk on the flywheel. No grooves or deformations should appear.
Check the flatness of the surface.
If the flywheel requires grinding, stick to the prescribed values (D 1.01).

- During re-assembly, the flywheel and the washer **(3)** may be mounted in a single position since the screw **(4)**, positioned with the yellow mark on the flywheel, is offset with respect to the others.

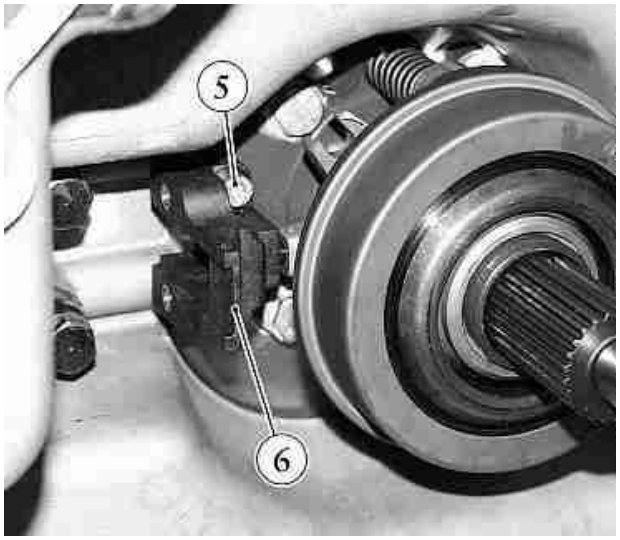
IMPORTANT
Always use new screws and washers every time the unit is refitted.

- Lock the engine rotation and tighten the flywheel screws to the prescribed torque.

Thrust bearing unit parts for clutch and pipes

- Unscrew the two screws **(5)** fastening the guide support **(6)** and remove the latter from the flange.

To prevent problems during the clutch position resetting stage, **FROM Ass.ly No. 50345** a guide mount **(6)** has been introduced. This has a longer housing slot for the anti-rotation pin (increased from 27.8 to 33 mm).

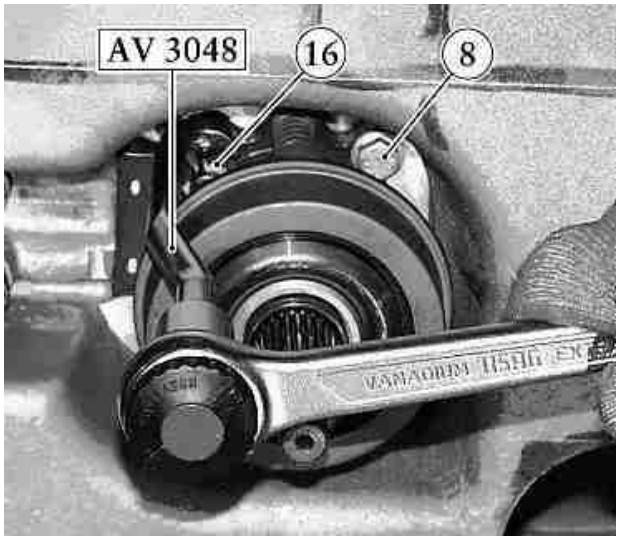


Notes for "F1" gearbox

In **"F1"** gearboxes the bracket **(6)** supports the clutch position sensor (D 6.08).

The bearing guide function is made of two stud bolts **(16)** which also contribute to fastening the bearing holder flange.

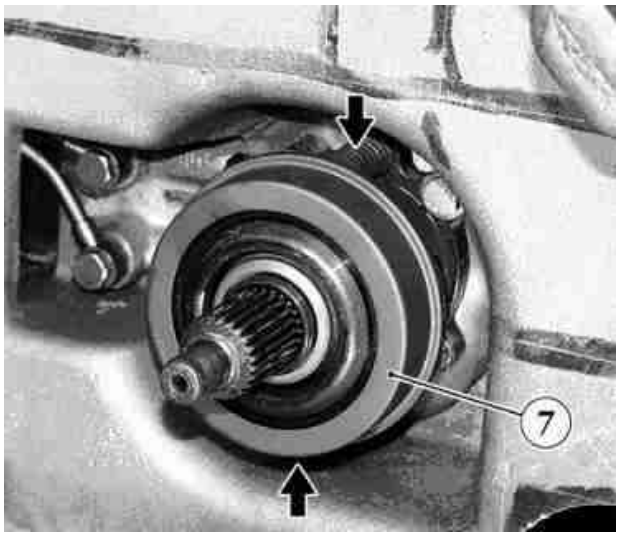
To prevent problems during the clutch position resetting stage, **FROM Ass.ly No. 53232** a stud bolt **(16)** with a longer shaft has been introduced.



NOTES

*On the engines installed in vehicles produced prior to this assembly no., when replacing the clutch, we recommend you replace the mount **(6)** and the stud bolts **(16)** with the new parts.*

- Slide off the bush bearing **(7)** together with the gaskets. Remember to keep the two thrust bearing springs.

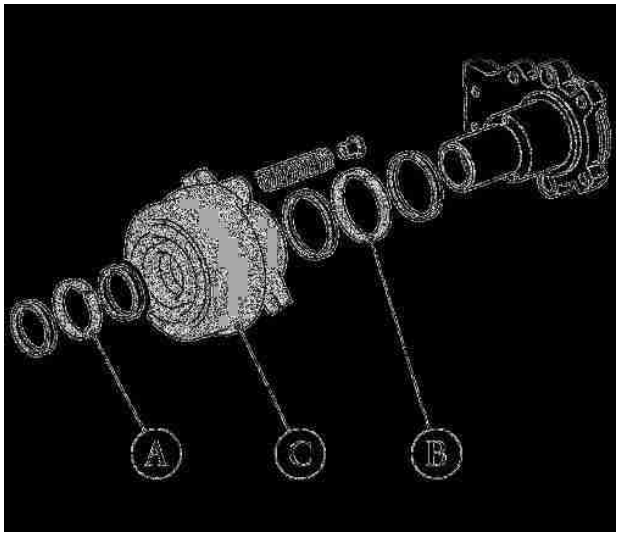


FROM Ass.ly No. 50913 new **light blue** sliding rings **(A)** and **(B)** have been introduced to replace the **orange ones** (no longer available). The new rings offer improved reliability at high temperatures and withstand the oil's aggressive action better.

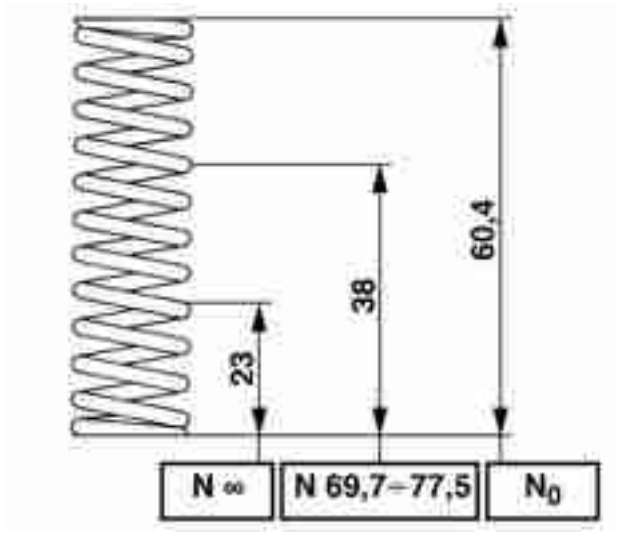
With the introduction of the new rings, the diameter of the relative seats on the bushing inside the thrust bearing **(C)** has been altered.

Our Spare Parts Department will no longer stock and deliver the complete thrust bearing, only the individual components.

Therefore, for the engines installed in the vehicles produced prior to this modification, in the event that the sliding rings are replaced, the thrust bearing must also be replaced.



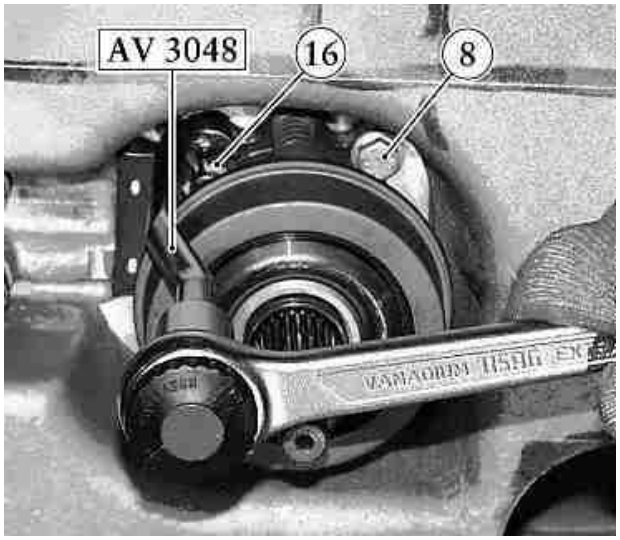
Check the thrust bearing springs, referring to the data in **Figure**.



Manually check the end float of the thrust bearing; if it is excessive, replace it.
FROM Ass.ly No. 50913 the bearing-holder bushing is supplied as a spare part without gaskets.

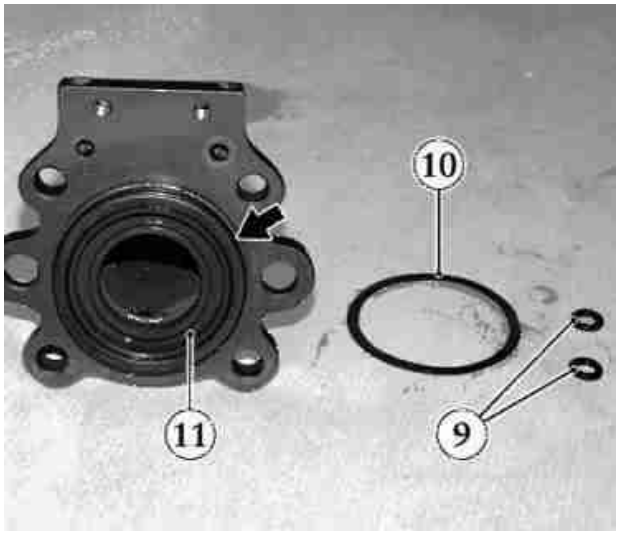
- Unscrew the four screws **(8)** and remove the flange.

NOTES
*In order to avoid disassembling the bushing bearing holder, use the **AV 3048** spanner to unscrew the screws **(8)**.*



- Remove the ORings **(9)** and the spacer **(10)**. It is advisable to replace the ORings at each overhaul/dismantling.

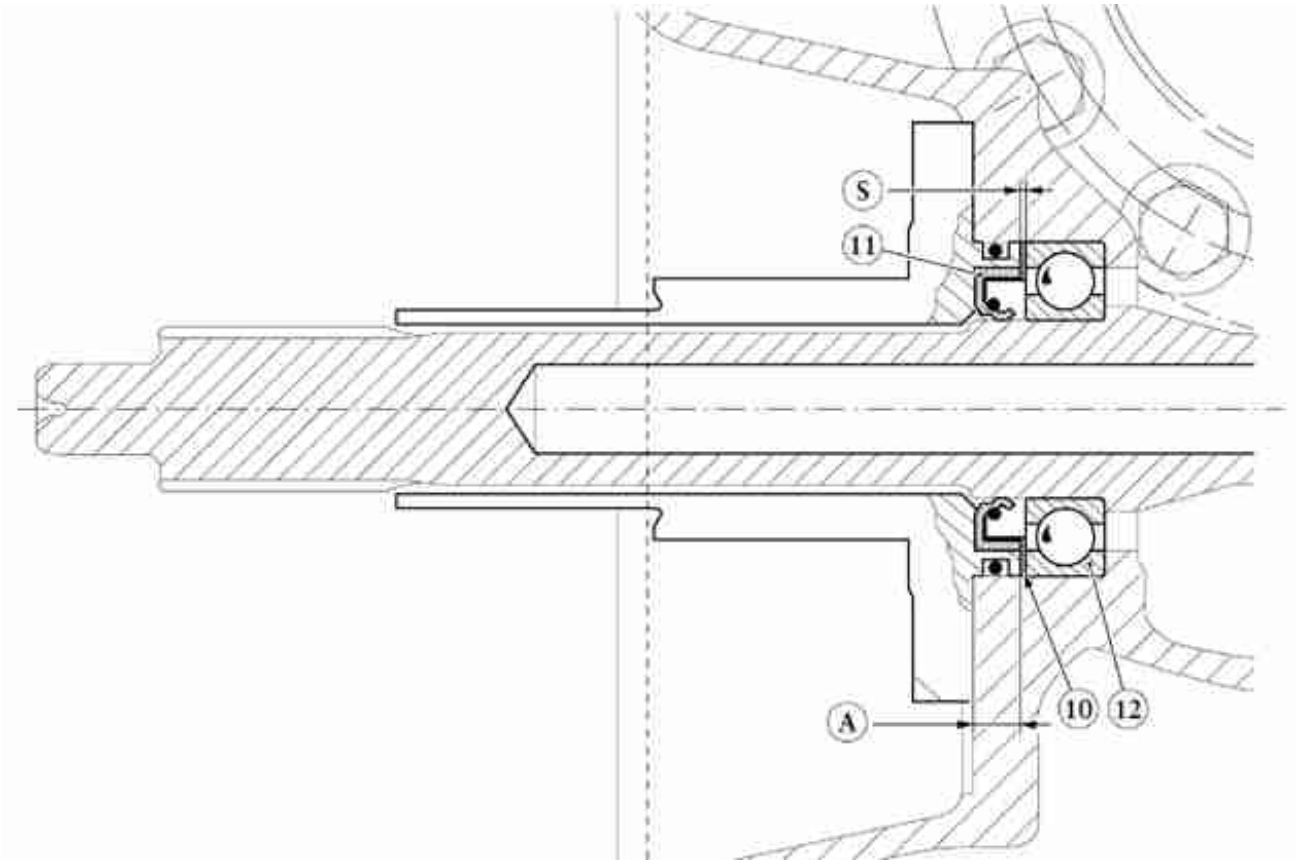
A seal ring **(11)** that must be replaced at each overhaul is fitted onto the gearbox side of the flange.



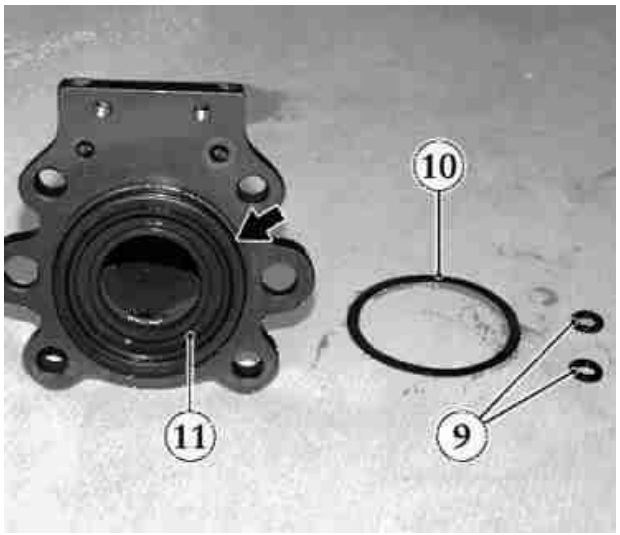
If the flange has been replaced, during re-assembly it is necessary to calculate the thickness of the spacer **(10)** to maintain a certain axial thrust load on the external track of the bearing **(12)**. To determine the thickness **(S)** of the spacer, apply the following formula: **S=(A1-A2)+0,1 mm**, where:

- **A1** = distance **(A)**, on the gearbox, between the front surface and outer track of the bearing;
- **A2** = distance **(A)**, on the flange, between the faying surface with box and the end-limit surface with outer bearing track

Spacers **(10)** with a thickness of **0,1 mm** are available. Using these it is possible to get close to the calculated thickness.

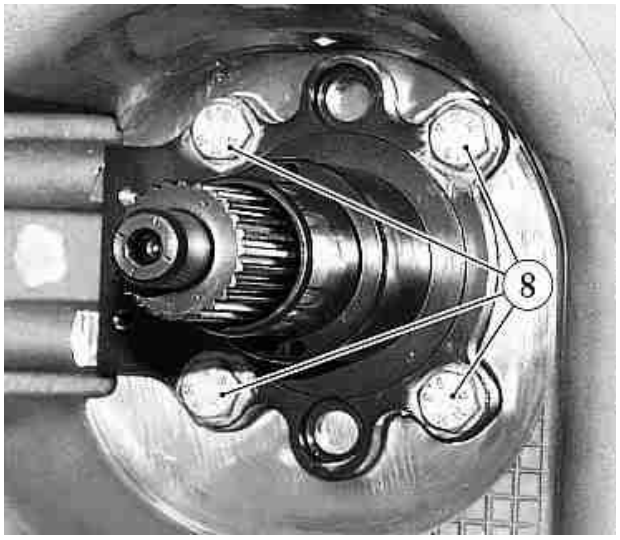


- Lubricate the ORings **(9)** and the gaskets within the bushing with a veil of **FIAT SP 349** grease and then install the spacer **(10)** laying it on the gearbox bearing.
- Mount the flange on the clutch shaft, being careful not to damage the seal ring **(11)**.

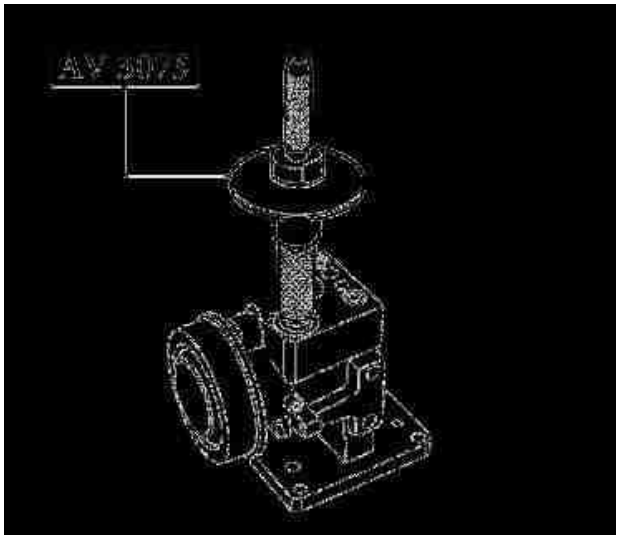


Mechanically controlled gearbox

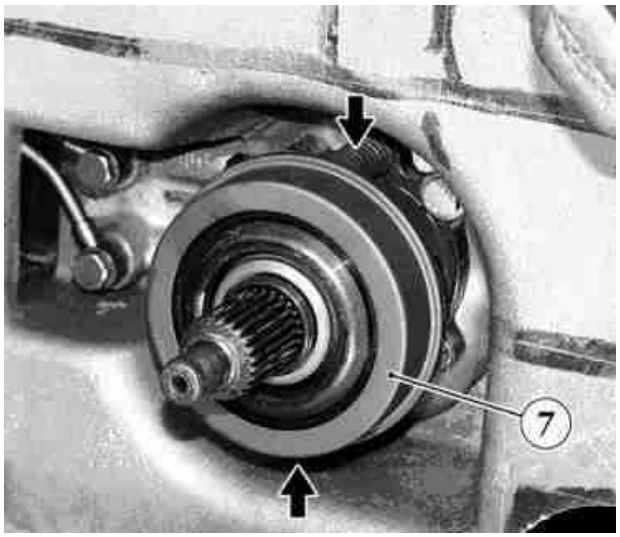
- Lock the four screws **(8)** to the prescribed tightening torque.



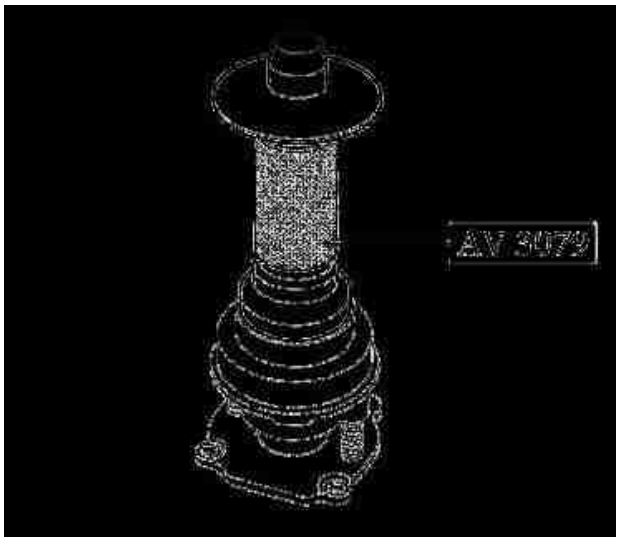
- Before reassembling, check the condition of the flexible guide pin fitted on the busing bearing holder hub. If it is damaged, remove it from its seat and fit and new flexible guide pin, using **AV 3075** tool.



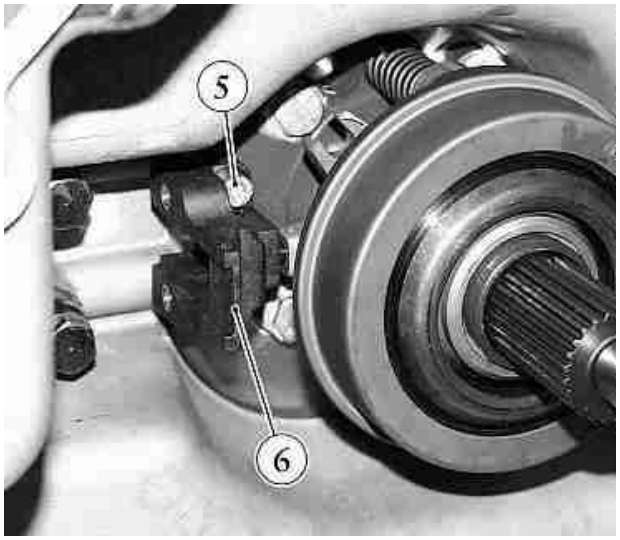
- Install the springs and the bearing bush **(7)** on the flange sleeve.



Use the tool **AV 3079** to centre the bushing bearing holder on the flange sleeve.

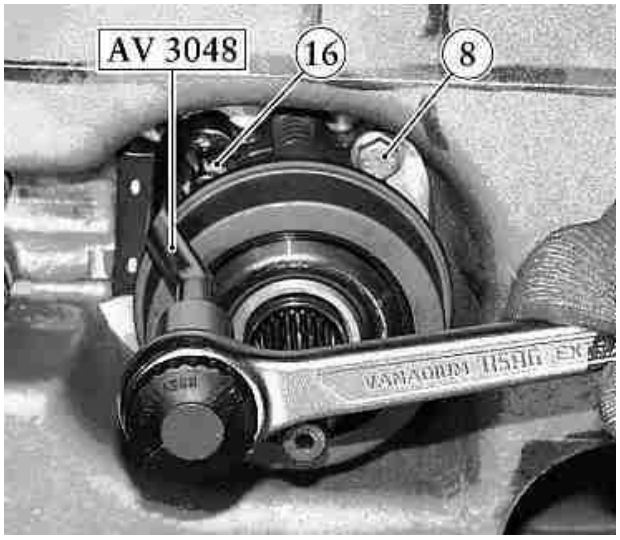


- Mount the guide support **(6)** making the elastic pin fit into the sliding hole.
- Lock the two screws **(5)** to the prescribed torque and check the bearing's movement.



Electronically controlled gearbox

- Tighten the two opposed screws **(8)** to the prescribed torque.
- Fit the springs and the bushing bearing holder **(7)** on the flange, using the **AV 3079** tool.
- Fit the two stud bolts **(16)** inserting them in the bushing's slots and tightening them to the prescribed, using the **AV 3048** wrench.



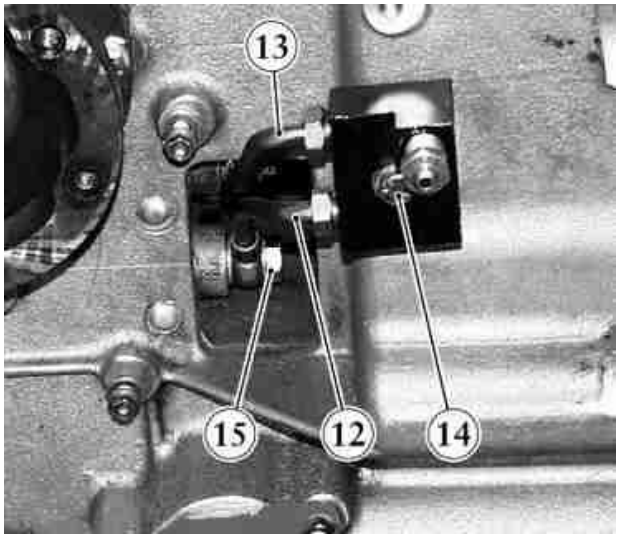
- Fit the bracket with clutch position sensor and tighten the fastening screws to the prescribed torque; check the bearing is moving correctly (D 6.08).

In the event that leakages or damages are found in the unions on the control and oil drainage pipelines **(12)** and **(13)** from the thrust bearing, these can be replaced.

NOTES

Replacement of the control and oil drainage pipelines may be done even if the gearbox is installed in the car: proceed as described for the removed gearbox.

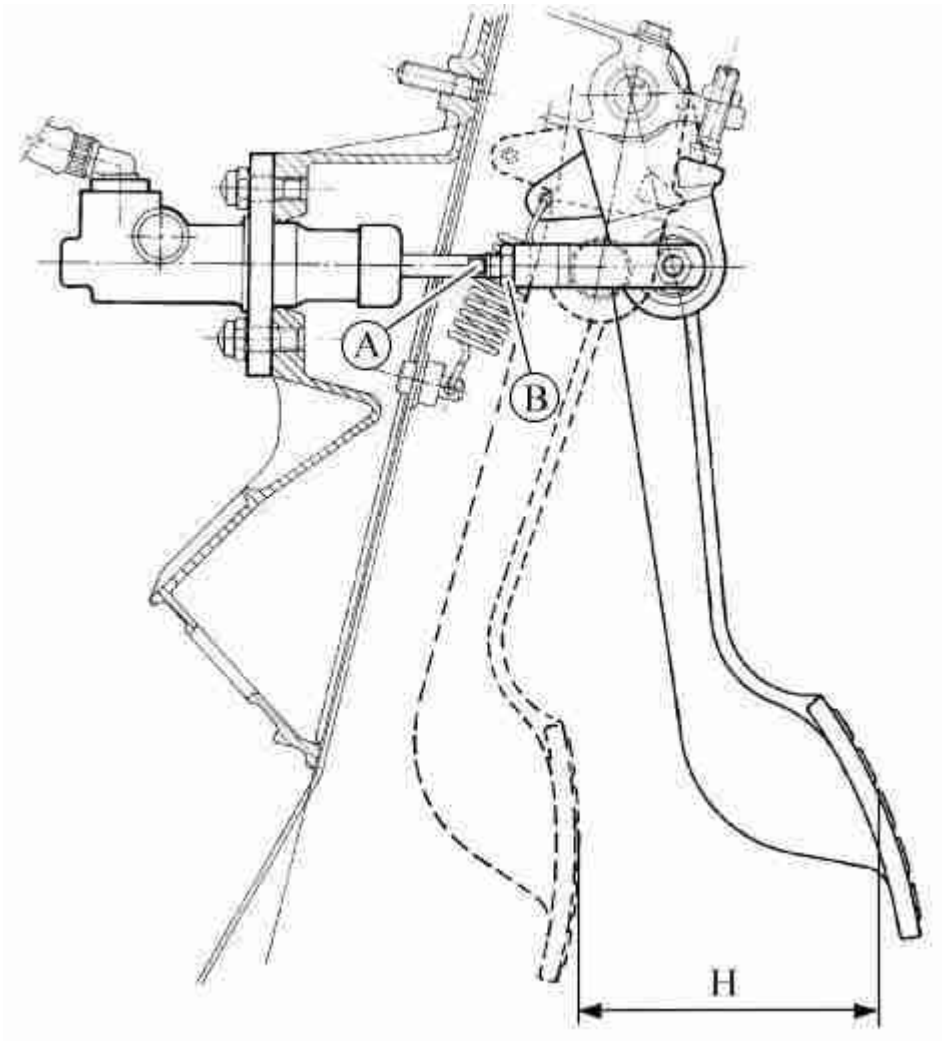
- Unscrew the screws **(14)** fastening the connection block to the gearbox.
- Unscrew the screws **(15)** on the filler neck unions of the pipes and remove them. Remember to keep the gaskets.



- Remove the pipes from the block and replace them.
- During re-assembly, first mount the pipes onto the block, without tightening the unions, and then fasten them with the screws **(15)** and the gaskets to the gearbox.
- Fasten the block and lock the screws **(15)** and then the oil pipe unions to the prescribed torque.

D3.02 CLUTCH PEDAL STROKE ADJUSTMENT

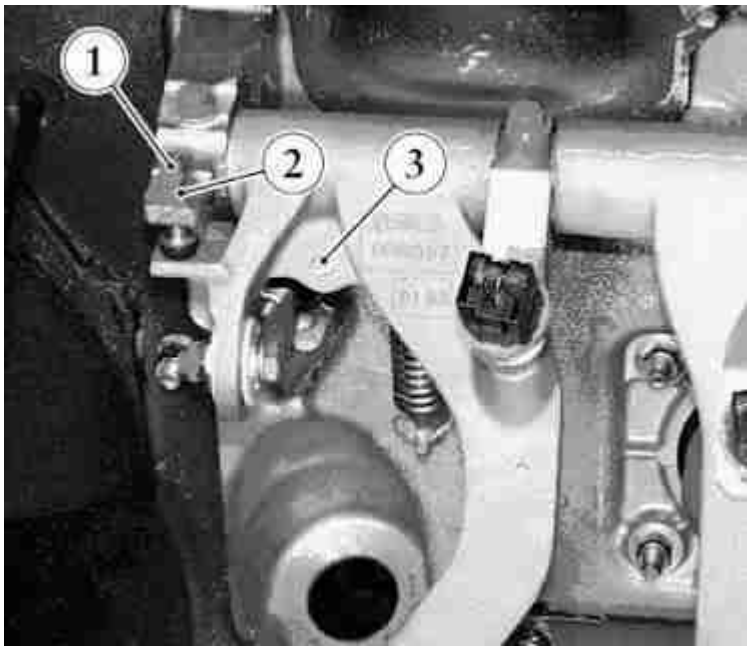
The release stroke **(H)** of the clutch pedal measured in the middle of the foot-rest plate must be **120,4 ÷ 121,4 mm** (**119,4 ÷ 120,4 mm** for the right-hand drive version).



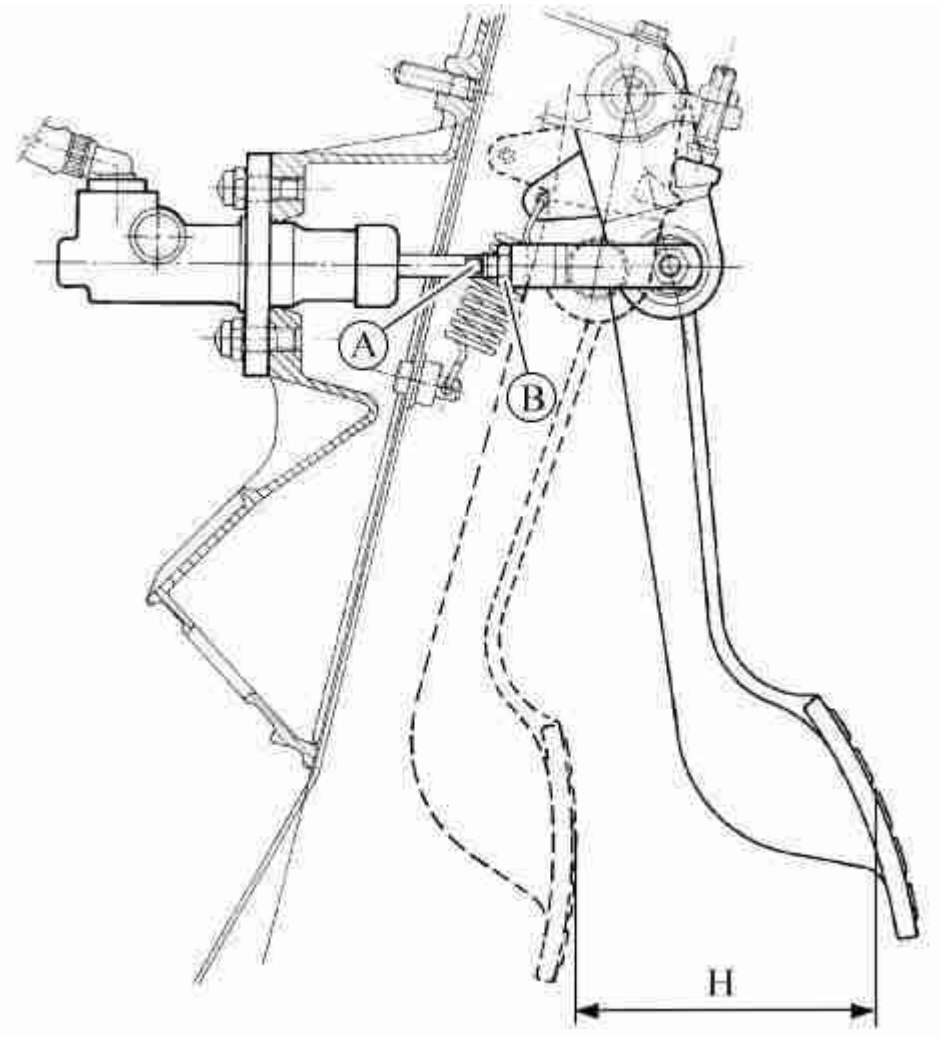
In case of replacement of the control pedal and/or the clutch cylinder, it is necessary to adjust the pedal into the resting position, in order to align it with the brake pedal.

Proceed as described.

- Loosen the lock-nut **(2)** and unscrew the adjusting screw **(1)**.

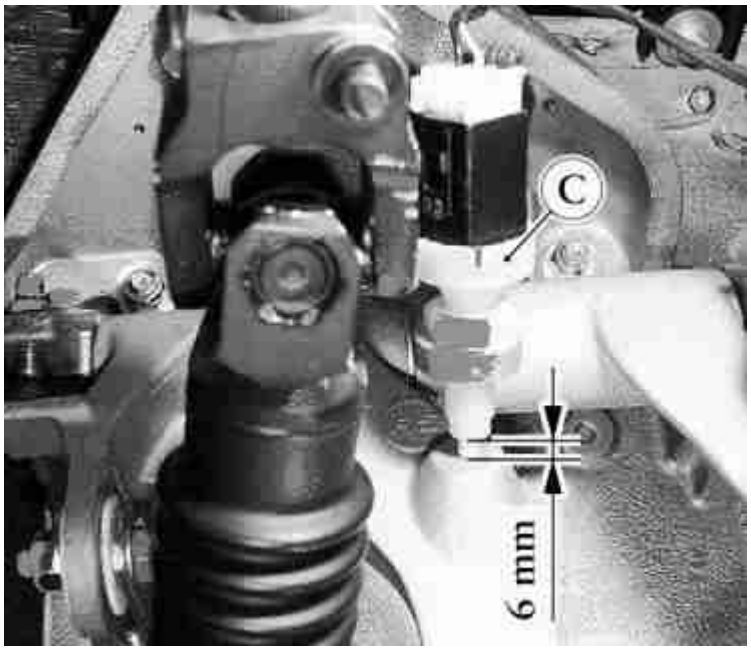


- Loosen the lock-nut **(B)** and turn the pump adjusting screw **(A)** until the pedal is properly positioned.



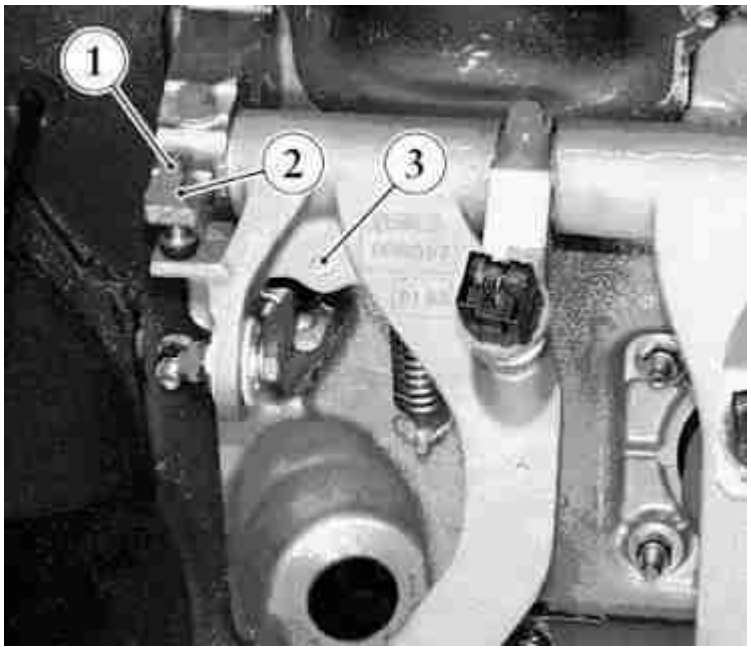
- Move the adjusting screw **(1)** until it touches the pedal, then screw it one turn.
- Tighten the lock-nuts on the cylinder screw and on the adjusting screw.

With the clutch pedal in resting position, the lower end of the switch **(C)** must be positioned 6 mm away from the push-button faying surface on the pedal.

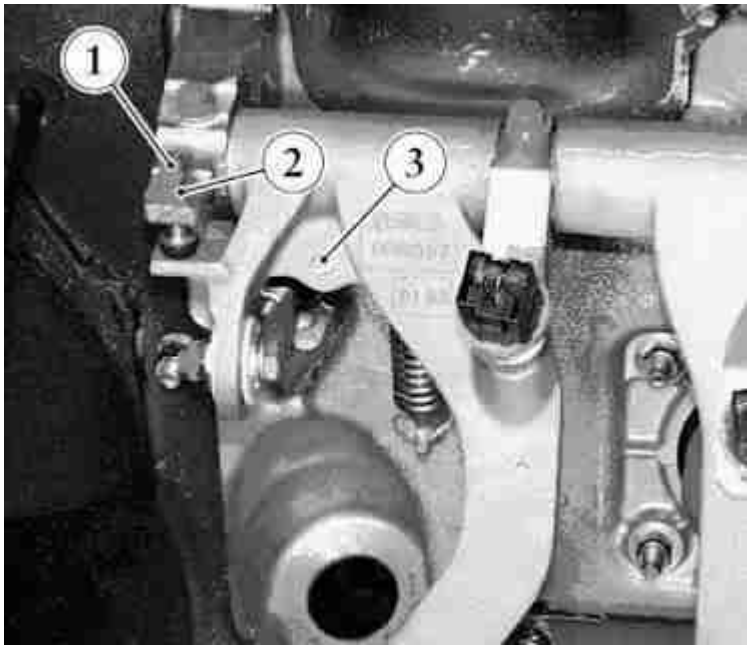


If the clutch pedal does not perform the prescribed stroke after alignment with the brake pedal, it is necessary to restore it by proceeding as follows.

- Move the adjusting screw **(1)** until it touches the pedal stop-limit and then screw it.
- Tighten the lock-nut **(2)**.
- Loosen the lock-nut and completely unscrew the adjusting screw **(3)**.



- Press the clutch pedal until the prescribed stroke is attained and then, keeping it in this position, bring the adjusting screw **(3)** in touch with the pedal support.



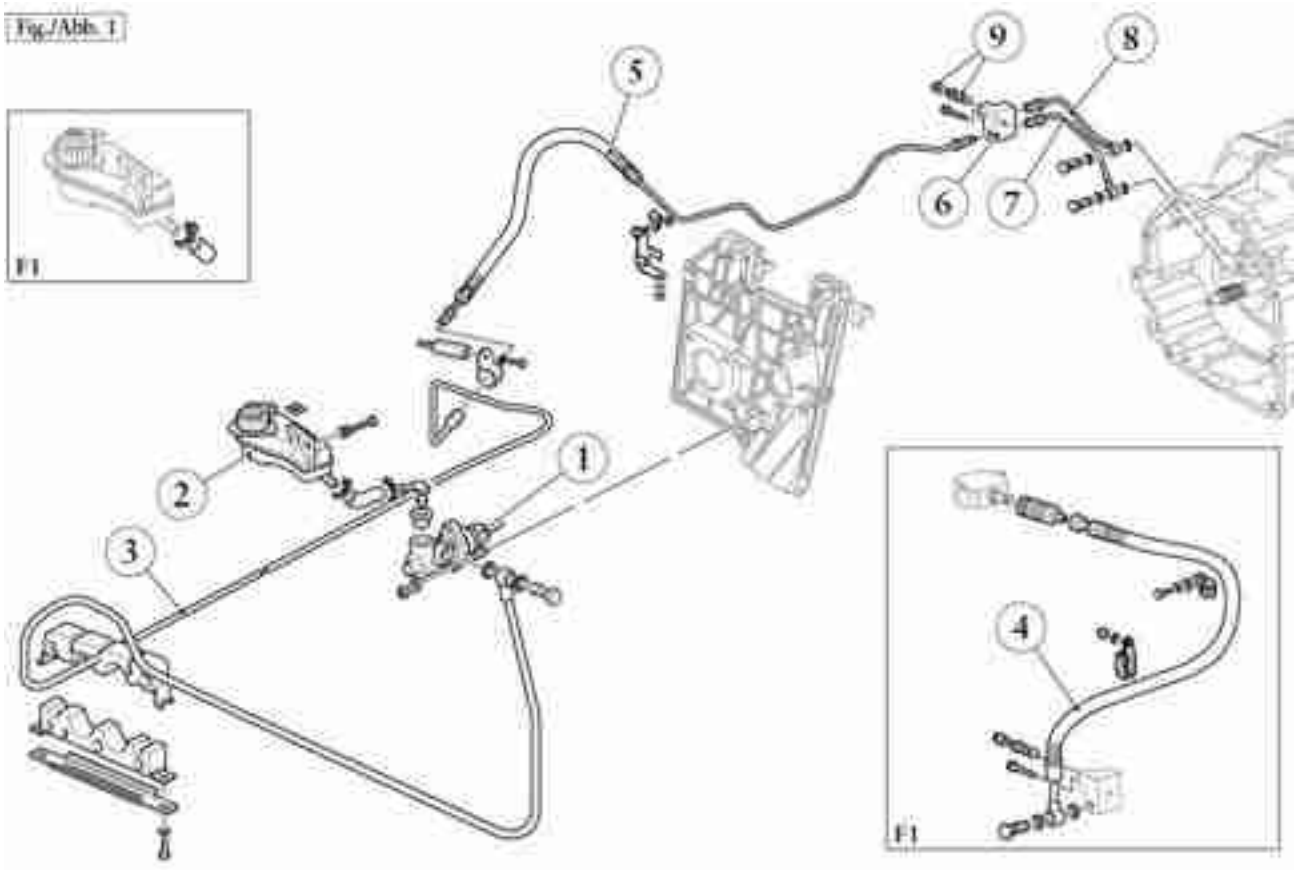
- Screw the adjusting screw **(3)** one turn and tighten the lock-nut.
- This way the end strokes of the pedal are set by the adjusting screws **(1)** and **(3)**, at the same time allowing to use the prescribed stroke.

IMPORTANT

Do not use the entire cylinder stroke as it would be excessive, giving the feeling of stressing the pressure plate springs.

D3.03 CLUTCH CONTROL HYDRAULIC SYSTEM

The hydraulic system of the clutch disengagement control is made up of the following parts (**Fig. 1**):



*Keys to **Fig. 1***
1 - Clutch cylinder
2 - Clutch/brake fluid tank
3 - Underfloor stiff pipe
4 - Complete clutch pipe (Electronically controlled gerabox)
5 - Engine compartment flexible pipe
6 - Connection block
7 - Gearbox connecting pipe
8 - Drainage system pipe
9 - Drainage union

NOTES
No adjustment is necessary since the control is the hydraulic type.
In case of excessive backlash of the control pedal on the pedal board pivot, replace the bushings (G 2.03).

Tightening torques	Nm	Category
Nut fastening clutch cylinder	**20**	**B**
Pipe union on clutch pump	**21**	**A**
Draining union (M12x1)	**18**	**A**

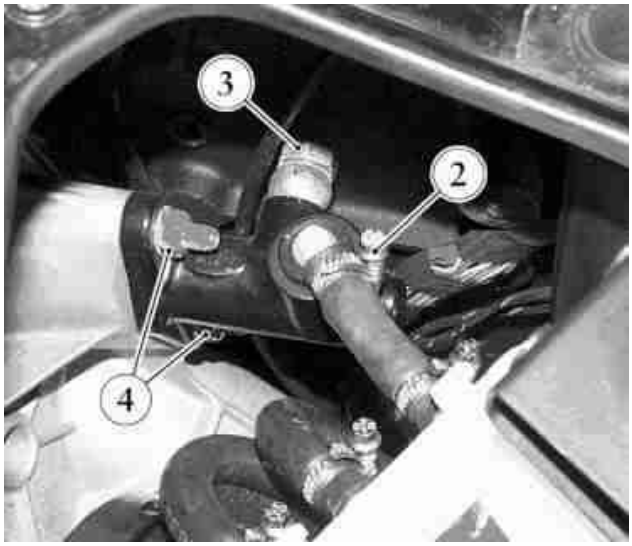
Clutch Cylinder Replacement

- Remove the movable back bulkhead fom the luggage compartment (_____).
- Remove the inspection cover and detach the brakes/clutch fluid tank (G 2.02), keeping it connected to the pipes.
- Remove the rear part of the underfloor (M 2.12).
- Drain the clutch system by unscrewing the draining union **(1)** on the right-hand side of the gearbox block. The drained fluid must not be reutilised.

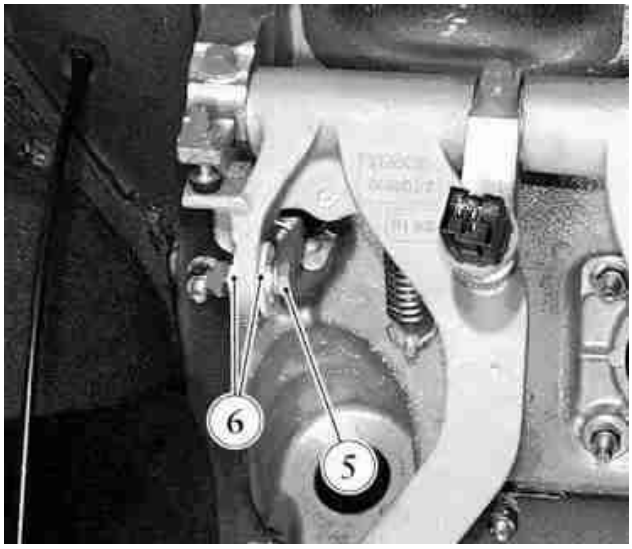
ATTENTION

The fluid used in the system can cause injury to eyes and skin.In the event of contact, thoroughly rinse the body area involved with abundant running water. In addition, the brake-clutch fluid may damage the car's polished parts.

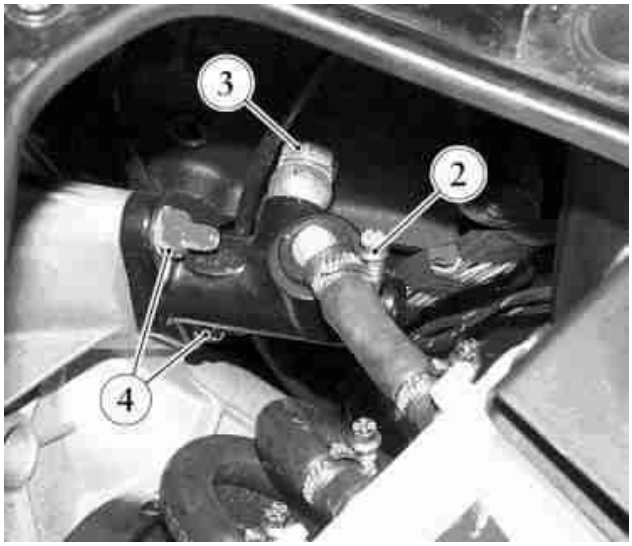
- Screw the union **(1)** again.
- Loosen the clamp **(2)** on the pipe connecting the tank to the clutch cylinder and remove it from the latter.
- Unscrew from the pump the screw **(3)** on the stiff pipe union for the clutch system and remove it from the pump. Remember to keep the gaskets.
- Unscrew the nuts **(4)** fastening the clutch cylinder to the pedal board support.



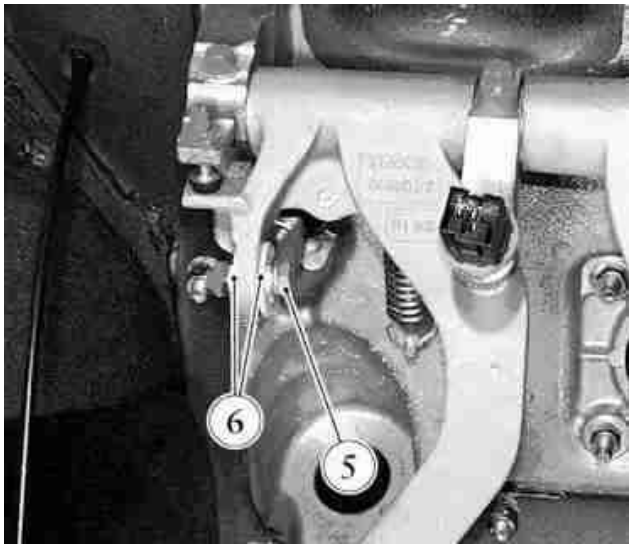
- In the passenger compartment, unscrew and remove the fulcrum screw **(5)** of the cylinder control fork to the clutch pedal: Remember to keep the shims **(6)**.



- Slide off the complete clutch cylinder from the luggage compartment.
- Install the new pump onto the pedal board support, fastening it with two nuts **(4)** to the prescribed torque.
- Fasten the stiff pipe union onto the pump with the screw **(3)**, interposing the gaskets and locking them to the prescribed torque.
- Re-assemble the tank connection pipe, locking the clamp **(2)** and mounting the tank.



- Fill and drain the clutch system (D 3.04).
- Connect the control fork to the pedal, interposing the shims **(6)** and tightening the nut on the screw **(5)**.



NOTES
After assembling a new cylinder, it is necessary to adjust the pedal stroke (D 3.02).

- Re-assemble the parts removed previously.

D3.04 SYSTEM BLEEDING

After replacing any of the system's parts bleed the air present in the system.

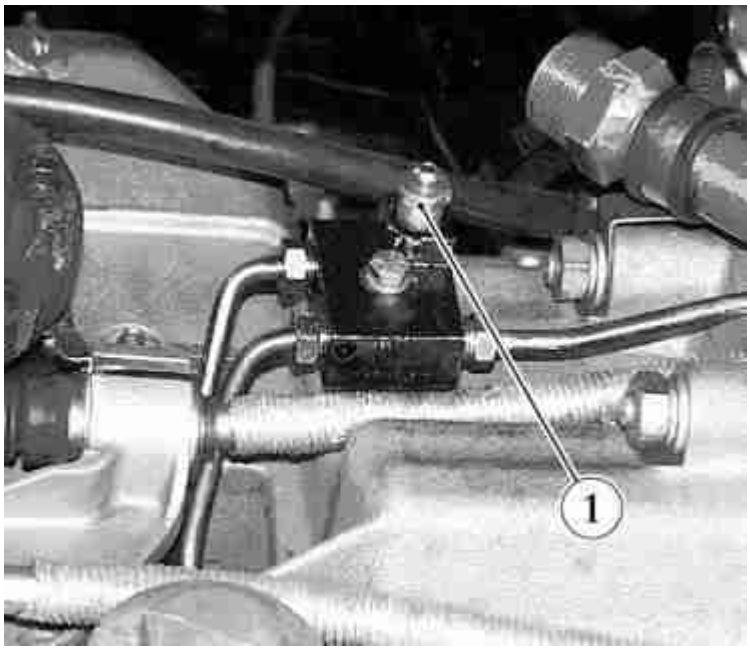
IMPORTANT
*During the bleeding phase, keep checking the oil level in the tank: it must never drop below the **"min"** level (A 3.18 or A 3.11).*
Never re-use the oil which has come out of the system.

Tightening Torques

Bleeding union	**18 Nm**

Mechanical gerbox

To gain access to the bleeding union, it is necessary to remove the rear part of the underfloor (M 2.12).
- Connect a transparent pipe to the bleeding union **(1)** and dip its end into a pan containing brake fluid.

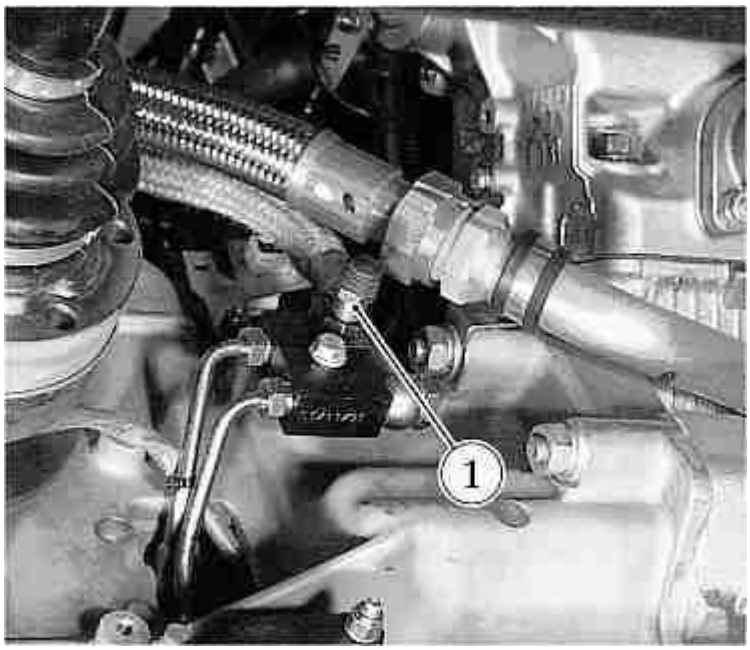


- Press the clutch pedal and simultaneously unscrew the bleeding union; carry out the necessary number of cycles until only fluid comes out of the pipe, without air bubbles.
- Tighten the bleeding union to the prescribed torque and re-assemble the protection plug.
- Fill-up the fluid in the tank to the **"MAX"** level.
- Re-assemble the parts removed during the procedure.

Electronically Controlled gerabox

Clutch Draining

In the system, as well as the union **(1)** on the gearbox, there is also a second union **(2)** on the block for the clutch pipe rapid coupling, located in position with the right-hand rear fastening point of the gearbox support frame.



NOTES

*In light of its position, it is advisable to begin draining at the union **(2)** and finish at the union **(1)** on the gearbox.*

1- Connect the SD-2 system to the diagnosis plug-in (L 2.12).
2- Choose **"Diagnosis"** from the main menu.
3- Choose **"CLUTCH DRAINING"** from the **"DIAGNOSIS"** menu.
4- Add oil into the tank to prevent the oil level from runninn low.
5- Press **"ENTER"** to activate the tester.
6- Open the clutch draining union and wait 3÷4 seconds to let the oil flow out.
7- Close the draining union once again.
8- Top up the oil level in the tank.
9- Repeat procedures 6-7-8 two or three times, on both draining unions.
10- Once the operation has been completed, tighten the unions to the prescribed torque.
11- Wait for the tester to exit the draining procedure and to display the related positive result.
12- Shift gears a couple of times and top-up the level.

Gearbox actuator draining

To gain access to the draining screws, remove the actuator from the gearbox (D 6.07), keeping it connected to the hydraulic and electric system.

IMPORTANT
During this procedure, the actuator must be supported to prevent the sensor cables from being taut and the pipes from being excessively bent(reduced radius of curvature)

1- Connect the SD-2 tester to the diagnosis plug (_____).
2- Choose "DIAGNOSIS" from the main menu.
3- Check the level in the tank and top-up if necessary.
4- Loosen the three draining screws **(3)** by two turns.

5- Choose "ACTUATOR DRAINING" from the "DIAGNOSIS" menu.
6- Press "ENTER" to activate the tester.
7- Wait for the automatic procedure to be completed.
8- Tighten the draining screws **(3)** to the prescribed torque.
9- Top-up the level in the tank.
10- Refit the actuator (D 6.07).
11- Carry out the self-learning procedure for the engagement and selection thresholds by choosing the "GEARBOX SELF-LEARNING" function from the "DIAGNOSIS" menu.

D4.01 REPLACING THE EXTERNAL COMPONENTS

NOTES

This paragraph only indicates the procedures for the replacement of some of the gearbox external components. For the procedures pertaining to the internal parts of the gearbox, it is necessary to remove the complete gearbox unit (D2.01) and consult the chapter "Gearbox Overhaul" (D4.05) or the paragraph "Component Replacement" in the "Differential" chapter. (D 5.01)

Tightening torques	Nm	Category
Screw fastening right flange cover	**30**	
Screw fastening differential cover	**10**	
Screw fastening gear-selection and shift lever	**27**	**A**
Nut fastening the cover to control lever rod	**7,4**	**A**
Screw fastening control gearbox lever (finger) on rod	**32**	

Seal Ring on Axle Shaft Connection Flange

It is possible to replace the seal rings on the connection flanges of the axle shafts also with the gearbox installed in the car, after having removed the rear part of the underfloor (M 2.12) and having removed the flange's axle shafts (D 5.02).

- To be able to remove the left-hand side cover from the gearbox housing, it is necessary to separate the hub carrier with axle shafts from the suspension (F 3.02) and from the toe-in tie rods.
- Detach the hub carrier complete with calipers, brake disk and axle shafts just enough to allow the left-hand side cover to be removed from the gearbox housing.

NOTES

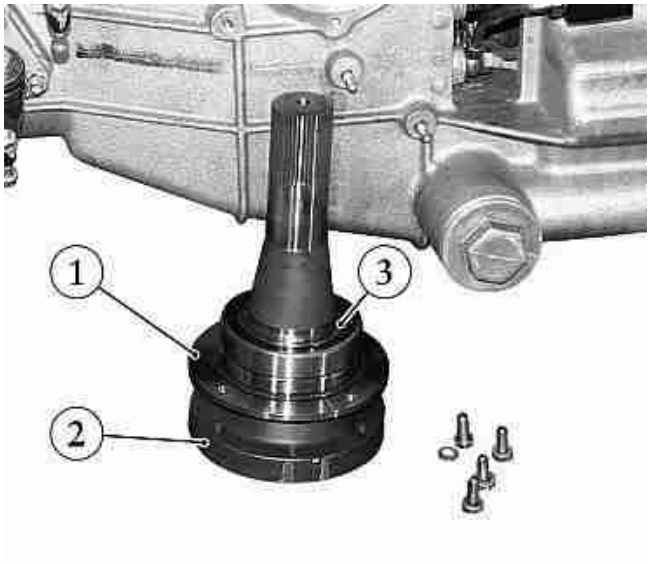
For a clear understanding, the figures show a gearbox removed from a car.

- Drain the gearbox oil (A 3.02).

Right-hand side

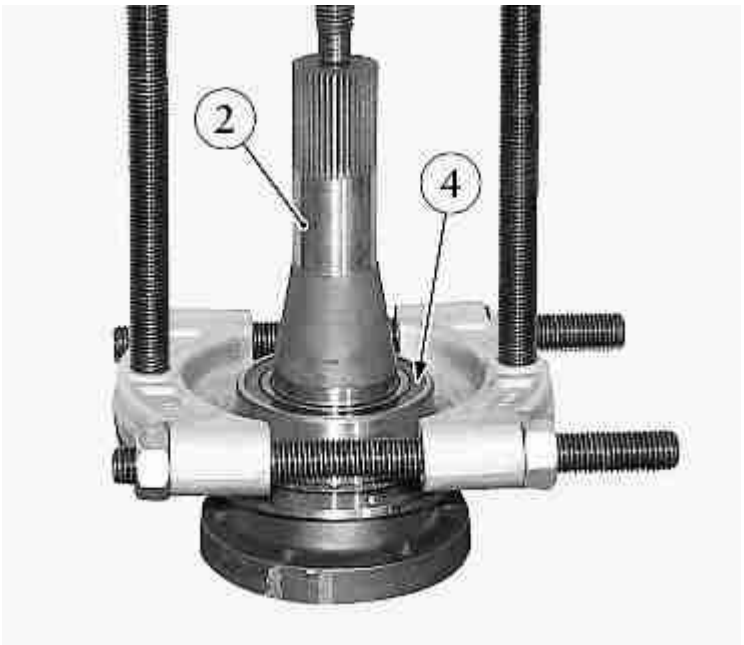
- Unscrew the four screws fastening the external cover **(1)** to the gearbox housing.
- Remove the complete flange from the gearbox using the **AV 2714** extracting tool equipped with **AV 3045** pins.

- Remove the flexible ring **(3)** from the flange shaft **(2)**.

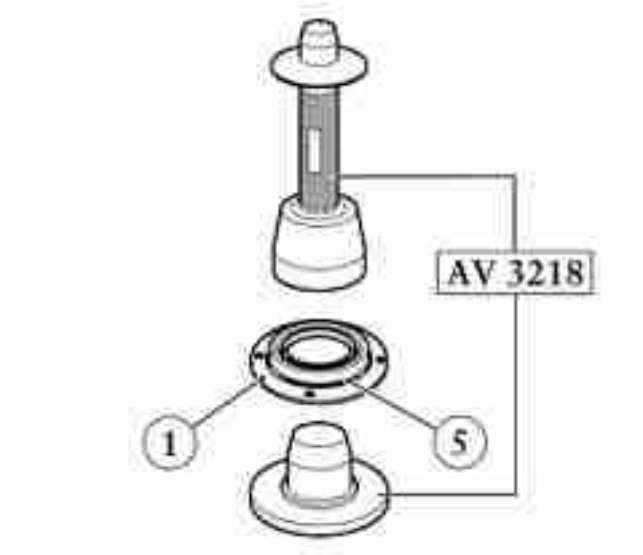


- Using a commercial bearing extracting tool, like the one illustrated, remove the support bearing **(4)** from the flange shaft **(2)**. Check it is in good condition, keeping in mind it must be refitted.
- Detach the cover **(1)** together with external O-ring and the internal grommet.
- Remove the grommet from the cover and replace it.
- Thoroughly clean the cover and the gearbox housing coupling surfaces and sufficiently grease the new grommet.

IMPORTANT
Grommet lubrication is indispensable to guarantee its proper functioning.



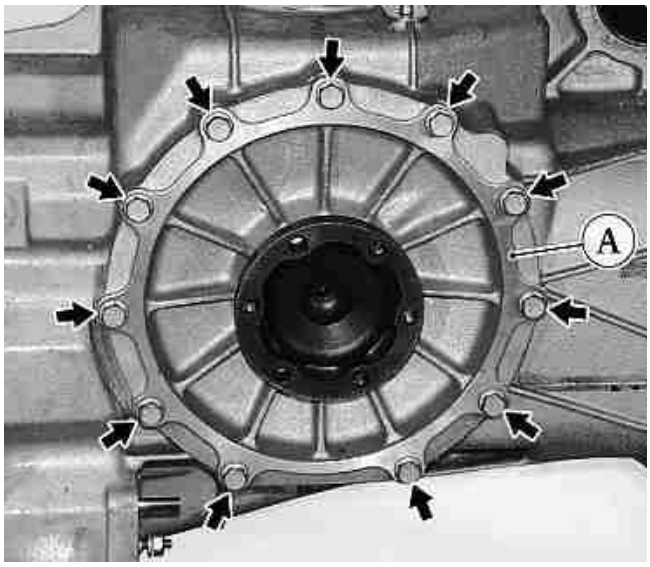
- Position the grommet with its closed side facing outwards and, using the **AV 3218** punch, bring it flush with the cover **(1).**
- Check that the O-ring **(5)** on the cover is in good condition, then grease the flange shaft with gearbox oil.



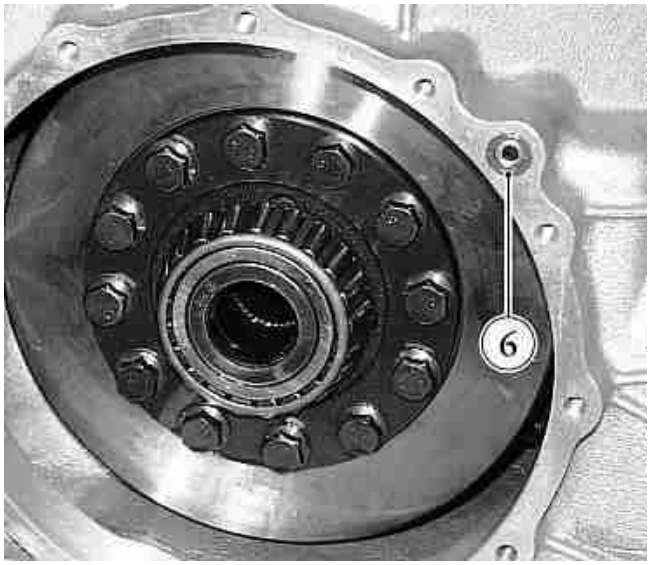
- Fit the previously removed complete cover and bearing **(4)** onto the flange shaft.
- Using the **AV 3275** tool's punch **(a)** and inserting the flange shaft **(2)** into the **AV 3277** tool, bring the bearing flush **(4)**.
- Fit the flexible ring **(3)** and re-assemble the complete flange onto the gearbox.
- Tighten the screws of the external cover **(1)** to the prescribed tightening torque.

Left-hand side

- Remove the left-hand side catalytic converter (B 7.06).
- Remove the starter motor (L 2.04).
- Unscrew the screws fastening the differential cover **(A)** to the gearbox housing.

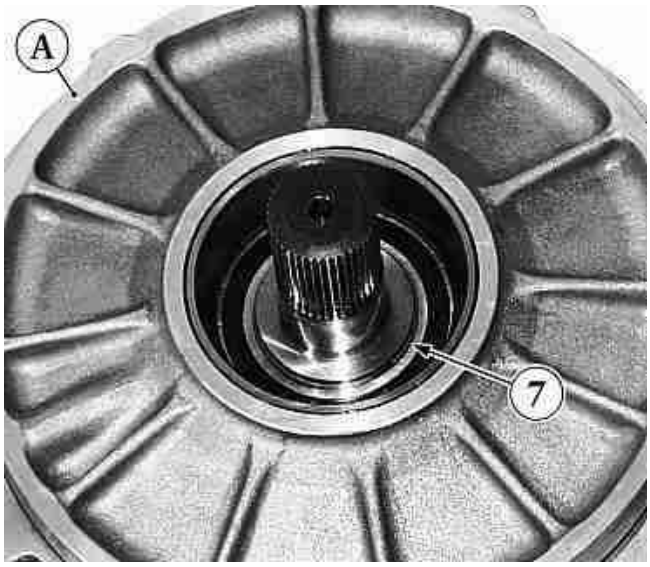


- Remove the cover together with the flange, using the **AV 2714** extracting tool fitted with the **AV 3045** pins, previously utilised for the right-hand cover, and keep the O-ring **(6)** situated on the lubrication hole.

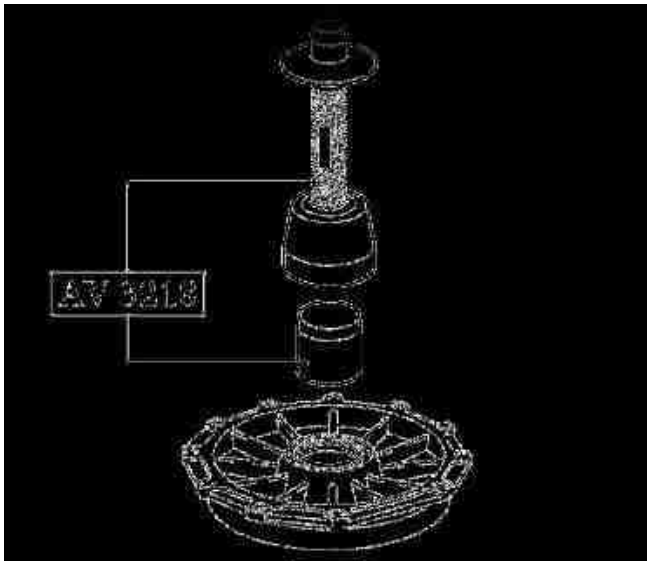


- Remove the flexible ring **(7)** from the flange shaft.
- Using a rubber hammer, beat the flange shaft until it comes out from the differential cover **(A)**.
- Remove the worn-out grommet from the differential cover.
- Thoroughly clean the cover and gearbox housing coupling surfaces and properly grease the new grommet.

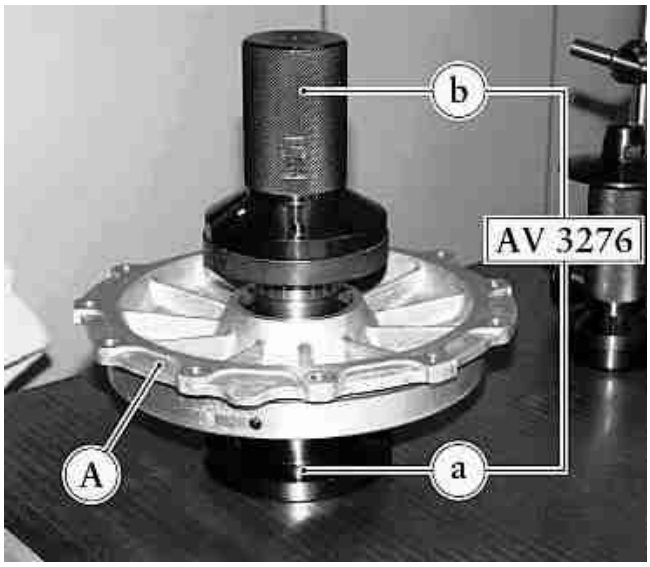
IMPORTANT
Grommet lubrication is essential to guarantee its proper functioning



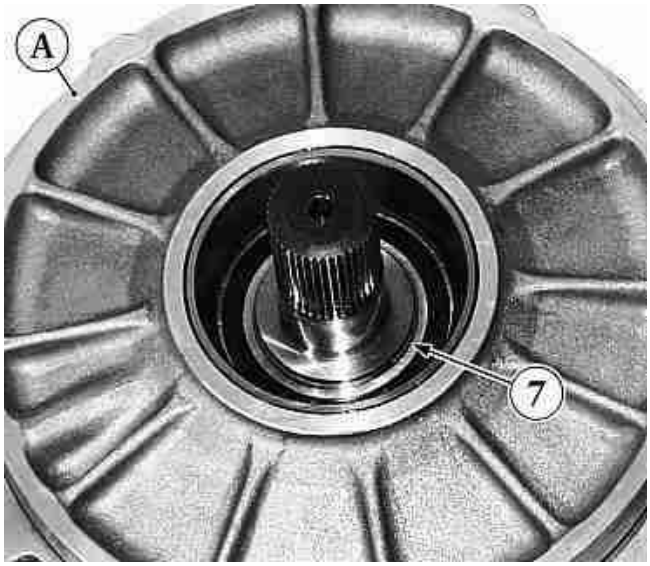
- Position the grommet with its closed side facing outwards and, reusing the **AV 3218** punch, bring it flush with the cover.



- Grease the flange pin with gearbox oil, then mount the differential cover **(A)** onto the flange shaft
- Rest the inner ring of the differential lid's **(A)** bearing on the base of the **(a) AV 3276** tool.
- Using the punch **(b)**, bring the inner ring flush with the flange shaft.



- Fit the flexible ring **(7)**.
- Check the condition of the O-ring on the cover.
- Position the O-ring on the lubrication hole.
- Couple the parts and tighten the eleven screws to the prescribed tightening torque, working crosswise.



Flexible upper bushing on the gearbox housing

NOTES

The procedure is possible also with the gearbox installed in the car, after having removed the support cross member (D 4.04).

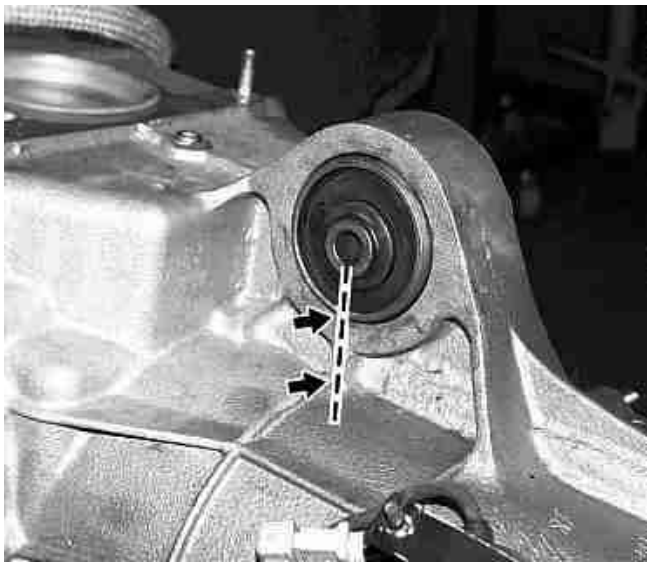
In this case it is necessary to sufficiently support the gearbox housing, by inserting a spacer between the gearbox and the chassis' lower bar or by supporting it using a hydraulic hoist..

To replace the upper flexible bushing it is necessary to use tools **AV 3219** and **AV 3375**.

- To remove the punch from the gearbox housing it is necessary to use tool **AV 3375**, configured for the “REMOVAL” procedure (**SMONT**).
- Position the tool on the gearbox housing punch, as shown in Fig. **1**, moving the pushing tool (**A**, marked with **SMONT**) so that it comes in tough with the flat side of the punch.

- Screw the nut (**B**) with the washer until the cylinder (**C**) comes in touch with the seat on the gearbox housing.
- Keep the central pin (**V**) locked and work on the nut (**B**), until the punch is removed.

- Before fitting the new bushing, check that the seat on the gearbox housing is mint, without grooves or deformations, then grease it to ease fitting.
- Position the new bushing so that the arrow is turned upwards.



- Position tool **AV 3375** configured for the “ASSEMBLY” procedure (**MONT**), as shown in Fig. **2**, inserting the shim (**Q**, marked with **MONT**), between the bushing and the pushing tool (**P**, marked with **MONT**, thickness **5,5 mm**).

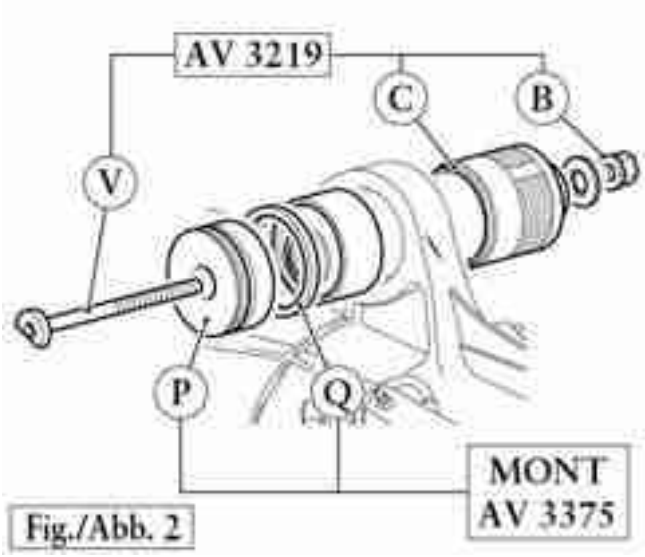
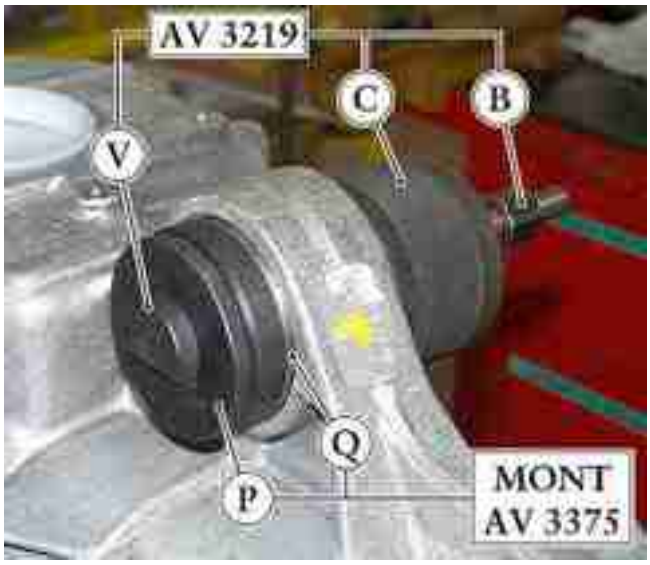


Fig./Abb. 2

- Screw the nut (**B**) with the washer on the central tool pin, until the shim (**Q**) is flush on the gearbox housing.
- Fit the spacers on every side of the bushing (D 4.04).



Gearbox Housing Lower Pad

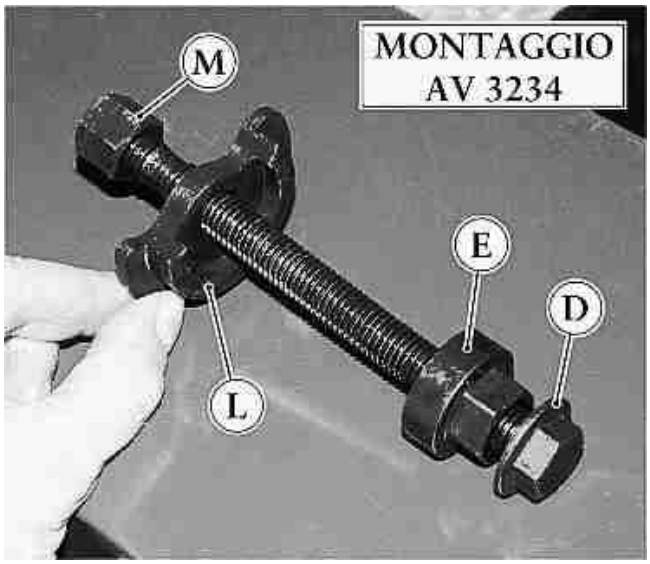
NOTES

The procedure is also possible with the gearbox installed in the car, after having detached the link rod reaction (D 2.01).

To remove the pad from the gearbox housing it is necessary to use the **AV 3234** tool, prepared for "DISASSEMBLY" .

- Position the tool on the gearbox housing pad, as illustrated in Fig. **3,** and tighten the screw (**D**) until the end part is aligned with the outer edge of the extractor (**E**).
- Tighten the nut (**F**) with the washer(**G**) until the shim (**H**) is in contact with the gearbox housing.
- Keep the screw (**D**) locked and work on the hexagonal part of the extractor (**E**), until the pad is removed.

- Before fitting the new pad, check that its seat on the gearbox housing is in good condition, without grooves or buckling and then grease the seat to facilitate insertion.
- Position the tool **AV 3234** ready for “ASSEMBLY”.



- Position the tool and the new pad on the gearbox housing, as illustrated in Fig. **4**.
- Lock screw (**D**) on the blind nut (**M**).
- Tighten the extractor (**E**) until the pad is completely inserted in its seat on the gearbox housing.

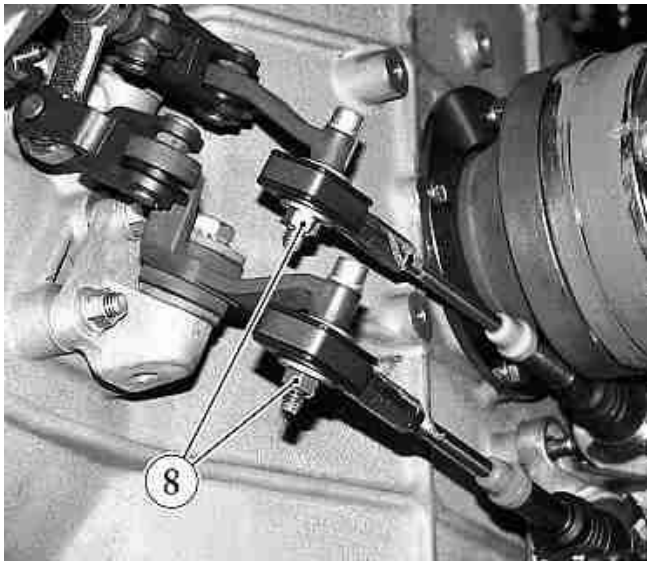
- Turn the screw (**D**) in a counter-clockwise direction to bring the pad in contact with the shim (**L**), then release the blind nut (**M**) and remove the tool (see Fig**. 5**).

- Reposition the link rod reaction and fix it on the punch D 2.02).

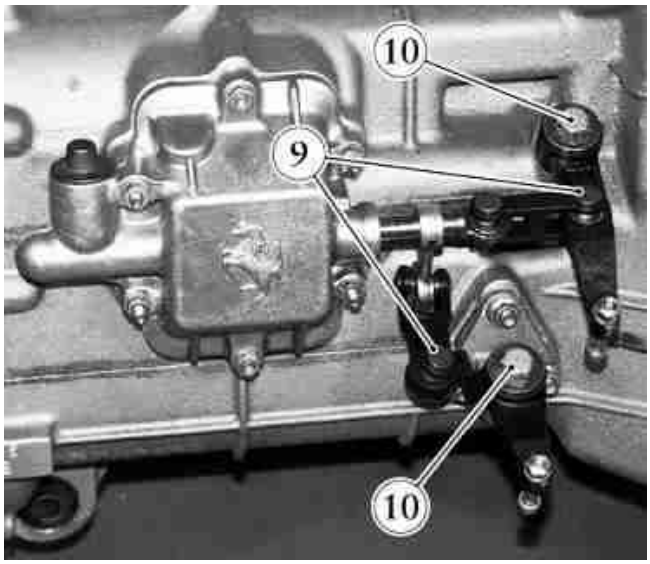
Gearshift selection levers (Mechanically controlled gearbox)

In case of excessive end float of the gear-shift selection levers on the respective pivots, it is possible to replace the levers which are supplied as spare parts complete with roller bearings.

- To gain access to the levers it is necessary to remove the rear part of the underfloor (M2.12).
- Remove the joints of the control cables from the levers, unscrewing the nuts **(8)** on the fulcrum screws.



- Remove the seeger ring on the pivots **(9)** and remove the connecting rods from the gear-shift selection and engagement levers.
- Unscrew the screw **(10)** and slide off the lever with all the support parts.



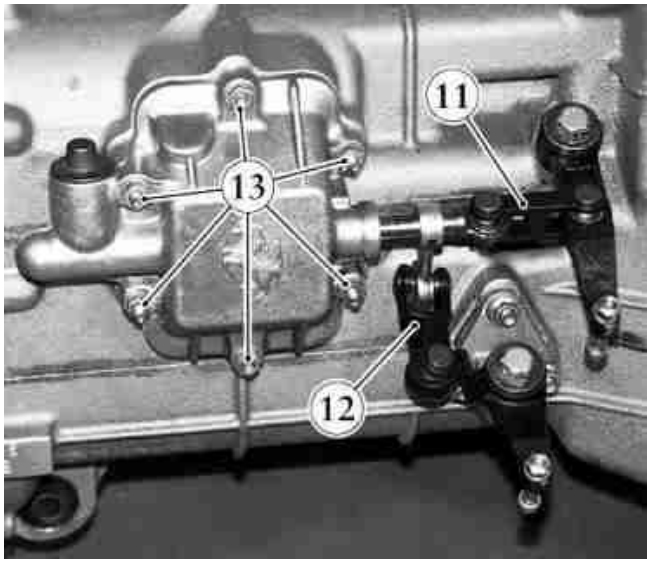
- When re-assembling, lubricate the roller bearings on the selection levers and the pivots **(9)** with **MOLYKOTE** grease.
- Tighten the screw **(10)** to the prescribed torque.

Cover with gearbox control rod (Mechanically controlled gearbox)

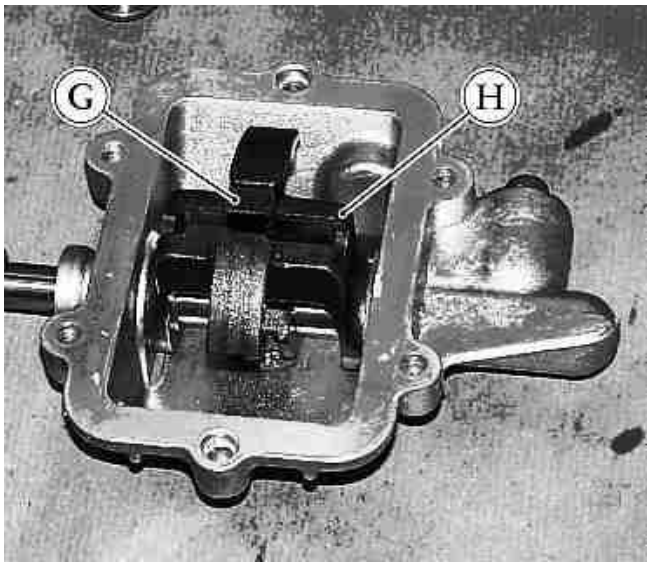
The cover unit with control lever for gearshift selection engagement/release, is mounted on the right-hand side of the gearbox.

The oil seal, in position with the control rod outlet, consists in a gasket made up of an O-ring and a nylon ring. If this is removed, the O-ring must be positioned towards the outside.

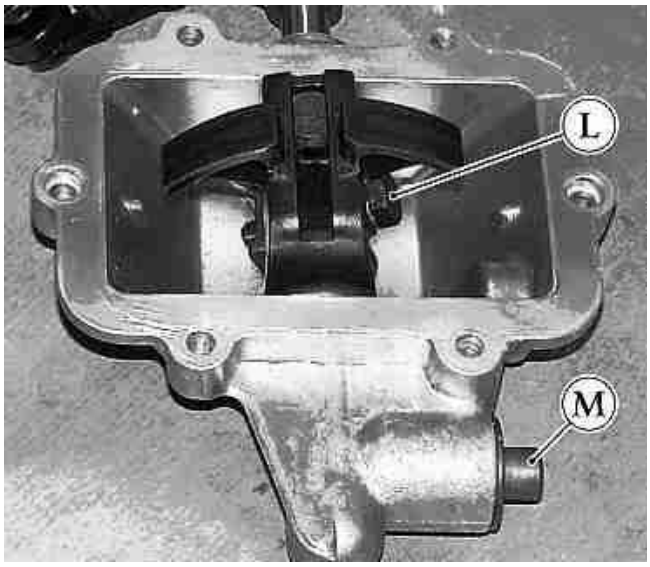
- To remove the cover, detach the connecting rods **(11)** and **(12)** from the coupling and selection levers, as described earlier.
- Unscrew the nuts **(13)** and remove the cover, striking it with a rubber hammer, to release the resistance of the sealant used during assembly.



- Check that the equaliser **(H)** and the lever **(G)** move correctly, without excessive clearance.

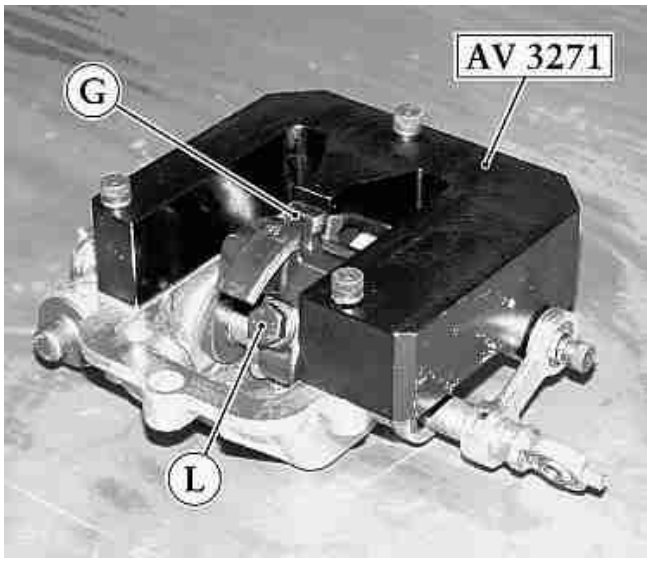


- Check the radial clearance of the control lever in the cover bushing.
- If clearance is excessive, remove the screw **(L)** to release the equaliser, next remove the adjusting screw **(M)** and then slide out the control lever.

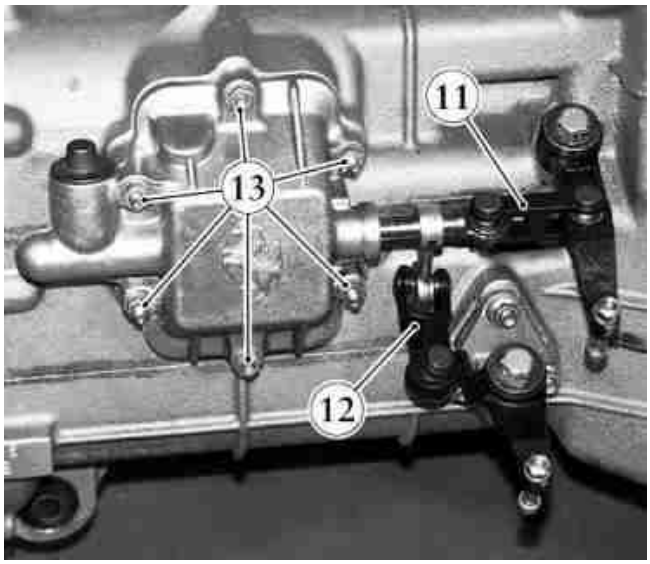


Re-assembly

- If previously used to remove the gearbox control rod, use the **AV 3271** tool, resting on the surface of the cover, to direct the lever **(G)**.
- Push the lever **(G)** against the tool supports and tighten the screw **(L)** to the prescribed torque.



- Clean the coupling surfaces of the gearbox cover thoroughly, removing all traces of sealant.
- Apply **AREXONS 2144** sealant to the cover surface and mount the latter onto the gearbox.
- Tighten the nuts **(13)** to the prescribed torque and reassemble the parts removed for the operation.



- Check the gearbox oil level (A 3.02) and that the controls are functioning correctly (D 4.02).

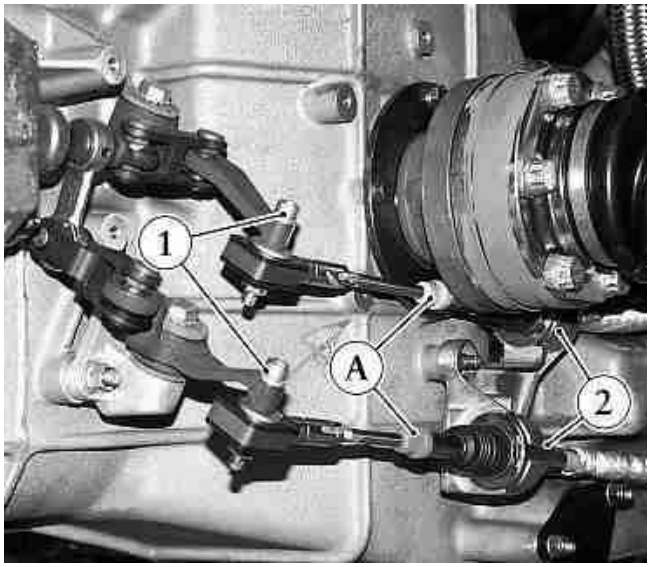
D4.02 REPLACING AND ADJUSTING THE CONTROL CABLES

Tightening torques	Nm	Category
Screw fastening gear-shift and selection lever	**27**	**A**
Lock-nut on ball joint	**7,4**	**B**
Nut fastening ball joint to gear selection and engagement levers	**7,4**	**B**

Dismantling

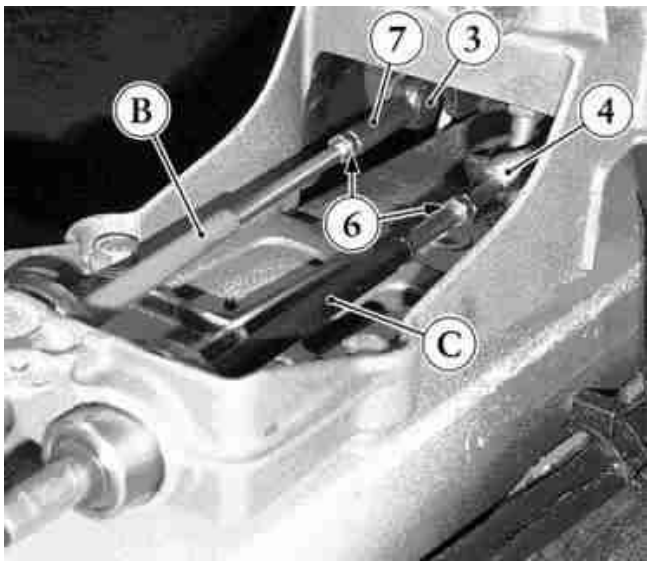
On the gearbox side, the Bowden gearbox control cables are provided with special protections **(A)** that prevent dust, water, etc. from damaging the inside surfaces, while preserving the original smoothness. For this purpose, during periodic maintenance, it is necessary to remove any accumulations of dirt within the above mentioned protections.
In case of friction or poor smoothness, or if the control cables are deformed, it is necessary to replace them.

- Detach the joints of the control cables from the selection and gear-shift levers, unscrewing the screws **(1)** and relative nuts.
- Slide off the locks **(2)** of the Bowden cables on the support.

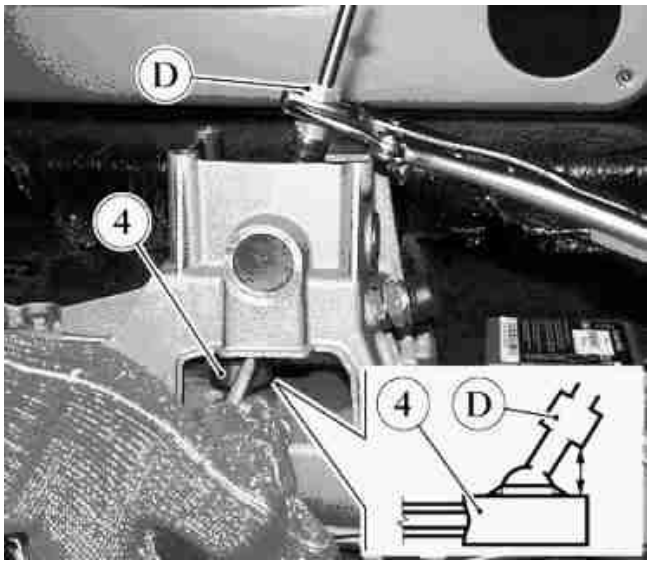


- Unscrew the three nuts and remove the support with the cables from the gearbox.
- Slide off the control cables from the support.
- Within the passenger compartment, remove:
  - the tunnel covering sheet and the rear tunnel covering (M 3.02);
  - the coverings of the right side electronic control unit (M 3.04);

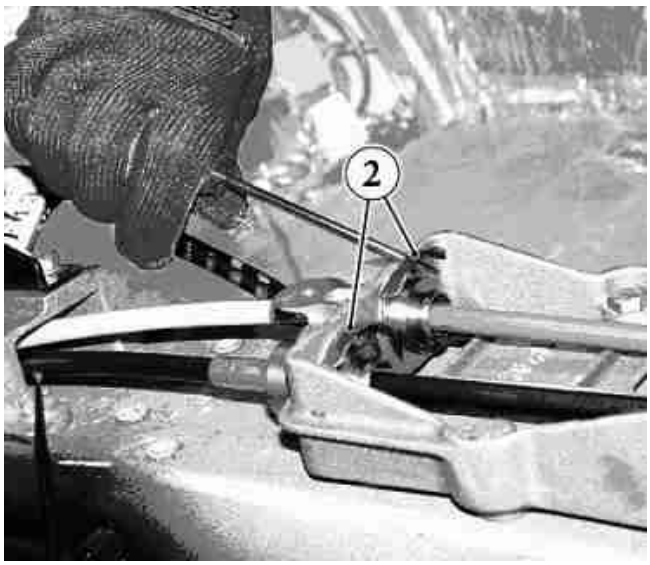
- Remove the hand brake support lever (G 2.06), keeping the control cables connected.
- Slide off the pivot **(3)** and remove the selector cable joint **(B, light blue)**.
- To be able to release the joint **(4)** of the coupling cable **(C, black)** from the control lever, it is necessary to shift the latter to the third gear. Lock the lever with self-locking calipers, using an aluminum protection shim.



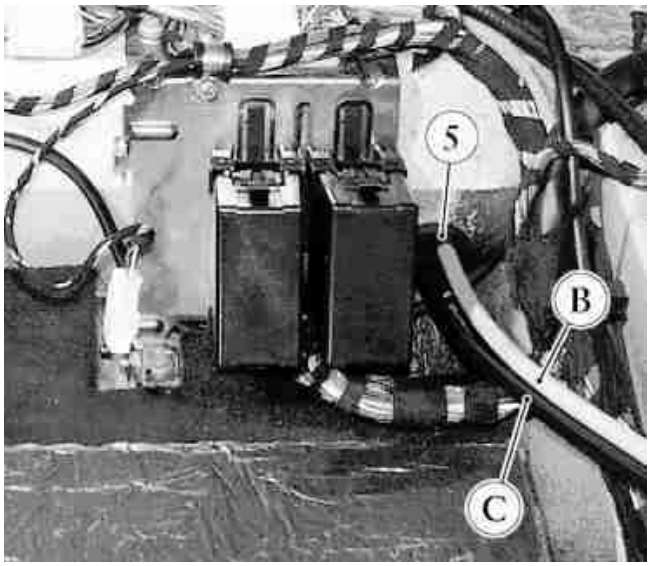
- With a screwdriver, prize between the ball joint **(4)** and the base of the lever until they are detached.



- Slide off the locks **(2)** and release the cables from the support.



- Pull the two cables from the passenger compartment, making the cable hitch **(5)** come out of the chassis and replace them.



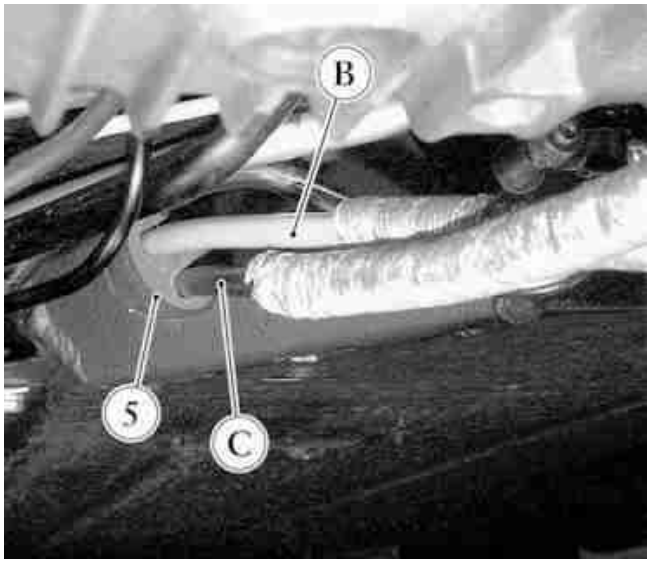
Re-assembly

NOTES

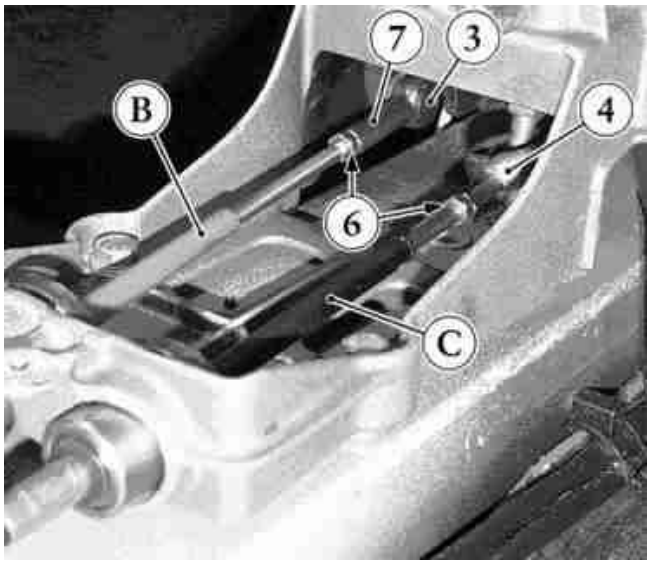
The control cables are supplied as spare parts complete with joints and cable hitches and therefore are always replaced in pairs.

- Position the joints onto the cables, on the gearbox side, in the same condition as those replaced, keeping the lock-nuts loose.

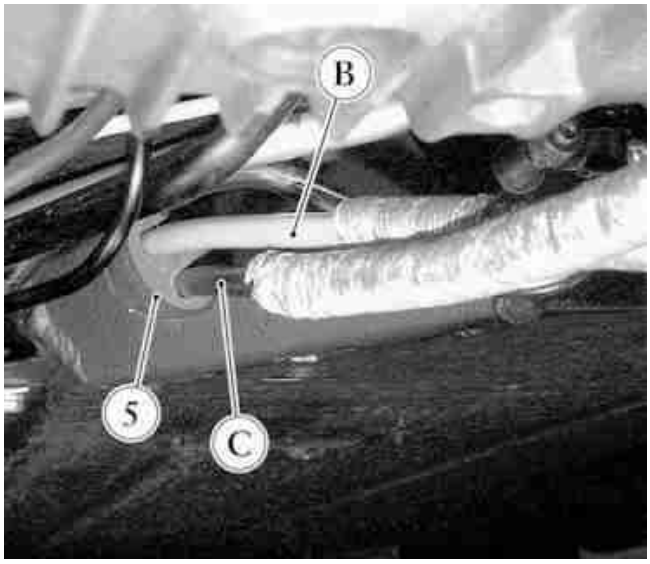
Insert the new cables from the passenger compartment, positioning the cable hitch **(5)** so that the cable **(B, light blue)** is in the upper part and make sure they do not intertwine.



- Screw down the joints on the lever housing side almost completely, leaving only a few threads after the lock-nuts **(6)**.
- Insert the joint **(4)** of the coupling cable **(C)** on the ball end of the control lever.
- Assemble a new pivot **(3)** and fasten the joint of the cable **(B)** onto the side lever.



- Working from under the car, make sure that the cable hitch **(5)** is correctly positioned on the chassis and lay the cables next to the propeller, avoiding intertwining.

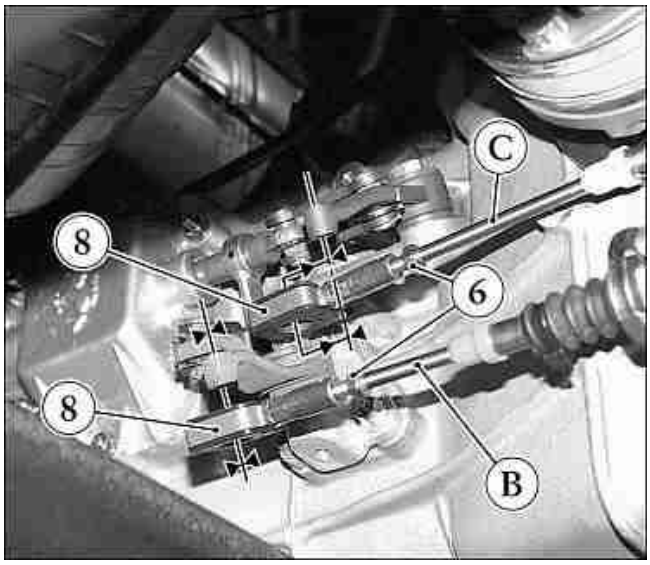


- Connect the cable joints to the levers on the right-hand side of the gearbox, making sure that the cable with the protection **(B, light blue)** is connected to the lower selection lever.

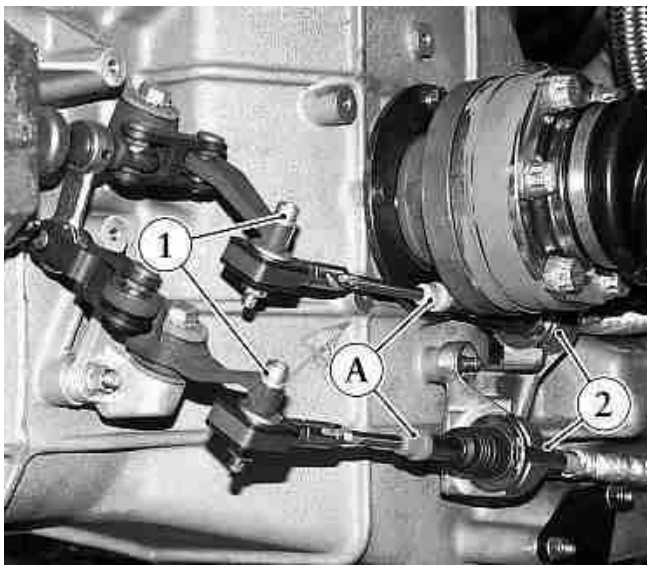
Adjustment

Before adjusting the length of the control cables, temporarily fit the gear selector. Fasten the latter using the original screws and inserting four shims which must feature the same thickness as the removed central console (about 3 mm).

1 Check that the control lever's is in the centre of the selector when in neutral position.
2 Check that the gearshift is in neutral.
3 Check that the joints on the shifting lever housing side are almost completely screwed down on their respective cable, leaving only some threads (about 2 mm) above the check-nuts **(6)**.
4 Adjust the position of the joints **(8)** on the gearbox side, so that the screw **(1)** fastening them to the gearshift and selection lever inserts without being forced.
5 Tighten the joint check-nuts **(6)** and check the alignment once again.

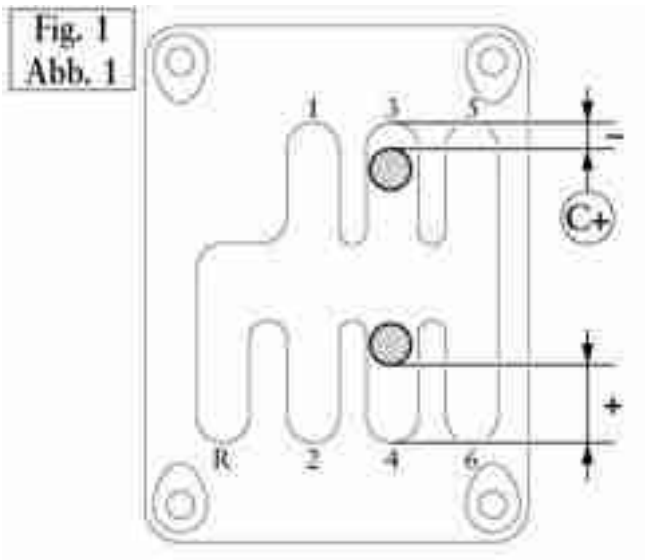


6 Finally tighten the joint screws **(1)** onto their respective levers to the prescribed torque.



7 Check that the control lever is in the centre of the selector when it is in neutral position.
8 Check that the **gearshift** selector moves freely.
9 Engage the **3rd** and **4th** gears, and check that the span between the control lever and the selector is identical. If it is the same, check that all the gears engage correctly.

If however, when the **3rd** gear is engaged, this distance is less than the one read for the **4th** gear (see **Fig.1**), it is necessary to lengthen the gearshift cable **(C+)**. Shorten the cable if this is not the case.



To adjust the length of the gearshift cable (C), detach the gearbox side terminal and, after loosening the check-nut **(6)**, tighten or unscrew the terminal on the cable.

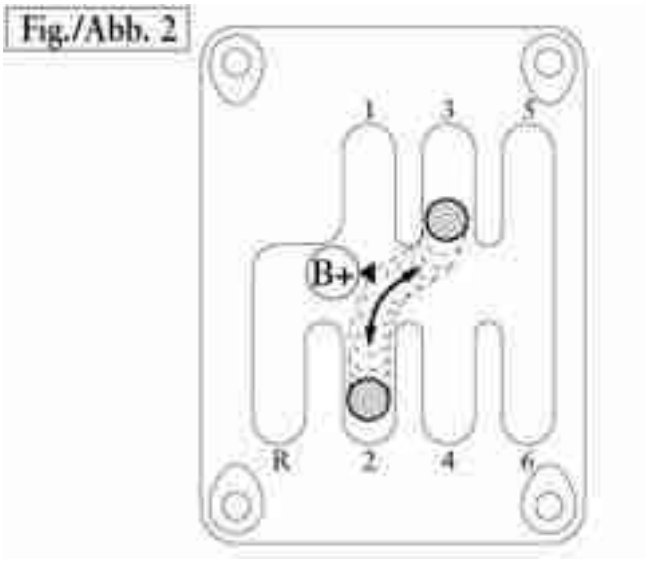
Reassemble the terminal on the gearshift, according to the specifications reported in points 4,5 and 6.

10 Check that the gearshift engages correctly, and make sure there is a minimum span of **1 mm**, between the control lever and the selector's under-plate.

11 Check the various gearshifts engage correctly by moving them diagonally (for example: **2st-3nd-2nd** and **4th-5th-4th**).

If the gearshift lever sticks between **2nd –3rd –2nd** (see **Fig.2**), it is necessary to lengthen the selection cable **(B+)**.

Fig./Abb. 2



In case of interference during **4th –5th –4th** gearshifting, it is necessary to shorten the cable.

To adjust the length of the gearshift cable (B), detach the gearbox side joint and, after loosening the check-nut **(6)**, tighten or unscrew the cable joint.

Re-fit the joint onto the gearshift lever, according to the specifications reported in points 4, 5 and 6.

IMPORTANT

When adjusting, tighten or unscrew the joints by 1/2 turn a time, then once again check that the control is working correctly. Carry out this procedure until all interferences are eliminated.

- Re-fit the components removed in the procedure and remember to remove the shims positioned under the selector.

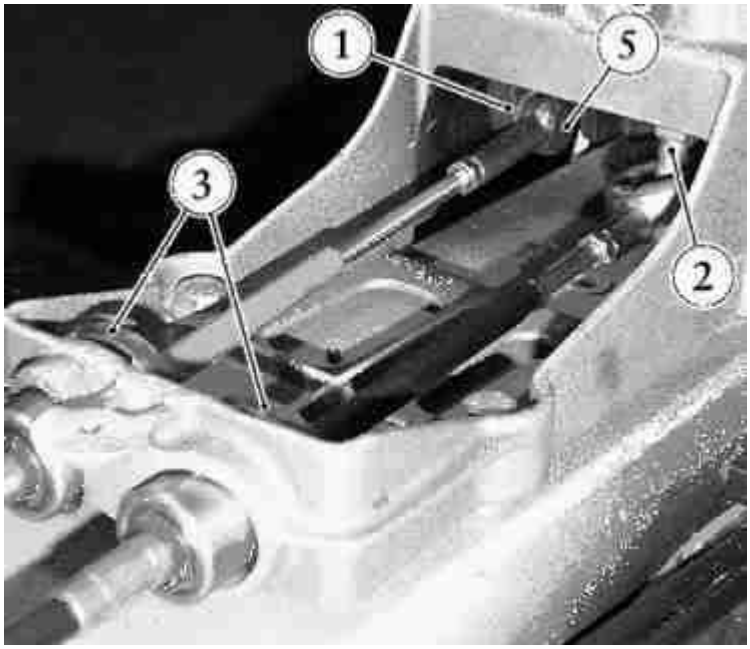
D4.03 REPLACING THE THE GEARBOX LEVER HOUSING

Tightening Torques

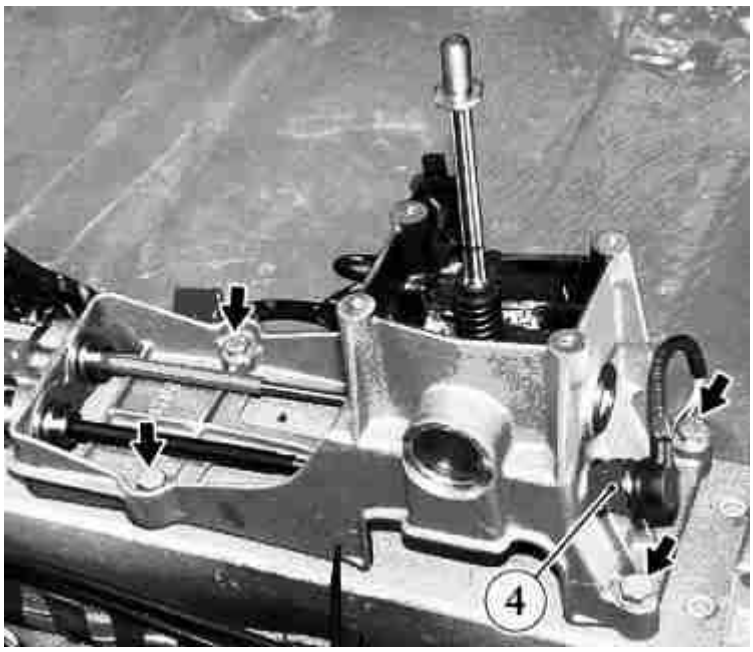
Screws fastening gearbox lever housing **25 Nm**

Dismantling

- Remove the tunnel cover sheet and the rear part of the tunnel covering (M 3.02).
- Remove the joints of the control cables from the selection lever **(1)** and from the gear-shift lever **(2)** as described in (D 4.02)
- Slide off the locks **(3)** of the cables of the gearbox lever housing.



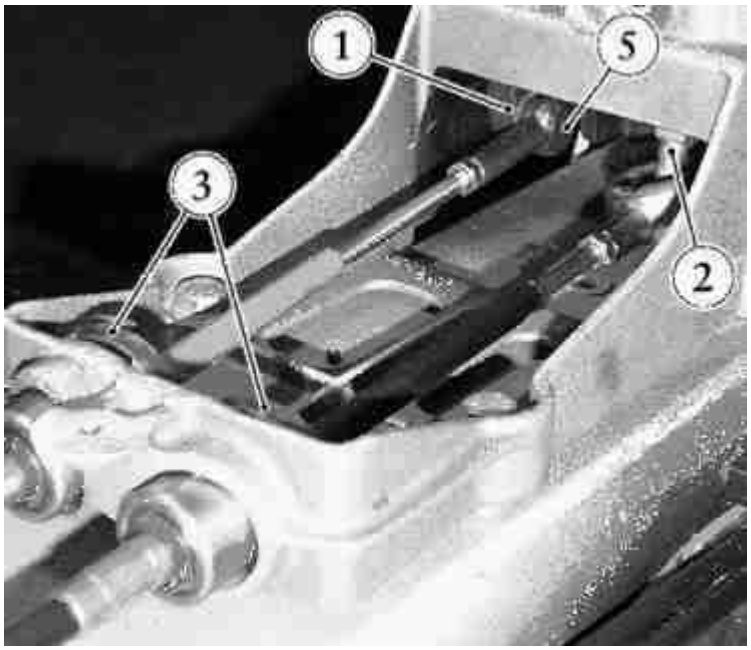
- Detach the reverse gear light switch connection **(4)** from the left side of the tunnel cable.



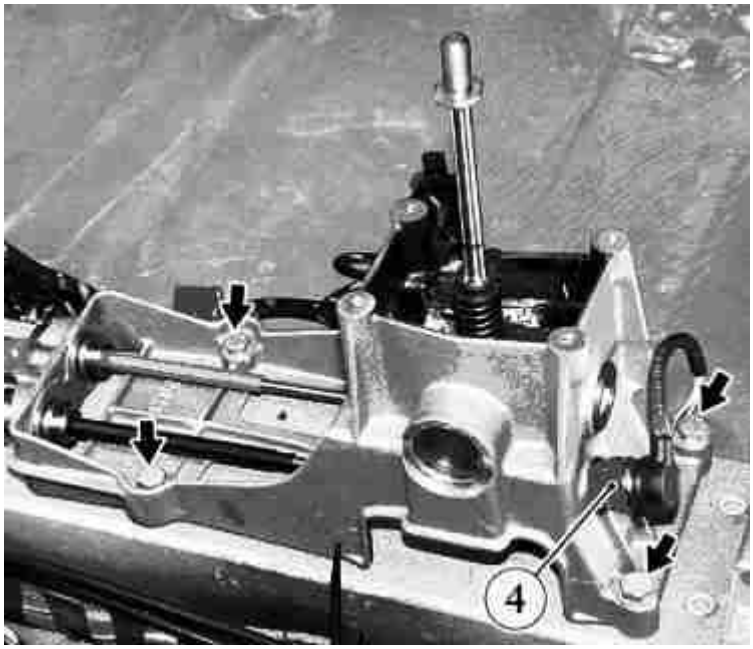
- Unscrew the four screws fastening the chassis of the gearbox lever housing.
- Remove the complete lever housing.

Re-assembly

- Insert the control cables in the lever housing and position it onto the chassis in position with the fastening holes.
- Lock the cables on the lever housing with the locks **(3)**.



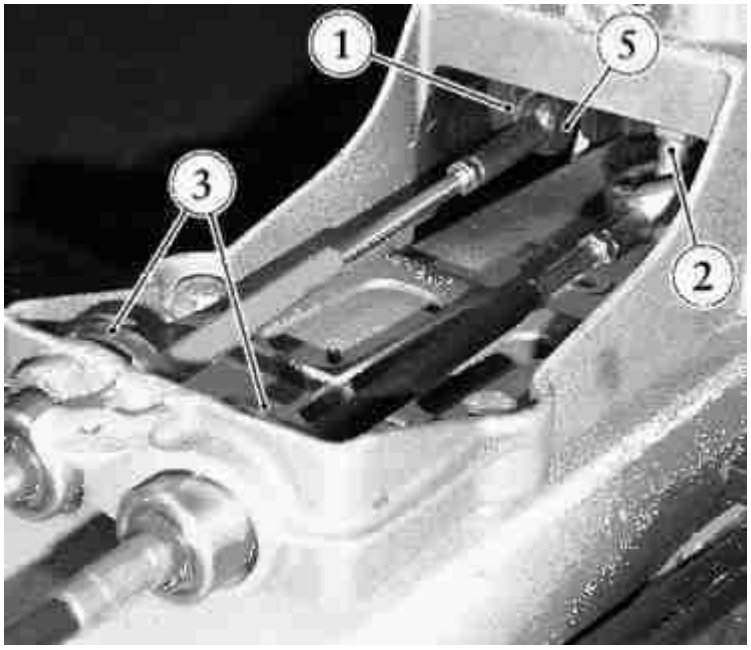
- Fasten the lever housing to the chassis, locking the four screws to the prescribed torque.
- Reconnect the harness **(4)** for the reverse gear light switch.



IMPORTANT

In case of replacement of the complete lever housing or of the control lever, it is necessary to adjust the length of the control cables (D 4.02).

- Insert the joints of the control cables onto the gear-shift lever **(2)** and onto the selection lever **(1)**, replacing the pivot **(5)**.



- Re-assemble all the parts removed during the procedure.

D4.04 DETACHING/RE-FITTING THE GEARBOX SUPPORT MOVABLE FRAME

Tightening torques

Screws for fastening frame to chassis	**28,5 Nm**
Screws for fastening frame to gearbox	**98 Nm**
Screw fastening the cross member to the frame	**9,8 Nm**

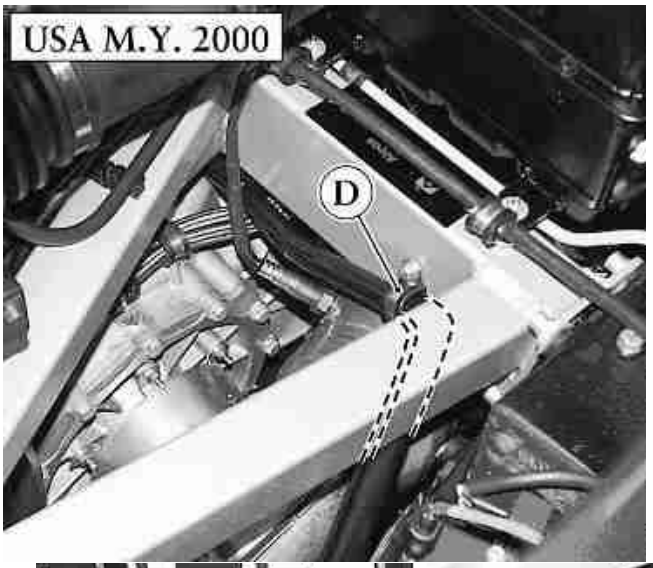
Detaching the frame

- Remove the rear part of the underfloor (M 2.12);
- Remove the engine compartment side guards (M 2.13);
- Remove the coolant expansion tank (_____), leaving it connected to the system.
- Remove the air intake way (B 7.03).
- From the movable frame, detach the clamps which support the stiff pipe **(1)** connecting the left-hand by-pass solenoid valve to the coupling on the vacuum tank as well as the rear Lambda sensor and thermo-couple cables.
- Remove the piping **(2)** which connects the vacuum tank to the chambers from the movable frame.
- In the electro-actuated version it is necessary to release the sheath retaining the Power Unit – gearbox actuator's connection pipes from the support brackets (**3**) on the chassis.

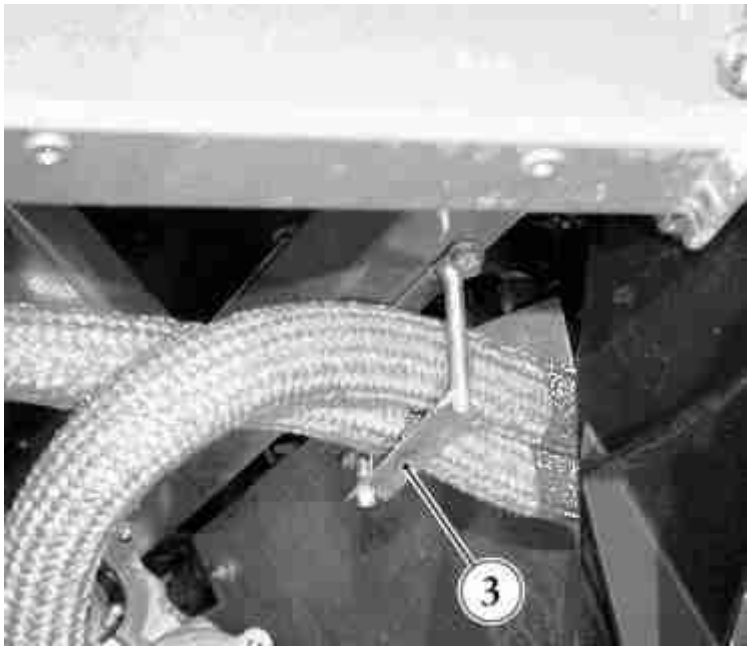
Note for the US M.Y. 2000 version

On these cars, the pipe connecting the air pump to the pneumatic valve for the secondary air system is fitted to the lower part of the frame. This pipe can remain connected to the pump and to the valve, but it must be removed from the frame.

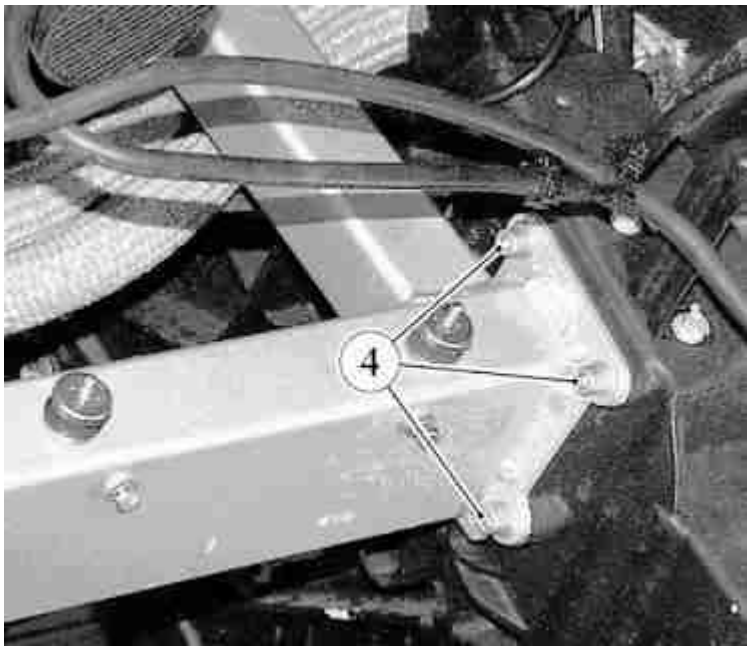
- Remove the clamps **(D)** from the two inner sides of the rear frame along with the one supporting the intermediate pipe **(E)** between the air pump and the pneumatic valves connection pipe.



- Unscrew the fastening screws and then remove from the right-hand branch of the movable frame, the supporting U-bolt **(3)** for the engine oil cooling pipes.

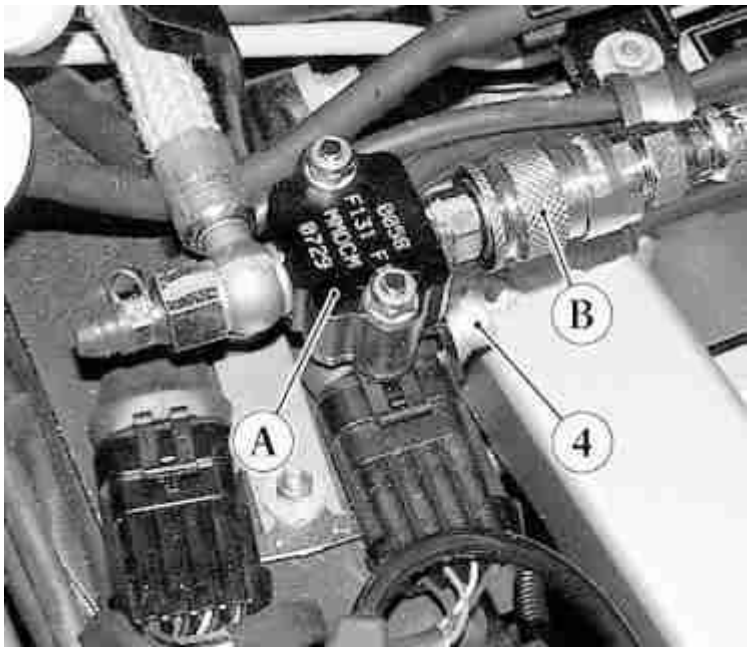

3

- Place a hydraulic jack under the gearbox, to support the weight of the rear engine-gearbox unit, to prevent the lower beam of the chassis from deforming.
- Unscrew the screws **(4)** which fasten the rear part of the movable frame to the chassis laterally.



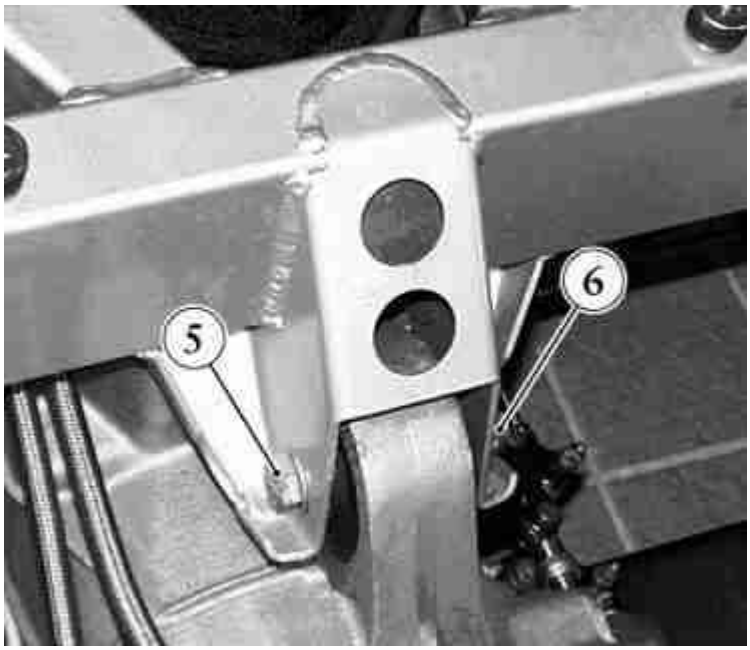
NOTES

*In the electronically controlled version, the upper screws **(4)**, on the right-hand side of the movable frame also bear the support bracket of the block **(A)** for the clutch pipe rapid coupling. Detach the clutch pipe **(B)** from the block.*

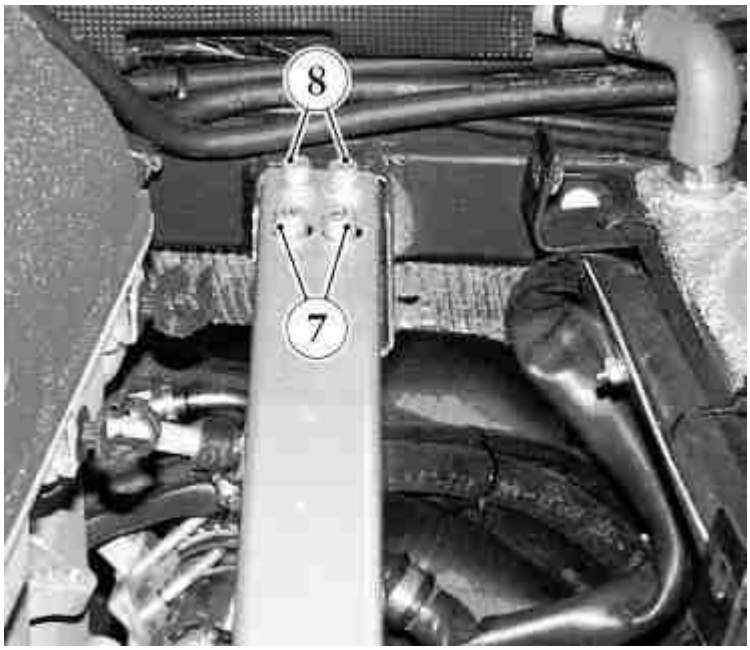


- Unscrew and remove the screw **(5)** with the nut **(6)** fastening the gearbox to the movable frame.

NOTES
*Use the hoisting jack to facilitate the removal of the screws **(5)**.*

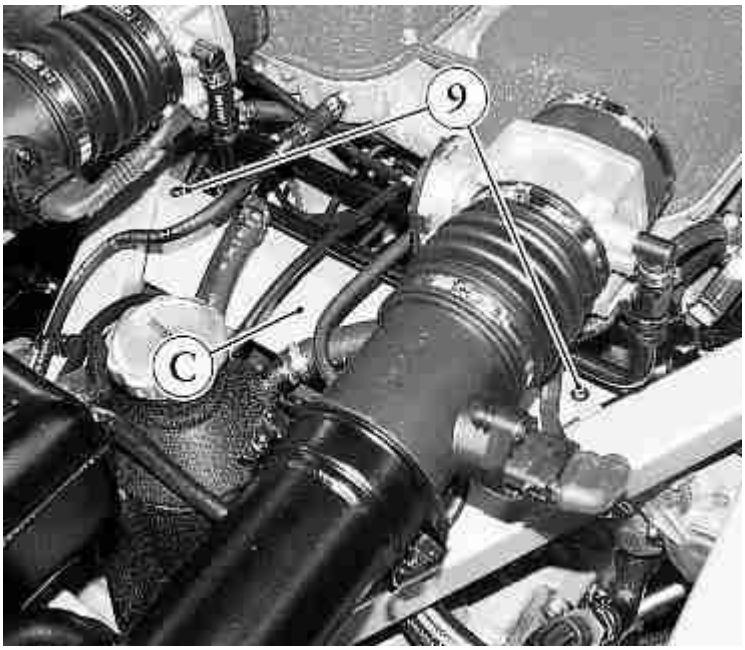


- Unscrew the screws **(7)** and **(8)** which fasten the front part of the movable frame to the chassis.



The frame has a reinforcing cross member **(C)** which can be removed to facilitate some procedures when disassembling the motor-propulsor's components.

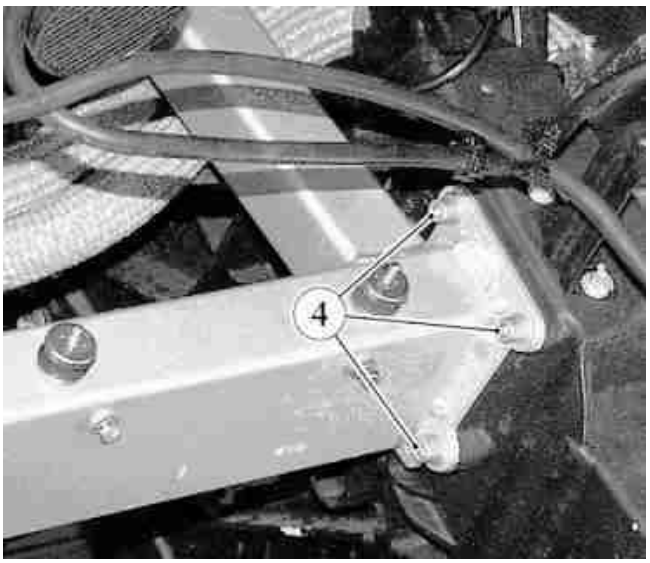
- To remove the cross member it is necessary to unscrew the six fastening screws **(9)**, four of which are fitted from underneath.

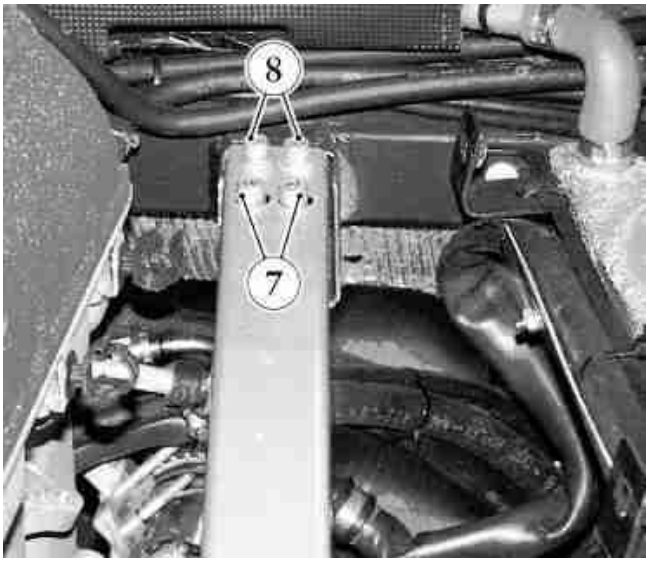


- Remove the movable frame from the engine compartment.

Re-attaching the frame

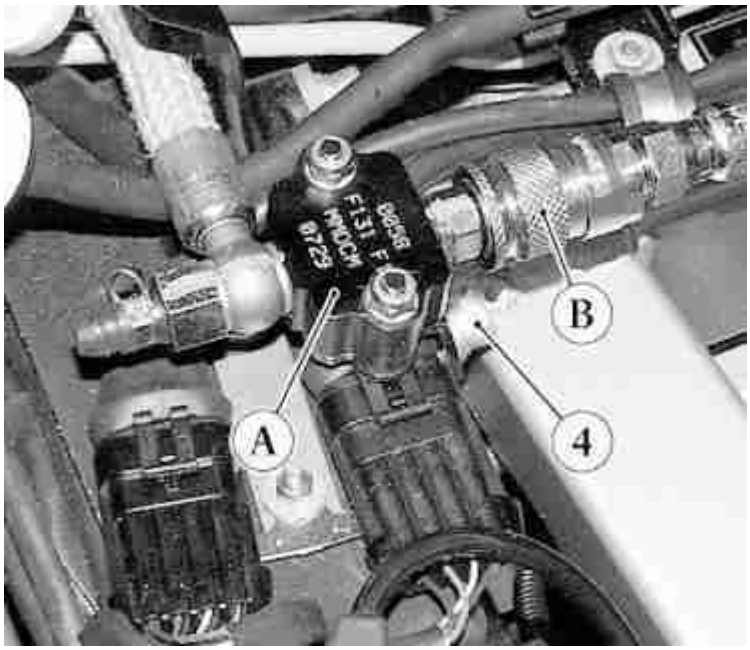
- Position the movable frame on the gearbox, making it rest on the frame supports.
- Secure the movable frame with the fastening screws **(4)**, **(7)** and **(8)** and tighten them to the prescribed torque.



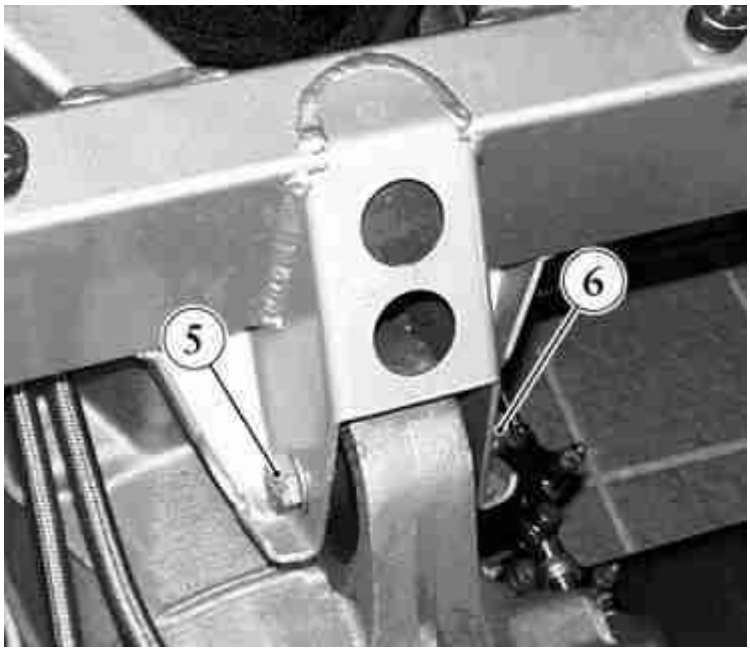

8
7

NOTES

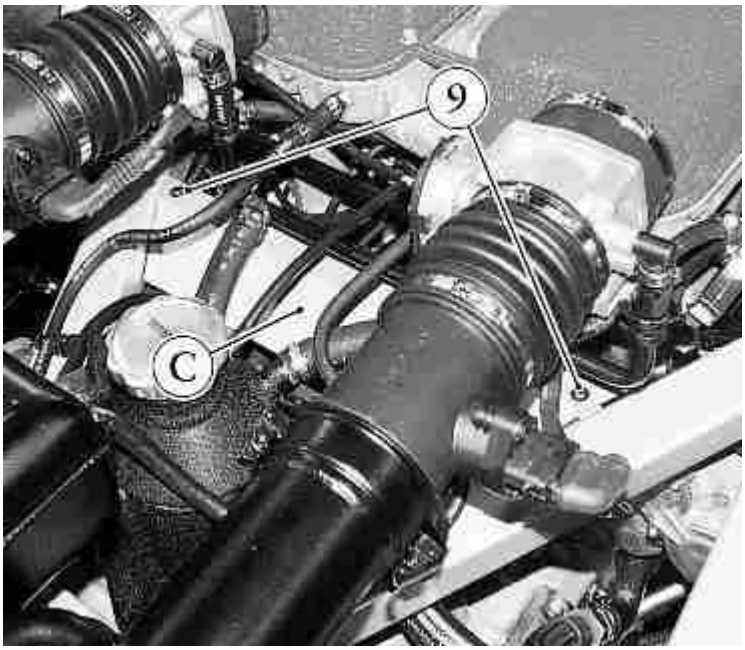
*In the electronically controlled version, insert the block's **(A)** support bracket for the rapid coupling of the clutch pipe under the upper screws **(4)**, on the right-hand side of the engine frame. Connect the clutch pipe **(B)** to the union on the block*



- Align the hole on the gearbox flexible support with those on the movable frame, using the hydraulic jack positioned underneath the gearbox.
- Insert the screw **(5)** and lock the nut **(6)** to the prescribed tightening torque.



- Fasten the pipes which have been detached to the movable frame.
- Re-assemble the reinforcing cross member **(C)** by tightening the screws **(9)** to the prescribed tightening torque.
- Remove the hydraulic jack and reassemble all the components removed for the operation.



D4.05 GEARBOX OVERHAUL

Gearbox identification

The gearbox is identified by two numbers punched into the upper part of the housing, on front of the upper flexible bushing's seat (see Fig. **1**).

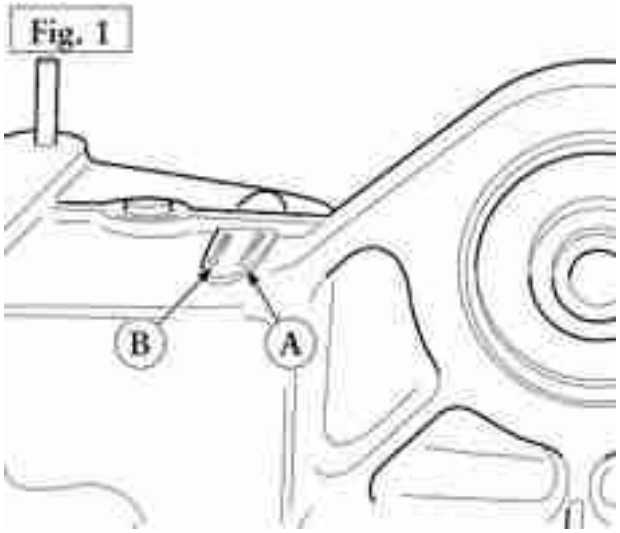
A Identification number for gearbox type:
177892 Manual control
177893 Electronically controlled
181248 Challenge

B Manufacturer's serial number.

NOTE

*Gearboxes up to the serial number **2100** reported the complete engine power unit number along with the identification number.*

Fig. 1

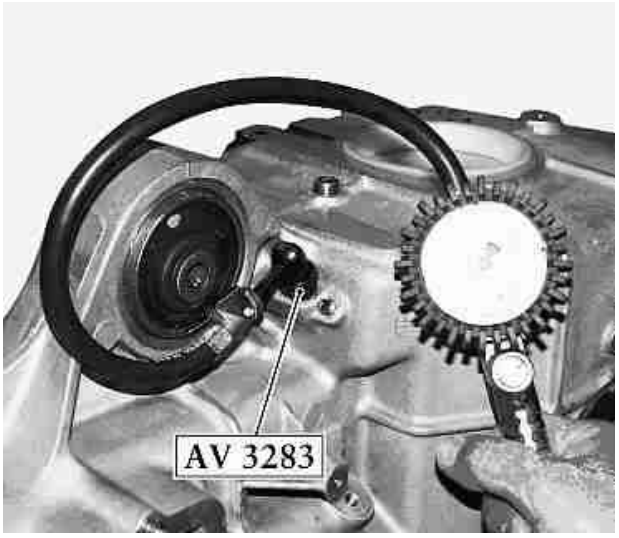


Seal test

To check there are no leaks, it is possible to carry out a gearbox seal test while still completely assembled. All the outward openings must be stopped (use the closing plate **AV 3536**, to close off the engine coupling side) and the relative air inlet union **AV 3283** must be fitted in the breather valve seat.

- Supply air until reaching a pressure of **0,3 bar**, using a standard inflation equipment with a precision pressure gauge.
- Using the leakage detector spray, check for any eventual leakages on the gearbox housing.

In case of leakage, it is necessary to replace the external seal rings and/or check the couplings of the covers and of the intermediate plate.

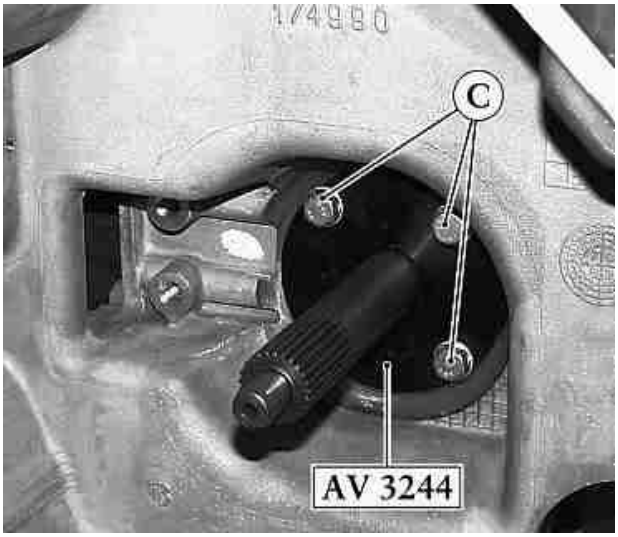


Test bench check of the rolling torque

Workshops where a test bench is available can replace the clutch thrust bearing flange with a special tool to check the rolling torque of the gearbox parts after overhaul.
To remove the flange retaining the clutch thrust bearing (D 3.01).

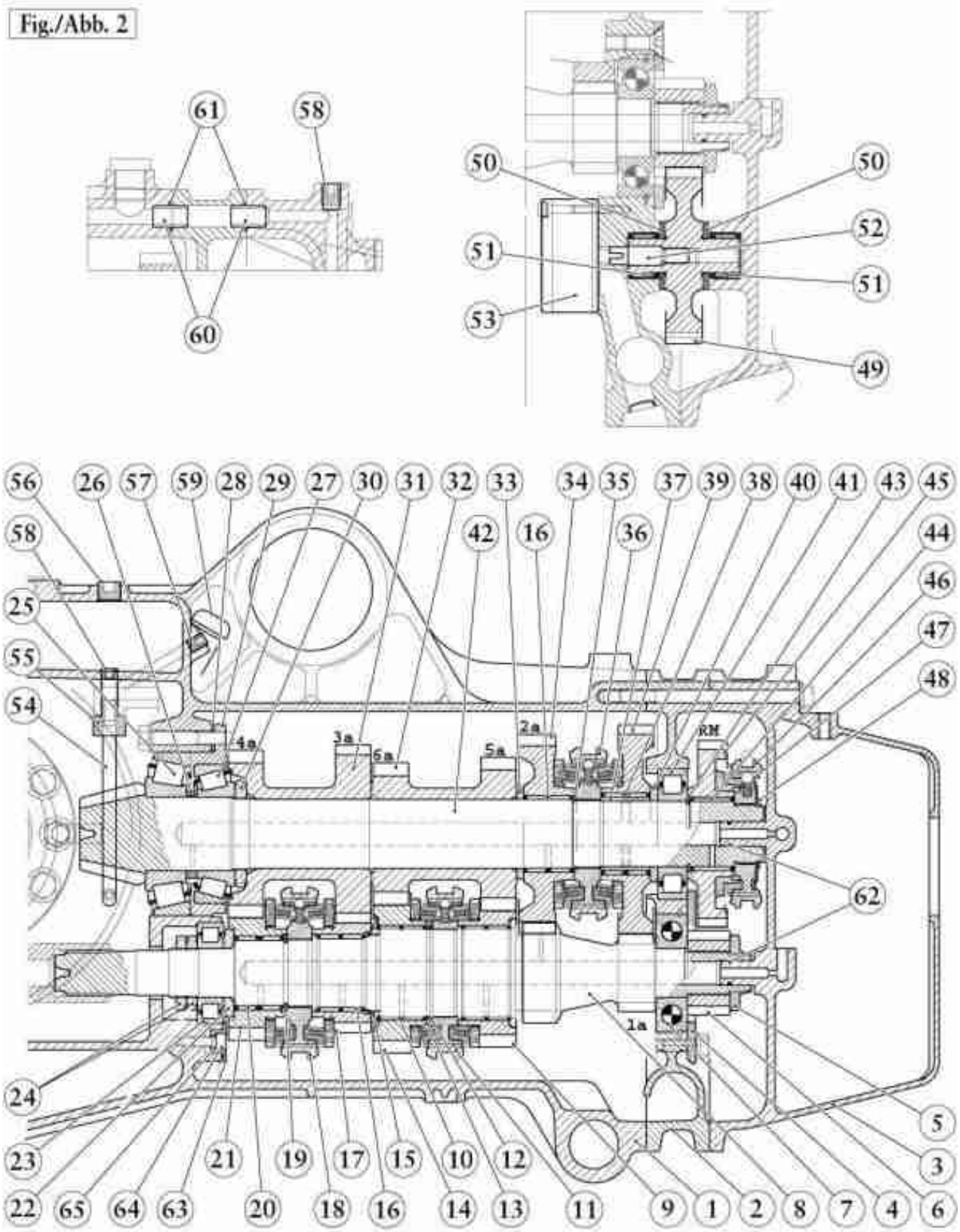
IMPORTANT
When carrying-out the test, the gearbox must be completely fitted, with oil topped-up and at ambient temperature.

- Fit the original O-ring **(A)** and grommet **(B)** on the **AV 3244** tool**,** then mount it on the clutch shaft.



- Fix it on the housing, using the original screws **(C).**
- Connect the car power takeoff on the clutch shaft and check that the rolling torque for the different gearshifts is the prescribed one (D 1.01).

Gearbox unit components (Fig. 2):



1 Gearbox housing
2 Intermediate plate
3 Rear Cover
4 Retaining plate for plate bearings
5 Main shaft rear nut
6 Reverse drive gear
7 Main shaft ball bearing
8 Main shaft
9 Complete 5th speed gear
10 Roller cage
11 Complete 5th -6th speed double contact synchroniser
12 Flexible ring
13 6th speed gear spacer
14 Complete 6th speed gear
15 3rd- 6th speed gear shoulder ring nut
16 Roller cage
17 Complete 3rd speed gear
18 Complete 3rd -4th speed double contact synchroniser
19 Flexible ring
20 Roller cage
21 Complete 4th speed gear
22 Support washer
23 Main shaft roller bearing
24 Main shaft front ring nut
25 Front tapered roller bearing
26 Spacer for bearings
27 Rear tapered roller bearing
28 Spacer for bushing
29 Bearing holder bushing
30 Lay shaft ring nut
31 3rd-4th speed double gear
32 5th-6th speed double gear
33 2nd speed gear shoulder ring
34 Complete 2nd speed gear
35 Flexible ring
36 Complete 1st- 2nd speed triple contact synchroniser
37 1st speed gear bushing
38 Roller cage
39 Complete 1st speed gear
40 1st speed gear shoulder wheel
41 Lay shaft rear roller bearing
42 Lay shaft (pinion)
43 Flexible ring
44 Roller cage
45 Complete reverse gear **(*)**
46 Complete reverse synchroniser **(*)**
47 Retaining washer for reverse synchroniser rollers **(*)**
48 Flexible ring
49 Idle gear - Rev.
50 Idle gear shoulder ring
51 Roller casing
52 Driving pin
53 Complete oil pump
54 Lubrication nozzle
55 Union
56 Threaded taper plug
57 Threaded taper plug
58 Threaded taper plug (no. 3)
59 Oil bleeding
60 Driving dowels
61 O-ring for dowels
62 O-ring
63 Retaining bushing for bearing
64 Bushing screw
65 Flexible washer

(*) Starting FROM gearbox 10298 a new **Reverse gear** synchronizer with a **62 mm** diameter is installed (the diameter was previously 60 mm). This modification concerns not only the individual components of the synchronizer, but also the Reverse gearing and the roller retaining washer. The new parts cannot be used in combination with parts used before the modification. In the event that even a single component among those mentioned is replaced, the complete Reverse synchronizer and the new Reverse gearing must be fitted.

NOTES

*In the stages described below, the gearbox unit components will be identified by the reference numbers used in **Fig. 2.***

For the gearbox characteristics and technical data (D 1.01).
As regards the gearbox 's external components, the manual command unit and the seal rings on the differential flange shafts (D 4.01).
For disassembling the F1 system's actuator unit (D 6.07).
Per interventi sul differenziale D 5.01).
If the components inside the gearbox are not working correctly or are broken, the complete gearbox must be removed from the car (D 2.01).

Removing the shaft-rod cluster with forks

Before working on the gearbox internal parts, it is advisable to check the housing's condition, to identify any eventual cracks or buckling, or any loss of lubricant on the coupling points or closing flanges.

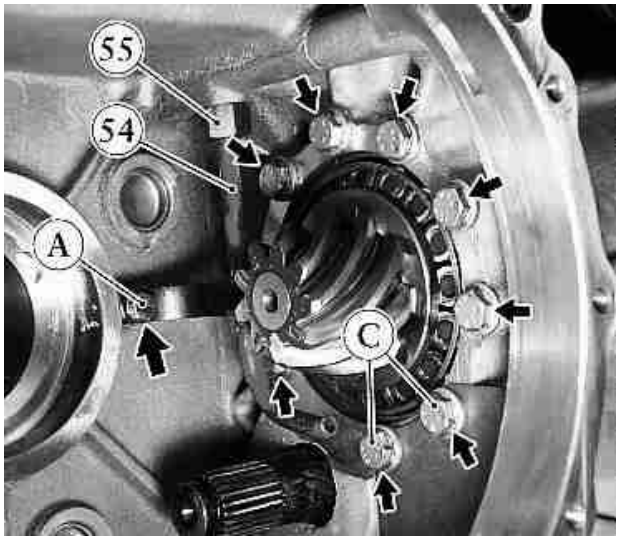
IMPORTANT

Should the gearbox housing need replacing, it is necessary to calculate the spacer thickness of the crown and pinion according to the new dimensions.

- Remove the complete differential unit and the clutch shaft from the gearbox housing (D 5.01).
- Remove the lubrication nozzle **(54)** from the differential compartment by unscrewing the fastening screw **(A)** and sliding it out from the upper union **(55)**.
- Unscrew the bearing holder bushing **(29)** nine fastening screws. The two screws **(C)** also fasten the protective sheet for the oil-flow channels.

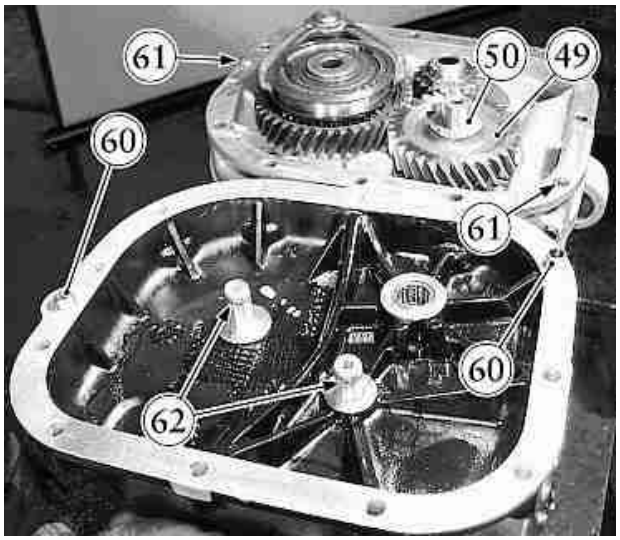
IMPORTANT

*In no case should the union **(55)** be unscrewed, as it is fitted with locking Loctite and it may get damaged during removal.*

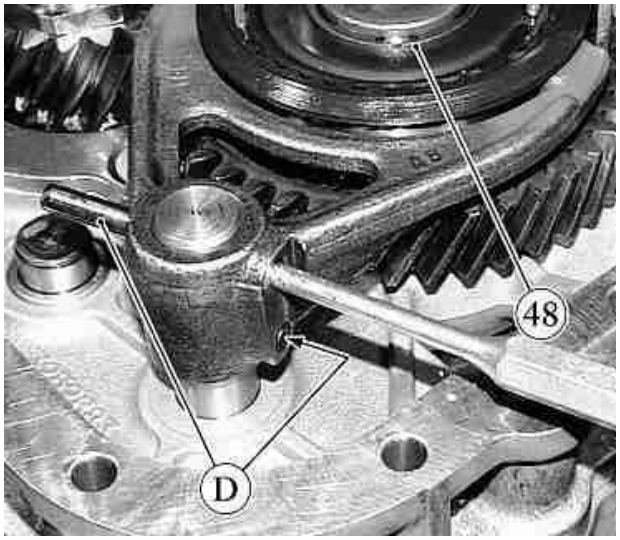

55
54
A
C

- Unscrew the screws fastening the rear cover **(3)** and the intermediate plate **(2)** to the gearbox housing **(1)**.

- Beat the cover with a rubber hammer to extract the driving dowels **(60)** and the pins equipped with O-rings **(62)** from the gearbox shafts. Keep the dowels' O-rings **(61)**.
- Detach the reverse idle gear **(49)** and the relative shoulder rings **(50)**.



- Beat out the flexible pins **(D)** from the rod.
- Detach the flexible ring **(48)** from the lay shaft.

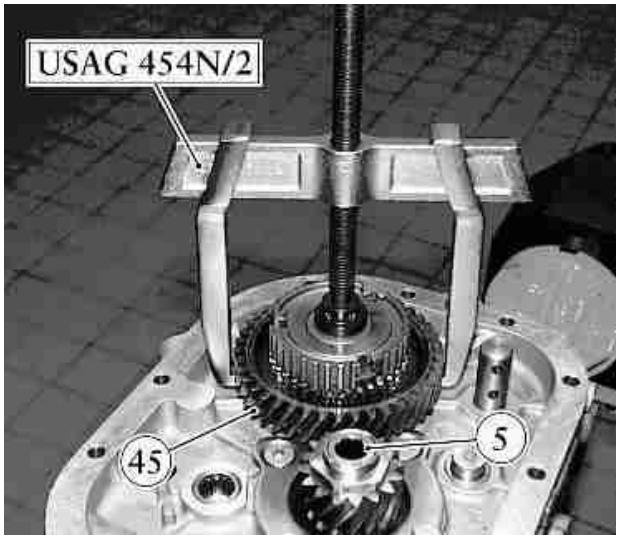


- Remove the reverse gear's fork and the synchroniser's sliding sleeve **(46)**. Keep the pad, balls and springs.

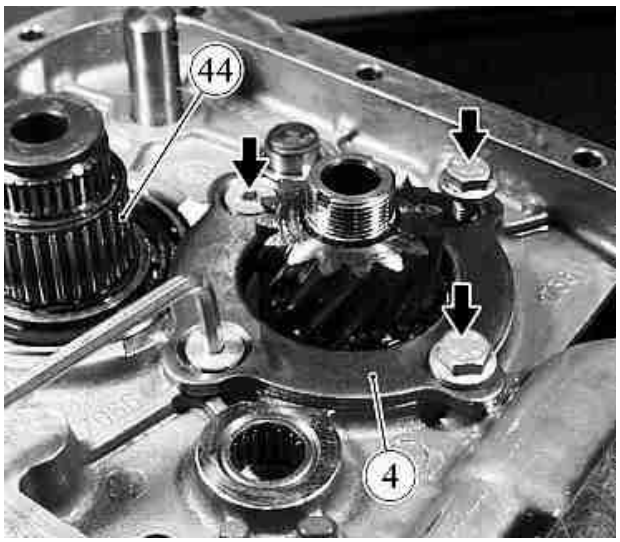
- Use the **USAG 454N/2** extractor positioning its arm ends under the **REV** gear **(45)** and detach the latter and the synchroniser body.

NOTES
Engage a gear to lock the main shaft.

- Rivet the ring-nut **(5)** and unscrew it from the main shaft.



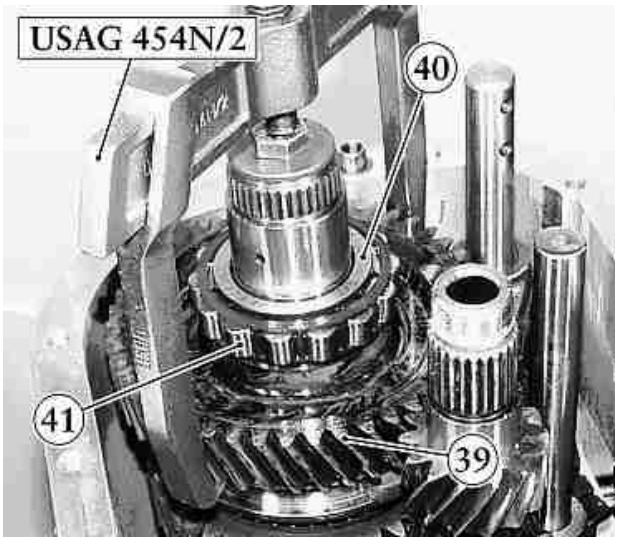
- Detach the roller cage **(44)** from the lay shaft.
- Unscrew all the screws fastening the bearing retainer plate **(4).**
- Detach the bearing retainer plate **(4)**.



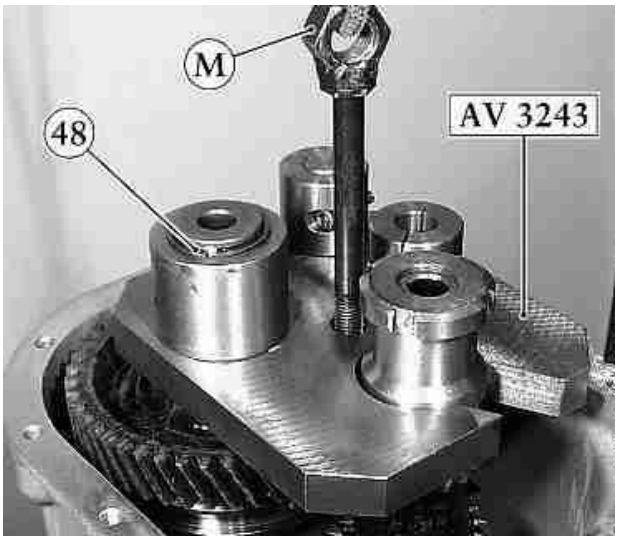
- Screw the extracting tool tie rods into the holes of the previously removed screws and separate the intermediate plate **(2)** from the gearbox housing **(1)**.
- Remove the intermediate plate together with the oil pump and the bearings on the gearbox shafts.

- Detach the flexible ring **(43)** from the lay shaft.

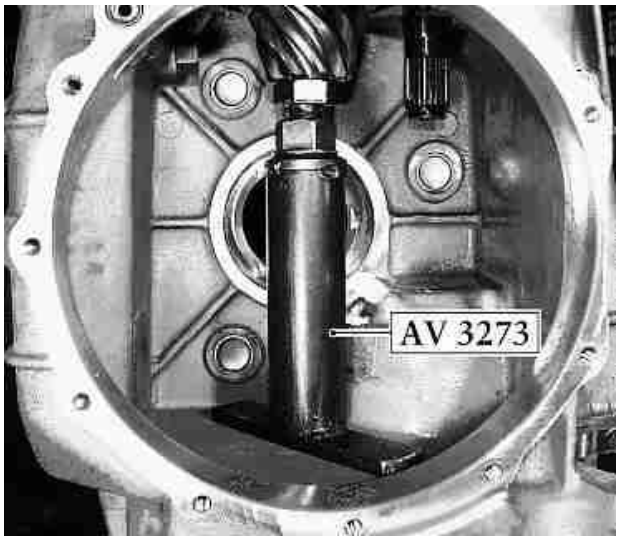
- Fit the extracting tool arms **USAG 454N/2** under the **1st** speed gear **(39)** and lift it just enough to be able to remove the shoulder wheel **(40)** and the race with the bearing rollers **(41)** from the lay shaft; leave the complete **1st** speed gear **(39)** mounted on the shaft.



- Position the **AV 3243** tool on the shafts and fix it on the lay shaft using the flexible ring **(48)**, on the fork supporting rods and on the main shaft using the specific bushings.
- Tighten a hook **(M)** on tool **AV 3243**, and hook it to a hoist.



- Position the **AV 3273** tool under the pinion to release the support bearings' coupling and to facilitate extraction.
- Lift the cluster together with the shafts from the gearbox housing.
- Beat the shafts using a rubber hammer to help the forked shaft-rod cluster come out from the gearbox housing.
- Keep the spacer **(28)** from within the gearbox housing for the bearing holder bushing **(29).** The ball bushing for the fork supporting rod and the roller bearing outer race **(23)** will remain in position inside the housing, on the main shaft.
- Detach the shafts and the rods from the tool **AV3243**.
- Separate the forks from the rods.



Main shaft components' disassembly

- Lock the base **AV 3252** in a vice.
- Stop the main shaft from rotating by inserting its end, on the intermediate plate's side, into the base **AV 3252**.
- Unlock the ring nuts **(24)** using the tubular tool **AV 3245**.
- Remove the ring nut and the check ring nut from the main shaft.

- Using an armed extractor **USAG 454N/2**, lift the **3rd** and **4th** speed synchroniser's sliding sleeve **(18)** a few millimetres.

- Push the **4th** gear speed **(21)** downwards and position the extracting tool arms under the washer **(22)**.
- Remove the race with bearing's rollers **(23)** and the **4th** gear speed support washer **(22)**.
- Detach the **4th** gear speed **(21)** and the roller cage **(20)** from the main shaft.

- Remove the flexible ring **(19)** and detach the sliding sleeve as well as the **3rd -4th** speed synchroniser components **(18)**.

- Insert the arms of extracting tool **AV 3272** in the hub wedge seats and detach the complete **3rd -4th** speed synchroniser **(18)** and the **3rd** gear speed **(17)**..

IMPORTANT

*Avoid letting the extracting tool arms grip under the toothing of the synchroniser or under the **3rd** speed gear.*

- Rivet the caulkings of the shoulder ring nut **(15)** and unscrew it from the main shaft reusing the **AV 3246** spanner.
- Detach the **6th** speed gear **(14)**, the roller cage **(10)** and the **5th - 6th** speed synchroniser rings **(11)**.

- Using a small flat screwdriver lift the spacer **(13)** and remove the flexible ring **(12)**.

- Fit the shaft into the base of the press, resting on the **5th** gear speed **(9)**. Press the shaft to extract the complete **5th-6th** speed synchroniser **(11)** and the **5th** speed gear **(9)**.

Lay shaft components' disassembly

The **5th - 6th** and **3rd - 4th** speed double gears are mounted on the lay shaft at a specific distance for coupling; the two tapered roller bearings with retaining ring nuts are positioned between the pinions and the gears along with the spacer which determines the pre-load of the bearings. The disassembly of these lay shaft components is a delicate procedure which should be carried out only when replacing the crown and pinion or the above mentioned elements.

- Insert the lay shaft, on the pinion side, into the base **AV 3255**.

- Using the previously used armed extractor **USAG 454N/2,** detach the **1st** gear speed **(39)**, the roller cage **(38)** and the inner bushing **(37)** from the lay shaft end.
- Detach the sliding sleeve and the **1st - 2nd** speed synchroniser components **(36)**.
- Reusing the armed extractor **USAG 454N/2**,detach the **1st - 2nd** speed synchroniser hub **(36)**.

- Remove the flexible ring **(35)**.
- Using the armed extractor **USAG 454N/3** remove the **2nd** speed gear **(34)** and then detach the roller cage **(16)**.

To remove the double gears **(31** and **32)** and the shoulder ring **(33)** from the lay shaft, it is necessary to use a press with a support cylinder and two sufficiently large support flanges **(N)**.

- Position the flanges under the **5th** speed gearing and press until removing the shoulder ring **(33)** and the first double gear **(32)**; carry out the same procedure to extract the second double gear **(31).**

- It is necessary to use the tool **AV 3257** to unscrew the ring nut **(30)** from the lay shaft **(42)**

-
- Lock the tool's support plate in a vice and insert the lay shaft bringing the flange's ridges in line with the ring nut's grooves. To keep the shaft in this position, use the screws supplied with the tool and tightened on the bushing **(29)**.
- Apply the tool **AV 3247** to the end of the shaft and unscrew the bearings' retaining ring nut.

- Adequately support the internal race of the front tapered roller bearing **(25)** and, using the press, detach the assembly composed of the two tapered roller bearings **(25** and **27)** from the lay shaft, from the intermediate spacer **(26)** and from the bushing **(29)**.

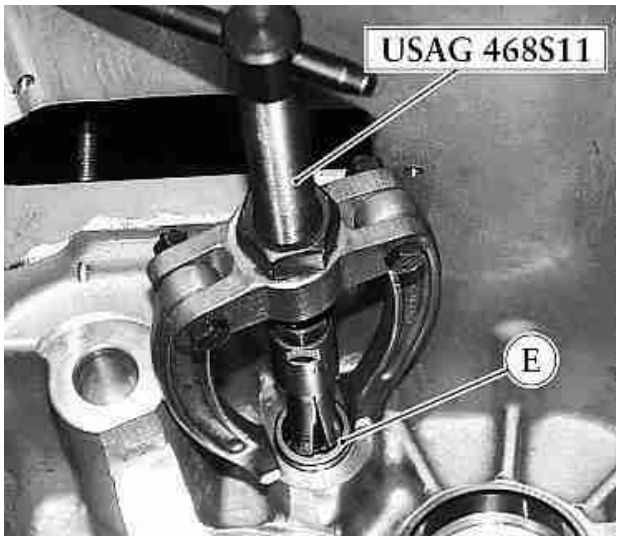
Component maintenance and overhaul

In order to carry out a visual check of the components, it is advisable to thoroughly wash all the metallic parts using a solvent, biodegradable if possible, and blow them with compressed air.
Pay particular attention to the internal lubrication channels, on the gearbox shafts, housing and covers, which must be spotlessly clean.
Check that the housing and the covers show no indentations and that the bearing seats are intact, without scoring or ridging. If this is the case, they must be replaced immediately.
Check that the surfaces and the edges of the gear toothing show no signs of wear or spalling. The contact area must extend over the whole surface of the toothing and must look smooth and uniform. Replace all gears showing signs of said defects.
Before reassembling the double gears **(31** and **32)**, it is necessary to visually check the coupling surfaces: they must show no signs of scoring or buckling. Check that the gears have maintained the minimum specified interference with the lay shaft (D 1.01). If this is not the case, replace the components immediately.
Check the sides of the sliding sleeve for signs of wear, along with the contact surfaces of the gear shift forks. It is extremely important that the contact surfaces of the fork and the sleeve remain upright in respect of the support rods.
Check that the shimming surfaces of the idle gears, the spacers and the shoulder rings show no signs of snagging or seizure. Replace if this is the case.
Check that the engaging teeth of the sleeves and of the idle gears show no signs of snagging, spalling or excessive wear, which would impede engagement.
Check the threading and the grooving on the shafts and the synchronised elements on the **reverse driving** gear are in good condition.

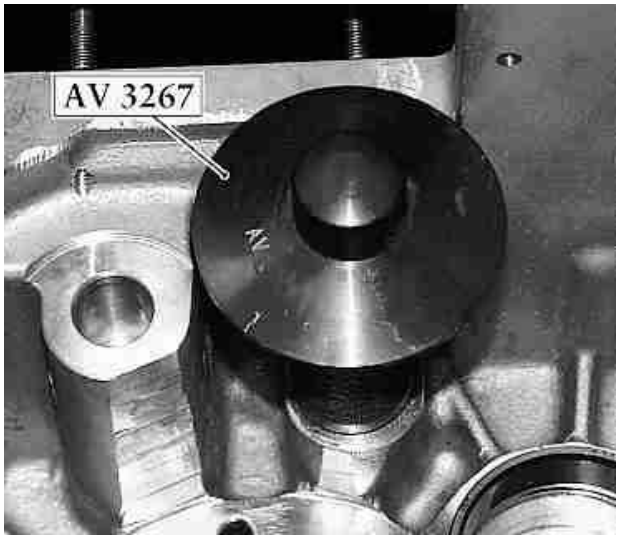
Plugs for tapping the machined holes are fitted on the gearbox housing along with tapered thread plugs **(56**, **57** and **58)** which close the lubrication ducts. When disassembling, apply **LOCTITE 510** on the threading.
The oil bleeding neck **(59)** is fitted flush on the housing. Check that it is not clogged with foreign bodies.

- To remove ball bushing **(E)** for the fork supporting rod use the bushing extractor **USAG 468S11**.

IMPORTANT
Once the ball bushings are removed they cannot be reinstalled



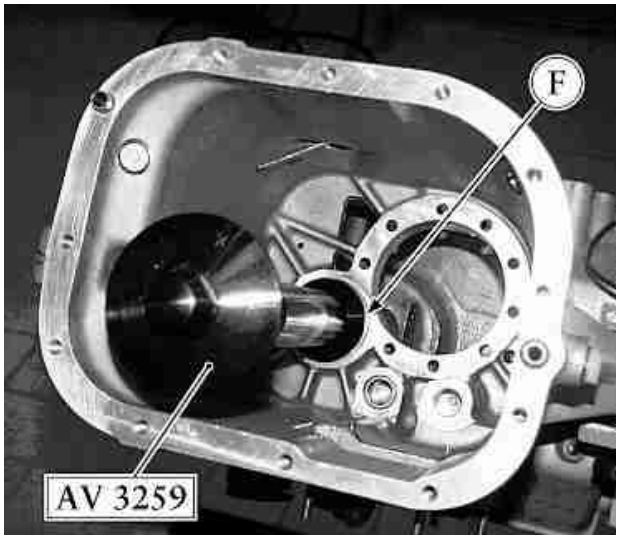
- Use the **AV 3267** punch for ball bushing **(E)** re-assembly.



- To remove the outer race **(F)** of the roller bearing **(23)**, it is necessary to unscrew the screw **(64)** with the flexible washer **(65)** and extract the retaining bushing **(63)**.

- Working from the differential compartment, re-hammer the roller bearing outer race **(F),** taking care not to damage the gearbox housing seat and continually moving the thrust point.

- When re-assembling, use the punch **AV 3259** to bring the race flush with the housing seat.
- Fasten the race **(F)** with the retaining components, applying the recommended locking product on the fixing screw **(64)** and tightening it to the prescribed torque.

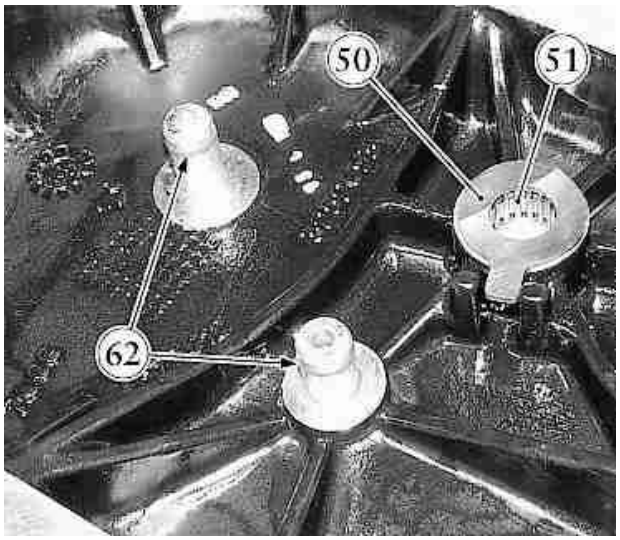


Covers

The roller casing **(51)** for the fork support rod is installed on the rear cover **(3)** and the O-rings **(62)** are positioned on the pins for oil delivery to the gearbox shafts. Before re-assembly, grease the O-rings and the shoulder ring **(50)**, positioning it between the raised parts of the cover.

- To replace the roller casing **(51)**, use the previously utilised bushing extractor **ASAG 468S11.**

In the event that the lower inspection cover or the tapered plugs **(58)** are removed, before refitting, apply **CAF4** sealant to the coupling surface on the housing and **LOCTITE 510** to the thread on the plugs.



Intermediate plate

Once the bearing retaining plate **(4)** has been removed, it is possible to extract the tapered bearing **(7)**. Use the **AV 3264** punch for removing and fitting the bearing. The bearing has a ledge to help obtain the correct position on the plate.
A roller casing **(51)**, identical to the one on the rear cover, is installed in position with the oil pump on the intermediate plate, along with a ball bushing **(E)** for the fork support rod, which is identical to the one fitted inside the gearbox housing.

- Use the bushing extractor **USAG 468S11** to remove said components.

- To extract the outer race **(G)** of the roller bearing **(41),** work from the oil pump side using a punch, and utilising the specific notches machined on the plate. Work with great care to avoid damaging the seat.

NOTES

For oil pump disassembly and overhaul, see paragraph "Lubrication".

To refit the components on the intermediate plate, use the tooling **AV 3265**, consisting of the following parts**:**

- base: **(a)**;
- punches: **(b)**, **(c)** and **(d)**.
- Position the intermediate plate **(2)**, having removed the oil pump **(53),** on the specific base **(a)**.
- Use the punch **AV 3264** to insert the ball bearing **(7)**.
- Using the punch **(b)** insert the outer race **(G)** of the roller bearing **(41)**.
- Using the punch **(c)** fit the roller cage **(E)**.
- Using the punch **(d)** fit the roller cage **(51)** on the intermediate plate.

Synchronisers

Synchronisation details for gear engagement are illustrated in figures **3** and **4**.

The sliding sleeve **(A)** has an inner toothing, which engages with the gear's **(C)** coupling element **(B)**, thereby rigidly connecting it to the synchroniser unit **(D)** splined on the shaft.

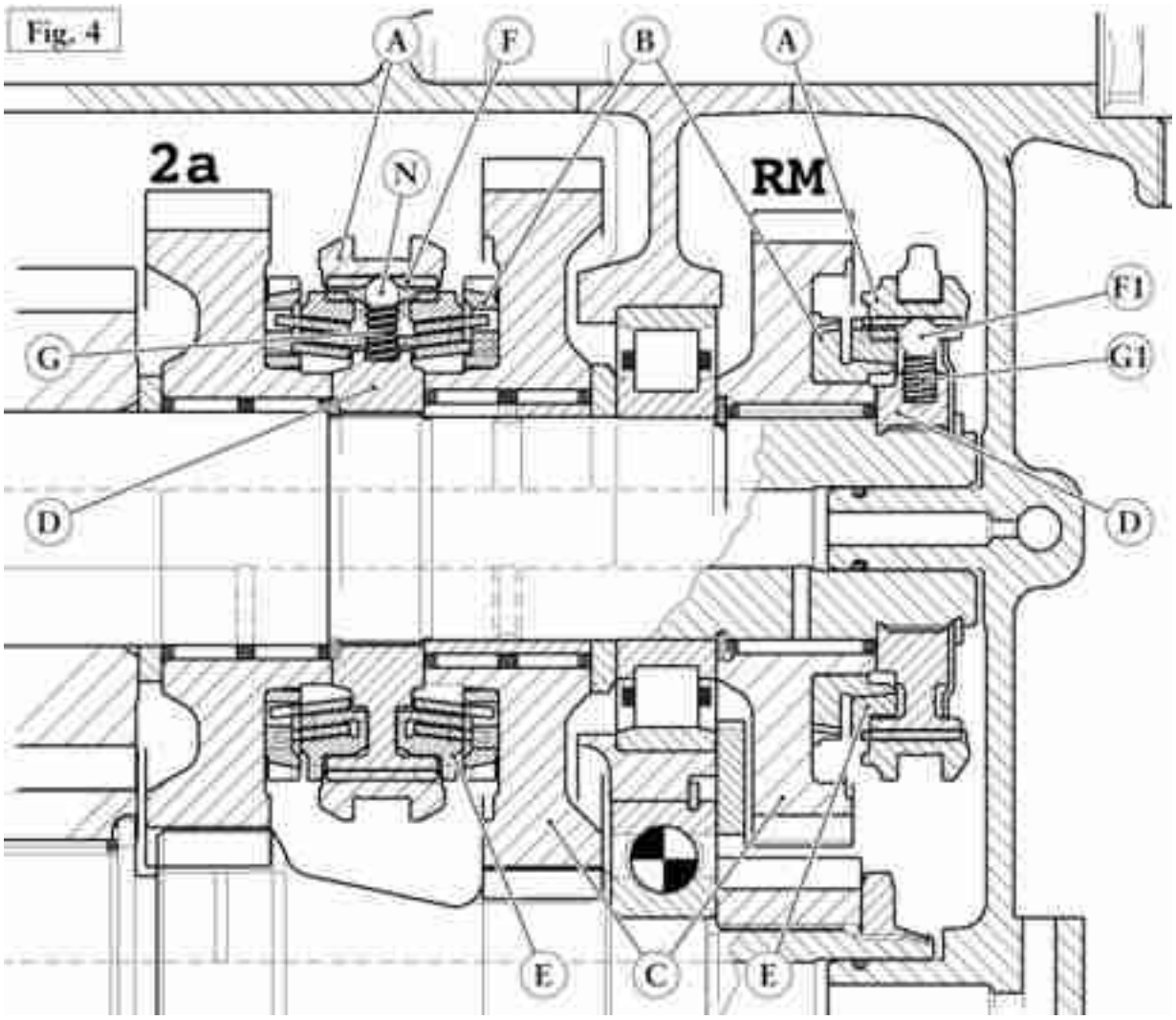
Moving the sleeve **(A)** axially, the synchroniser ring **(E)** is driven simultaneously with it by means of the pressure blocks **(F)**. These are pushed against the ring by the balls **(N)**, held up in the grooves of the sleeve by the spring clamps **(G)**. This allows the sliding sleeve to move.

The **Reverse gear** synchroniser, **UP TO** gearbox no. **10297**, does not have pressure blocks **(F)** the function of which, together with that of the ball, is carried out by special rollers **(F1)**.

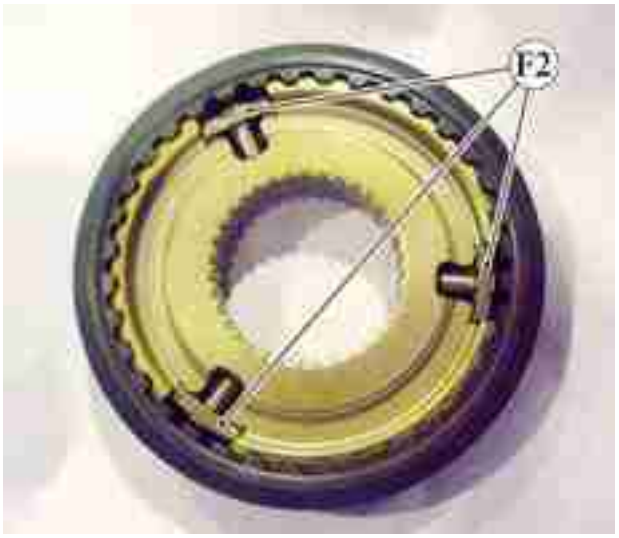
The concave surface of the synchroniser ring therefore, adheres to the correspondent convex surface of the intermediate ring or of the coupling element.

Due to the slight caster angle between the two tapered surfaces, radial forces are generated on the gear **(C)**, which, by causing it to rotate, counteract the differences of spin velocity between the gear to be engaged **(C)** and the synchroniser body **(D)**, and therefore between the shaft and the gear.

As soon as synchronism between the parts is obtained, there is a further movement of the sleeve which, engaging on the gear's coupling element, brings about the definitive coupling between the gear **(C)** and the synchroniser body **(D)**.



Starting **FROM** gearbox **10928**, the new **Reverse gear** synchronizer features, besides an increased diameter, special “INA” **(F2)** pressure blocks, which cannot be disassembled.



Checking for wear

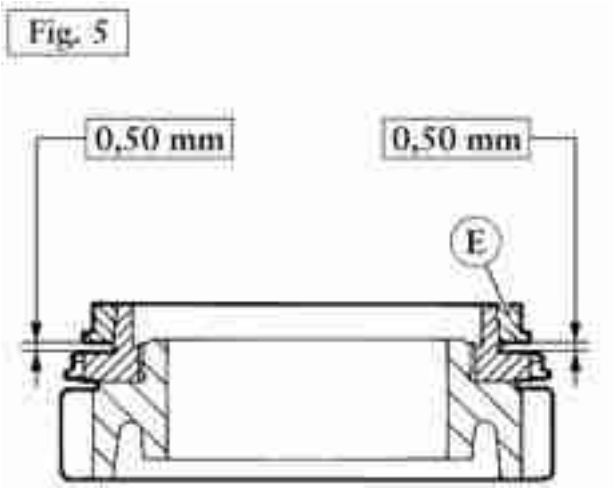
The **1st - 2nd**, **3rd- 4th** and **5th - 6th** speed synchroniser rings are similar to each other, but different from those of the **reverse gear**.

Visually check that the male cone does not show signs of smoothing, excessive seizure or overheated areas.

To check the **reverse gear** synchroniser wear, proceed as follows:

- Centre the synchroniser ring **(E)** on the corresponding friction cone. By a relative axial rotation, the two cones should be positioned so to couple in a uniform and parallel way.
- Measure the gap between the engaging element and the synchroniser ring at several diametrically opposed points (**Fig. 5**).

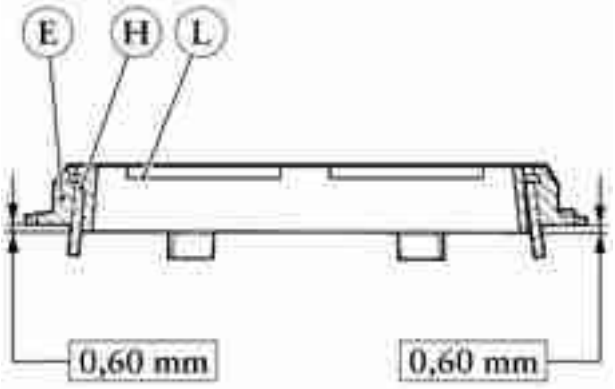
Fig. 5



To check the **3rd - 4th** and **5th - 6th** speed synchronisers for wear, proceed as follows (**Fig. 6**):

- Make an assembly pack by centring the lined intermediate synchroniser ring **(H)** in the outer ring **(E)** and inserting the inner ring **(L)** into the intermediate ring. Make sure the couplings are parallel and uniform.
- Position this so formed assembly pack with the divergent side of the inner ring on a suitable checking plane and, exerting a gentle pressure on the external ring, measure the gap at diametrically opposed points.

Fig. 6



To check the **1st - 2nd** speed synchronisers for wear, proceed in the same way as for **3rd - 4th** and **5th - 6th** speed synchronisers, adding the second lined inner ring **(M)** to the assembly pack and making sure that the couplings are parallel and uniform.

- Rest the assembly pack and measure the gap at diametrically opposed points.

If the measured gap is less than the prescribed value, replace the synchroniser.

Assembly notes

- Before re-assembly, lubricate all the synchroniser components and in particular the rings with grommet using gearbox oil.
- Insert the sliding sleeve onto the synchroniser body.
- To facilitate the assembly of the ball **(N)**, the wedge **(O)** and the spring **(G)** the tool **AM 106121** is available.

- Lock the synchroniser hub on the tool **AM 106121** using a suitably sized screw **(t)** and a washer **(k).** If this tool is unavailable, insert the spring into the wedge and push it into its seat thereby inserting the ball as well. After inserting all the components, lift the sliding sleeve to keep them in a working position.

- The **3rd - 4th** or **5th - 6th** speed synchroniser body can be assembled in either direction.
- The **Reverse gear** synchroniser's springs **(G1)**, **UP TO** gearbox no. **10297**, are specific for this purpose (see **Fig. 4**).
- When assembling the **3rd - 4th** and **5th - 6th** speed synchroniser rings, pay attention to the direction of the inner ring driving teeth **(L)** in respect of the outer ring **(E)**.

- When assembling the **reverse gear** synchroniser **(46)**, pay attention to the direction of the body **(D),** making sure that the lubrication millings face the gearing, and to the sliding sleeve **(A),** whose grooved side must face the gearing. Also take care that the retaining washer **(47)** is mounted with its outer raised edge facing the gear.

Rods with forks

The **5th - 6th** speed fork, like the **reverse gear** ones, are supplied as spare parts coupled to their relative rods. The Manufacturer carries out the drilling and the fixing using flexible pins, with the components already coupled: this system guarantees a precise and stable coupling.

The forks of the **1st - 2nd** and **3rd - 4th** speeds, which must move on the rod, have inner bushings made of an anti-friction material. When disassembling, always check the rod clearance on the fork bushings. Replace the fork if this is excessive.

The surfaces of the forks in contact with the synchroniser sliding sleeve have a molybdenum covering which increases their surface hardness. Check that these surfaces do not show signs of excessive wear or scoring; replace the fork if this is the case.

Lubrication

A concentric gear volumetric pump **(53)** is used to lubricate the gearbox's internal elements, operated by the **reverse gear** auxiliary gearing **(49)**.

NOTES
The pump is supplied as a spare part as a single assembly and must not be dismantled.

Unscrew the four fastening screws with flexible washers to remove the intermediate plate **(2)**.
Once removed, rotate the driving shaft **(P)** to check that there is no interference or irregularity in its rotation.
Also check that the driving ends both on the pump shaft and on the driving pin **(52)** are in good condition.

For cleaning and replacing the mesh filter (A 3.02).
The oil/water heat exchanger, fitted to the gearbox housing with flexible piping, is used for cooling the oil flessibili (B 5.06).
The gearbox's internal components are lubricated through the use of ducts machined in the casting of the gearbox housing and the covers and on the main and lay shafts.
The said ducts must show no signs of clogging and must be spotlessly clean for the unit to work correctly.

Lubrication of the crown and pinion takes place by suction of the oil from the bottom of the housing and through a nozzle **(54)** which aims the oil jet directly on the crown toothing.
A sheet **(Q)** is inserted in position with the ducts connecting the differential compartment with the one housing the gear shafts. This partially obstructs the said ducts and therefore prevents the oil from draining too quickly.

Fig. 7 illustrates the gear lubrication circuit.

Re-assembling the gearbox shaft components

IMPORTANT

*The correct positioning and the end float of the gears on the main and lay shafts is determined by the shoulder rings. Check the thickness of these rings every time a component in the assembly pack is replaced. It is possible to keep the same shims only if the new component shows a deviation which is lower or equal to **0.02 mm**, in respect of the replaced component's thickness.*

Main shaft

Use the tool **AV 3252** composed of the base **(a)**, different punches **(b**, **c** and **d)** to reassemble the components on the main shaft.

- Position the main shaft on the base **(a)**.
- Using the punch **(b)** bring the **5th** speed gearing **(9)** flush with the main shaft.
- Fit the complete **5th** and **6th** speed synchroniser **(11)** on the shaft and bring the elements flush using the punch **(b)**.

- Fit the **6th** speed spacer **(13)** with its released side resting on the flexible ring **(12)** retaining the **4th - 5th** speed hub.
- Fit the roller cage **(10)** and the **6th** speed gearing **(14)** on the shaft.

- Apply the locking product recommended on the shoulder ring nut threading **(15)** of the **3rd - 4th** speed gear and lock it on the shaft.
- Using the wrench **AV 3246**, tighten the ring nut to the prescribed torque and press down in the two points (see arrows), in correspondence with the shaft notches.
- Fit the roller cage **(16)** and the complete **3rd** speed gearing **(17)** on the main shaft.

- Using the tool **AV 3252**'s punch **(c)**, fit the complete **3th** and **4th** speed synchroniser **(18)**.
- Fit the flexible ring **(19)**, the roller cage **(20)** and finally the complete **4th** speed gearing on the main shaft.
- When mounting the **4th** speed gear support washer **(22),** place its side with the millings for the lubricating oil flow facing the gear.
- Using the tool **AV 3252's** punch **(d)** fit the roller bearing's inner ring **(23)** on the main shaft.

- Apply the recommended locking product on the threading and lock the first ring nut **(24)** on the main shaft. Lock the ring nut to the specified torque using the tool **AV 3245** together with a torque wrench.
- Carry our the same procedure for the check ring nut.

Lay shaft

If the crown and pinion and / or the support tapered roller bearings have been replaced, it is necessary to calculate the size of the shoulders to be inserted between the bearings and under the bushing **(29)** in order to obtain the specified bearing pre-load (D 1.01) and the correct positioning of the pinion in respect of the differential crown (D 5.01).

The procedure which we are going to illustrate will enable the shoulder thickness to be calculated. As a reference, we will use the value **"Z"** on the gearbox housing (see Fig. **9**) compared with the theoretic value **(77 mm)** for the distance between the pinion head and the differential centre line (**0**, see Fig. **10**).

To measure the necessary values, a checking plane capable of bearing the weight of the gearbox housing and a measuring instrument equipped with a dial gauge, with a range of at least **500 mm** are needed.

- Reset the dial gauge on the checking plane.
- Measure the distance **"J"** between the pinion head's ground plane **(42)** and the supporting surface of the front tapered roller bearing's inner race **(25)**.

- Considering the deviation marked on the pinion head, measure the distance between the tapered roller bearing plane **(25)** and the differential centerline **“0”**:
  P1 = 77 ± deviation **+ J**

Use tool **AV 3255,** composed of a base **(a)** and punches **(b**, **c** and **d)**, to assemble the support components on the lay shaft.

- Fit the front bearing's inner roller race **(25)** on the lay shaft, using the tool **AV 3255**'s tubular punch **(b)** and the press.

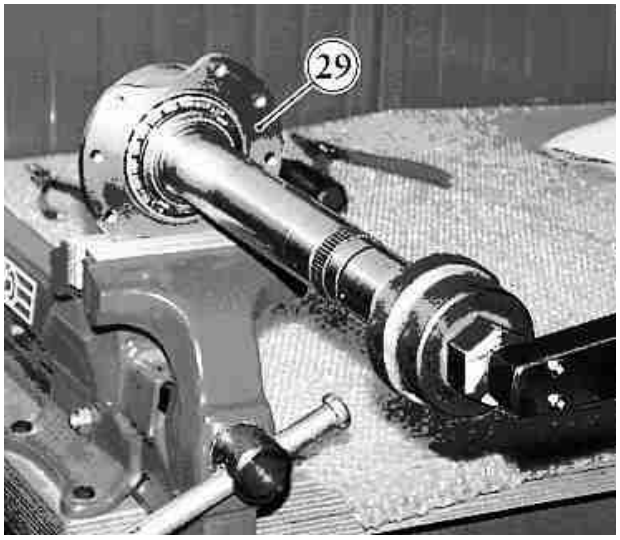
- Place the pinion on the checking plane and install the bearing's outer race **(25)**, checking it is parallel with its supporting surface.
- Measure the distance **"R_1"** between the outer race surface and the bearing's inner race.

- Fit the outer race of the rear tapered roller bearing **(27)** into the bushing **(29)** until flush, using the base **(a)** and the tool **AV 3255's** punch **(d)**.
- Position the inner race with rollers on the checking plane and rest the bushing with outer race.
- Make sure the bushing is level with the resting surface and re-set the dial gauge.
- Measure the distance **"T_1"** between the bushing plane and the bearing's inner race.

  Taking into account a bushing pre-load of **0.03 mm**, we will have:
  $S1 = R_1 + T_1 - 0.03$
  where **"S1"** represents the spacer thickness **(26)** to be inserted between the tapered roller bearings.

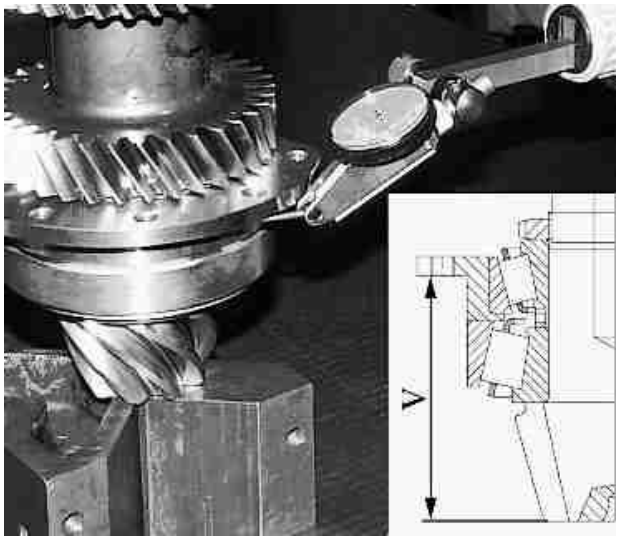
- Fit the spacer **(26)**, the bushing **(29)** and the bearing's inner race with rollers **(27)** on the lay shaft and bring them flush using the press reusing the tubular punch **(b)**.
- Mount a new ring nut **(30)** and tighten it to the specified torque, using the tool **AV 3257** to lock the ring nut and the shaft and the tool **AV 3247** together with a torque wrench to tighten the ring nut.

- Lock the bushing **(29)** in a vice and check that the pinion bearings' rolling torque corresponds to the specified value using a torque wrench (D 1.01).
  If not, adjust the spacer thickness **(26)** until the prescribed torque is obtained.

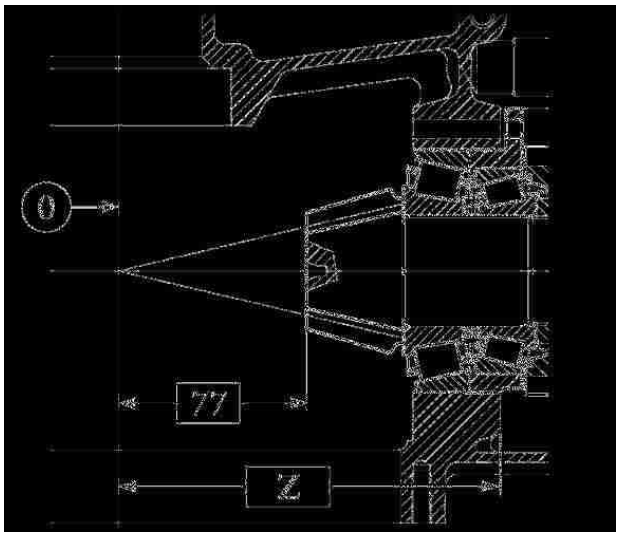


It is necessary to add the deviation to the theoretic value, checked by the Manufacturer and marked on the pinion head, in order to determine the thickness **"S2"** of the spacer **(28)** to be inserted under the bushing **(29)**.

- Place the lay shaft on the checking plane and measure the distance **“V”** between the pinion head and the bushing's resting surface **(29)**.



At this point, we are able to calculate the pinion shoulder:
S2 = V + 77 ± deviation – Z



- Clean and degrease the surface of the lay shaft and the inner surface of the double gears **(31** and **32)**.

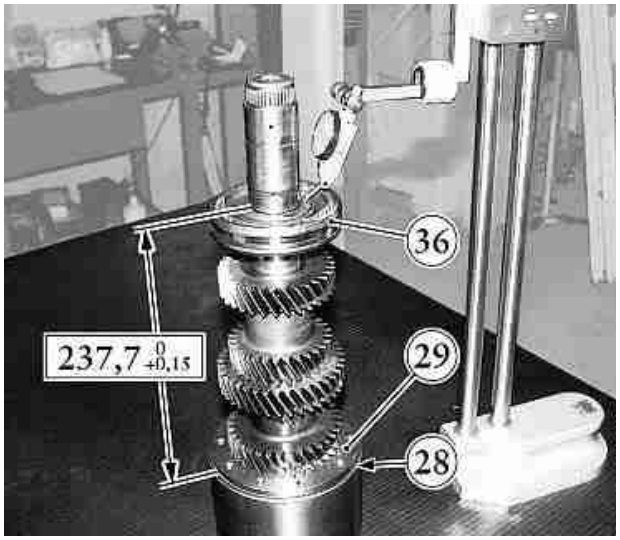
IMPORTANT
*Put the two gears in the oven, in the correct assembly position, and leave them for at least two hours at a temperature of **140°C**.*

- Position the pinion on the base **AV3255 (a)** and use a tubular punch **(b)** to fit the **3rd – 4th** speed double gear. Rest the newly formed assembly on the surface of the press and align it with the thrust axle before fitting the first gear **(31)**.
- Leave it on load **(10.000 kg)** for at least **15 minutes** and let the shaft cool down.
- Mount the **5th – 6th** speed double gear **(32)** following the same procedure and using a tubular punch **(c).**

- To determine the thickness **(S3)** of the **2nd** speed gearing shoulder ring **(33),** it is necessary to fit the original flexible ring **(35)** and the **1st - 2nd** speed synchroniser element **(36)** using the punch **AV 3262**.

IMPORTANT
*The flexible ring's bevelled side **(35)** must face the roller cage.*

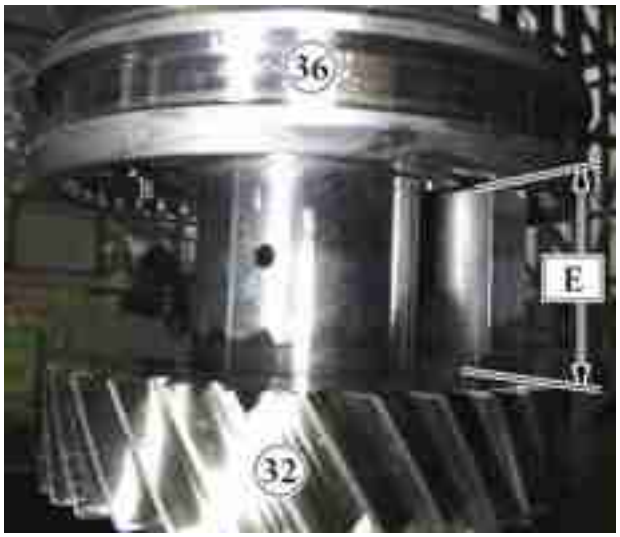
- Insert the spacer **(28)**, with the calculated proper thickness, under the bushing **(29)** and place it on the base of the checking table.
- Measure the distance between the spacer surface and the synchroniser hub:
  this must be **$237.7^{+0,15}$ mm**.
  If the result differs, adjust the thickness of the flexible ring **(35)** until obtaining the specified distance.



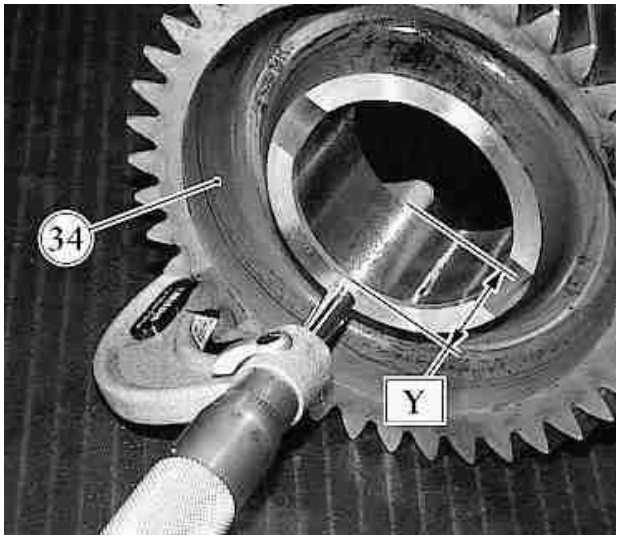
- Having mounted the flexible ring and the synchroniser, measure the distance **"E"** between the synchroniser hub **(36)** and the **5th** speed gear **(32)**, using gauge blocks.

IMPORTANT

*The calibrated blocks must rest on the synchroniser hub's flush surface and not on the flexible ring's ridge **(35)** as this would alter the detected measurement.*

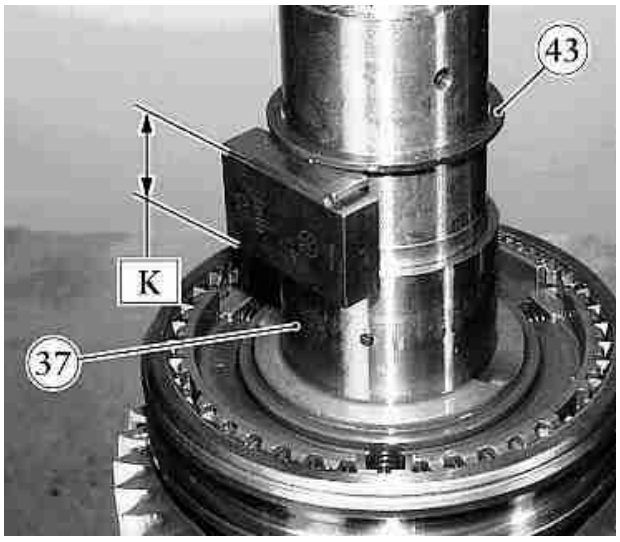


- Using a micrometer measure the thickness **"Y"** of the **2nd** speed gear hub **(34)**.
  To obtain the shoulder ring thickness **(33)**, keeping in mind the specified end float, calculate:
  S3 = E – Y – end float
- Fit the bushing **(37)** resting on the **1st - 2nd** speed synchronizer hub using tool **AV 3263** and install the seeger ring **(43)** in its seat.



- Again using the gauged blocks, measure the distance **"K"** between the bushing edges and the seeger ring.

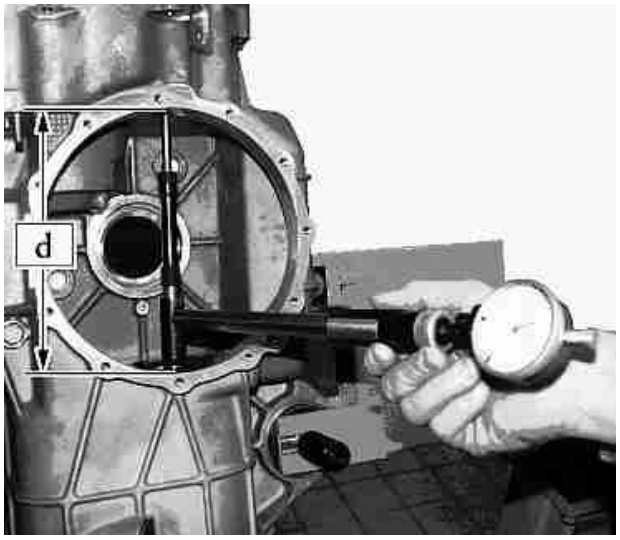
To obtain the thickness **"S4"** of the shouldering fifth wheel **(40),** subtract the thickness **"W"** of the inner roller bearing track **(41)** and the prescribed value of the roller bearing end float from the distance **"K"** measured.
S4 = K – W – end float



- Remove the bushing, the synchroniser **(**with the extracting tool **USAG 454N/3)** and the flexible ring and, after heating it in the kiln like the double gears, bring the shoulder ring **(33)** flush using the punch **AV 3255** and the press; position it with its grooved side facing the double gear.

Having calculated all the shimmings, to verify the correct positioning for the pinion in respect of the differential crown, it is necessary to refit and lock the lay shaft.

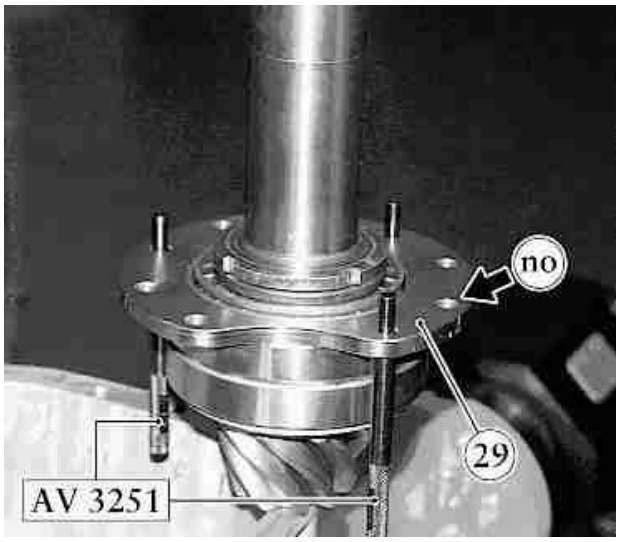
- Measure the diameter **(d)** of the left-hand differential cover's seat on the gearbox housing, using a bore meter.



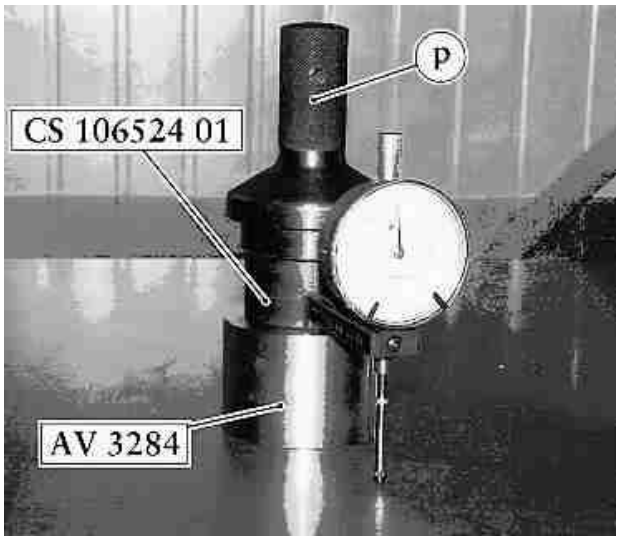
- Check that the shim **(28)**, having a proper thickness, is fitted inside the gearbox housing.
- Fit the lay shaft inside the gearbox housing and bring it flush using a rubber hammer. To ease the fitting, tighten the centring screws **AV 3251** on the bushing **(29)**, in diametrically opposed positions.

NOTES

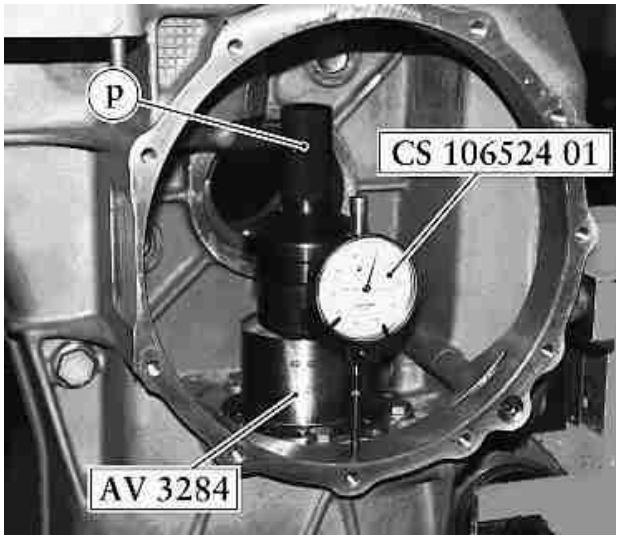
To avoid contact with the gearbox housing, the centring screw must not be positioned in the hole nearest to the gearbox housing's right-hand side wall (see illustration).



- Remove the three centring screws and fit the screws fastening the bushing **(29),** tightening them to the prescribed torque.
- Reset the dial gauge **CS106524 01** to **2 mm** on a checking plane and position it on the bushing **AV 3284**. Rest a weight **(p)** on the dial gauge support, to obtain a perfect resetting.



- Fit the bushing **AV 3284** in the pinion resting on the front tapered roller bearing **(25)**.
- Place the dial gauge **CS106524 01** on the bushing **AV 3284,** along with the weight **(p)** and read the deviation **"M"**.
- To determine the real positioning of the tapered roller bearing in respect of the differential axle **"0"** carry out:
  P2 = d/2 + M
  To obtain the correct positioning of the pinion in respect of the differential axle **"0"** the result must be:
  P2 = P1
  where **"P1"** represents the previously measured value with the pinion removed from the housing;
  "d" is the diameter of the seat of the differential's left cover, previously measured.
  If the value is different, increase or decrease the thickness of the shim **(28)**, to obtain this correct value.
- Remove the lay shaft from the gearbox housing.
- Position the lay shaft (**a**) onto the base of tool **AV 3255**.
- Fit the roller cage (**16**), the elastic ring (**35**), the complete **1st -2nd** speed synchroniser (**36**) and bring flush using tool **AV 3262**.
- Using a tubular punch **AV 3263**, insert the bushing (**37**) for the **1st** speed gearing.
- Fit the roller cage (**38**), the **1st** speed gearing (**39**) and, using punch **AV 3263**, bring the shouldering fifth wheel flush (**40**).

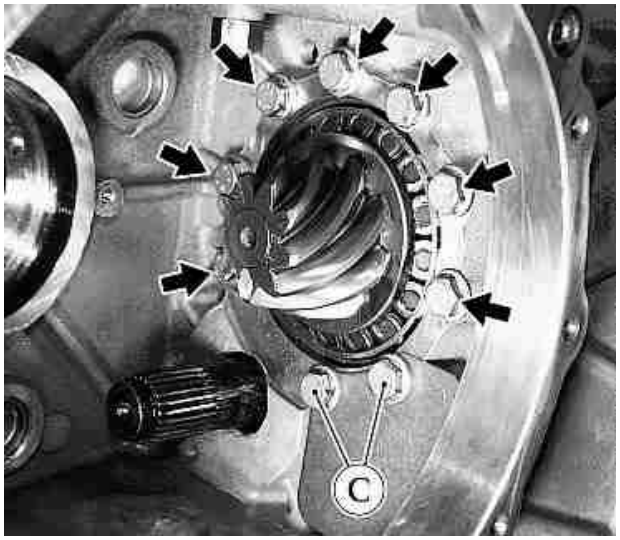


Re-assembly of shaft-rod cluster with forks

- Assemble the gearbox shafts and rods with forks using the **AV 3243** tool, utilised for disassembly.
- Check that the spacer **(28)**, whose thickness has been calculated, is fitted inside the gearbox housing.
- Grease the bearings on the shafts and their relative seats on the housing with gearbox oil.
- Lift the cluster and fit it in the housing, lowering it gently to avoid damage or interference.
- Take great care when inserting into the relative race of the bearing roller cage **(23)** on the main shaft: incorrect insertion could damage it.
- Take care also when inserting the **reverse gear** rod in the housing's ball bushing: turn it while lowering the cluster to ease insertion.
- Fit the three screws **AV 3251** for centring the bushing **(29)**, in diametrically opposed positions, to ease fitting the bearings into the housing.
- Unscrew the ring nut **(A)** holding the main shaft on the cluster support tool. If the main shaft does not lower at the same time as the cluster, there may be an interference of the end bearing. It is therefore necessary to repeat the insertion procedure from the beginning.

- Using punch **AV 3262** and a rubber hammer bring the lay shaft flush with the housing.
- Using tool **AV 3262** insert the roller bearing (**41**) into the lay shaft.
- Insert the elastic ring (**43**) onto the lay shaft.
- Remove the three centring screws and apply the specific locking product to the screws fastening the bushing **(29)**.

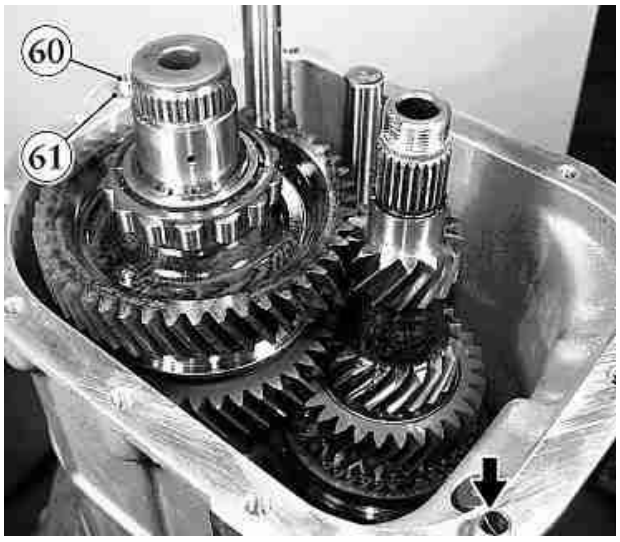
- Fit the screws inserting the oil shield sheet under the two screws **(C)** and tighten them to the prescribed torque, working crosswise.



Rear cover and plate re-assembly

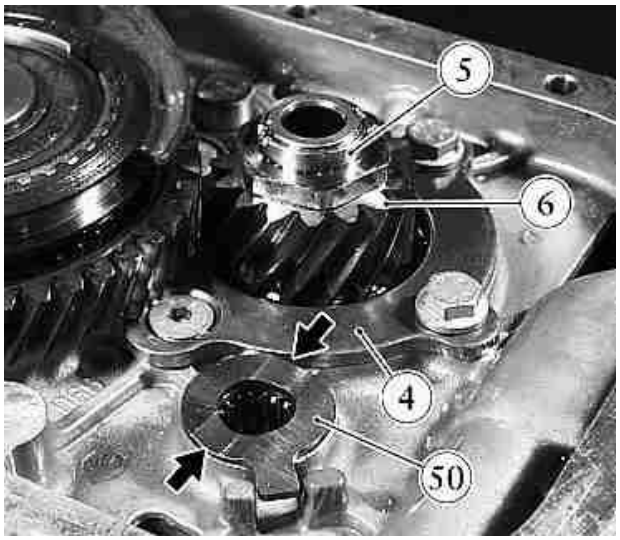
NOTES
Follow the disassembly sequence in reverse order for re-assembling the components.
Only the indications specific to re-assembly will be described below.

- Test the movement of the shafts, the gears and the forks before re-assembly.
- Clean and degrease the contact surfaces of the housing **(1)** and the intermediate plate **(2)**. Then check that the oil pump **(53)**, the ball bearing **(7)**, the roller bearing's outer race **(41)** and the ball bushing for the fork support rod are mounted on the intermediate plate.
- Fit the two driving dowels **(60)** and the new O-rings **(61)** on the housing, then grease the ends of the shafts, of the rods and the bearings with gearbox oil.
- Apply a continuous, even seam of **CAF4 sealant** around the holes in the internal area of the contact surface of the housing.



- Mount the intermediate plate using the tool **AV 3264** - utilised during disassembly - to help insertion of the main shaft into the bearing **(7)** and beating at diametrically opposed points with a plastic hammer.
- Install the bearing retaining plate **(4)** and, after having applied the locking product recommended on the fixing screws, tighten to the specified torque.
- Mount the driving **reverse gearing (6)** and, after applying the locking product recommended on the ring nut threading, **(5)**, tighten to the prescribed torque.
- Fit the roller cage **(44)**, the driven reverse gearing **(45)** and the complete reverse gear synchroniser **(46)** using tool **AV 3263**.
- Insert the retaining washer **(47)** and lock the entire set using the elastic ring **(48)**.
- Using a drift, insert the elastic pins onto the reverse gear fork, keeping the respective control rod in position.

- Position the idling reverse gearing **(49)** on the corresponding seat.



- Install the shoulder ring **(50)** on the roller casing **(51)** with its lubrication milling facing outwards and with its protrusion inserted between the plate clamps.
- Check that the second roller casing **(51)** and the new O-rings **(62)** are inserted on the rear cover.
- Grease the O-rings and the shoulder ring seat **(50)** on the cover, to keep it in position between the clamps during cover assembly. Make sure its lubrication milling is opposite the cover.
- Check that the centring dowels **(60)** and the new O-rings **(61)** are mounted on the plate before applying a strip of **CAF4 sealant** on the plate surface, as in the previous coupling.
- Mount the rear cover **(3)** on the plate **(2)**.
- Apply the recommended locking product on the fixing screws' threading and tighten them to the prescribed torque, working crosswise.
- Proceed by fitting the differential unit (D 5.01).

D5.01 COMPONENT REPLACEMENT

Differential unit components (Fig. 1):

Left-hand flange shaft
2 Gearbox housing left-hand cover
3 Right-hand flange shaft
4 Gearbox housing right cover
5 Seal ring
6 Flange shaft ball bearing
7 Left-hand spacer for tapered roller bearings' pre-load
8 Tapered roller bearing for differential
9 Crown
10 Differential housing
11 Differential housing cover
12 Right-hand spacer for tapered roller bearings' pre-load

NOTES
*In the below described procedures, the differential unit components will be identified by the reference numbers used in Fig. **1***

- *For differential unit specifications see* (D 1.01).
- *In case of differential unit malfuncions or breakins it is necessary to remove the gearbox unit block*

(D 2.01).

IMPORTANT
Avoid opening the differential housing since the internal components are not supplied as spare parts.

Ball bearing on the left cover

- Remove the differential left-hand cover **(2)**, the flange shaft **(1)** and the external grommet **(5)** (D 4.01).
- Adequately support the cover by positioning a suitably sized bushing **(A)** under it. Extract the outer race of the tapered roller bearing **(8)**, the spacer **(7)** and the ball bearing by positioning the tool **AV 3252**'s punch **(b)** on the ball bearing's outer ring **(6)**.

IMPORTANT
The ball bearing removed in this procedure must always be replaced.

- Turn over the left-hand cover and fit the new ball bearing **( ).**
- Fit the spacer **(7)** placing its side with millings for delivering the lubricating oil opposite the ball bearing and the outer race **(B)** of the tapered roller bearing.

- Insert the cover with components into the base **(a)** of the tool **AV 3275**.

- Using the tool **AV 3275**'s punch **( ),** bring the ball bearing **(** , the spacer **(** **(**

IMPORTANT

After replacing the bearing it is advisable to test the rolling torque (see chapter "Differential tapered roller bearings")

- Re-assemble the outer grommet **(5)** and the flange shaft **(1)** (D 4.01).

Differential crow

IMPORTANT
The differential crown is supplied as a spare part together with the pinion (crown and pinion): the two components must always be replaced together.

Disassembly

- To access the differential crown **(9)** it is necessary to remove the left cover **(2)** (D 4.01).
- Detach the complete differential from the gearbox housing with tool **AV 3266** locked.
- Remove the inner roller track **(C)** of the right-hand bearing with the extracting tool **USAG 454N/3**, inserting its arms into the grooves on the differential housing, as shown in the figure.

- Lock the differential using the **AM 106628** tool, locked in a vice, and unscrew all the screws fastening the crown.

IMPORTANT
The screws fastening the crown must be replaced with every disassembly.

- Detach the cover **(11)** from the differential housing and remove the crown.

Re-assembly

- After cleaning the coupling area on the differential housing, fit the new crown **(9)** and the differential housing cover **(11).**
- Apply **LOCTITE 270** on the threading of the new screws and fit them on the differential housing.
- Lock the screws to a pre-load of **60 Nm** working crosswise and, using the torque wrench **USAG 815 F** (progr. 10), paying attention to the angle, tighten up to the yield point.

- Re-assemble the differential unit on the gearbox housing.

IMPORTANT

After replacing the crown, it is necessary to check the backlash with the pinion toothing and the differential roller bearing pre-load as described in the previous paragraph.

- Re-assemble the left-hand cover **(2)** and the flange shaft **(1)**.

Differential tapered roller bearings

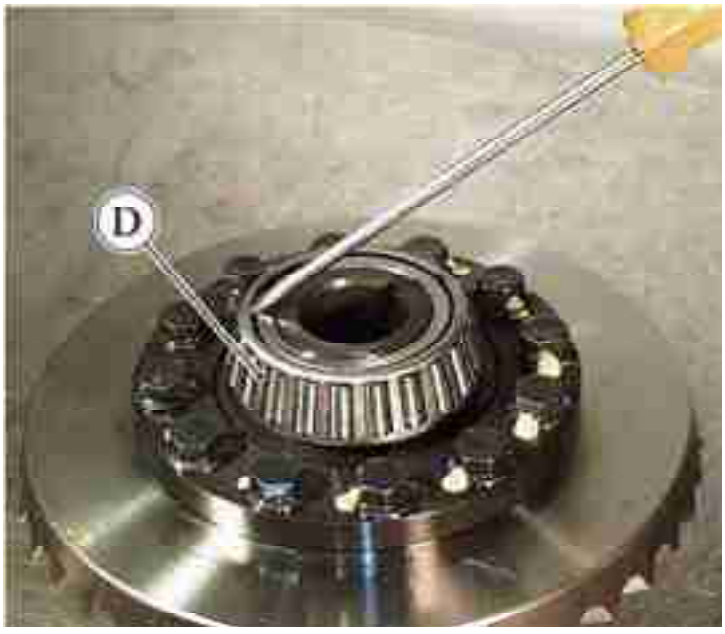
NOTE

*The differential's tapered roller bearings **(8)** must always be replaced in pairs. Avoid mixing up the components belonging to the individual bearings. Removed bearings cannot be re-assembled.*

Disassembly

- Remove the differential housing complete with crown, as previously illustrated.
- To remove the inner roller race **(C)** of the right-hand side bearing, use extractor tool **USAG 454N/3** as illustrated in the figure, by inserting its arms in the differential housing's notches.

- Force open the roller cage **(D)** detaching it from the inner race of the left-hand side bearing.



- Apply the separator jaws under the inner race neck **(E)** and extract it from the differential housing using the extractor **USAG 454N/3.**

- Remove the outer race of the roller bearing on the left-hand cover, as previously illustrated.
- Remove the clutch shaft **(13)**, levering it out with a tackle and protecting the gearbox housing from direct contact with the tool.

- Use the expanding hub of tool **AV 3260** to remove the outer race **(** from the right-hand side roller bearing.
- Detach the spacer **(12)** situated under the outer race.

Calculatin the spacer thickness

The value of the tapered roller bearing pre-load is essential for correct functioning and for crown wheel and pinion durability: this value is determined by the thickness of the shoulders **(7)** and **(12)**.

It is possible to fit new bearings reusing the original spacers and checking that the rolling torque and the backlash correspond with the specified values (D 1.01).

The procedure we are going to illustrate shows how to determine the thickness of the shoulders, taking as references the values **"R"** and **"S"** of the seats on the gearbox housing, compared to the theoretic value **(45,10 mm)** of the distance between the crown and pinion axle **"0"** (see Fig. **2**).

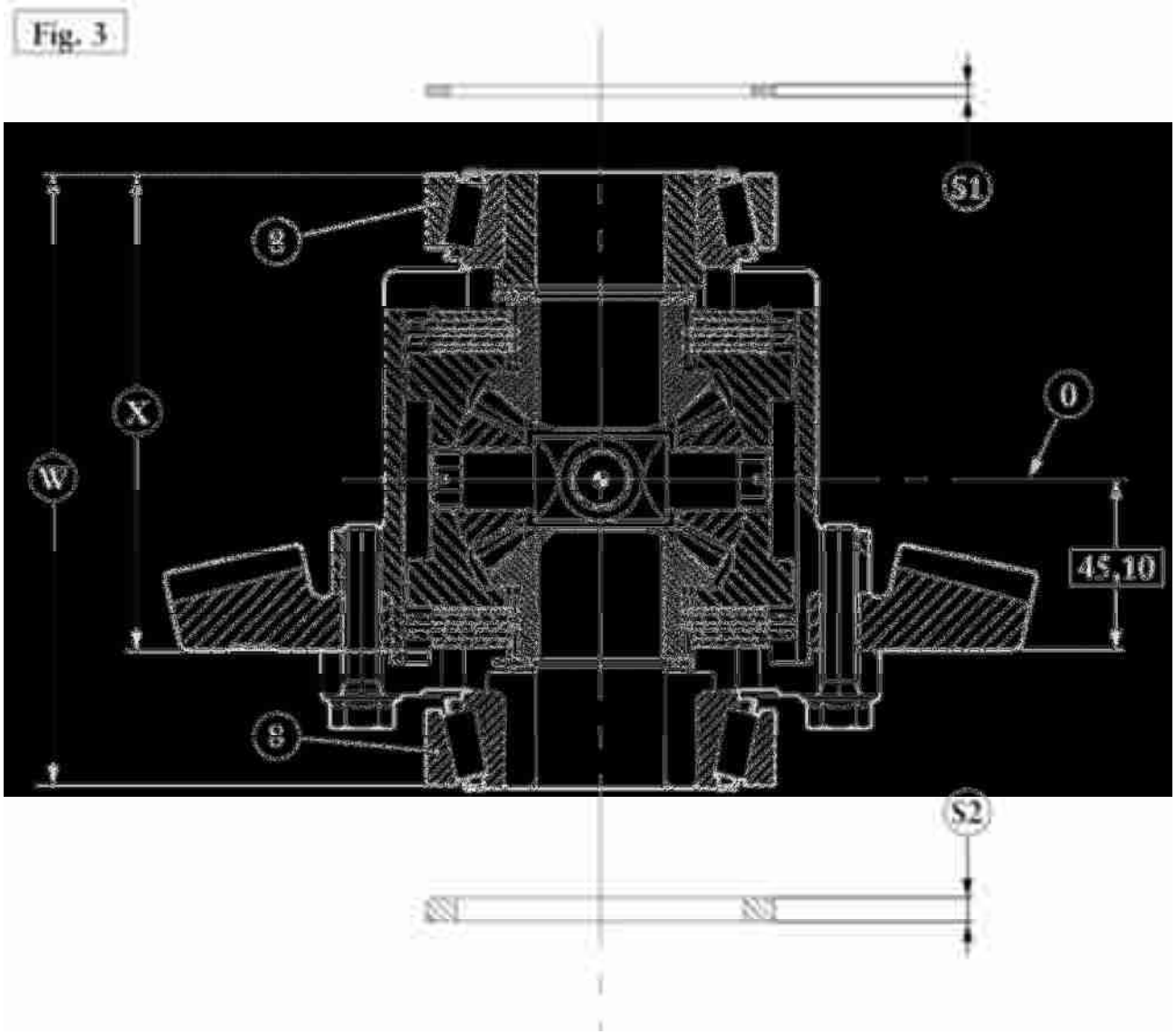
NOTE

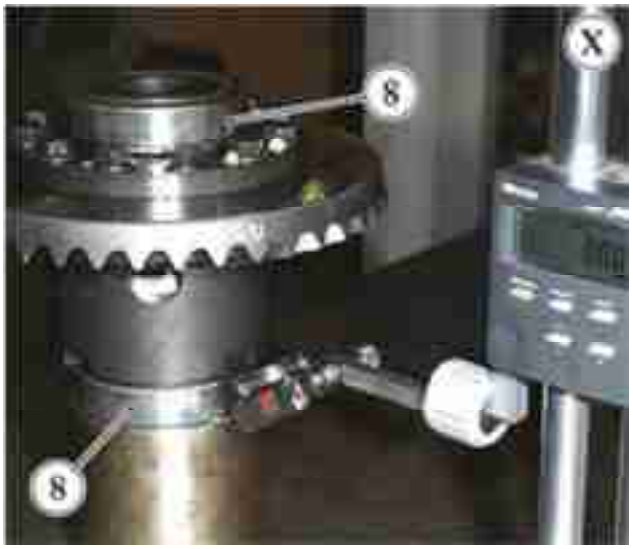
For positioning the pinion (D 4.05).

To determine the said values, it is necessary to use a checking plane capable of supporting the gearbox housing and a measuring instrument equipped with a dial gauge, with a range of at least **500 mm.**

Besides the housing sizes, it is also necessary to measure the sizes **"X"** and **"W"** of the differential unit (see Fig. **3**), with bearings **(8)** already fitted

Fig. 3





and the size **“ ”** of the left-hand cover (see Fig. **4**).

NOTE
*The value **“V”** is also punched on the left-hand cover.*

- Proceed mounting the inner races with rollers **(** **8**.

The deviation **"t"** compared to the theoretic value **45.10 mm** is marked by the Manufacturer on the differential crown and corresponds to the distance between the crown's rear surface and the pinion axle.
The real distance **"G"** between the crown's rear surface and the pinion axle will be:
G = 45.10 ± t
To determine the total size (**"L"**, see Fig. **1**) of the differential assembly pack with bearings and spacers, calculate:
L = R – V
To determine the size (**"H"**, see Fig. **1**) from point **"0"** to the tip of the right-hand bearing, calculate:
H = X – G
At this point, we are able to determine the thickness (**"S1"**, see Fig. **3**) of the spacer **(12)**:
S1 = R – S – H
To obtain the thickness (**"S2"**, see Fig. **3**) of the spacer **(7)**, take into account the new bearing pre-load of **0.07 mm** and calculate
S2 = L – W – S1 + 0.07 mm

NOTES
The thickness of the spacers supplied as spare parts may not correspond with the value obtained using the above calculations: should this be the case, reduce the thickness of the thickest supplied spacer using a surface grinder.

Re-assembly

- Using the tool **AV 3260**, fit the spacer **(12)** with the proper calculated thickness, along with the outer race of the right-hand side bearing **(8)**, in the gearbox housing's inner seat.
- Bring it flush using the press.

NOTES

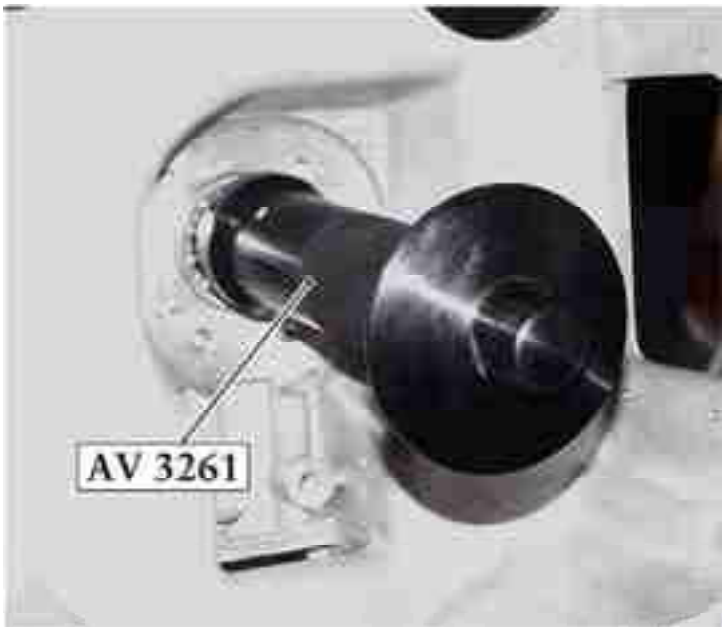
*Bearing in mind the possibility of having to disassemble the components in order to adjust the pre-load values or to modify the impression between the crown wheel and pinion toothing, it is advisable to use the fake ring **AV 3274** with the same dimensions of the ball bearing **(6)**, to avoid damaging it during the removal procedure.*

- Use the punch **AV 3261** to refit the clutch shaft **(13)** from the front part of the gearbox housing.
  If the support bearing has been removed **(13)**, it is necessary to use the base of the **AV 3255** tool and the **AV 3258** punch for re-assembling the clutch shaft.
- Fit the **AV 3258** tool's centering pin in the **AV 3255** base.

- Fit the shaft in the base and using the **AV 3258** punch, bring the bearing flush **(13)**.

- Install the components on the left-hand cover **(2)** following the instructions in the paragraph "Ball bearing on left cover" found in this chapter.

To check the crown wheel and pinion toothing backlash, it is necessary to fit the complete differential unit and the left-hand cover, without flange shaft and O-rings.



- Fix the left-hand **(** **(**

D 1.01).

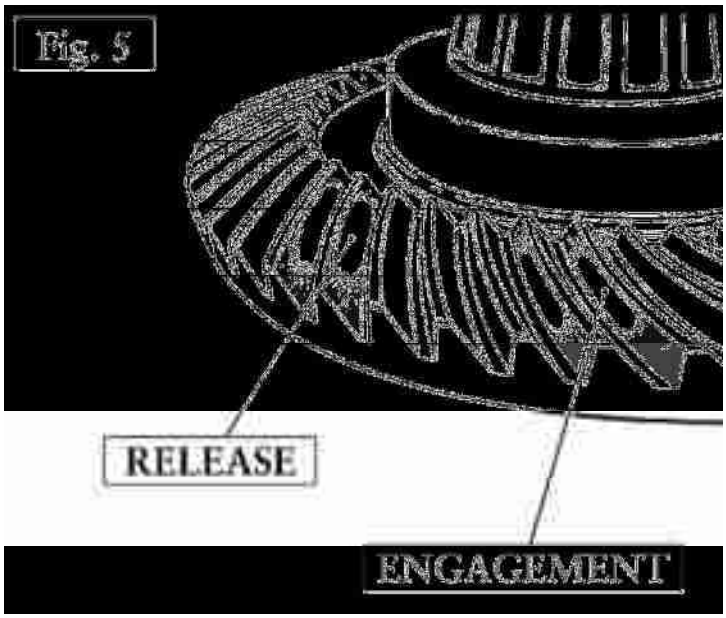
If the measured play is out of the specified limits, the crown wheel and pinion must be replaced.

To check the rolling torque of the new bearings, it is essential that the pinion of the bevel gear pair has not been fitted.

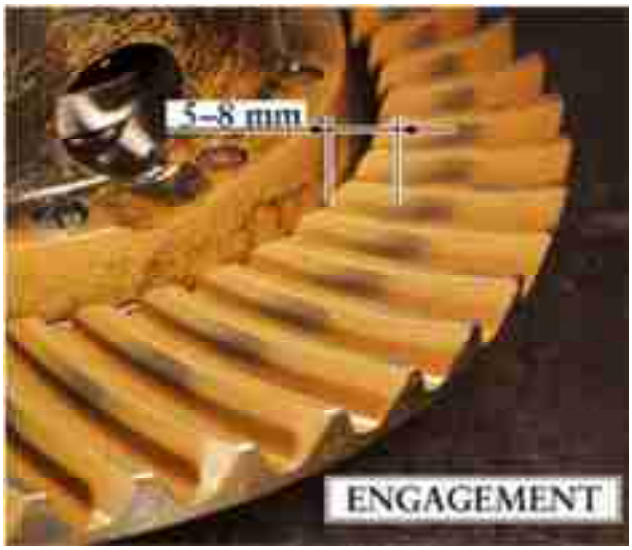
- Apply a torque wrench **(G)** on the **AV 3266**'s nut, and check that the torque corresponds to the prescribed one (D 1.01).

At this re-assembly stage, it is a good rule to check the contact impression of the pinion's toothing on the crown.

- Apply red lead paint to the crown and make the crown and pinion do some revolutions.
- Check that the impression on the crown corresponds to 3/4 of the tooth side, both on the tensioning side and on the releasing one (see Fig. **5**).



The distance of the crown toothing's inner edge and the beginning of the impression should result between **5–8 mm**.



If this is not the case, adjust the spacer thickness to obtain an optimal crown and pinion positioning (see Fig. **6**), making sure the prescribed backlash and pre-load conditions are maintained.

- To adjust the pinion spacer thickness (D 4.05).
- Definitively assemble the cover and the left-hand flange shaft (_____).
- Re-assemble the complete gearbox in the car (_____).

D5.02 AXLE SHAFT

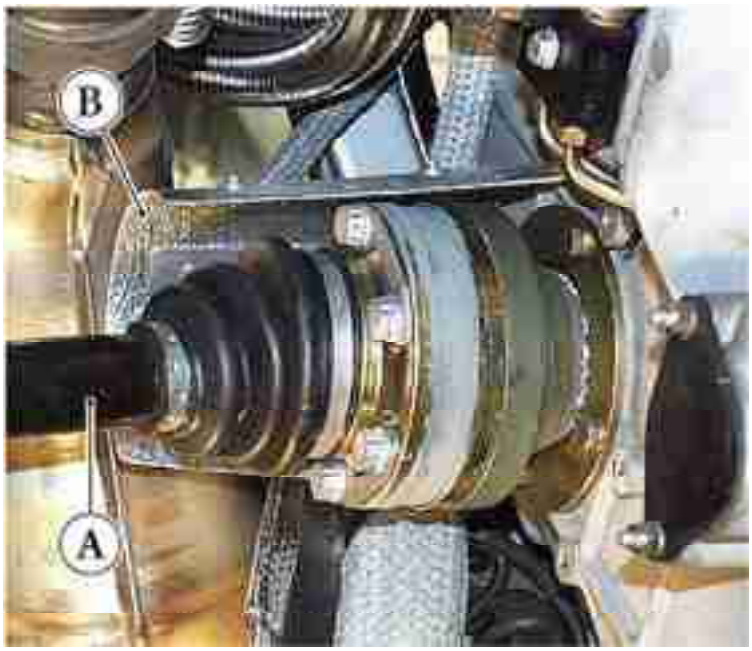
Tightening Torques		Product	
Screw fastening axle shaft (preload **40 Nm**)	**78 Nm**	Grease **MOLYKOTE 1000**	

The axle shafts are enblocs (Lobro type). Each one is provided with a homokinetic joint fitted on its ends. This consists of balls running on special groove tracks within the sleeves. The axle shafts are lubricated by the manufacturer and do not require maintenance. In case of breaking, it is possible to replace the protection boots which are supplied as spare parts in a kit which also includes the clamps.

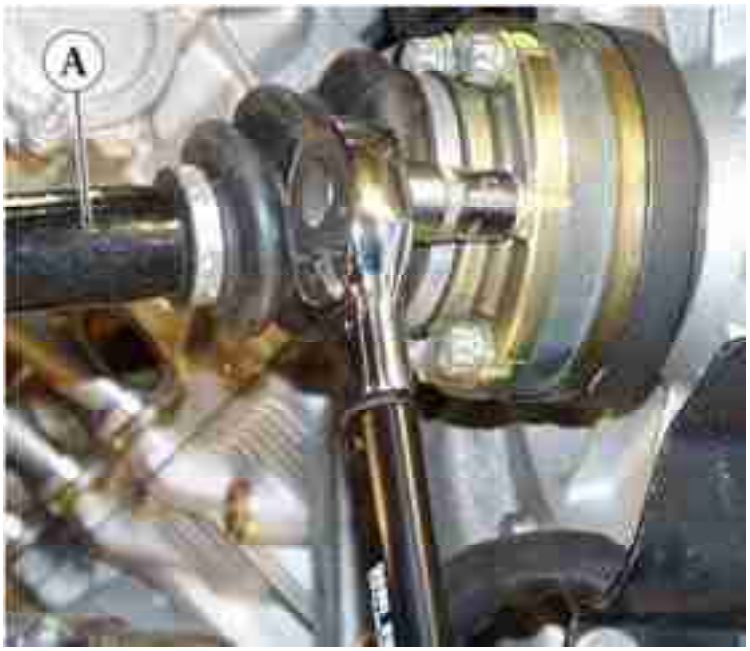
Dismantling

- Remove the rear part of the underfloor (M 2.12).
- Remove the rear wheel (F 3.06).

- Detach the brake calipers from the hub holder, keeping it connected to the system (G 3.01).
- Remove the hand brake calipers from the hub holder, keeping it connected to the control cable (G 3.04).
- Remove the brake disk from the bearing (G 2.05).
- Remove the protection shield (**B**) from the gearbox housing.



- Unscrew the six screws fastening the axle shaft **(A)** to the differential flange.

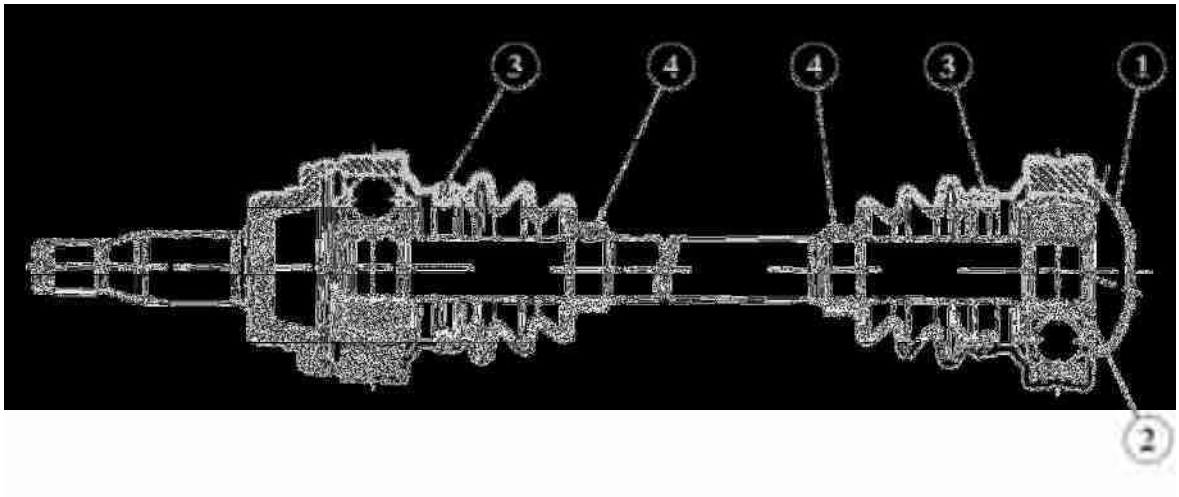


- Remove the screws and the shim plate nuts.
- Carry out the dismantling procedures described in (F 3.04), until the axle shaft is detached from the hub holder.

Replacing the Protection Boots

In case of tearing of the protection casings, it is possible to replace them as follows.

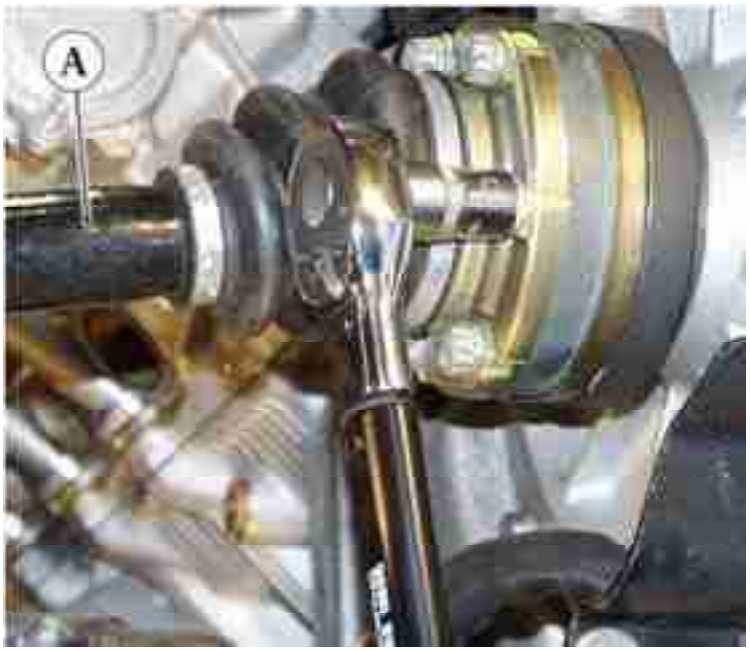
- Slide off the cover **(1)** on the differential side and remove the seeger ring **(2)** from the central shaft.
- Open the clamps **(3)** and **(4)** and slide off the complete sleeve on the differential side from the shaft.



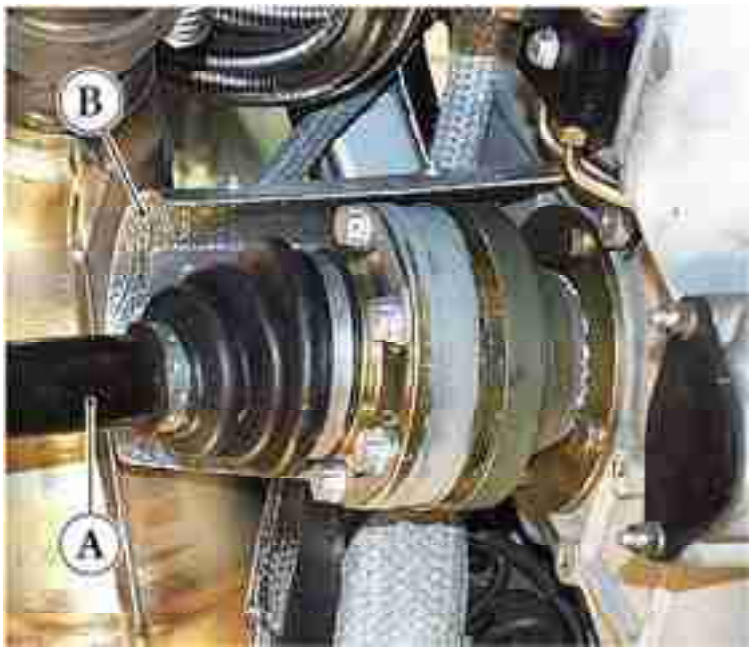
- Remove the damaged casing and wash the joint.
- Put the new casing onto the central shaft and fasten it with the clamp **(4)**.
- Lubricate the joint with **MOLYKOTE BR2** grease and then mount the sleeve.
- Install the seeger ring **(2)** and fit the clamp **(3)**.
- Mount the cover **(1)**.

Re-assembly

- Carry out the re-assembly procedures as described in (F 3.04), starting from the insertion of the axle shaft into the bearing.
- Install the screws together with the shim plates and apply the prescribed grease on the thread.
- Manually position the screws on the differential flange.
- Pre-tighten and finally tighten the screws to the prescribed torque.



- Re-assemble the components removed during the procedure.



D6.01 INTRODUCTION

The "F1 Gearbox" transmission was designed with the intent of:

- Enhancing the performances of the mechanical transmission parts.
- Avoiding the control of the clutch pedal and the gearshift lever by the driver without, however, taking away his/her pleasure of direct transmission control.
- Increasing safety measures through a gearbox system that can prevent human mistakes and an incorrect use of the transmission control itself.
- Offering the latest release of car interface.

The system is, basically, a mechanical transmission: dry single-plate clutch and synchronised mechanical gearbox, both driven by a hydraulic interlocking circuit.

There is no need to change the clutch or the gearbox to install the hydraulic actuators that control the clutch's travel and the gear engagement and selection movements.

Gear shifts requested by the driver or by the automatic control (according to the selected driving mode) are carried out autonomously by the system, without any need for the driver to intervene.

The clutch pedal has been removed: the special electronically-controlled levers fitted behind the steering wheel (as in Formula 1 cars), have replaced the traditional H-shaped gearbox lever of mechanical transmissions.

D6.02 GENERAL FEATURES

The electronically-controlled gearbox was first designed for Formula 1 cars but is now mass-produced.

F1 Gearbox is a "hydraulic interlocking" system for gearbox and clutch which allows to enjoy the advantages of mechanical gearbox and dry clutch (reduced weight, sturdiness and reliability, low energy consumption), while simplifying their use and reducing fatigue due to city traffic and frequent gear shifting. This system, moreover, ensures excellent performances, smooth gear shifting and progressive wheel coupling.

Thanks to the hydraulic interlocking and to the interfacing with the engine ECU and the ASR/MSR drive control systems the F1 Gearbox can guarantee either sport or comfort gear shifting, according to the driver's needs or driving style.

In the passenger compartment there is no clutch pedal; the gearbox lever is replaced by electric controls (Up-Down) fitted on the steering wheel, just like in Formula 1.

F1 Gearbox, therefore, relieves the driver from all the boring and tiring aspects of gear shifting, without depriving him of the pleasure of direct transmission control. Furthermore, a fully automatic transmission mode is available too, in case the driver decides to give up all manual control.

The interlocking system is composed of a hydraulic actuator fitted directly to the gearbox housing. This actuator controls through two separate pistons the gear selection and engagement movements.

The two pistons are controlled by a group of solenoid valves to which both an electric pump and an accumulator supply the needed hydraulic power.

Once the driver's requests have been identified and the car operative status has been evaluated by a set of sensors, the gear shifting is directly managed by an ECU which controls autonomously the clutch, the gearbox and the engine torque.

During gear shifting, the engine control is interlocked with the gearbox control.

The interface between gearbox and engine control improves remarkably the system performances and frees the driver, while shifting gears, from requests of synchronised clutch-accelerator movements. As a matter of fact, gears can also be shifted with the accelerator pedal pushed all the way down.

Not only can **F1 Gearbox** control the transmission (if requested to by the driver), but it also acts as a "tutor" and driver assistant : the system inhibits incorrect requests for gear shifting in order to avoid an involuntary engine switch-off and the locking of wheels with low grip conditions. As far as its assistance function is concerned, the system ensures the immediate availability of the first gear when the car stops suddenly and the automatic and progressive Down-shifting of gears in case the speed is drastically reduced, with a subsequent aggressive request of acceleration.

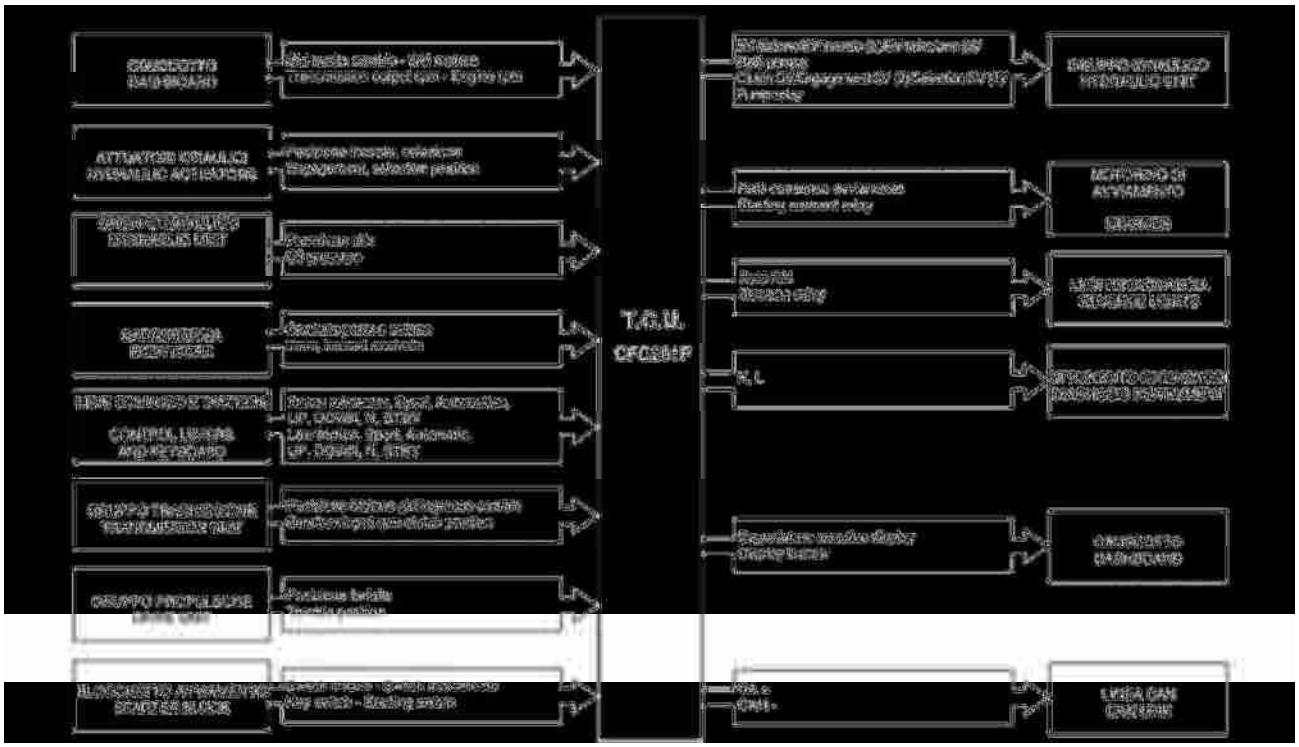
These features guarantee safe driving, since the risk of incorrect manoeuvres is considerably reduced.

The selected gear is shown on a display in the instrument panel, whereas the diagnosis results are controlled by the transmission's ECU (**TCU**) through a warning light and a buzzer.

Through the CAN line the instrument panel is informed of the gear engaged, of any TCU failure status and of all alarm controls.

D6.03 TRANSMISSION CONTROL UNIT (TCU)

The TCU is designed to: (see block diagram)



- acquire signals coming from sensors;
- interface with driver control device;
- interface with engine ECUs, drive control (ASR/MSR) and instrument panel;
- control the hydraulic sub-system.

The signals that TCU must receive concern:
- engine revolutions;
- primary transmission shaft speed;
- clutch actuator position;
- gear selection actuator position;
- gear engagement actuator position;
- key turned to **"running"**;
- driver door switch status;
- foot-brake pedal switch status;
- power unit oil pressure;
- CAN line signal (see block diagram);
- engine compartment lid on-off switch.

The interfacing with the engine ECUs, the ASR/MSR drive control and the instrument panel is controlled by the CAN line.

To control the hydraulic actuator sub-system, the TCU is equipped with:

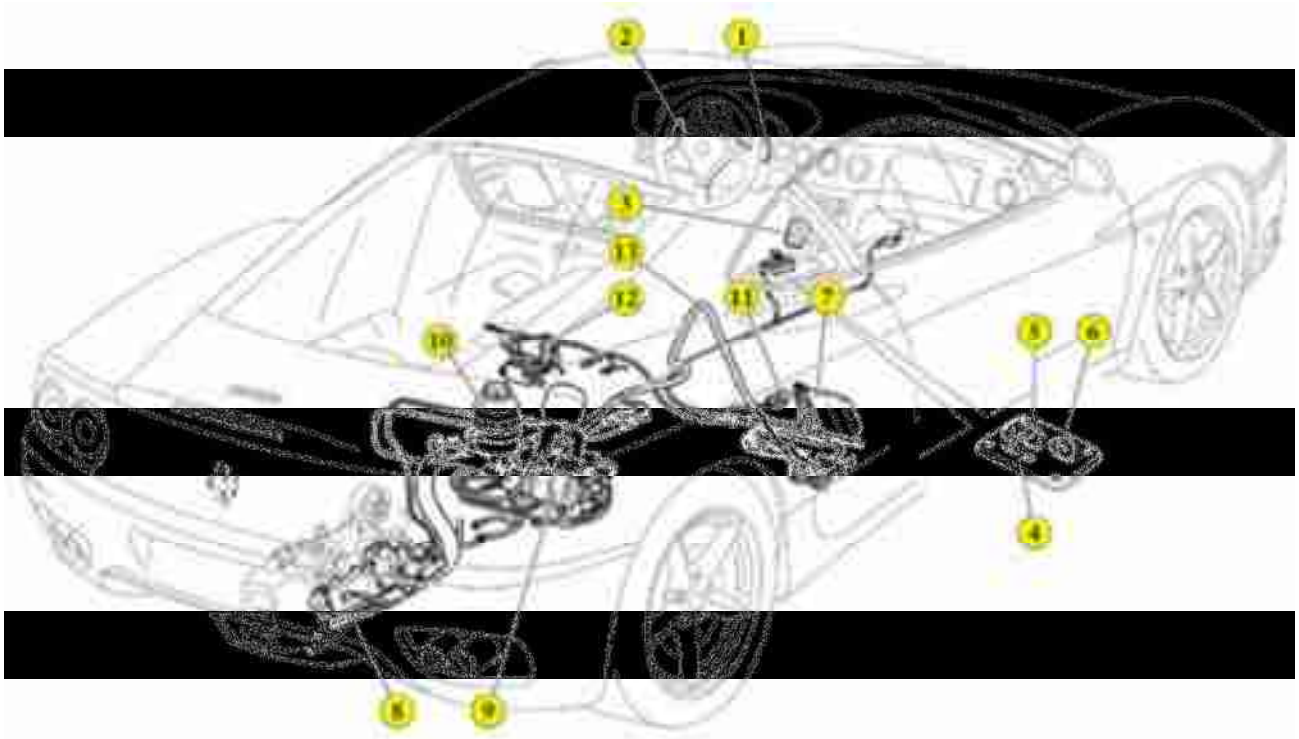
- outputs for adjusting the delivery proportional solenoid valve for clutch control;
- outputs for adjusting the pressure proportional solenoid valves for gear engagement control;
- outputs for controlling the proportional solenoid valves for gear selection control;
- output for electric pump control.

Furthermore, the TCU also enables the engine to switch on.

NOTES
*To replace the TCU, (*D 6.11*)*

D6.04 OPERATION

The system is composed of the following main parts:



1 - Lever **UP**
2 - Lever **DOWN**
3 - Foot brake pedal
4 - Reverse gear lever
5 - **AUTO** mode switch
6 - **LOW GRIP** mode switch
7 - Transmission control unit(TCU)
8 - Actuator Unit
9 - Power Unit
10 - Oil tank
11 - Pump relay
12 - Fuses
13 - Electronically-controlled gearbox harness

The TCU:

- *Detects driver commands.*

The two levers, fitted behind the steering wheel, control gear **UP**-shifting **(1)** or **DOWN**-shifting **(2)**. Through lever **(4)**, placed on the central tunnel panel, the reverse gear is engaged; the **AUTO** mode is activated through switch **(5)** and a second switch **(6)** activates the **LOW GRIP** mode. An "on-off" switch, placed on the lateral pannel (H 2.03), activates the **SPORT** mode (G4.01) and (F 4.04). The latter is not connected to a TCU input: the control unit receives data concerning the instrument panel switch status through the CAN line.

- *Informs the driver of the system's status, through visual and acoustic signals.*

On the instrument panel there are: a display on which the engaged gear is indicated, two warning lights that indicate if **AUTO** and **LOW GRIP** modes are active, a third warning light indicating system failures. Moreover, an acoustic alarm indicates the presence of anomalies or an incorrect manoeuvre by the driver. The **SPORT** mode is indicated by a warning light also placed on the instrument panel but which is shared by the suspensions ECU.

- *Checks the hydraulic actuators.*

The comands sent by the ECUs are actuated by a hydraulic system composed of a Power Unit (**9**) and of

actuators for gear engagement and selection **(** and for clutch movement.

- *Detects the position of the three hydraulic actuators.*

A position sensor has been fitted on each of the hydraulic actuators for the gearbox and clutch control.

- *Detects the angular engine speed.*

Above the rear part of the gearbox, there is a sensor (D 6.08) for the detection of speed at gear shifting.

- *Detect special car conditions.*

Through apposite sensors and switches, the system can detect any intervention carried out on the foot brake pedal **(3)**, on the engine compartment lid and on the driver side door.

- *Interface with the engine control system.*

This is a very important connection, since during gear shifting the EMS (Engine Monitoring System) turns into a torque generator interfaced with the gearbox. The EMS, moreover, can communicate to the transmission system some useful data, therefore avoiding duplicating sensors on the vehicle..

- *Please read all information provided on ECUs that communicate through the CAN line.*

Working

In order to better understand the clutch control strategies, you must consider two working conditions: pickup (during start up) and gear shifting.
When picking up, the engine is idle and the car is stationary.
The driver, wanting to start the car, presses the accelerator pedal. As a consequence of this, the engine speed increases. In order to avoid excessive rpm, the clutch must close progressively with a speed depending on how the accelerator pedal is controlled: the car accelerates. As we can see, the way in which we close the clutch is strictly linked to the engine rpm and to the command the driver sends by means of the accelerator pedal.
The system is designed to modify pick-up conditions, taking into account the temperature of the engine coolant: with very low temperatures, pick-up takes place with a faster engine rpm.
By attempting pick-up manoeuvres repeatedly or for too long (ex.: on an uphill road, the car at a stand point, the accelerator pedal pressed), the clutch may overheat dangerously.
However, thanks to a mathematical model and without the use of sensors, the TCU can detect the increase of temperature. Once reached the danger threshold, a buzzer is activated to warn the driver that the clutch might be damaged.
The driver must then interrupt as soon as possible the pick-up manoeuvre, operating on the accelerator. The buzzer will start sounding every time the pick-up us attempted until the clutch will have reached normal working temperatures.

IMPORTANT
Reduce pick-up times whenever the buzzer starts: press harder on the accelerator pedal to prevent clutch sliding.

To understand how the TCU controls gear shifting, consider the 3 subsequent operations carried out by the driver (just as with traditional mechanical transmission):

- **Torque reduction:** at this stage, a synchronised control of engine torque reduction, clutch opening and gear release takes place.

- **No torque:** the gear is by now completely released and the next gear is selected and engaged.

- **Torque return:** this is when the synchronised control of clutch closing and engine torque request takes place.

The various clutch control strategies are peculiar to each step:

- during drive reduction, the clutch is opened according to the torque reduction controlled by the engine;
- when there is no drive, the clutch is kept open;
- during torque return, the clutch closing depends on the engine shaft's and the primary gearbox shaft speeds.

Clutch control during gear shifting takes into account the throttle angle (accelerator position) and the engine revolution ratio: with the pedal pressed right down and high engine revolutions, the clutch control will be set to sport mode.

Gearbox Control

The gearbox control is carried out by an engagement and selection actuator controlled by the TCU through the respective solenoid valves: the pressure proportional valves control the engagement actuator, whereas the proportional solenoid valves control the selection actuator.
The gear shifting actuator is controlled in accordance with the driver's requests, transmitted through the levers on the steering wheel an the switch controls on the central tunnel.
By pressing the "automatic" mode push-button, the gear shifting control is carried out by the TCU, which will then use pre-set controls managing.

Interfacing With The Engine Monitoring System (EMS)

Communications with the engine ECU have 3 main aims:
- acquire signals coming from the engine;
- control engine switch off during emergencies;
- control engine speed and torque during gear shifting.

In order to understand how the engine control works during gear shifting, you must examine the 3 main phases of gear shifting:

Drive reduction
At this stage, the engine is requested to reduce the torque according to a time profile depending on the accelerator position, on the engine rpm and on the **SPORT** switch position when the gear shifting is requested: the higher is the request of performance, the quicker will the torque reduction be.

No drive
During this phase, the engine is requested to reach a certain revolution speed and then to maintain such speed until the end of this step. The revolution speed requested to the engine is functional to the car speed and the gear requested: the higher the gear, the lower the engine speed; the lower the gear, the higher the engine speed.

Torque return
This is when the engine is requested to increase the torque in accordance with a profile depending on the requested car performance: the higher the performance requested, the more rapid the torque return.

Interfacin nosis System

The TCU is pre-set to be connected to apposite diagnosis instruments. This is why it can store certain car parameters, any failure it may occur and some data regarding heavy use of the transmission system and, in particular, of the gearshift and the clutch.

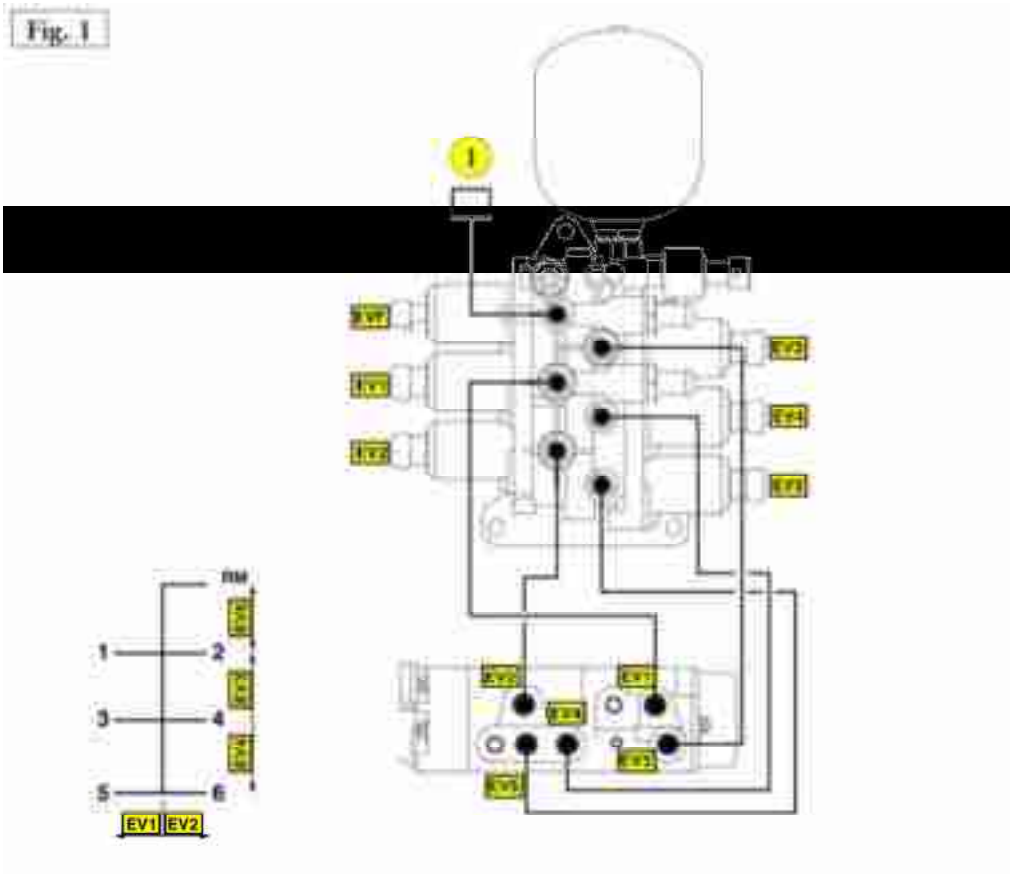
Key "Time history gear shifting "

t - Time
A - Torque reduction phase
B - Actuation phase
C - Torque return phase
D - Clutch position
E - Selection position
F - Engagement position
G - Synchronisation
H - Throttle opening position
L - Open
M - Close
N - Uneve
P - Even
Q - Sliding point

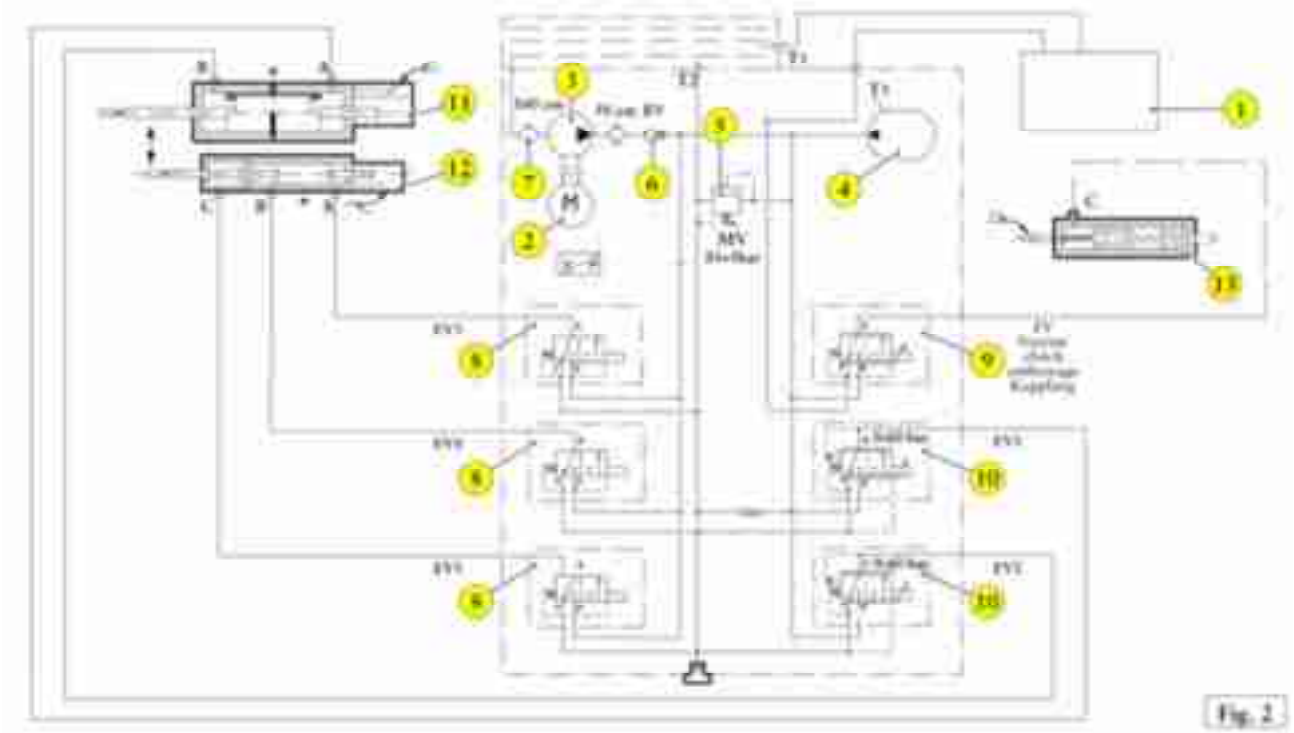
D6.05 HYDRAULIC SYSTEM

The clutch and the gear movement with gear selection and engagement takes place through a hydraulic system (see **Fig. 1** and **2**).

Fig. 1



*Keys to **Fig. 1***
1 - Clutch actuator
EVF - Clutch solenoid valve (Black connector)
EV 1 - 2 - Engagement solenoid valves
EV 3 - 4 - 5 Selection solenoi valves



Keys to ***Fig. 2***
1 - Oil tank
2 - Pump control motor
3 - System supply pump
4 - Hydraulic accumulator
5 - Max pressure valve
6 - Check valve
7 - Oil filter
8 - On/off solenoid valves for gear selection
9 - Delivery proportional solenoid valve for clutch control
10 - Pressure proportional solenoid valves for gear engagement
11 - Gear engagement actuator
12 - Gear selection actuator
13 - Clutch control actuator

The table below shows the working schema of the solenoid valves involved in gear selection.

Solenoid Valve:		***EV1***	***EV2***	***EV3***	***EV4***	***EV5***
GEAR	*Connector colour:*	*Grey*	*Blue*	*Blue*	*Black*	*Grey*
1		**ON**		**ON**		**ON**
2			**ON**	**ON**		**ON**
3		**ON**		**ON**	**ON**	**ON**
4			**ON**	**ON**	**ON**	**ON**
5		**ON**			**ON**	**ON**
6			**ON**		**ON**	**ON**
RM			**ON**	**ON**		

On the Power Unit, near the pipe connection, are printed two initials:
- EVF (Clutch solenoid valve);
- EV1, EV2, EV3, EV4, EV5 (solenoid valve + engaged gear).

The numbers **1-2-3-4-5**, which correspond to the solenoid valves, can be found (except for the EVF) on the harness's reference clamps.

The main hydraulic parts are divided in two groups (see **Fig. 3**):

- The Power Unit **(A)**, fixed to the rear right hand part of the chassis;
- The actuator unit **(B)**, fitted on the gearbox housing.

In the **hydraulic system** there are also:
- an annular actuator for clutch movement
- a tank for oil collection **(C)**;
- a set of lines **(D)** for hydraulic pressure use, linking the Power Unit to the gear and clutch actuators.

WARNING

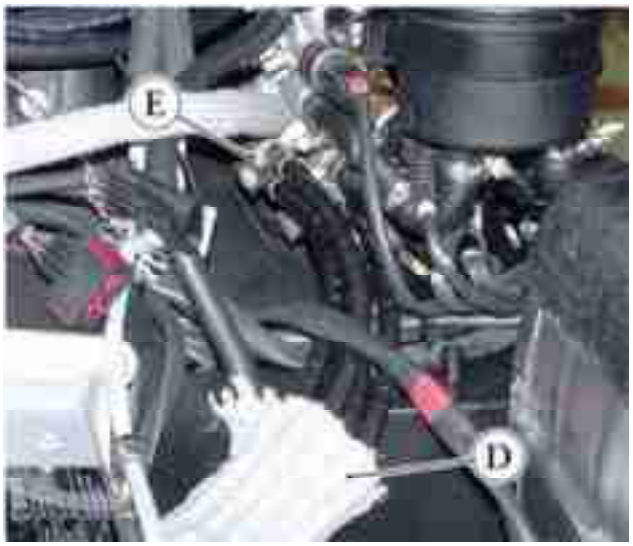
In case of damage to pipes (after an accident, for egs.) that might have introduced foreign matters into the circuit, the Power Unit, the actuator and the respective pipes must be replaced.

Replacing draulic lines

WARNING

The hydraulic system contains high pressure oil.

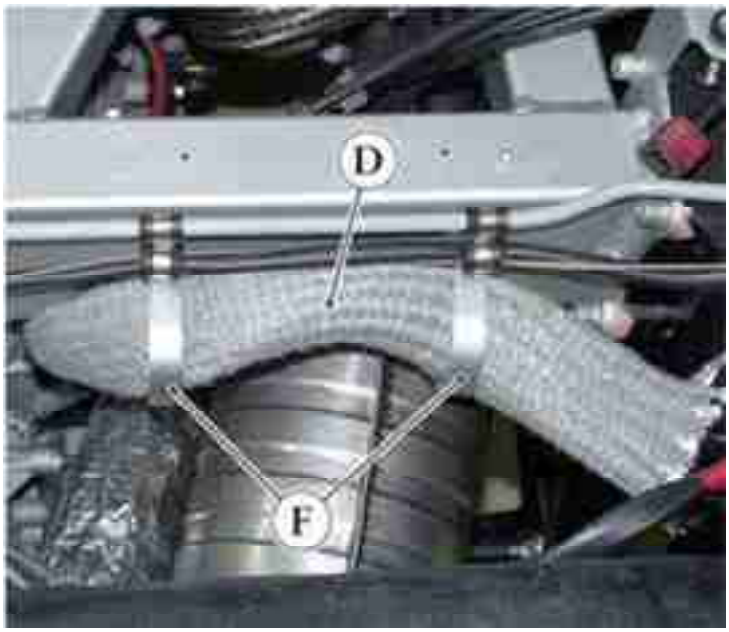
- Detach the tube from the Power Unit (D6.06) and from the actuator (D6.07) by removing the union pipes (**E**) or, by loosening the pipe restraining clamp if the pipe is rubber.



NOTES

As draining must be carried out at the end of the procedures, it is necessary to remove the actuator from the gearbox housing (D6.07).

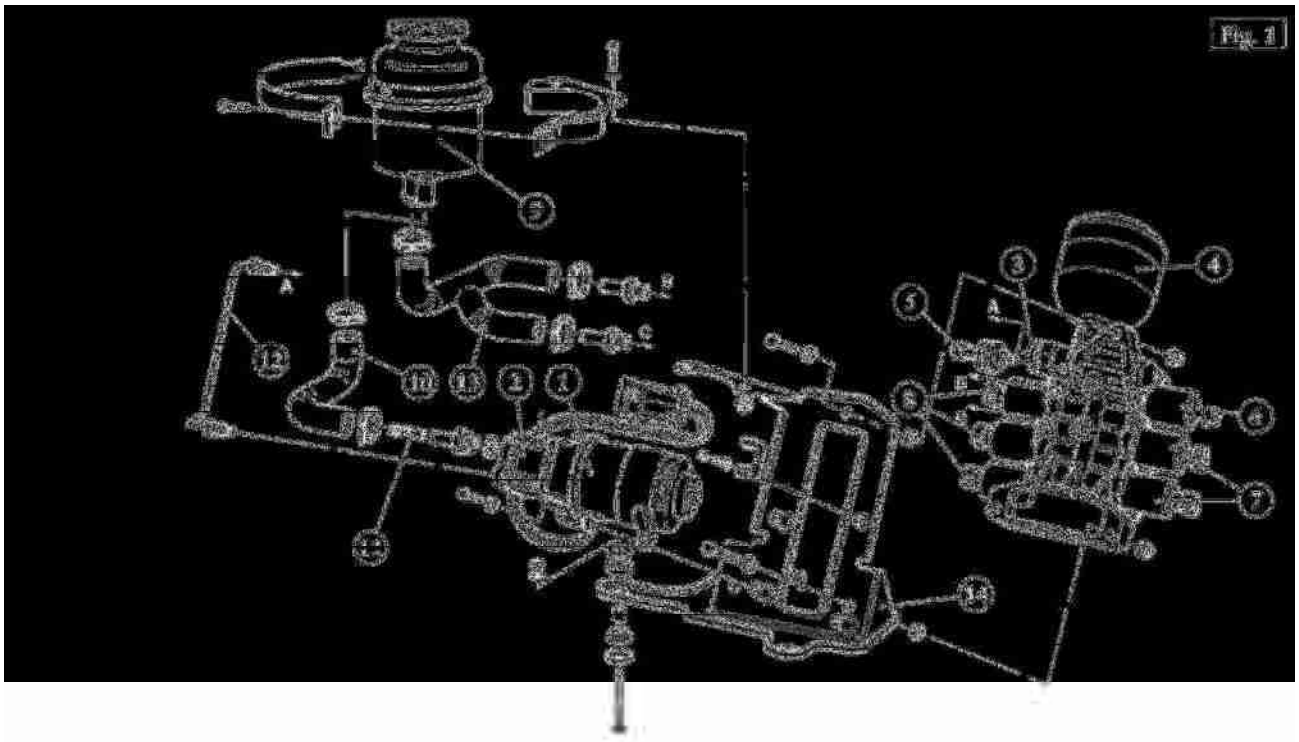
- Release the pipe bundle (**D**) from the retaining brackets (**F**) on the chassis on the gearbox support frame.



- Hook the new pipe to the one being replaced and detach the latter from the protective sheath.
- Fit the new unions on the union pipes (**E**) and tighten them to the torque of **22 Nm**, after having positioned the pipe correctly.
- Refill the system and/or check the level (A3.11) and the draining using the SD2 tester (D3.04).
- Replace the components removed in the procedure.

D6.06 POWER UNIT

The Power Unit is composed of the following (Fig. **1**):



1 - Supply pump motor
2 - Hydraulic system supply pump
3 - Check valve, to avoid accumulator discharge when the pump is not in use
4 - Hydraulic accumulator
5 - Line pressure sensor
6 - Delivery proportional solenoid valve for clutch control (EVF)
7 - Pressure proportional solenoid valves for gear engagement (EV1, EV2)
8 - On-off solenoid valves for gear selection control (EV3, EV4, EV5)
9 - Hydraulic oil tank
10 - Oil-to-pump feed pipe
11 - Net oil filter
12 - Pump-check valve connecting line
13 - Oil-to-tank pipe
14 - Holding bracket

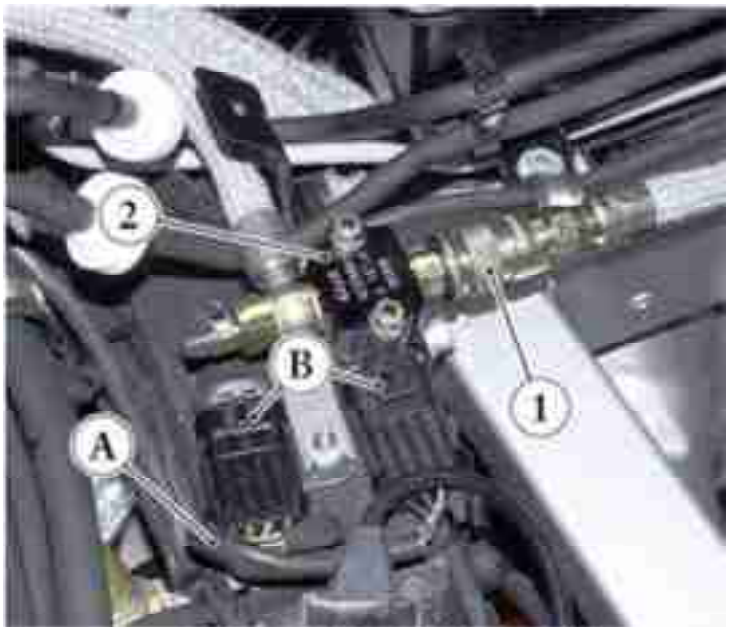
Hydraulic Oil Supply

- Check periodically the system's oil level (A 3.11) and, if need be, fill the tank from the filler cap **(9**, Fig. **1)**.
- Use SD-2 Tester to carry out the system purge (D 3.04).

Replacing the complete Power Unit

CAUTION
The hydraulic unit contains high pressure oil.

- Disconnect the union (**1**) for the clutch actuator's victaulic coupling from the union block (**2**).
- Detach the block (**2**) from the support bracket.
- Disconnect the connectors (**B**) for the gear selection and engagement position sensors from the F1 harness (**A**).



- To replace the Power Unit: disconnect it from the electronically-controlled gearbox harness (**A**).

- Unscrew the three nuts fastening (**4**) the Power Unit to the chassis and remove it from the flexible supports.

NOTES
When replacing the complete hydraulic Power Unit-actuator system, first detach the actuator from the gearbox housing (D6.12).

- Suitably position the Power Unit in order to be able to gain access to the hydraulic piping unions, then position a tray under the unit to collect the oil.
- Disconnect the hydraulic lines, attaching the gearbox housing to the actuator, from the Power Unit, then plug the holes.
- Replace the complete unit or detach the components to be replaced, following the unit lay out illustrated in Fig. **1**.
- When replacing the connection pipes for the tank, first drain the latter using a suction pump.
- Then detach the actuator from the gearbox (D6.07) in order to be able to drain the system.

NOTES

After replacing the Power Unit, together with the filling (A3.11) *and the air bleeding from hydraulic circuit* (D3.04) *a **IO** autosetting cycle must be carried out* (D6.12).

REASSEMBLY

- Reassemble the components removed from the unit and refill the tank with about **0,75 liters** of prescribed hydraulic oil (A1.02).

IMPORTANT

Make sure the Power Unit is in a vertical position, with the vacuum tank at the top.

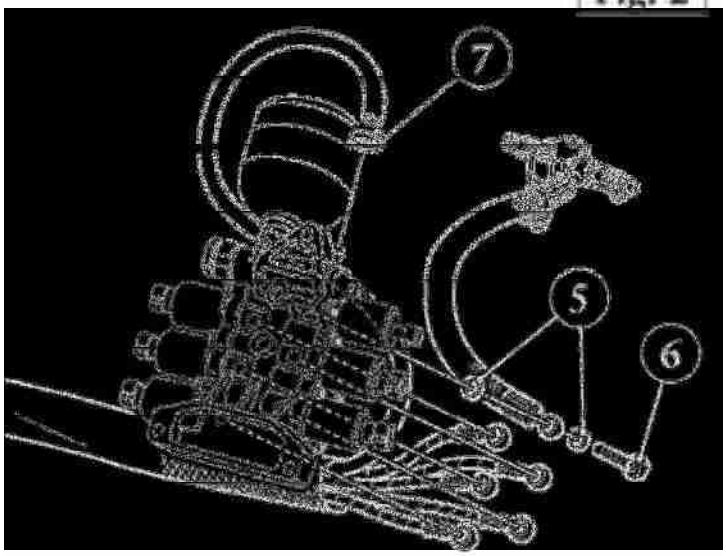
- Position the complete unit on the chassis and attach the disconnected piping. Always use new gaskets (**5**, Fig. **2**) and tighten the unions (**6**) to the torque of **22Nm**.

IMPORTANT

The Power Unit-actuator connection pipes must be positioned correctly, in order to avoid unnatural bends or contact with mobile components.

- Reconnect the rubber pipe to the union on the upper part of the Power Unit and tighten the clamp (**7**).

Fig. 2



- Fasten the unit onto the chassis and attach the disconnected cables.

For connection to the system, see Table **P** - ELECTRICAL SYSTEM.

D6.07 ACTUATORS

Tightening torques		Category
Eng ement-selection actuator stop nut	**1**	
Nut and screw fastening actuator's supporting brackets and guard	**24**	**B**

Gear Engagement-Selection Actuator

The actuator unit **(1)**, fitted to the gearbox housing, is composed of the following basic parts:

- an engagement actuator, controlling the gear engagement and release, with a linear movement; it is a double-effect actuator, with three stable positions, mechanically set.
- a gear engagement position sensor **(2)** (D 6.08).
- a selection actuator, controlling the gear selection with a rotary movement; it is a double-effect actuator, with four stable positions mechanically set.
- a gear selection position sensor **(3)** (D 6.08).

In the mechanical transmission version, the coupling of actuator unit and gearbox housing is carried out by means of the six stud bolts fixing the supporting lid for the gear shift control lever (D 4.01), the actuator is also fastened to the gearbox housing by means of a bracket **(4)** in its front side and two brackets **(5)** in its rear side.

Disassembly

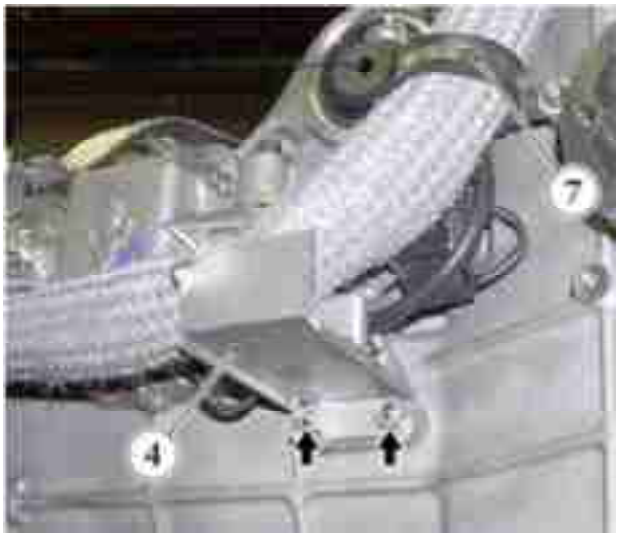
CAUTION
The hydraulic system contains high pressure oil.

NOTES
The disassembly of the actuator unit can be carried out also with the gearbox installed in the car. To better explain the procedures, the images show a removed gear.

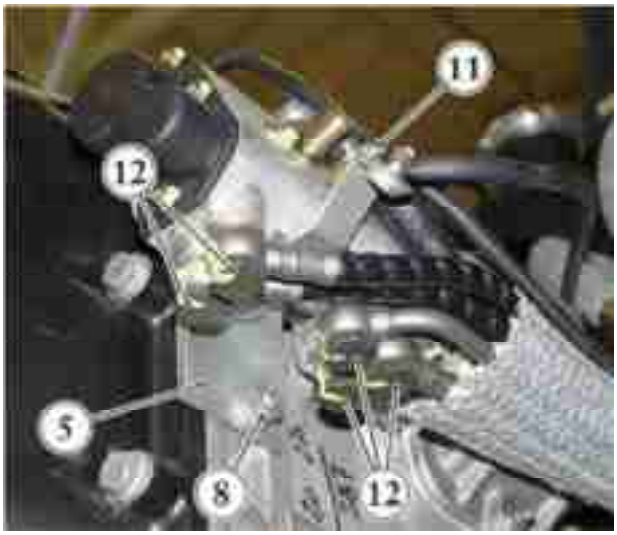
- Remove the rear part of the underfloor (M 2.12).
- To operate easily on the actuator unit, remove the right-hand catalyst (B 7.06).
- Disconnect the selection and engagement sensors connections **(A)**, where they merge with the connector unit **(B)**.

- Loosen the nuts **(6)** and remove the lateral fender.

- Unfasten from the gearbox housing the clamp **(7)** holding the hydraulic lines connecting the actuator unit to the Power Unit.
- Remove the rear bracket **(4)**, unscrewing the two fastening nuts.



- Unscrew the nuts **(8)** fastening the rear brackets **(5)** to the gearbox housing.
- Position a suitable tray under the gearbox housing to collect the oil coming out from the pipes.
- Loosen the clamp **(11)** and detach the rubber pipe from the union on the actuator.
- Unscrew the pipe unions **(12)** and detach the piping from the actuator.



- Unscrew the nuts **(9)** and remove the actuator unit from the gearbox housing, hitting with a plastic hammer on the unit's coupling flange, to detach the unit fixed to the housing with dope during assembly.

Re-assembly

- Clean the actuator's and gearbox's coupling surfaces, to eliminate all traces of dope.
- Use **AREXONS 2144** dope on the actuator coupling flange and assemble the unit on the gearbox housing.
- Tighten the fastening nuts to the prescribed tightening torque.
- Re-assemble the actuator's holding-protection brackets **(4)** and **(5)**, fastening the nuts at the prescribed tightening torque.
- Reconnect the rubber pipe, fastening the clamp (**11**, **Fig. 1**)
- Refit the pipes on the actuator. Make sure they are directed correctly and always use new gaskets **(13)**.
- Lock the pipe unions **(12)** to the prescribed torque of **22 Nm**.

- Re-assemble the parts removed and check the oil levels in the gearbox (A 3.02) and in the F1 system (A3.11).

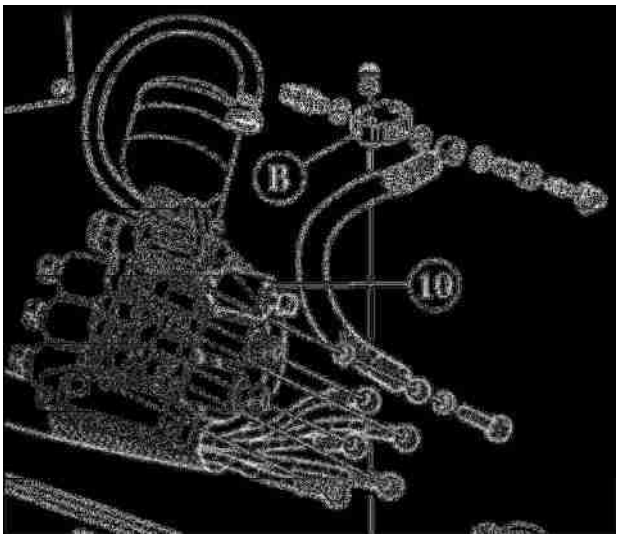
NOTES

After having replaced the actuator, as well as a hydraulic circuit bleeding (D 3.04) a self-learning cycle must be carried out (_____).

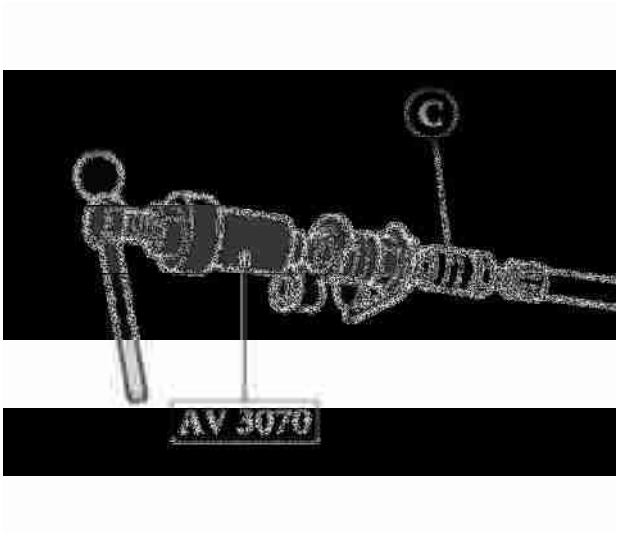
For connection to the system, see Table **P** - ELECTRICAL SYSTEM.

Clutch Control Actuator

To control the clutch, the system uses an electronically-controlled actuator **(10)** that operates on a pressurised circuit, thereby determining the necessary hydraulic thrust. Passing through connecting lines, the oil reaches the connection unit **(B)**, on the right side of the gearbox housing.



The gear release device is obtained through the use of a thrust bearing similar to the one used in mechanical transmission cars.
A position sensor (D 6.08) connected to the TCU has been fitted next to the thrust bearing.
On the unit **(B)** has been fitted a fast engagement joint **(C)** that, in case a serious system failure occurs (with closed clutch and gear engaged), allows the clutch to open connecting the apposite manual pump **AV 3070** to the fast joint.



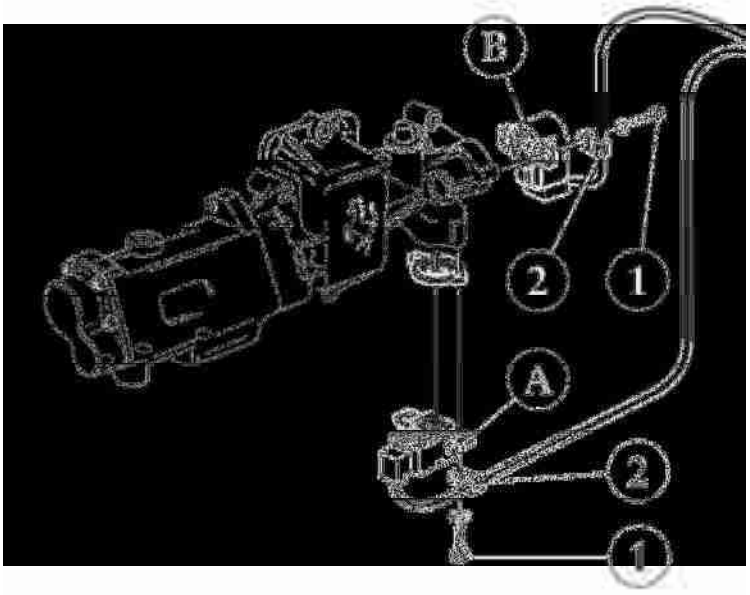
D6.08 MEASURING SENSORS AND SIGNAL SWITCHES

The TCU detects the measures needed for transmission control by means of a series of sensors fitted in the car and through a CAN line communicating with the engine ECU or the ASR/MSR drive control ECU and the instrument panel.
The TCU interfaces with all the sensors and all the actuators by means of a specific harness (see Section - ELECTRICAL SYSTEM).

NOTES
After replacing a sensor, you must execute a self-learning cycle (D 6.12).

Gear Selection Position (B) and Gear Engagement (A) Sensors

These sensors are installed on the gear engagement and selection actuator and they detect the position of the piston actuating the selection and engagement of gears.

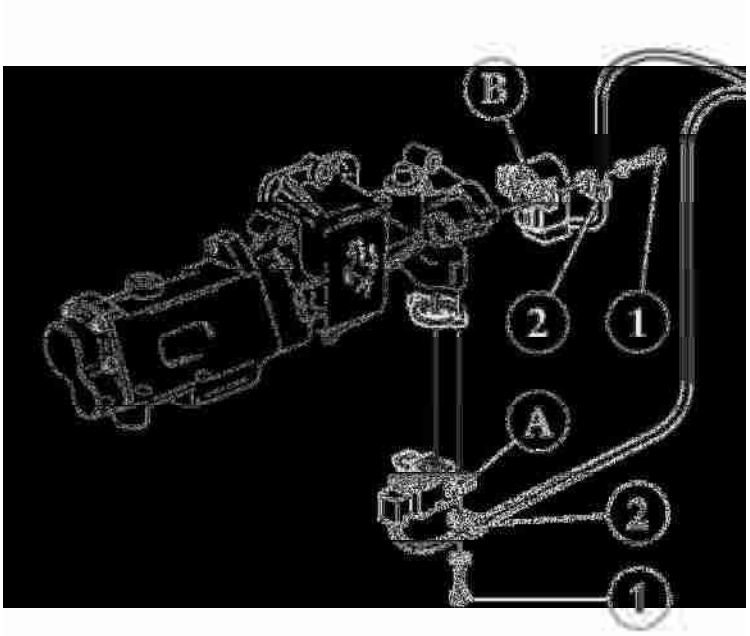


IThese sensors are **"contact-less"** and they work similarly to the clutch position sensor. Inside the sensor there is an electronic unit that converts electric signals in **0÷5 V**.

NOTES
We suggest you replace the sensors (especially the gear selection sensor) after having removed the actuator form the gearbox housing, in order to avoid extracting the sensor's control shaft too.

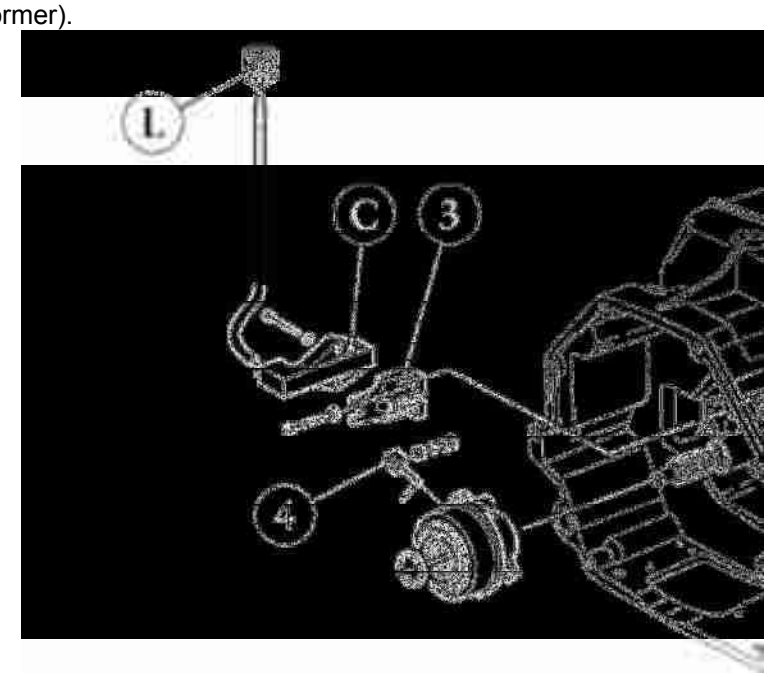
- Remove the actuator from the gearbox housing (D 6.07).
  Place the actuator so that the sensor is vertical to the assembly axis.

The sensors **(A)** and **(B)** are fixed to the actuator by means of screws **(1)** that fasten also the holding clamp **(2)** belonging to the cable bundle for connection to the **F1** harness.
For connection to the system, see Table **P** - ELECTRICAL SYSTEM.



Clutch Position Sensor (C)

In order to detect the thrust bearing clutch position, the system is fitted with an LVDT sensor (Linear Variation Differential Transformer).

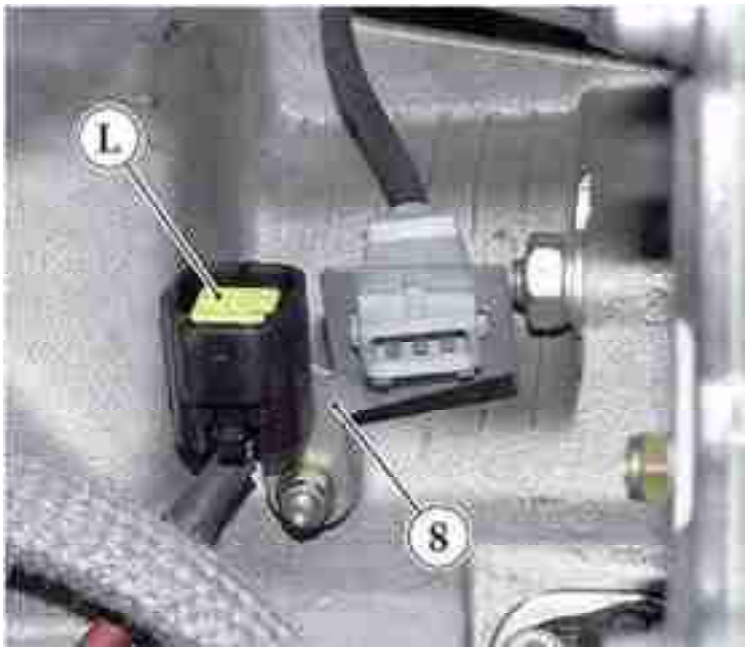


The sensor's signals are transmitted to the TCU.

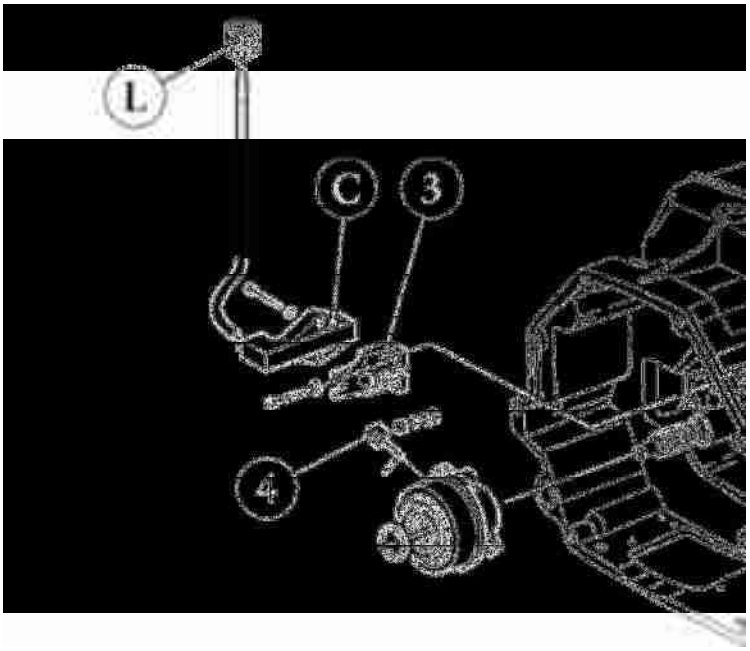
- In order to reach the sensor, detach the gearbox unit from the engine (D 2.01).

The sensor **(C)** is held in place by means of a bracket **(3)** fixed to the flange with a coupling sleeve for the thrust bearing.

The sensor's connector **(L)** is fastened to a support bracket **(8)** on the right-hand side of the gearbox housing.
For connection to the system, see Table **P** - ELECTRICAL SYSTEM.

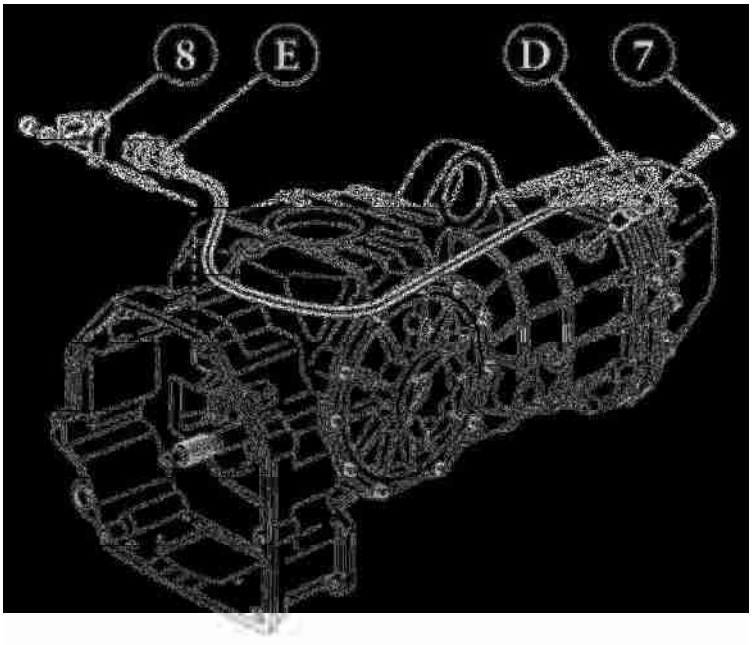


In order to allow the sensor to detect the clutch position, a striker **(4)** with magnet is mounted on the bearing's hub.



Gearbox Input Shaft Revolution Sensor (D)

The variable reluctance sensor **(D)**, is installed on the rear left hand side of the gearbox housing.

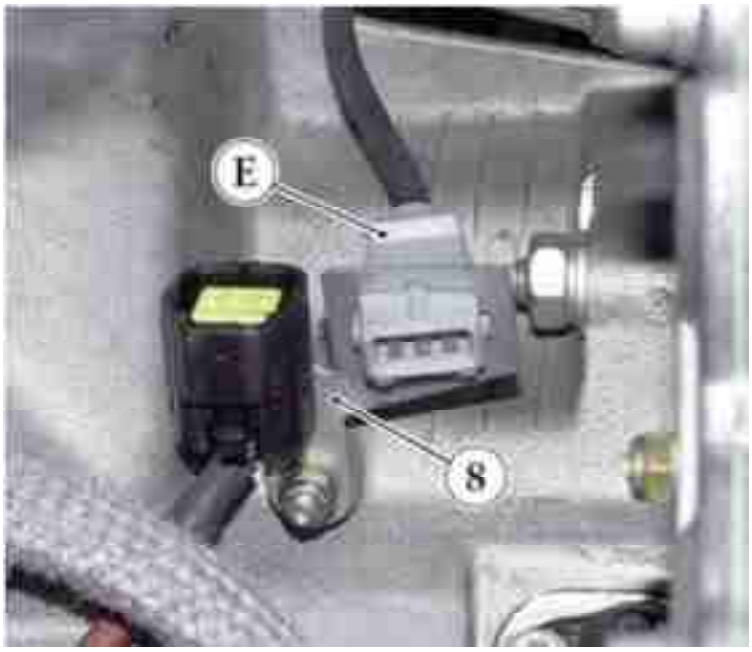


Since it is very near to the exhaust system parts, it is fitted with a heat-resistant bulkhead **(5)**.

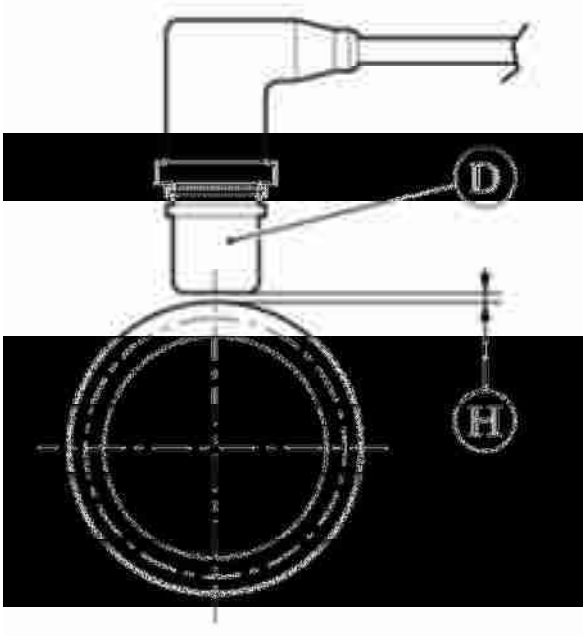
- In order to remove the sensor, unscrew the nuts **(6)** fastening the heat-resistant bulkhead **(5)** to the lateral holding brackets of the gearbox housing.
- Unscrew the fastening nut **(7)** and extract the sensor **(D)** from its housing on the gearbox.

- Detach the sensor's connection **(E)** from the holding frame **(8)**, on the right hand side of the gearbox.

For connection to the system, see Table **P** - ELECTRICAL SYSTEM.

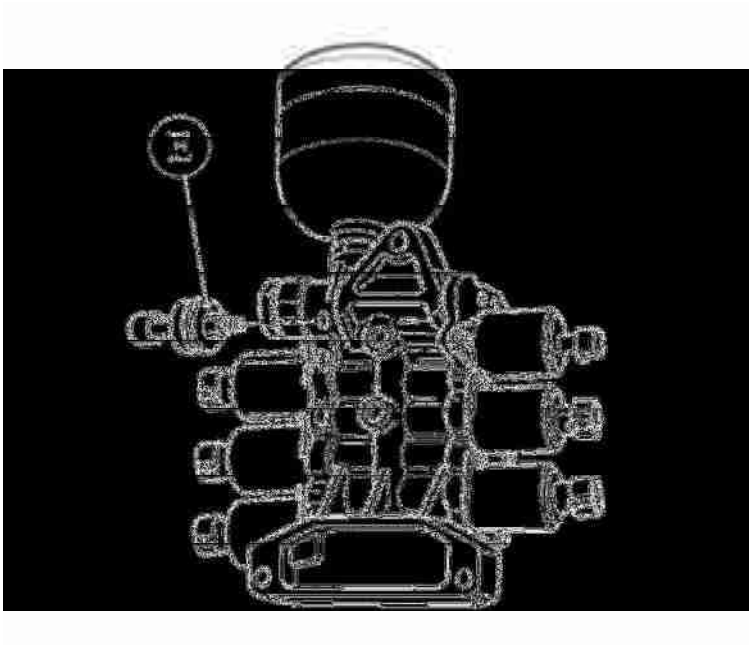


To check the sensor, apply a ohmmeter on the connector pin and verify that the resistance value corresponds to **530 Ω±10%**.
Replace the sensor if the value is incorrect.
When fitting a new sensor, always check the distance **(H)** from the gear on the primary gearbox shaft: its value must be **H=0,2÷1,3 mm**.



Hydraulic Circuit Pressure Sensor (E)

This sensor is fitted on the Power Unit and has the following features:



- pressure range: **0÷80 bar**
- response tension: **0,5÷4,5 Volt**
- supply: **5 Vcc**.

To remove it, disconnect the F1 Gearbox connector from the harness and unscrew it from the Power Unit.

Engine Revolution Speed Sensor

The engine rpm signal is generated by the engine ECU (square wave with duty cycle **50%** and range **0 ÷ 12 Volts**) and is sent to the TCU.

NOTES

The engine speed revolution signal is always acquired by the CAN line too.

Driver Side Door Opening Switch

The **"open door on driver side"** message reaches both the TCU and the alarm system ECU, through an ON-OFF switch that closes the circuit to ground.

If this happens, with the car at a stop, the engine running, a gear engaged and foot brake/accelerator pedals untouched, the system activates the buzzer and releases the gear setting itself in neutral position.

The switch is placed on the door pillar (H 3.01).

Engine Compartment Lid Switch

The **"lid open"** message reaches both the TCU and the alarm system ECU, through an ON-OFF switch that closes the circuit to ground.

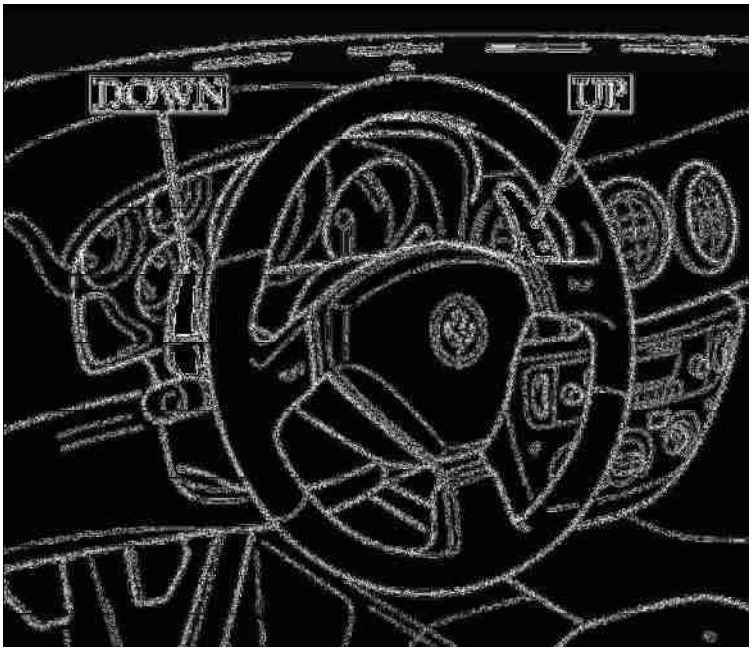
If this happens, with the car at a stop, the engine running, a gear engaged and foot brake/accelerator pedals untouched, the system activates the acoustic alarm and releases the gear setting itself in neutral position.

The switch is placed on the respective opening device (H 2.13).

D6.09 SIGNALS AND CONTROLS

Controls

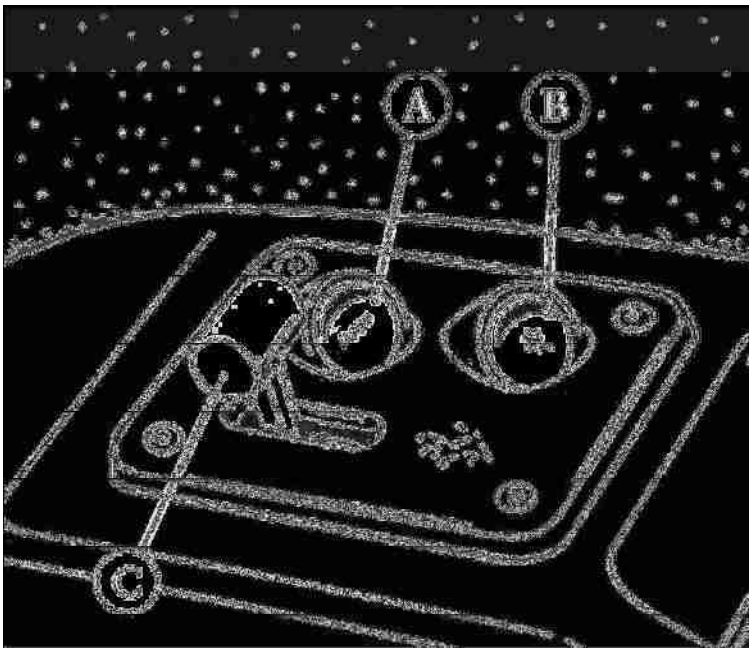
The driver controls the system gear-shifting by means of two levers connected to the switches. These determine the **DOWN**, **UP** and **neutral positions**.



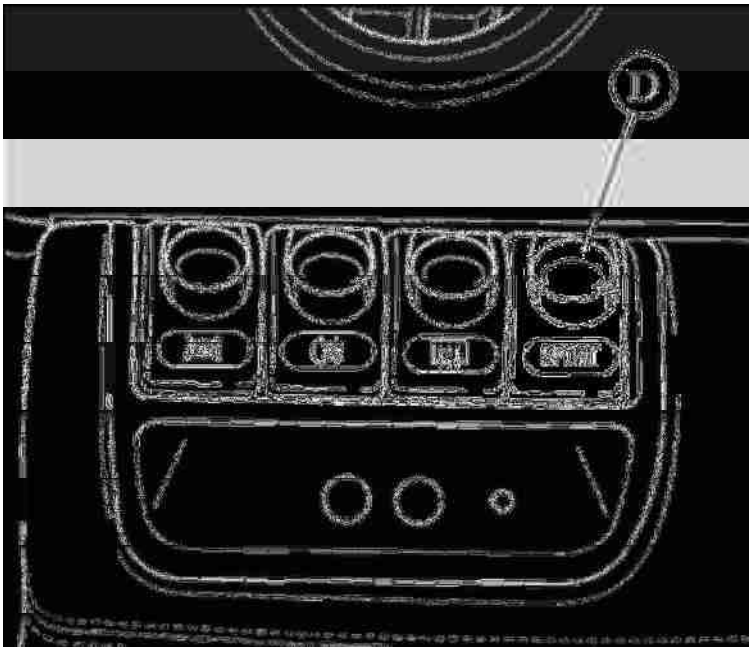
The left-hand lever is used to downshift gears (**DOWN**), while the right-hand lever is used to up-shift gears (**UP**); by operating both levers, neutral is requested (H 4.03).

NOTES
*To replace the levers behind the steering wheel(*H 2.11*)*

The system is also fitted with two buttons and a switch which can be used to request the "automatic" **(A)**, "low grip" **(B)** and **SPORT (D)** modes.
The two push-buttons **(A)** and **(B)** are located on the central console instrument panel, together with the lever **(C)** used to engage the reverse gear (H 2.11).

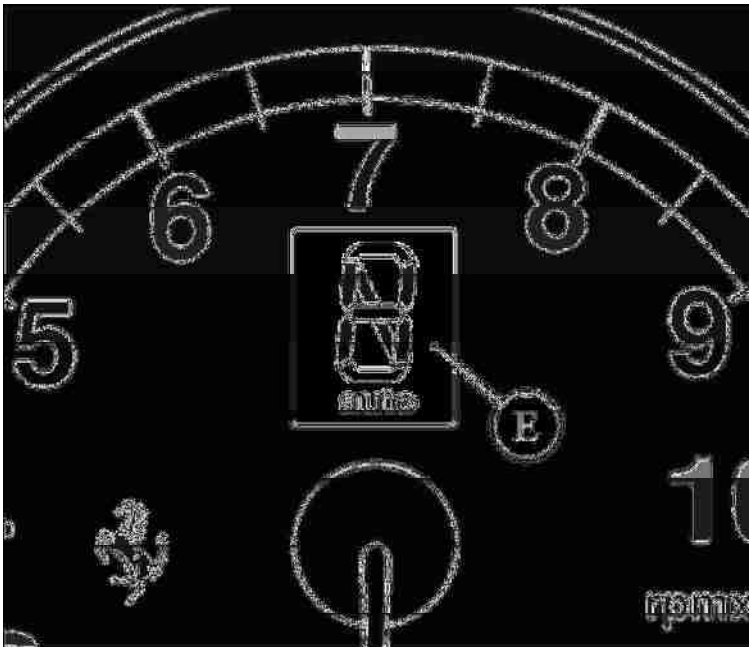


The switch **(D)** is fitted inside the switch and button panel, on the left-hand side of the dashboard (H 2.03).



Display

The driver is informed about the system working conditions through a display and some warning lights located inside the instrument panel.
The display **(E)**, is positioned in the middle of the instrument panel and shows the gear currently engaged (H 1.01).



A set of warning lights indicates the system status: "automatic", "low grip" and SPORT function, or a failure(H 1.02).
The warning lights are controlled by the display. This receives the information from the transmission control unit (**TCU**) through the CAN line.

Buzzer

Possible incorrect uses of the system or working failures can be signalled by a buzzer as well (e.g. in the event of clutch overheating).
The buzzer is managed by means of the instrument panel, which receives the commands from the TCU, via CAN line.

D6.10 SYSTEM FUNCTIONS

The functions operated by the system can be grouped in two main sections:
- technical functions;
- safety functions.

Technical functions

The technical functions managed by the system are the following:

- *Hydraulic power generating unit control*

The electric pump for the hydraulic power supply is managed by an ON-OFF control system: pump-ON operation is activated when the pressure is ≤**42 bar,** OFF operation when the pressure is ≥**60 bar**.

- *Detecting the driver's commands*

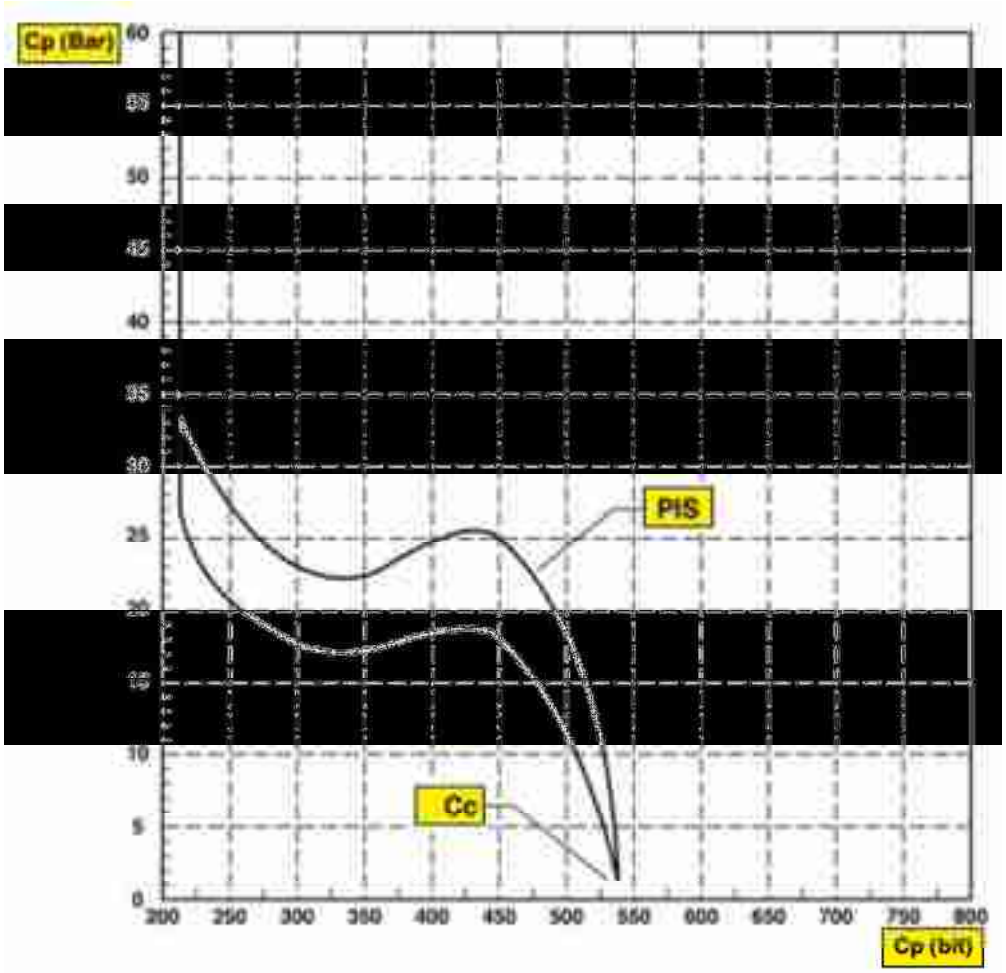
This function permits to monitor the commands given by the driver. These are detected as voltage variations when the steering wheel levers, push-buttons and switches on the central console or on the dashboard are operated.

- *Transmitting information to the driver*

This function is used to send display messages, to control the buzzer and the warning lights (emergency, **"automatic"**, **"low-grip"**, and **SPORT**) in order to keep the driver informed on the system working conditions and efficiency.

- *Clutch control*

This function supplies a **"real-time"** control of the thrust bearing position, that is the torque transmitted by the engine to the driving wheels through the clutch.
This function is extremely important to ensure the system performances in terms of comfort and sports driving.
The clutch is driven by a **closed loop** control logic: the TCU controls the actuator by means of the delivery proportional solenoid valve.
The clutch control is based on the component peculiar curve, that is on the thrust bearing to transmittable torque ratio. The curve (**Fig. 1**) is automatically set by the software which estimates two points: the **"kissing point"** or skidding start point (**PIS**) and the closed clutch position (Cc).



*Keys to **Fig. 1***
Cc - Closed Clutch position
Cp - Clutch position
PIS - Skidding start point

The first point depends on the clutch wear and on the friction surface conditions, which are detected each time the system is started.
The second point depends on the clutch wear and is detected whenever a gear-shifting has been completed.
Being acquainted with these points makes it possible to monitor friction material wear and to modify the car pick-up parameters in order to have always the same conditions when the car is started and for the entire clutch life.
Moreover, a gearshift regulating system has been introduced so to keep the system performances steady, until the clutch is worn out.
To calculate the clutch wear trend, the TCU must contain the information relating to the thrust bearing when the clutch is new and closed.
Each time the clutch is replaced, the closed clutch position at **0 km** must be stored in the TCU. This operation must also be performed whenever the TCU is replaced (D 6.11).

Safety functions

The system is endowed with several safety functions, which are mainly used for:
- Avoid an improper use of the system.
- Detect any malfunction, signal it to the driver and manage recovery procedures in order to reach a service centre without causing the car's stopping.

ATTENZIONE

In the event that the gearbox failure warning light switches on (H 1.02), the car efficiency may be strongly reduced. In these cases, take the car to a service centre to make all necessary checks.

- Protect the transmission mechanical components thereby guaranteeing their long life.
- Enable the system start-up.
- Accept the driver's commands.

To prevent potentially dangerous situations arising from an improper use of the car, the system is equipped with functions which make it even safer than a normal mechanical transmission:
- In the event that the requested gear-shifting would cause the locking of the wheels or the engine runaway speed rate or even an engine speed below idling, the command is not be accepted.
- With the engine running and the car at rest, if the driver's door is opened without pressing the brake pedal, the gear is automatically disengaged and shifted to neutral.
- With the engine running and the car at rest, if the engine lid is opened without pressing the brake pedal, the gear is automatically disengaged and shifted to neutral.
- With the engine running and the car stopped, if a gear remains engaged for over **4 seconds** without operating on the brake or accelerator pedals, the gear is disengaged and shifted to neutral.
- With the engine running, car at rest and gear engaged, the gear is automatically disengaged and shifted to neutral after **10 minutes**, even if the brake pedal is pressed.
- In case of severe system failure, which would not ensure a safe driving of the car, the engine stop is requested if the vehicle is at a standstill or running at a speed below **15 km/h**.
- Only in the event of icy road-bed is it possible to request the **"low grip"** mode by pressing the relative push-button on the central console. Under these conditions, the clutch control is more gradual, pick-up is performed in second gear and the engine cannot be used if it exceeds **3100 rpm**. The latter function is controlled by the automatic gear-shifting which is automatically activated any time that said threshold is exceeded. In sixth gear instead, the engine can be used in its thorough operating range.

D6.11 REPLACING THE THE ELECTRONIC CONTROL UNIT (TCU)

The transmission electronic control unit (TCU) is located inside the passenger compartment, under the ECU covering shield, behind the passenger's seat.
To replace the ECU, follow the procedure described below:

1 - With the ignition key turned to running position, connect the SD-2 tester to the old TCU and write down the mm value of the new clutch position (D 6.12).

2 - Turn the key to the **Stop** position and detach the battery by operating on the battery master switch (L 2.02).

3 - REPLACE the old TCU with the new one (see "TCU removal").

4 - Reconnect the battery and turn the key to the **ON** position. By means of the SD-2 tester, execute the **CYCLE** procedure.
When the question **new friction** is displayed, answer **NO**, correct the default value with the value noted, as described in point **1.** The maximum variation accepted by the system is **2 mm**. If this should not be sufficient to reach the value written down (point **1**), complete the cycle and go to **DIAGNOSIS** (see "new clutch position value"), then add the necessary mm to enter the correct value.

5a - *PIS setting **(*)** (**Valid UP TO Electronic Control Unit, part no. 176552**):*
Turn the key to the **ON** position, wait for the **"check"** of all the warning lights and start-up the engine.
Wait ca. ten seconds, turn the key to the **Stop** position and wait for the display to switch off.
Repeat the procedure another **4 times** (this operation must be carried out when the engine water temperature ranges between **30** and 70°C and when the air conditioning is turned off).

5b - *PIS writing (**Valid FROM Electronic Control Unit, part no. 189542**):*
Turn the key to the **ON** position, wait for the **"check"** of all the warning lights and start-up the engine.
In the diagnosis program you will find the item “PIS setting”.
The PIS value taken from the Electronic Control Unit parameters will appear in the initial mask.
This value can be increased/decreased by degrees of **± 0.1 mm**.
The PIS variation range is the following:
- Min **4,0 mm**
- Max **5,5 mm**

When the value is confirmed by selecting “Save”, the PIS value displayed will be stored in the Electronic Control Unit.
The basis for PIS value modification is as follows:

If, during vehicle testing, pickup proves to take place at a too high rpm (**over** approximately **1700/1800 rpm**), reduce the PIS value by **0.1mm** by pressing the SD-2 menu key (–). There will be a **0.1mm** variation each time the key is pressed.
We recommend to check the result of the PIS modification by testing the vehicle each time a value is memorized.

If, on the other hand, pickup occurs at too low rpm or is too sharp, carry out the same procedure in reverse order, increasing the PIS value using the SD-2 menu key (**+**), and remembering to test the vehicle once again.

6 - ***IO** setting:*
Turn the key to the **ON** position, wait for the **"check"** of all the warning lights and start-up the engine
Wait for the hydraulic oil to reach a temperature ranging from **38** and **83 ∞C**. This datum can be displayed by means of the SD-2 tester in the **PARAMETERS**, environment.
Run the car engine idling for **5 minutes** in **neutral** gear and **5 minutes** with the **1st** gear engaged while pressing the foot brake pedal.
Turn the key to the **Stop** position and wait for the display to turn off.

7 - *Selection, engagement self-learning procedure **(Polipo)**:*
Release the parking brake lever, turn the key to the **ON** position and wait for the warning lights **"check"**.
Shift the gear to neutral.

Connect the SD-2 tester and activate the " Self-learning" function in the "Diagnosis" environment"
The system will engage all of the gears, progressively, from **"R"** to **6th**.

NOTES
To facilitate gear-shifting, the gearbox oil must be at least at room temperature.

If the procedure has been completed successfully, a **"beep"** (acoustic signal) will be heard.
If the procedure cannot be terminated due to interferences (these are signalled by **4 "beeps"**), turn the key to the **Stop** position and wait for the display to switch off, then repeat the procedure.

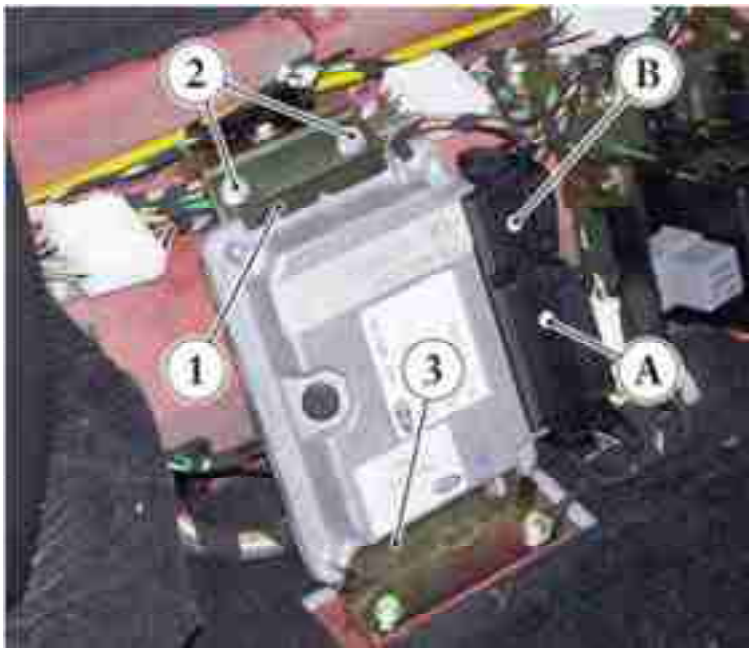
- Turn the key to the **Stop** position and wait for the display to switch off.

***(*)** Closed, new clutch value*

TCU removal

To remove the TCU, it is necessary to:

- remove the ECU covering shield (M 3.04);
- detach the two connections **(A** and **B)** (**10P** e **9P**, see Table **P** - ELECTRICAL SYSTEM) for the F1 gearbox cable from the TCU;
- remove the upper fastening bracket **(1)** from the TCU, by unscrewing the screws **(2)**;
- slide the TCU off of the lower bracket **(3)** and remove it from its support.



NOTES
*To reassemble, follow the operations described in reverse order, taking extreme care when fitting the connections **(A** and **B)** (**10P** e **9P**, see Table **P** - ELECTRICAL SYSTEM) onto the TCU.*

For connection to the system, see Table **P** - ELECTRICAL SYSTEM.

D6.12 DIAGNOSIS

Transmission Control Unit (TCU) supply

Signs of possible problems
- The display shows a horizontal line, the gearbox failure warning light is lit.
- The electric pump is never activated.
- The system seems to give no "response" when the levers are operated.
- The TCU cannot be connected to the Ferrari Tester.

Components involved
- Battery and knife switch connection.
- Fuse.
- Ignition switch.
- TCU.

Practical checks
- Check the fuse, check that the knife switch is closed and that the supply pins feature the battery voltage.
- By turning on the instrument panel, always with the TCU disconnected, check that pins **27** and **28** feature **+12V** battery.

When everything is working properly
- Pin **27** features **+12V** battery.
- When turning on the instrument panel, pin **28** of the TCU features **+12V** battery.

Sensor supply (5V)

Signs of possible problems
- Gear-shifting is irregular or not performed.
- The pump cannot be activated properly.

Components involved
- TCU.
- Pressure transducer
- Engagement and selection position sensors.

Practical checks
- By means of the Ferrari Tester, check that the line pressure ranges between **42** and **60 bar**.
- By means of the Ferrari Tester, check that the engagement and selection values range within the min. and max. thresholds shown.
- By means of a tester, check voltages between pin **2** and **73** and between pin **2** and **79**. On pin **73**, it is possible to read the supply voltage for the engagement and selection sensors, while on pin **79**, it is possible to read the supply voltage for the pressure sensor.

NOTES

*The short-circuit of one of the sensors mounted on the actuator can jeopardise supply and consequently the performance of the other. As a consequence, if pin **73** lacks supply, check which one of the two sensors has caused the problem.*

Hydraulic Power

Signs of possible problems
- The gearbox warning light continues to flash.
- The electric pump is not properly activated.
- The system does not shift gears

Components involved
- Battery and knife connection.
- TCU.
- Electric pump relay and 30A fuse.
- Electric pump.
- Pressure sensor.
- Hydraulic circuit.
- Power Unit and actuators.

Practical checks
- By means of the Ferrari Tester, check that the line pressure ranges between **42** and **60 bar**.
- If the pressure indicator is below **42 bar,** check that the electric pump features **+12V** battery using the 30A fuse and the **RLE** relay controlled by **31** of the TCU.
- If the electric pump is working properly and the pressure does not rise, check the pressure transducer or if there's any hydraulic leakage, including the screws used for draining the hydraulic actuator system and the oil level in the tank.

When everything is working properly
- The electric pump must be activated only when the pressure drops below **42 bar** and it must be deactivated when it reaches **60 bar** (display through Ferrari Tester).
- The electric pump activation time during normal operation **must not exceed 4÷5 seconds** and the deactivation time **must** not be **shorter than 8÷10 seconds**.

Engine Start-up

Signs of possible problems
- The starter motor does not switch on (essential condition).
- The display indicates a gear engagement or "N" is flashing.

Components involved
- Battery connection and knife switch.
- Ignition switch
- Starter relay and CD diode module.
- TCU
- Engagement sensor.
- Engagement solenoid valves.

Practical checks
- If the display shows the symbol **"N"** continuously, check that pins **27** and **28** of TCU feature **+12V** battery and, through the ignition switch, that pin **87** of the **RLA**, features **+12V** battery.
- If the display shows a gear engaged or **"N"** is flashing, use the Ferrari Tester to check that the engagement position lies within the min. and max. neutral thresholds. If this condition is not met, check the **gearbox actuation** as below described.

NOTES

If the car is not started even if the starter motor works and no request for motor stop is stored by the engine ECU, this means that the problem is not caused by the gearshift system.

Clutch Actuation

Signs of possible problems
- The gearbox self-learning procedure is not carried out.
- The system does not accept gear-shiftings.

Components involved
- Hydraulic power and Quick disconnect.
- Clutch solenoid valve.
- PLCD clutch sensor.
- Levers control.
- TCU.
- Brake switch.

Practical checks
- Check that hydraulic power is present and that the Quick disconnect is connected.
- Shifting a gear with the engine off, check that the clutch position signal displayed by means of the Ferrari tester shows that the clutch opens after PIS and the closes once again (see paramenters through the Ferrari Tester).
- Check the lever controls.
- To understand if actuation is being performed or if the sensor is not responding properly, check the control current for the clutch solenoid valve during gear-shifting.
- Using the Ferrari Tester, check that the pressed brake signal is correct.

When everything is working properly
- During gear-shifting, even with the engine off, the clutch must open after PIS and then close again after engaging the gear.

Gearbox Actuation

Signs of possible problems
- The system does not shift gears.
- The gear engaged is wrong.

Components involved
- Clutch actuation
- Engagement and selection solenoid valves.
- Engagement and selection position sensor.
- TCU.
- Pick-up and revolution signals (only if there's no actuation with the engine running).

Practical checks
- Check the **clutch actuation**.
- When requesting a gear-shift, check the control currents for the solenoid valves involved.
- Reading the parameters on the Ferrari Tester, check for consistency in the engagement and selection position signals by performing "open loop" gear-shiftings.

When everything is working properly
- The actuation features the following sequence (see "Time history" D 6.04):
  1. the clutch opens;
  2. the gear is disengaged (both eng. solenoid valves are triggered);
  3. if required, a gear is selected (eng. solenoid valves are triggered according to the table data);
  4. the requested gear is engaged (sel. solenoid valves are triggered according to the table data);
  5. the clutch closes.

List of procedures to be carried out after replacing a system component

PIS setting (*

Repeat the starting procedure **3** or **4** times, with the engine cold and switching off the system each time until the display is off.

IO setting (*

Before carrying out this operation, use the SD-2 tester to check that the hydraulic oil temperature ranges between **38** and **83 °C**. With the engine running and neutral engaged, hold the car at standstill keeping the accelerator pedal released for ca. 2 minutes.

New closed clutch value (*

New clutch

Using the Ferrari Tester and with the engine off, read the clutch travel value and write it in the clutch replacement procedure, in the Diagnosis page.

In the event that the TCU (and not the clutch) is replaced, and the value that had been previously recorded in its Diagnosis page cannot be read, carry out a few pick-up trials on the car and modify the value to be set as follows:

- if the car picks-up over **1700÷1800 rpm**, the set value must be decreased;
- if the car shows interferences or picks-up too sharply, the set value must be increased.

IMPORTANT

This value must never exceed the clutch travel value prescribed for the car.

- If it is still possible to read the value that had been recorded on the TCU Diagnosis page, set this value in the new TCU.

Compoment replacement

Compoment	***Procedure***	***Notes***
Power Unit	- Air bleeding from the hydraulic circuit (clutch actuator)	Ferrari Tester
	- Air bleeding from the hydraulic circuit (engagement/selection actuator)	Ferrari Tester
	- IO Setting	(
Gearbox actuator	- Air bleeding from hydraulic circuit (clutch actuator)	Ferrari Tester
	- Air bleeding from hydraulic circuit (engagement/selection actuator)	Ferrari Tester
	- Self-learning	Ferrari Tester
Pipes	- Air bleeding from hydraulic circuit (clutch actuator)	
	- Air bleeding from hydraulic circuit (engagement/selection actuator)	
Levers	None	
Control Unit (TCU)	- Self-learning	(
	- PIS setting	(
	- PIS writing	Ferrari Tester (1
	- IO setting	(

	- New closed clutch	**(**
Clutch	- PIS setting	**(**
	- New closed clutch	**(**
Buzzer and relay	None	
Switches (doors, boot, bonnet)	None	

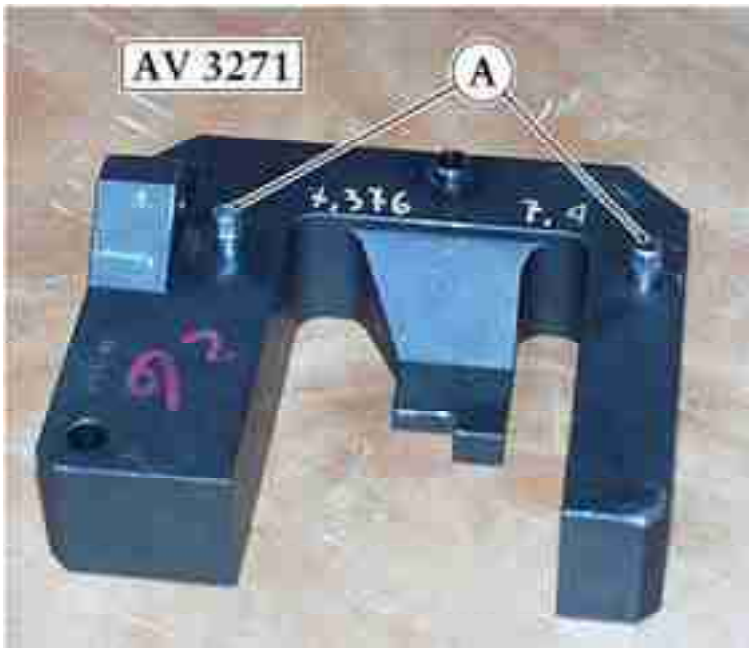
( ) *New closed clutch value*
(*Only FROM Electronic Control Unit part no.* ***189542***

D6.13 CENTRING THE GEAR SHIFTING-SELECTION ACTUATOR LEVER (FINGER)

NOTES

The lever centring procedure can be carried out by working from the under the car, after having removed the gear shifting-selection actuator (D 6.07).

To centre the lever correctly, it is necessary to use tool **AV3271**, which is equipped with new centring dowels (**A**) for a more precise tool positioning on the actuator's body resting surface.



- Loosen screw (**1**) which locks the lever support onto the control rod.

- Measure the diameter of the lever's ball terminal joint (**D**) using a micrometer: the new, nominal diameter ranges between **14,75** and **14,85 mm**.

This measurement is necessary to work out the thickness of the shim to be inserted between the finger's terminal ball joint and the tool's resting surface, according to the read diameter.
The table indicates the shim **S**) to be inserted according to the read diameter (**D**):

S (mm)	**D** (mm)
0,25	14,75
0,20	14,80
0,15	14,85

If the diameter read is not within the reported values, identify the shim (**S**) to be used in any case, following the logic reported in table (eg: with D= 14,90 use a shim S= 0,10, with D= 14,70 use S= 0,30).

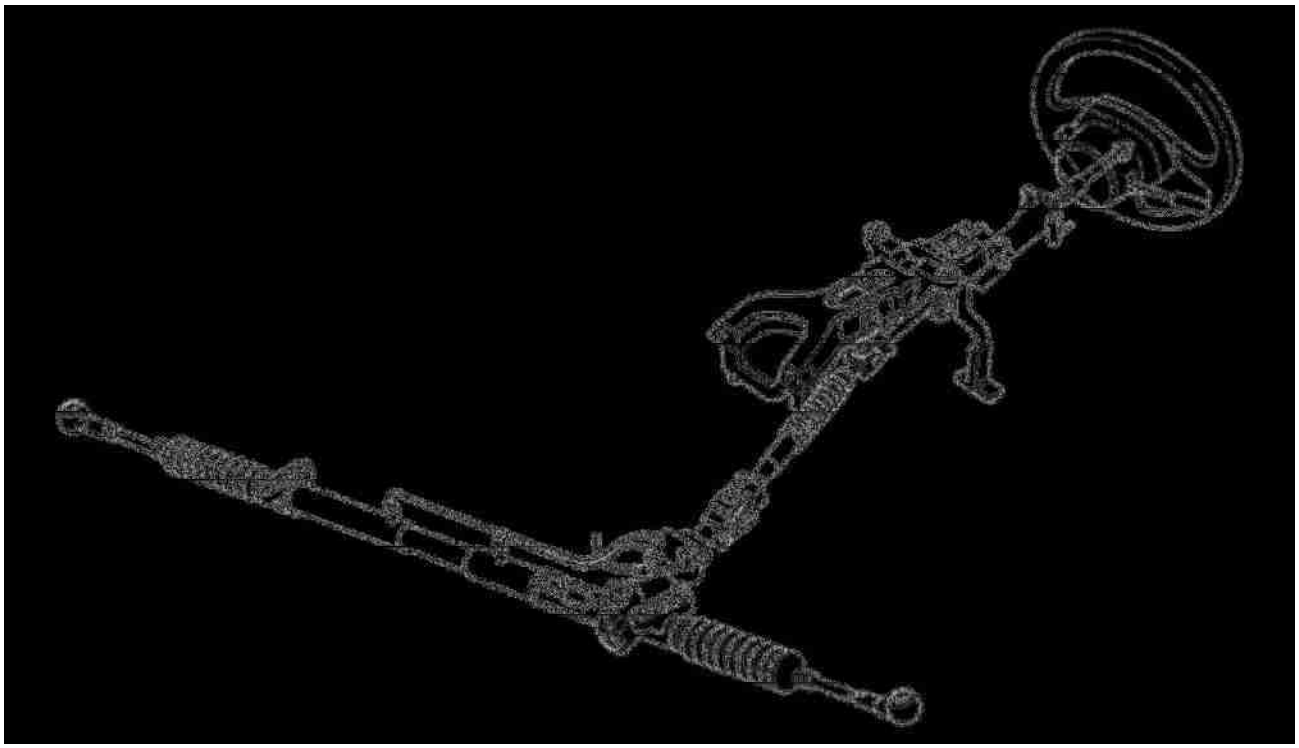
- Connect the SD2 tester to the car's diagnosis socket *(*L 2.12*)* and enter the "*360modena gearbox* " application in the "*Diagnosis*" menu: select the "*Actuator centring*" option.
- Position the **AV3271** tool on the actuator, as illustrated in the figure, and insert the feeler gauge blade(**B**),

whose thickness was previously defined, between the lever's terminal ball joint and the resting surface on the tool: Push the lever's end against the tool.

- Now lock the screw (**1**) to the prescribed tightening torque, making sure that the solenoid valves are still activated.
- Check that the clearance between the lever and the tool corresponds with the defined shim.

- Close the "*Actuator centring* " application using the SD2 tester.
- Refit the actuator and the other removed parts on the gearbox *(*D 6.07*)*.
- Carryout the gearbox self-learning process *(*D 6.11*)*.
- From the "*Engagement stroke test*" option on the "*Diagnosis*" menu, check the correct value of the engagement strokes, using the SD2 tester.
- On p e "*N.* " of the "*Parameters*" menu, check the centring value (ranging between **+ - 3°**).

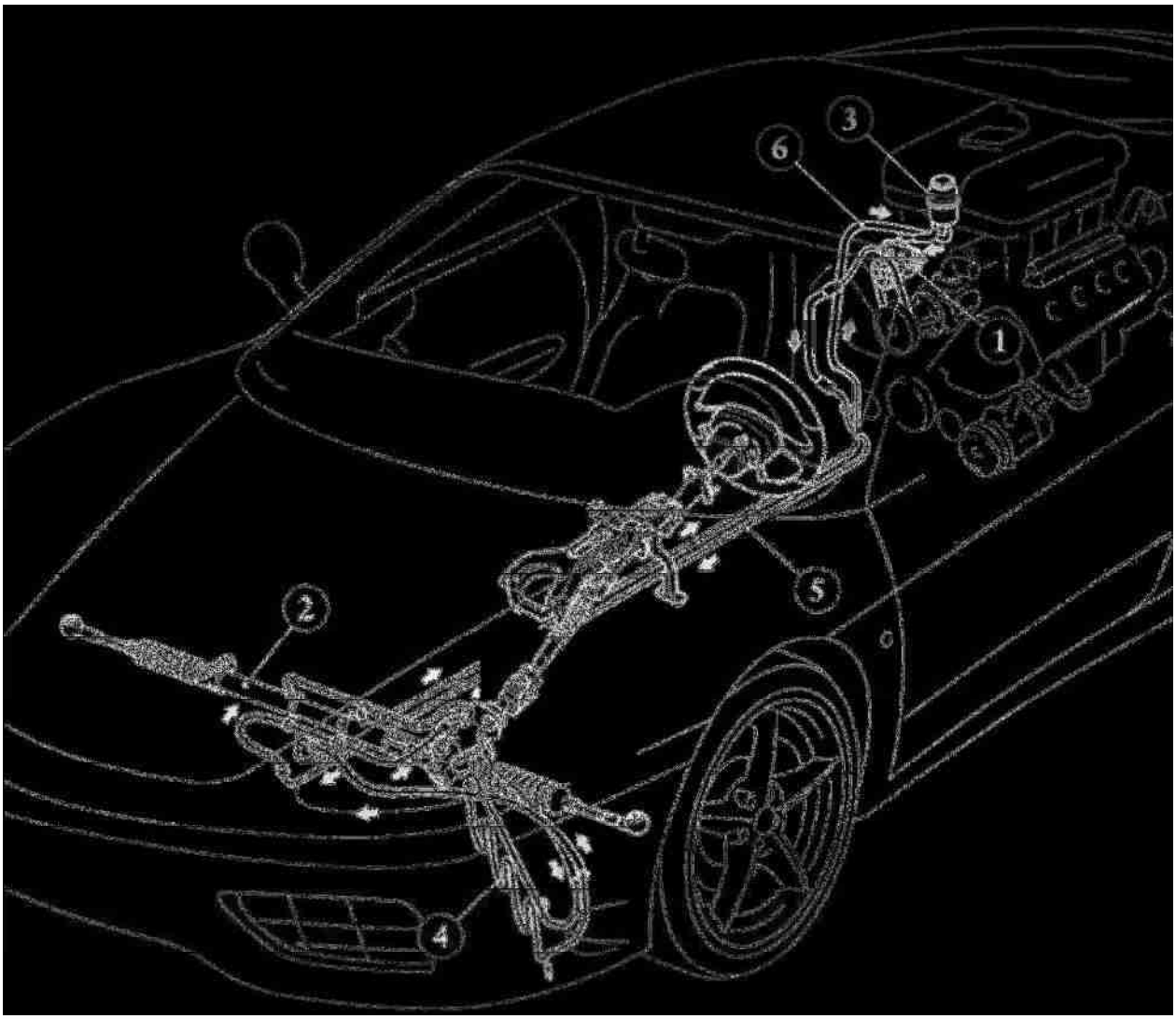
E1.01 TECHNICAL FEATURES



- Steering column with lever to adjust the position of the steering wheel.
- Steering with collapsible cardanic transmission.
- Rack-type hydraulic steering system, servo-controlled by a hydraulic circuit to facilitate parking manoeuvres for the driver. As the speed increases, the car's particular aerodynamic structure gives the driver a mechanical-driving sensation which ensures great steering precision and manageability. The steering box is equipped with oscillating arms with permanent lubrication joints.
- Hydraulic steering pump fastened to the engine and operated by a belt from the pulley on the hydraulic pump.
- Number of steering-wheel turns, lock-to-lock: **3**
- Minimum steering diameter: **10,8 m (425.2 in.)**

E1.02 HYDRAULIC SYSTEM OUTLINE

The hydraulic system is made up of the following components:



1 - Hydraulic steering pump
2 - Steering box
3 - Oil tank with dipstick
4 - Oil-cooling coil
5 - Delivery pipes from pump to steering box **(*)**
6 - Back-flow pipes from steering box to tank

(*) The delivery line from the pump to the steering box, from the first vehicle produced until today, has been subject to two service campaigns:

1st Service campaign: FROM Ass.ly No. 33656 (NOT for GD) and FROM Ass.ly No. 34015 (valid for GD)

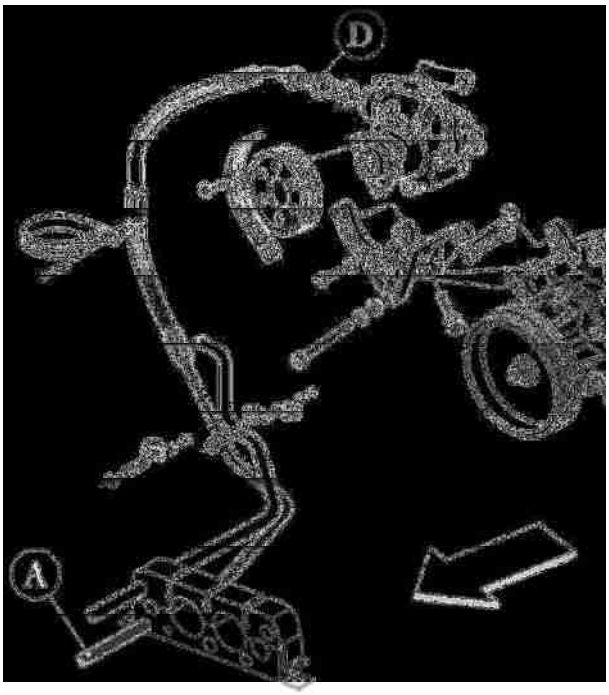
The three parts comprising the pipe (no longer available as spare parts) have been replaced by a single pipe **(A)** fitted at the end of a male/male union **(D)** for connection with the pump.

2nd Service campaign: FROM Ass.ly No. 53103

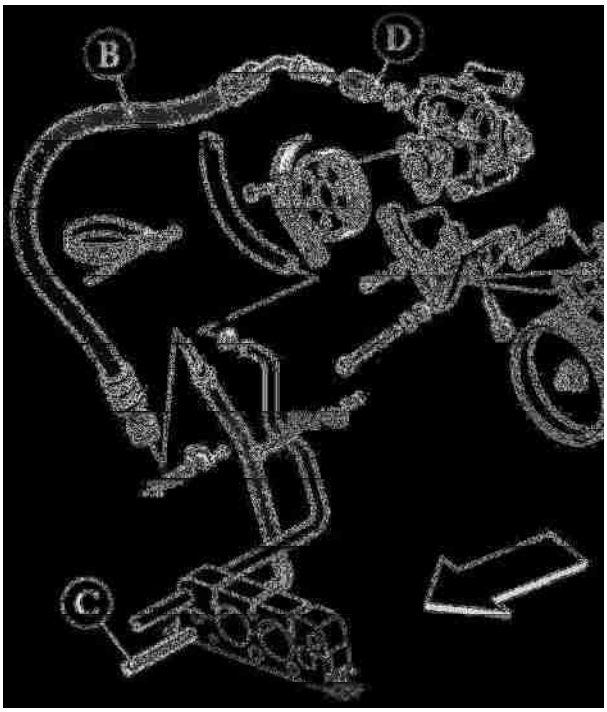
To facilitate the removal/refitting of the whole engine from/in the vehicle, the pipe has been split into two parts. One part **B** made of hosing, which runs from the pump to the underfloor; a second part **(C)**, which runs across the entire underfloor and connects with the steering box. The two parts are fitted with a quick coupling in the joint area.

The union **(D)** on the pump has also been altered so that the female part is now facing the pipe **(B)**.

1st Service campaign



2nd Service campaign



To maintain inalterable the system's original functions, it is necessary to completely replace the hydraulic circuit is oil at the intervals mentioned on the "PROGRAMMED MAINTENANCE PLAN" (E 3.01 and E 3.02).

E1.03 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category
Pipe unions on hydraulic steering pump and steering box (M16x1.5)	**35**	**B**
Union on steering box for delivery pipe (M12x1.5)	**35**	**B**
Screws fastening support to hydraulic pump	**25**	**B**
Screws fastening ulley to pump	**2**	
Screws fastening ump to support	**2**	
Screw with nut fastening steering box to chassis (preloaded: **35 Nm**)	**60**	**A**
Screw fastening universal joint	**22**	**B**
Filler-neck screw for union on adjustable coil pipe (M14x1.5)	**35**	**B**
Steering-wheel hub nut fastener	**50**	**B**
Screw fastening column to chassis	**7÷8**	**B**
Nut fastening column to pedal board	**12**	**B**
Screw fastening column to pedal board	**20**	**B**
Lockin of steering column adjustment p		

E2.01 HYDRAULIC STEERING PUMP

Tightening torques		Category
Pipe unions on hydraulic steering pump and steering box (M16x1.5)	**35**	**B**
Screws fastening support to hydraulic pump	**25**	**B**
Screws fastening to pump	**25**	**B**
Screws fastening ump to supp t	**25**	**B**

It is possible to dismantle and re-assemble the hydraulic steering pump and the control belt even with the engine installed in the car through the inspection panel (M 3.05).

CAUTION

The oil contained in the system can cause injury to eyes and skin and may damage the car's painted parts.

Please see (A 3.04) to replace the hydraulic steering pump's control belt.

Dismantling

- Remove the rear piece of the underfloor (M 2.12).
- Empty the system gaining access from under the car by detaching the rubber pipe **(1)** for the oil back-flow to the tank and the union **(2)** of the delivery pipe for the steering box (the latter operation is only possible on vehicles **UP TO Ass.ly No. 33655-GS and Ass.ly No. 34014-GD**).

- On the vehicles **FROM Ass.ly No. 33656-GS and FROM Ass.ly No. 34015-GD, UP TO Ass.ly No. 53102**, to drain the system, in addition to the rubber pipe **(1)**, you must detach the union **(E)** on the delivery pipe from the steering box (E 2.02).

- On the vehicles **FROM Ass.ly No. 53103**, drain the system by detaching the rubber pipe **(1)** and detach the quick coupling unions on the pipes **(B)** and **(C)**, using tool **AV 6038**.

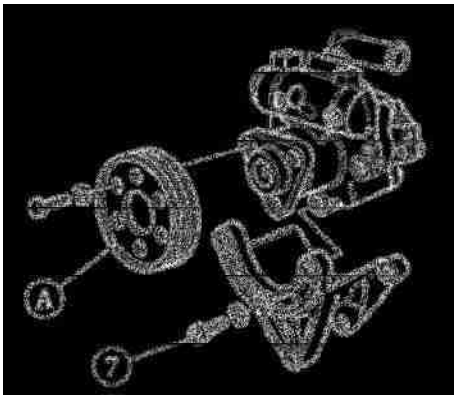
- Detach the union **(3)** of the pipe delivering oil to the steering box and to the tank from the hydraulic steering pump.

- The pipe **(B)**, fitted on the vehicles **FROM Ass.ly No. 51103**, is fitted on the pump side of a union which can withstand one tightening to torque only. Once detached from the union **(D)** on the pump, the pipe **(B)** must be replaced.

- Loosen the screws **(4)** and **(5)** and tighten the belt tensioner screw **(6)**.

- Slide out the belt from the pulley of the hydraulic pump.
- Completely unscrew the fastening screws and remove the pump together with its support from the hydraulic pump's body.

In case of pump replacement, it is necessary to separate it from the support, after having removed the pulley **(A)**.
- Unscrew the three screws **(7)** fastening the pump to the support and remove it from the latter.



The pump remains full even though it has been removed from the system; for the replacement of the oil within the pump, please see (E 3.01).
When re-assembling, lock the screws **(7)** and the screws fastening the pulley to the prescribed torque.

Re-assembly

- Install the hydraulic steering pump, complete with pulley and support, on the hydraulic pump body, positioning the belt tensioner screws **(6)** and the screws **(4)** and **(5)**.
- Insert the belt on the pulley and carry out the tensioning procedure (A 3.04).
- Lock the screws **(4)** and **(5)** to the prescribed torque.

- Mount the pipeline connecting the tank on the pump and lock the delivery pipe union **(3)** to the prescribed torque.

- On the vehicles **FROM Ass.ly No. 51103**, the pipe **(B)**, removed earlier, must be replaced with a new one. Position the union so that the pipe **(B)** is upright.
- Lock the pipe **(B)** on the union **(D)** to the prescribed torque, exerting a counterforce with the said union.

- Reconnect the pipes removed earlier on the underfloor and/or the steering box, locking the unions to the prescribed torque.
- Proceed with the filling and the draining of the system (E3.02).
- Re-assemble the items removed during the procedure.

E2.02 STEERING BOX

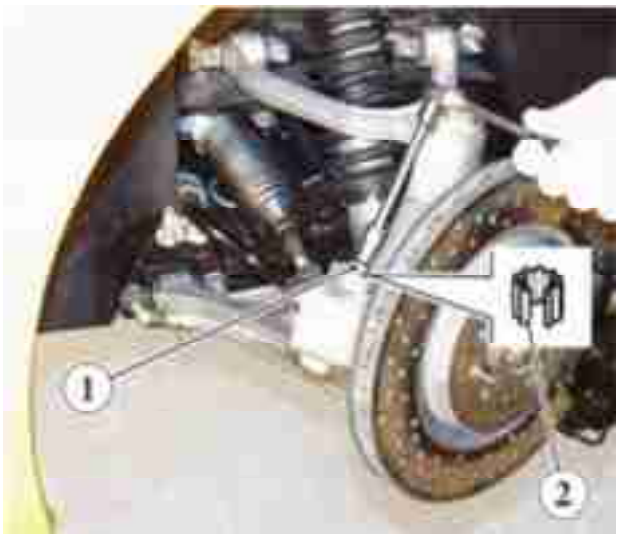
Specific Equipment

Torque wrench	**Cod. 95973305**
Torque wrench extension	**Cod. 95973306**

Tightening torques		Category
Screw with nut fastening steering box to chassis (preloaded: **35 Nm**)	**60**	**A**
Screw fastening universal joint	**22**	**B**
Pipe unions on hydraulic steering pump and steering box (M16x1.5)	**35**	**B**
Union on steering box for delivery e (M12x100.5)	**3**	
Filler-neck screw for union on adjustable coil p M14x10.5)	**3**	

Dismantling

- Drain the hydraulic steering system (E 2.01).
- Remove the front wheels (F 3.06).
- Remove the lower panels of the front gravel guards (M 2.05).
- Remove the front part of the underfloor (M 2.12).
- Remove the rear panel of the luggage compartment (M 3.06).
- Unscrew the screw fastening **(1)** the ball joints of the steering to the suspensions' stub axles.
- Detach the joints from the stub axles recovering the balancing spacers **(2)**.



- Working in the passenger compartment, unscrew the screw **(3)** fastening the universal joint of the steering column to the steering box.
- Mark some references on the universal joint and the steering box shaft in order to obtain the correct position when re-assembling.

- Place a tray under the connection zone for the steering box's delivery pipes, to collect the oil draining from the system.

Valid for vehicles UP TO Ass.ly No. 33655-GS and Ass.ly No. 34014-GD

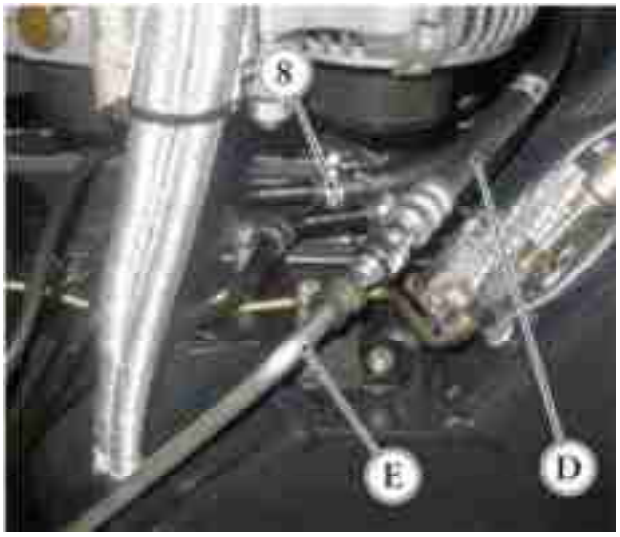
- Detach the steering box delivery pipe from the underfloor pipe.
- Drain the oil present in the steering box by turning the steering wheel several times.
- Working from the luggage compartment opening, remove the delivery pipe union **(4)** from the steering box.
- Loosen the clamp **(5)** on the pipe connecting the cooling coil and detach it from the steering box.
- Detach the supporting bracket **(6)** of the system's pipes from the chassis.

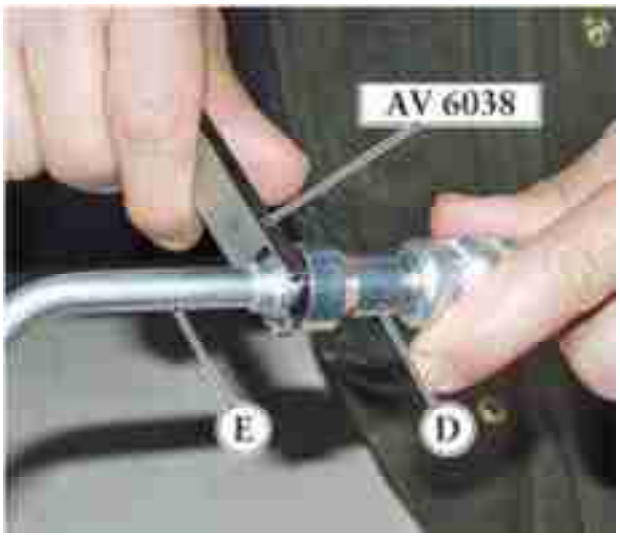
Valid for vehicles FROM Ass.ly No. 33656-GS and FROM Ass.ly No. 34015-GD, UP TO Ass.ly No. 53102

- Working from the luggage compartment opening, detach the delivery pipe union **(4)** from the steering box.
- Loosen the clamp **(5)** on the pipe connecting to the cooling coil and detach it from the steering box.
- Drain the oil present in the steering box by turning the steering wheel several times.
- Detach the support brackets **(6)** for the system's pipes from the steering box.

Valid for vehicles FROM Ass.ly No. 53103

- Remove the rear section of the underfloor (M 2.12).
- Place a pan underneath the delivery and return pipe connection areas, in order to collect the oil that leaks out the system.
- Drain the system by loosening the clamp **(8)** on the pipe connecting it to the tank and detach it from the underfloor pipe; separate the quick coupling unions on the delivery pipes **(D)** and **(E)**, using tool **AV 6038**.





- Working from the luggage compartment opening, detach the delivery pipe union **(4)** from the steering box.
- Loosen the clamp **(5)** on the pipe connecting to the cooling coil and detach it from the steering box.
- Detach the support brackets **(6)** for the system's pipes from the steering box.

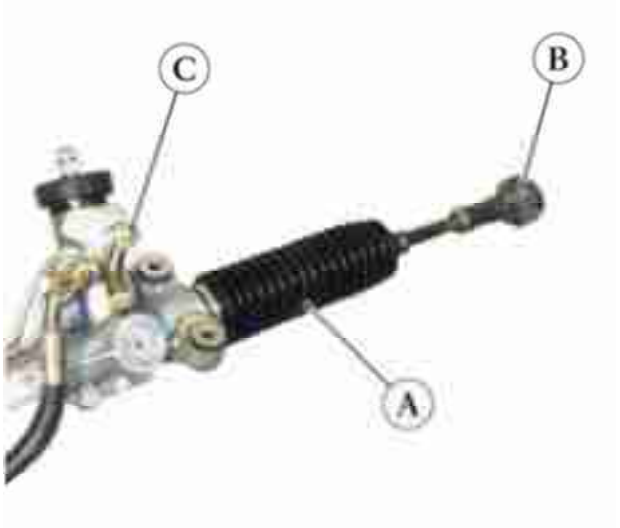
- Detach the terminal board of the **ABS** system.
- Detach the front stabilizing bar from the spherical tie rods and from the fastener on the chassis (F 2.06) and move forward without removing it.
- Working from the luggage compartment, keep the nut still on the screws fastening the steering box to the chassis.
- Unscrew the fastening screws **(7)** of the steering box, on both sides of the chassis.

- Slide out the universal joint from the steering box shaft and move the latter towards the right.
- Draw out the steering box complete with delivery pipe from the left side of the luggage compartment.

Checks

For proper steering, the protection bellows **(A)** of the arms and the boots **(B)** of the ball joints must be intact. If they are damaged, they must be replaced lubricating the knuckles with **FIAT MR3** grease.

An adjustable union fastened with a filler neck screw **(C)** is installed on the upper exit hole of the steering box. In case of replacement, it is necessary to mark out a reference of the union, to be able to re-assemble it correctly and to lock the screw **(C)** to the prescribed torque.



R -assembly notes

- To obtain the correct position of the universal joint, when re-assembling the steering box, it is necessary to centre it onto the rubber ring on the pedal board.
- To tighten the screws fastening the steering box to the chassis, use the special torque wrench **Cod. 95973305**, equipped with its **Cod. 95973306** extension.

- Proceed with tightening to the prescribed torque following the sequence 1-2-1.
- Lubricate the head of the fastening screws **(1)** and the boots of the ball joints with **FIAT MR3** grease.
- Insert the spacer ring **(2)** into the stub axles' seat; mount the screws **(1)** and lock them to the prescribed tightening torque.

- Insert the universal joint into the steering box shaft, fixing it on the basis of the references marked out during the dismantling phase.

NOTES

When assembling a new steering box, it is necessary to check the steering angle in both directions after inserting the universal joint.

- Lock the screw **(3)** fastening the universal joint to the steering box to the prescribed tightening torque.

- Connect the detached pipes and lock the delivery pipe union **(4)**, to the prescribed torque.

- Fill and drain the hydraulic steering systema (E 3.02).
- Re-assemble all the parts removed during the procedure.

E2.03 HYDRAULIC STEERING TANK

The hydraulic steering system's tank is located on the panel dividing the engine from the passenger compartment, under the rear window. It is equipped with a plug with a stick that controls the liquid level within the system (A 3.19).

- To remove it, the system must be emptied (E 2.01).
- Detach the delivery pipe to the pump from the tank and the back-flow pipe from the steering box.
- Unscrew the screws **(1)** fastening the dividing panel and remove it together with the support brackets.

- fter re-assembling, refill and drain the system (E 3.02).

E2.04 COOLING COIL

The coil used for cooling the system's oil is fixed onto the water radiator, on the left side of the car.
In case of removal, it is necessary to empty the system (E 2.01).

- Remove the left water radiator and separate the latter from the cooling coil (B 5.04).
- After re-assembling, fill and drain the hydraulic steering system (E 3.02).

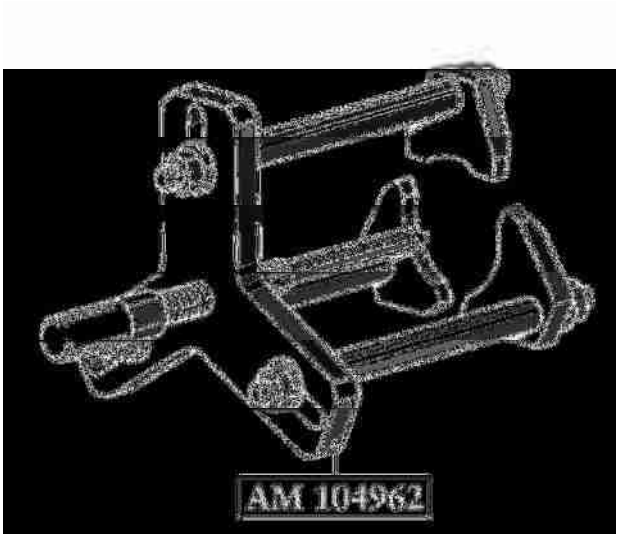
E2.05 STEERING COLUMN

Tightening torques		Category
Steering-wheel hub nut fastener	**50**	**B**
Screw fastening column to chassis	**7÷8**	**B**
Nut fastening column to pedal board	**12**	**B**
Screw fastening column to pedal board	**20**	**B**
Screw fastening universal joint	**22**	**B**
Screw fastening hub to steering wheel	**6÷7**	

Dismantling

- Remove the **Airbag** module on the driver's side (H 3.02).
- Remove the steering wheel (H 2.06).
- Remove the instrument panel (H 1.01).
- Remove the lower part of the dashboard (M 3.01).
- Remove the windshield wipers' control motor (L 2.05).
- Remove the steering column covers.
- Unscrew the nut fastening the steering-wheel hub to the steering control shaft.

- Detach the orange connection of the **Airbag** cable and the other connection **(A)** on the left-hand side and slide out the hub with the spiral contact. If the operation proves to be difficult, use the **AM 104962** tool to remove the hub from the steering column shaft.



- Detach the 5 connections to the dashboard cable from the release switch.
- Unscrew the nuts **(1)** and remove the disconnecting switch.

NOTES

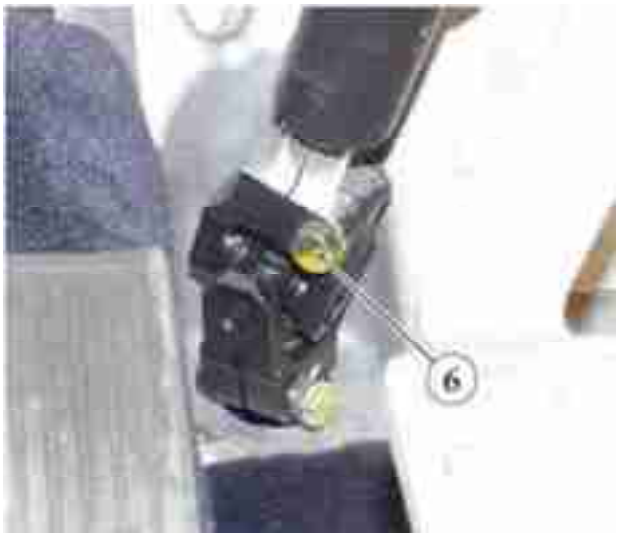
*The electronically-controlled version is equipped with the gearshift lever control device, located under the steering column switch . For disassembly instructions, see (*H 2.11

- Remove the two connectors of the antitheft device.
- Unscrew the screws **(2)** fastening the support column to the chassis.
- Remove the support clamp **(3)** for the dashboard cables on the support column.

- Unscrew the nuts **(4)** fastening the support column to the pedal board.

- In the trunk, unscrew the outer screw **(5)** fastening the support column.

- Unscrew the screw **(6)** fastening the universal joint to the steering box.
- Mark some references on the two pieces in order to obtain the correct position when re-assembling.

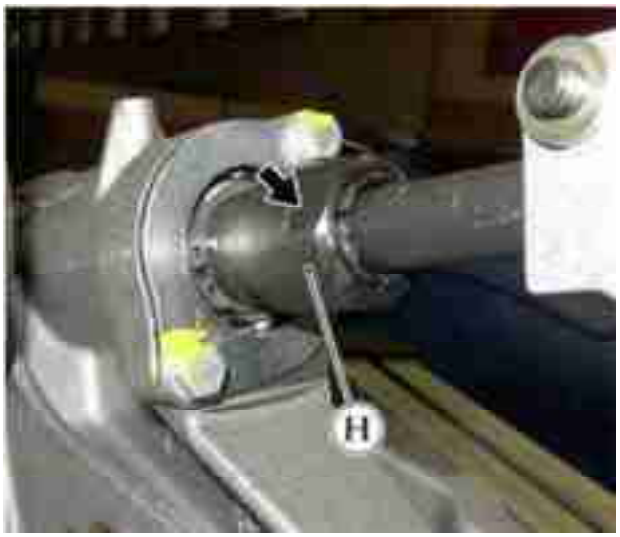


- Remove the column together with the support and the universal joint.

Torsional clearance adjustment on steering column

FROM Ass.ly No. 39406 the lower and upper steering column shafts have been modified by fitting a ring nut **(H)** on the upper one, in order to adjust the steering wheel's torsional clearance.
When the ring nut is tightened, the torsional clearance is reduced and the load increased, resulting in the axial adjustment of the steering wheel.

IMPORTANT
Do not overtighten the ring nut as this could impair the steering wheel axial adjustment.



To adjust the clearance, proceed as follows.
1 With the engine switched off, turn the steering wheel slightly to check the amount of clearance.
2 Release the axial/angular adjustment lever on the steering column (*Link H 2.06*) and check that the axial adjustment load is acceptable.
3 Using the special wrench socket on the ring nut **(H)**, tighten the latter by a few degrees.
4 Check whether there is still any angular clearance and check the axial adjustment load is still acceptable.
5 Repeat the procedure outlined above in points **3** and **4** until all clearance is eliminated.
6 Unscrew the ring nut slightly in the event of excess axial adjustment load.

Load reference values for steering wheel axial adjustment
- Optimum: **12 Kg**
- Maximum: **16 Kg**

Replacing the Steering Column parts

Antitheft device

- To remove the antitheft device of the column, take off the screw **(7)**. To be able to unscrew it from the device, make an incision on the head.

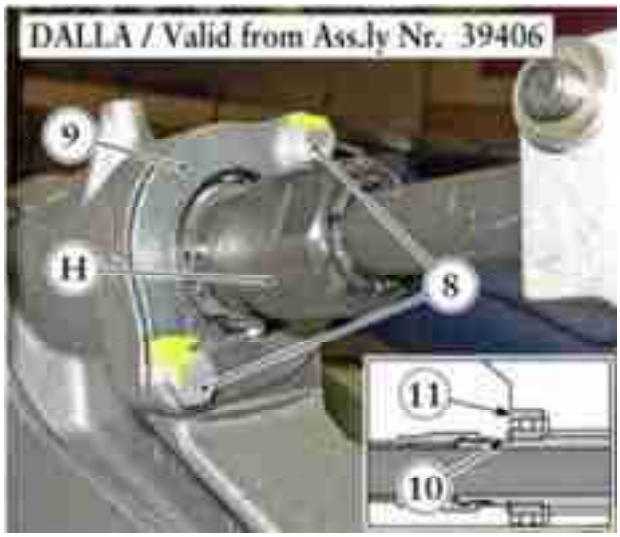
IMPORTANT

The antitheft device is supplied as a spare part together with the door-locks.

- Assemble the new device and fasten it with a new predefined self-breaking screw **(7)**.

Steering control shaft bearings

- Remove the universal joint from the upper end of the steering control shaft.
- On vehicles **FROM Ass.ly No. 39406**, unscrew the ring nut **(H)** and remove it.
- Unscrew the screws **(8)** and remove the supporting plate **(9)**.
- Remove the stop ring **(10)** on the shaft.
- Adequately support the steering column and push out the shaft together with the bearing **(11)**.
- Remove the bearing **(11)** from the shaft.



- A roller bearing **(12)** is fitted on the steering column, on the steering wheel side. To replace it, first remove the shaft, as described earlier, then use a standard extracting tool to remove it from the steering column.

IMPORTANT
*Once removed, the bearings **(11)** and **(12)** must always be replaced with new ones.*

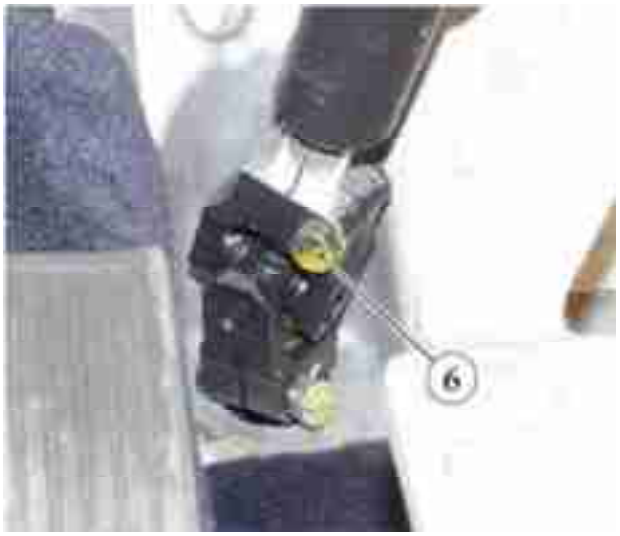
Re-assembly notes
- Re-assemble the complete column on the chassis and on the pedal board.
- Lock the screws **(2)** and **(5)** and the nuts **(4)** fastening to the prescribed torque.

- Insert the universal joint from the lower end of the shaft on the steering box, positioning it correctly on the basis of the reference marks made during dismantling.

NOTES

If a new steering column must be assembled, it is necessary to check the steering angle in both directions after having inserted the universal joint.

- Tighten the screw **(6)** to the prescribed torque.



- After having mounted the connectors of the dashboard cables of the release switch, fix the cables with tear clamps in the places marked out in the drawing.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

NOTES

The electronically-controlled version must be fitted with the gearshift lever control device and related connections (H 2.11).

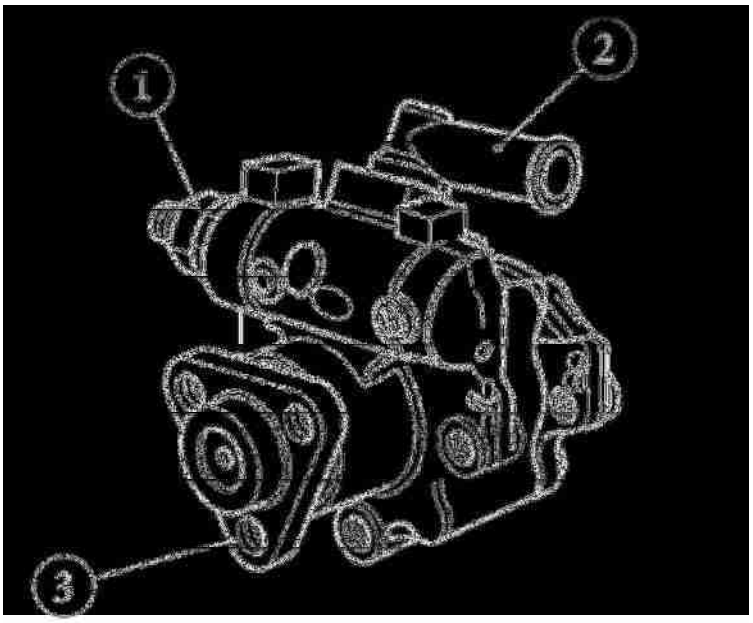
- Re-assemble the steering hub and lock the fastening nut to the prescribed torque.
- Re-assemble the components previously removed.

E3.01 FILLING OF THE HYDRAULIC STEERING PUMP

NOTES

This procedure is not essential since the system is self-draining (E 3.02)*. In any case, prior filling of the pump accelerates and facilitates the filling of the system*

- To facilitate the filling and the draining of the pump, position it with the delivery union **(1)** upwards.
- Connect the intake union **(2)** to a pipe equipped with a cock and coming from a tank placed over the pump. The tank must only contain fluid of the prescribed type (A 1.02).
- Open the cock and start turning the hub **(3)** of the pump clockwise until only oil, without air bubbles, comes out of the delivery union **(1)**.



- Immediately plug the delivery union and close the cock.
- Turn the pump so that the intake union **(2)** is at the highest point.
- Disconnect the cock pipe and plug the suction union.
- Position the pump with the unions upwards.

IMPORTANT

To avoid emptying of the pump, when this is connected to the system, the pipelines must be quickly connected

E3.02 SYSTEM FILLING AND DRAINING

After having emptied the hydraulic circuit during periodic maintenance, or in case of replacement of a component or of a pipe, only use quality oil and in the prescribed quantity to fill the system (A 1.02).
The system self-drains but, to facilitate this function, carry out the following procedure.

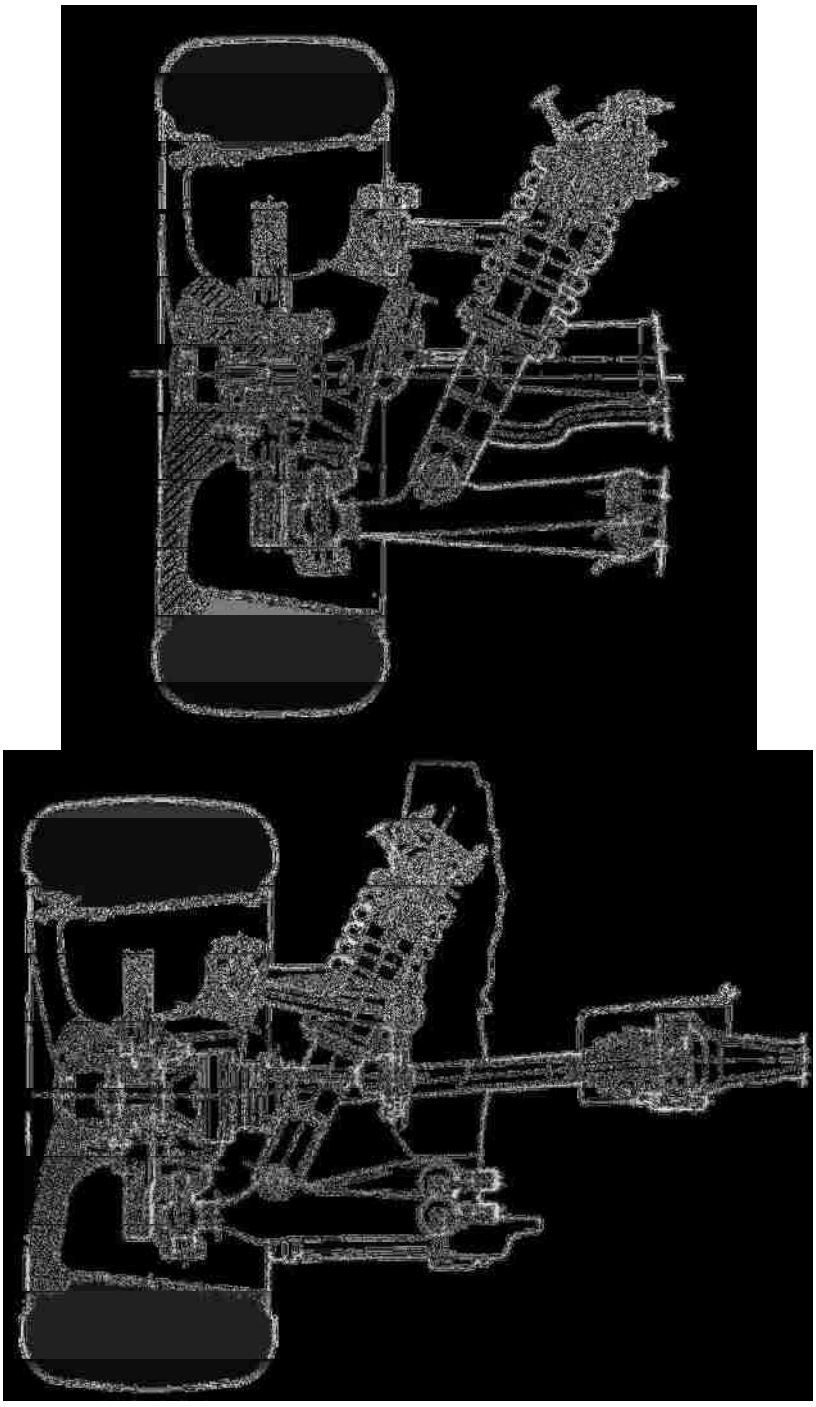
- With the engine at rest and the system filled with oil at the maximum level, make five full steering-wheel turns. During this procedure it is necessary to avoid emptying of the tank.
- Check the oil level in the tank and refill it if necessary (A3.19).

- Start the engine for about five seconds.
- When the engine stops, check the level.
- With the engine at rest, make another five or more full steering-wheel turns.
- When the engine stops, check the level again and the status of the oil; excessive emulsified air prevents effective self-draining.
  If this occurs, leave the engine at rest for a few minutes, to allow the oil to settle.
- Restart the engine and, if this situation persists and the pump seems loud, the liquid in the tank must be replaced with new oil.
- At the end of the procedure the oil in the tank must be at the maximum level (A3.19).
- Carefully close the tank cap.

F 1.01 TECHNICAL FEATURES

Suspension Systems

- All-around independent suspension systems, with swinging upper and lower tranverse triangular arms.
- Double-acting telescopic hydro-pneumatic shock absorbers, with continuous variation of the electronically-controlled setting.
- Low kingpin offset to improve braking stability and minimise kick-back on the steering wheel.
- Anti-dive configuration owing to the lower arm being tilted to reduce front pitching when braking.
- A maintenance-free, one-piece double-row ball bearing is fitted on the wheel hub.
- Tranverse stabilizer bars.



Wheels

Light alloy wheel rims.

Wheel rim dimensions and types:

- front: **7,5" J x 18" H2**
- rear: **10" J x 18" H2**

"Tubeless" type unidirectional tyres.

Tyre dimensions:

- front: **215/45 ZR18**
- rear: **275/40 ZR18**

Type of tyres:

- GOODYEAR EAGLE F1 GS FIORANO
- PIRELLI P ZERO
- BRIDGESTONE POTENZA S02A
- MICHELIN PILOT SPORT

Snow tyres (Max speed 210 km/h)

PIRELLI WINTER 210 PERFORMANCE

Spare Wheel

- rim 3"1/2 B x 17" - SPEEDLINE
- tyre T 125/80 R17-GOODYEAR (max. speed 80 km/h)

Tyre Pressure

Types of tyres	**GOODYEAR**	**PIRELLI**	**BRIDGESTONE**	**MICHELIN**
- front:	2,2 bar	2,2 bar	2,2 bar	1,8 bar
- rear:	2,2 bar	2,0 bar	2,2 bar	1,9 bar

Snow tyres

- front:	2,2 bar
- rear:	2,0 bar

S are	4,2 bar

F1.02 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category	Product
Hub-holder and stub axle tie-rod fastening screw	**6**		**TUTELA Z2** Grease
Stabilizer bar ball tie-rod	**50**	**B**	
Nut fastening upper arm to chassis	**25**	**A**	
Screws fastening upper arm to stub axle and hub-holder	**65**	**A**	**TUTELA Z2** Grease
Screws fastening lower arm to stub axle and hub-holder	**85**	**A**	**TUTELA Z2** Grease
Nut fastening lower front arm to chassis	**60**	**A**	
Nut fastening lower rear arm to the chassis	**60**		
Screw fastening shock absorber to lower arm	**60**		**Molykote U-N** Paste
Check nut fastening the joint on the steering wheel tie rod and toe-in	**60**	**A**	
Screw fastening rear tie-rod to chassis	**25**	**B**	
Upper shock absorber fastening screw	**50**		
Shock absorber ring nut	**6**		
Shock absorber head	**60**	**A**	**OMNIFIT 230 M** thread locking product
Screw fastening front bar support	**25**	**B**	
Screw fastening arm to rear bar	**35**	**B**	
Ball tie-rod to bar	**5**		
Central pin nut	**27**	**B**	**TUTELA Z2** Grease
Bearing fastening screw	**65÷75**		
Screw fastening bearing's retaining bracket	**5,2÷6,7**		
ghtening	**9**	**B**	

(1) FROM vehicle Ass.ly No. 51428

F1.03 SPECIFIC EQUIPMENT

Code	Tool no.	Description
95973206	**AV 3206**	Support for complete hub
95973304	**AV 3304**	Tool for removing/fitting the shock-absorber punch
95973189	**AV 3189**	Tool for disassembling/assembling the upper flexible bushing on the shock-absorber
95973217	**AV 3217**	Tool for disassembling/assembling the lower joint on the shock-absorber
95973281	**AV 3281**	Tool for removing/fitting the flamblock on the lower arm
95973282	**AV 3282**	Tool for removing/fitting the flamblock on the upper arm
	AS 10723-07	Upper lever resting ad for ball joint removal
	AV 3427-14	Lower lever resting pad for ball joint removal
95971651	**AV 1651**	Punch for lower lever ball joint removal

F2.01 HUB-HOLDER-STUB AXLE

Tightening Torques		Product
Hub-holder and stub axle tie-rod fastening screw	**65 Nm**	**TUTELA Z2 Grease**

Both components consist of a cast light alloy with housing for the wheel support bearing and the seats for the ball joints of the suspension arms and tie-rods for the steering box (stub axle) or the toe-in adjustment.
With each overhaul, ensure that the cast alloy is free of cracks or dents and that the threads are in good condition.

Disassembly

STUB AXLE

- Follow the procedure described for front wheel bearing replacement, (F 3.03) in order to remove the stub axle from the front suspension system.

HUB-HOLDER

- Follow the procedure described for rear wheel bearing replacement, (F 3.04) in order to remove the hub-holder from the rear suspension system.
- The toe-in tie-rod **(1)** is fastened on the hub-holder. The fastening screw **(2)** must be unscrewed in order to remove it.

Re-assembly

STUB AXLE

- Re-assemble the stub axle on the front bearing and on the suspension system (F 3.03).

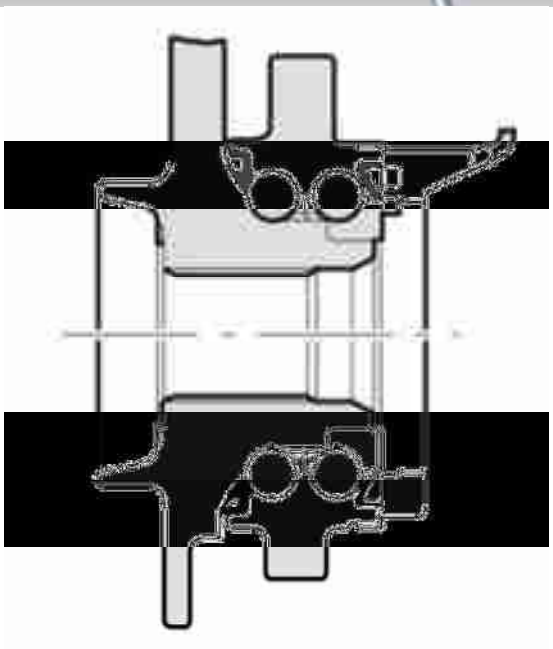
HUB-HOLDER

- Lubricate the fastening screw head and the toe-in tie-rod joint boot with **FIAT MR3** grease.
- Insert the balancing ring **(3)** into the tie-rod fastening screw seat.
- Install the toe-in tie-rod **(1)** in the hub-holder and tighten the screw **(2)** to the prescribed torque.

- Re-assemble the hub-holder on the rear bearing and on the suspension system (F 3.04).

F2.02 WHEEL BEARINGS

The wheel support bearings are of a composite-type, double row ball bearings, with double, airtight shielding.



The toothed wheel with ABS sensor is incorporated in the bearing.
For connection to the system, see Table **A** and **L** - ELECTRICAL SYSTEM.
The bearing parts cannot be disassembled.
The bearings should not show any clearance.
To test the clearance, a load of **30 Nm** must be applied axially towards the outside of the brake disk, at a **102 mm** radius.
Carry out the same procedure, this time applying the same load towards the inside. The total angular pivoting of the disk/flange, detected using the gauge resting on the brake disk at the indicated radius, must be **0,1 mm max.**
If the clearance exceed **0,03 mm**, the bearing must be replaced (F 3.03 and F3.04).

F2.03 SUSPENSION ARMS AND TIE-RODS

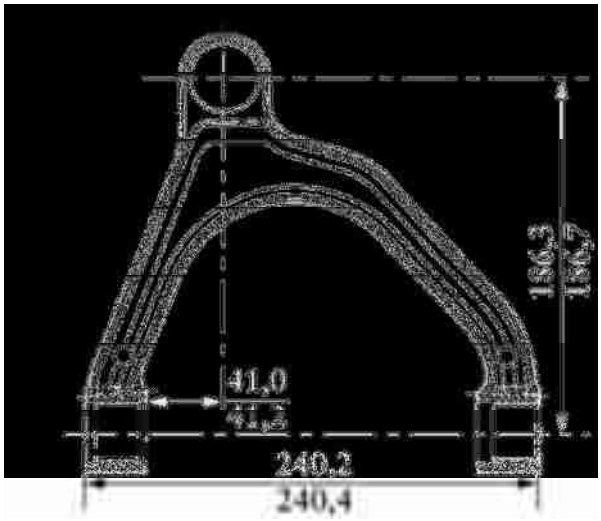
Tightening torques	Nm	Category	Product
Stabilizer bar ball tie-rod	**50**	**B**	
Nut fastening upper arm to chassis	**25**	**A**	
Screws fastening upper arm to stub axle and hub-holder	**65**	**A**	**TUTELA Z2** Grease
Screws fastening lower arm to stub axle and hub-holder	**85**	**A**	**TUTELA Z2** Grease
Nut fastening lower front arm to chassis	**60**	**A**	
Nut fastening lower rear arm to the chassis	**60**	**A**	
Screw fastening shock absorber to lower arm	**60**	**A**	
	80 (1)	**A**	**Molykote U-N** Paste
Screw fastening tie-rod to hub-holder and stub axle	**65**	**A**	Grasso **TUTELA Z2**
Screw fastening rear tie-rod to chassis	**25**	**B**	

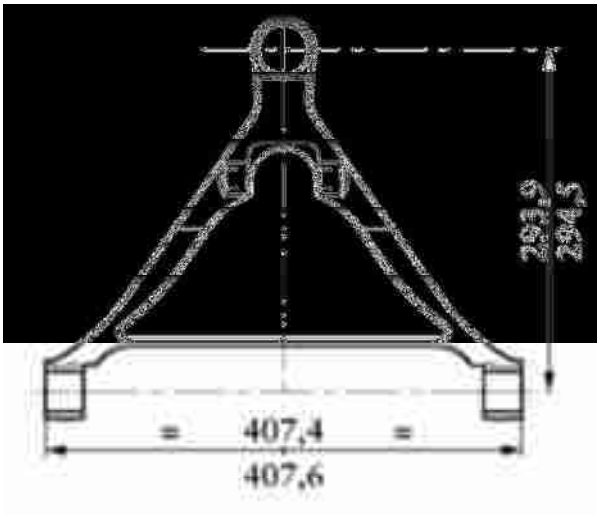
(1) FROM vehicle Ass.ly No. 51428

Suspension Arms

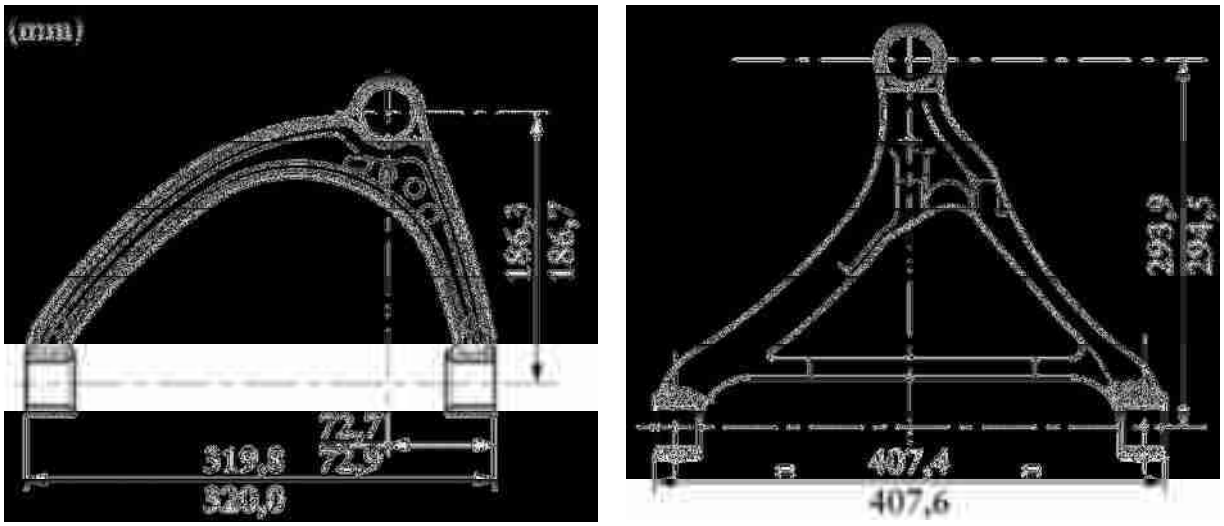
The suspension arms are made of aluminum alloy in order to reduce the effect of the unsuspended masses. They are connected to the chassis by means of flexible bushings of the flambloc type.
With the arm still fastened to the chassis, check the end float of the flamblocs and replace them if necessary (F 2.04).
The arms are connected to the stub axle or the hub-holder by means of special ball joints equipped with protective boots.
With the arm still fastened to the stub axle or the hub-holder, check the clearance of the ball joints and replace them, together with the arm, if necessary (F 2.04).
The arms should prove to be in good condition upon visual inspection, free of bending, strain or cracks. The drawings show the reference dimensions for the arms, serving for dimensional checks and if necessary, to establish whether it is necessary to replace them.

Front





Rear



FROM Ass.ly No. 47928 the lower cast levers have been replaced with moulded levers of the same size.
In addition to their design (see photo), the new levers also differ in the shock absorber fastening on the front lever, and this results in the use of a new, shorter screw.
Our Spare Parts Department, in addition to supplying the pre-modification cast levers, can also supply the ball joint and relative fastening components. This allows the workshops to replace the said component, in the event that the malfunction is attributable to the joint only, since in this case the original lever can be reused.
The joint supplied as a spare part can be fitted on all the cast or moulded levers.
For the ball joint replacement procedure and the checks to be carried out to establish whether the lever can be reused, see (F 2.04).
However, our Spare Parts Department also supplies the levers complete with the joint.

To prevent excessive suspension noise, which may occur if the vehicle travels on loose ground or paving, **FROM vehicle Ass.ly No. 51428** fastening screws have been introduced for the shock absorber on the suspension lever, which are sprayed with Molykote product in the area **(A)** where it is coupled to the lever, and the tightening torque has been increased (from 60 to **80 Nm**).

If the screws on the front suspension are replaced, in addition to the screw, the nut **(B)** and relative washer (see Notes at the end of this paragraph) must also be replaced.

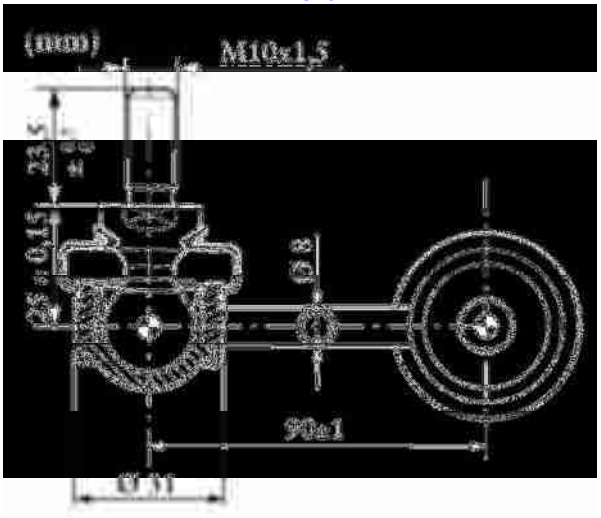
NOTES

The new fastening screws on the front shock absorber, coeated with Molykote product, cannot be fitted on the pre-modification cast levers.

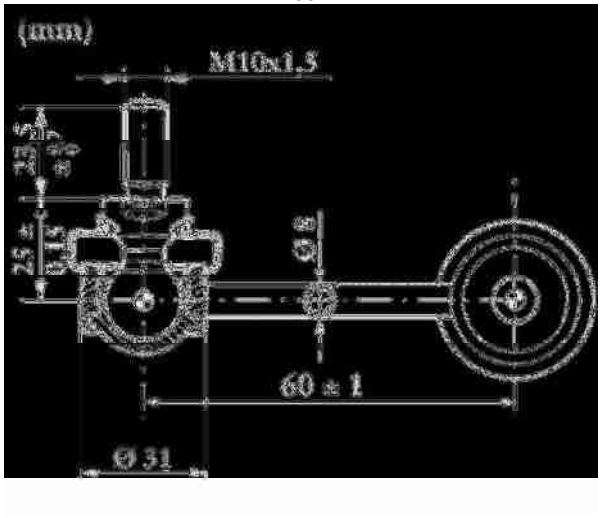
Tie-rods

The lower arm is connected to the stabilizer bar with a ball tie-rod. This tie-rod is of an established length and has two revolving end heads.

Front

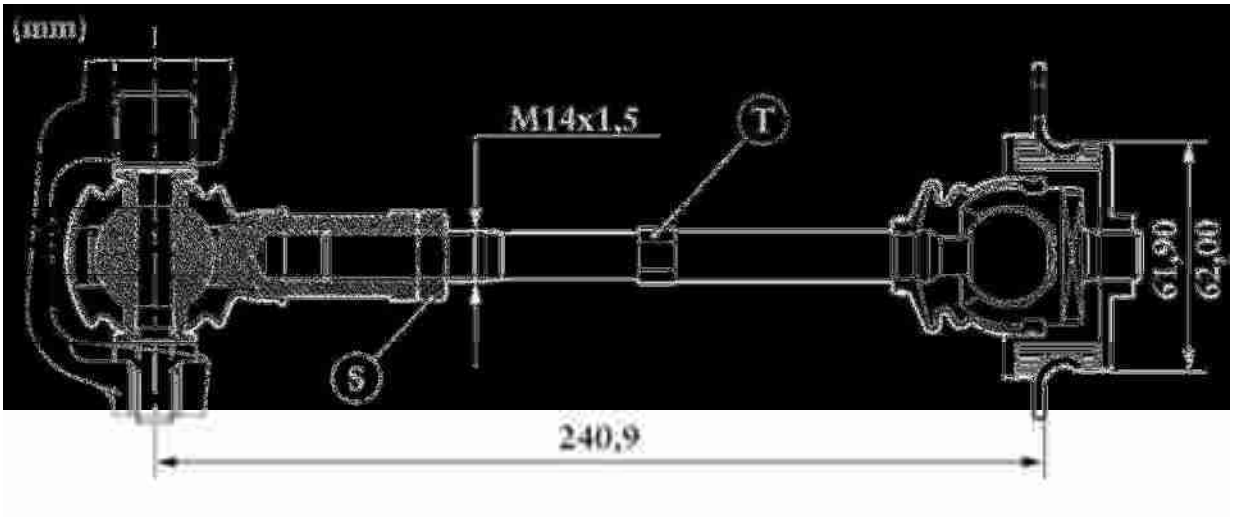


Rear



Rotate the heads to ensure that there is no blockage or bending. If there is, replace them.

There is a tie-rod anchored on the hub-holder. It serves for adjusting the toe-in of the rear wheels (F 3.05). The tie-rod is fastened to the chassis frame by means of a flexible support, incorporated with a ball joint and with the hub-holder by means of a ball joint, of the type utilized for fastening the suspension arms.
The length can be adjusted by loosening the lock nut **(S)** and rotating the tie-rod out of the wrench notch **(T)**.



NOTES
The figure includes the length of the tie-rod with reference to the prescribed toe-in.

Check the clearance of the joints and replace them if necessary (F 2.04).

Detaching Front Suspension Arms

NOTES

*The figures show a suspension with shock absorber attachment support, removable from the chassis (valid **UP TO Ass. No. 120057**) (F2.05).*

- Support the suspension with the **AV 3206** support tool.

Upper

- Unscrew the screw fastening the upper arm **(A)** to the stub axle.

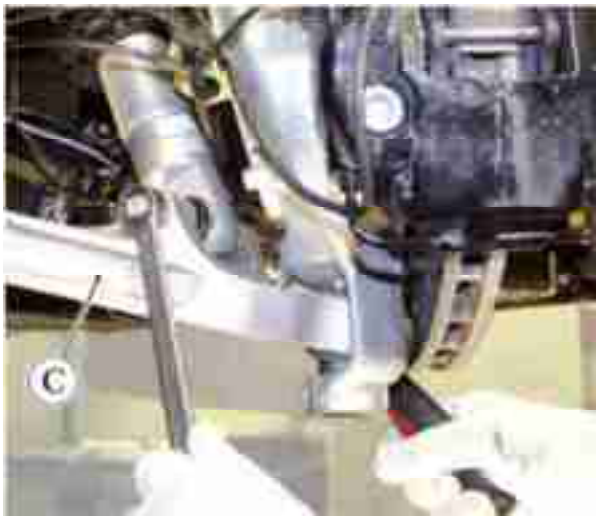
- Unscrew the four nuts **(1)** fastening the upper arm to the chassis.

- Remove the upper arm complete with the flambloc and ball joint

Lower

- Detach the front stabilizer bar ball tie-rod **(B)** from the lower shock absorber fulcrum screw.

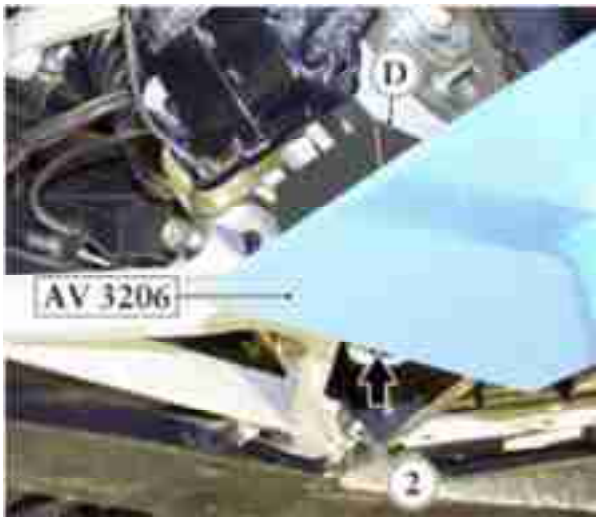
- Unscrew the nut and slide off the shock absorber fulcrum screw on the lower arm **(C)**.



- Unscrew the four nuts **(2)** fastening the lower arm to the chassis.
- Unscrew the screw fastening the lower arm to the stub axle.

NOTES

*To carry out this procedure, a pad **(D)** must be inserted on the support tool, on which to rest the brake disc.*



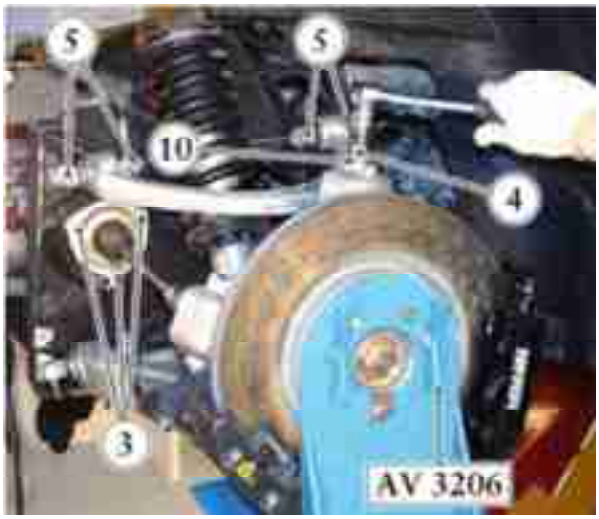
- Slightly move the support tool back in order to make the arm ball joint exit from the axle.
- Record the positions of the camber adjustment shims to permit re-assembly in the same positions.
- Remove the entire lower arm, ensuring that you keep the camber adjustment shims.

Detaching Rear Suspension Arms

- Detach the rear component of the underfloor (M 2.12).
- Detach the axle shaft from the differential flange (D 5.02).
- Detach the toe-in tie-rod by unscrewing the screws **(3)** fastening it to the chassis.
- Support the suspension with the **AV3206** support tool.

Upper

- Unscrew the screw **(4)** fastening the upper arm to the hub-holder.
- Unscrew the four nuts **(5)** fastening the upper arm to the chassis.



- Remove the upper arm complete with flambloc and ball joint.

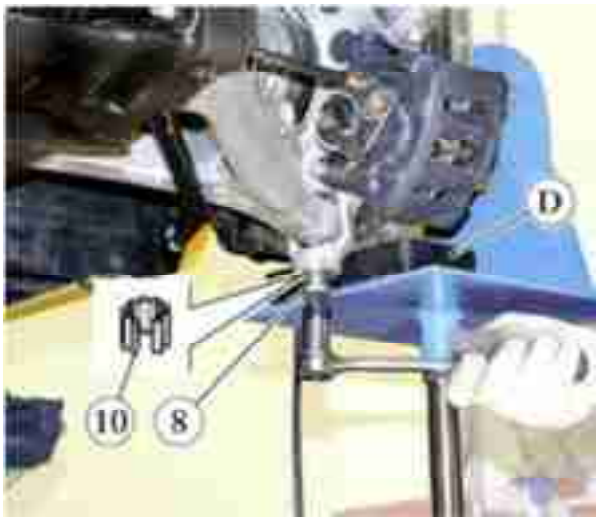
Lower

- Detach the ball tie-rods on both sides of the rear stabilizer bar (F 2.06).
- Unscrew the nuts **(6)** fastening the lower arm to the chassis.
- Unscrew the nut **(7)** on the shock absorber fastening screw and slide that screw out just enough to free the shock absorber from the lower arm.

- Unscrew the screw **(8)** fastening the lower arm to the hub-holder.

NOTES

*To carry out this procedure, a pad **(D)** must be inserted on the support tool, on which to rest the brake disc.*



- While lifting the suspension support, detach the lower arm from the hub-holder.
- Record the positions of the camber adjustment shims to permit re-assembly in the same positions.
- Slide the arm off the chassis, ensuring that you keep the camber adjustment shims and the spacer found between the shock absorber and the lower arm, on the side of the nut.

R -assembly notes

- Lubricate the heads of the screws fastening the stub axle ball joints and hub-holder to the arms and the relative boots with **FIAT MR3 grease**.
- Install the original camber adjustment shims between the lower arm and the chassis.
- The original spacer **(9)** must be inserted when installing the shock absorber on the lower arm.

- Insert a balancing ring **(10)** in each ball joint fastening screw seat.

- Tighten all screws and nuts at the prescribed tightening torque.
- Re-assemble all parts that have been removed for this procedure.

Notes for fitting screws with Molykote coating

If, when refitting the suspension on vehicles **UP TO Ass.ly No. 51427**, equipped with moulded levers, you wish to fit the Molykote-coated screws, you must proceed as follows.

- Carefully clean and degrease the seat of the lever and the lower shock absorber joint.
- Apply a thin layer of **Molykote U-N paste** to the new screw with a paintbrush, in the cylindrical section already sprayed with Molykote, and to the relative lever seat.
- Fit the screw and push it in so it is flush, then fit the other fastening components; on the front suspension, replace the washer and nut **(B)**.
- Tighten the nuts to a new torque of **80 Nm**.

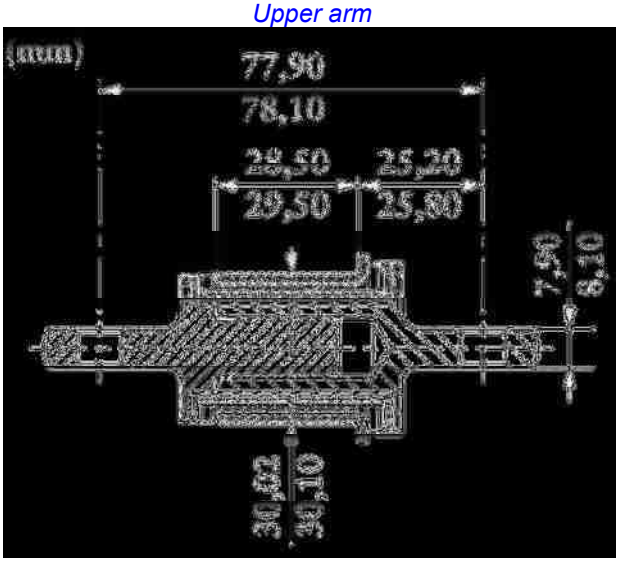
F2.04 FLAMBLOCK - BALL JOINTS

Flamblock

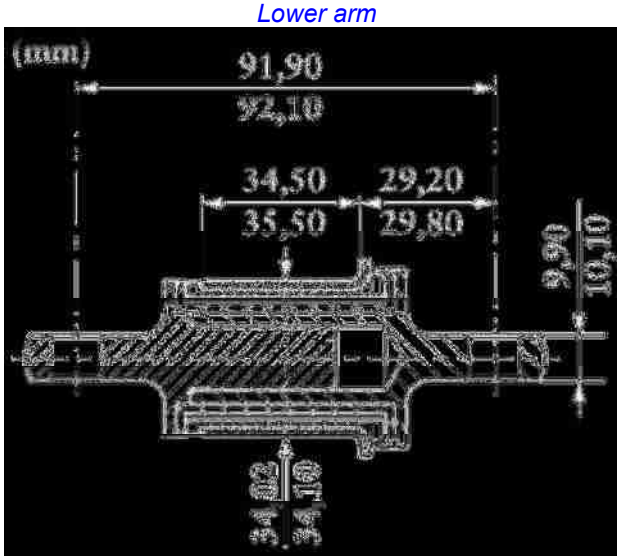
Flamblocs are made up of two metal elements coupled internally in the arm support zone. They are equipped with a stud bolt hole for fastening them to the chassis.

- Manually rotate the internal pins after having disassembled the arm. If they show excessive coupling allowance with the seat, they must be replaced.

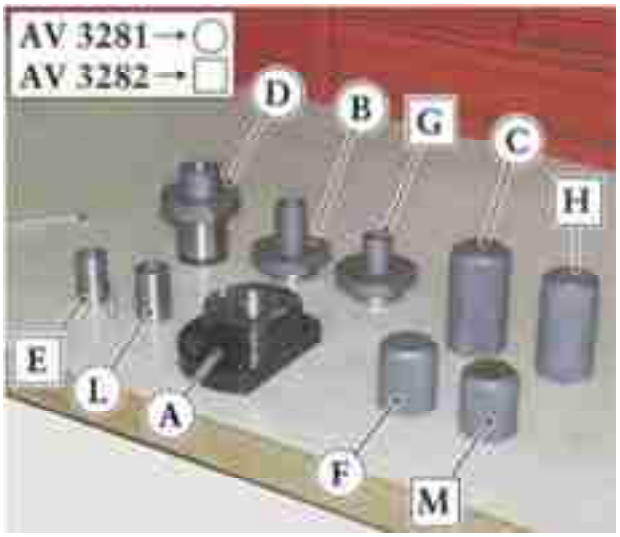
Upper arm



Lower arm



The flamblocks are interference-fitted on the suspension arms. To replace them, use a press and the special tools **AV3281** (parts with **circular reference** mark) and **AV3282** (parts with **square reference** mark).

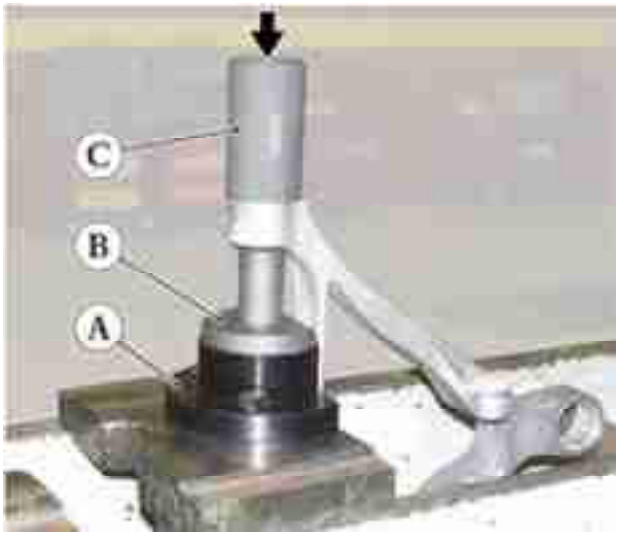


N.B.
The illustrations only show the front arms: the procedures for the rear ones are identical.

Replacing the lower flamblock arm

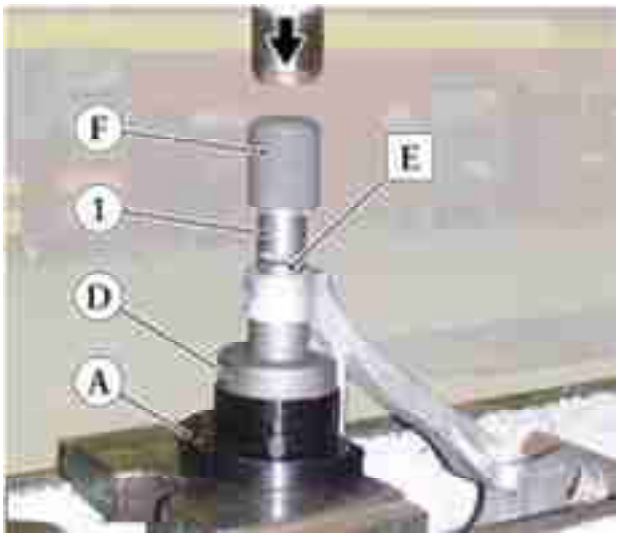
DISASSEMBLY

- Fix the base **(A)** on the press surface and position the tool for disassembling by inserting the flange **(B**, diameter **33 mm)** into the base.
- Rest the punch **(C**, **100 mm** height**)** on the flambock to be removed and operate the press.



ASSEMBLY

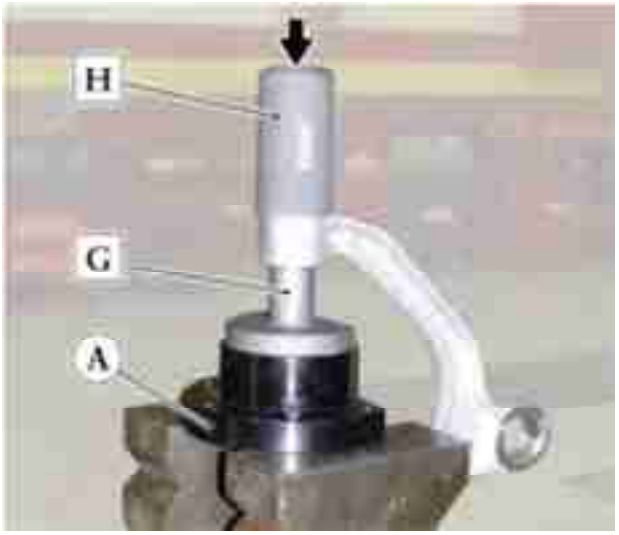
- Position the tool for assembling by using the flange **(D)** with the sliding pin **(E,** diameter **34 mm)**.
- Insert the arm onto the sliding pin **(E)** and position the suitably lubricated flambock **(1)**, with the flange facing outwards.
- Rest the punch **(F,** height **60 mm**) on the new flambock and operate the press until it is fully inserted.



Flamblock upper arm replacement

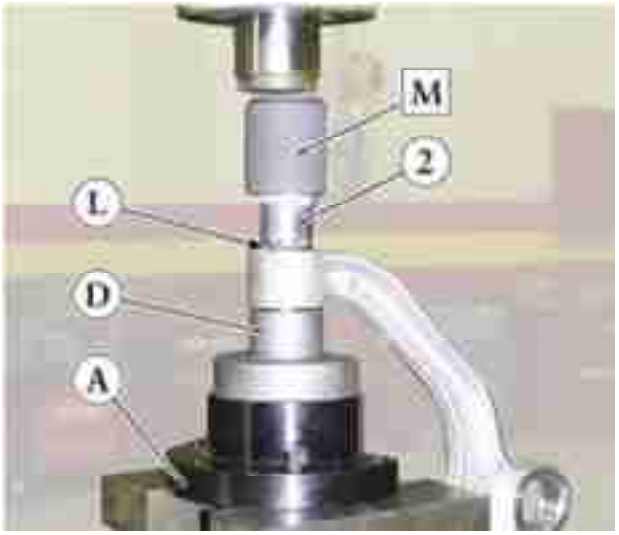
DISASSEMBLY

- Position the tool for disassembling by inserting the flange **(G,** diameter **29 mm)** into the base **(A).**
- Rest the punch **(H,** height **95 mm)** on the flambock to be removed and operate the press.

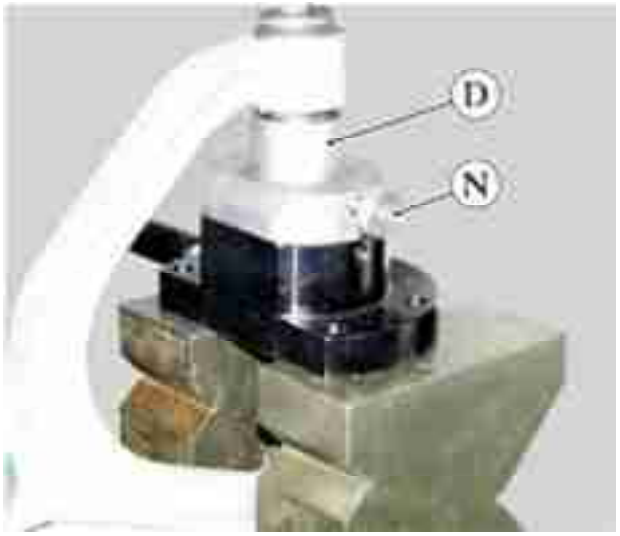


ASSEMBLY

- Position the tool for assembling by using the flange **(D)** with the sliding pin **(L,** diameter **30 mm)**.
- Insert the arm onto the sliding pin **(L)** and position the suitably lubricated flamblock **(2)**, with the flange facing outwards.
- Rest the punch **(M,** height **55 mm)** on the flamblock to be removed and operate the press until it is completely inserted.



- Using the knob **(N)**, lock the sliding pin **(L)** pushed inside the flange **(D)**. This is the only way to remove the arm when the two flambocks have been assembled using the press.

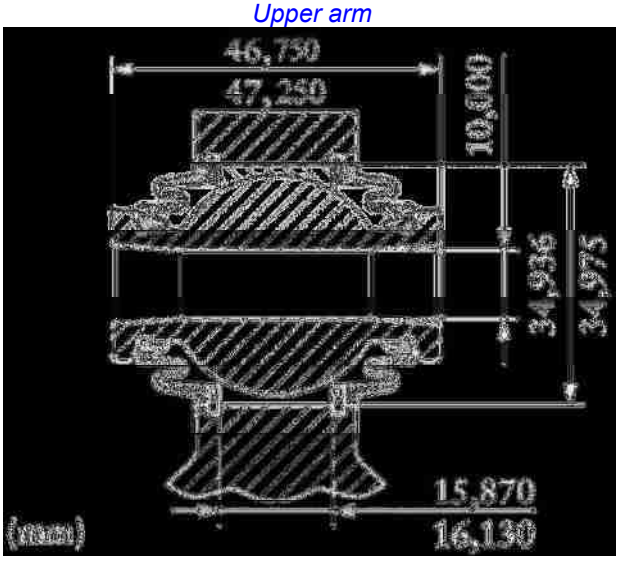


Ball Joints

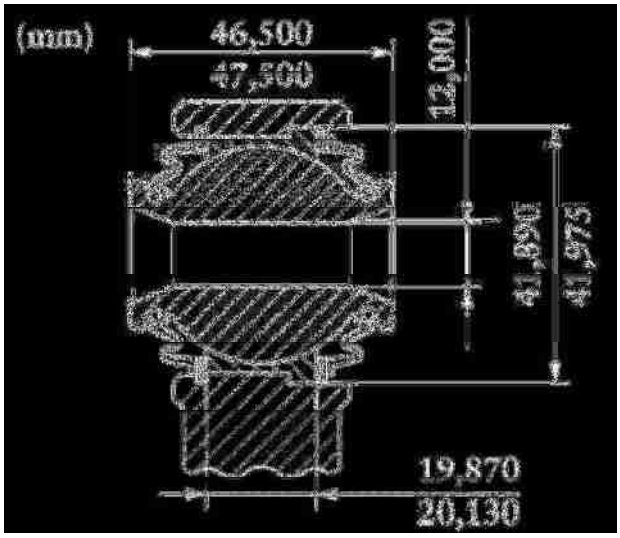
BALL JOINTS ON SUSPENSION LEVERS

The ball joints are fastened to the arms by means of stop rings and they are equipped with special boots that protect the joint from the outside agents and preserve the original lubrication of the surfaces subject to friction.

Upper arm



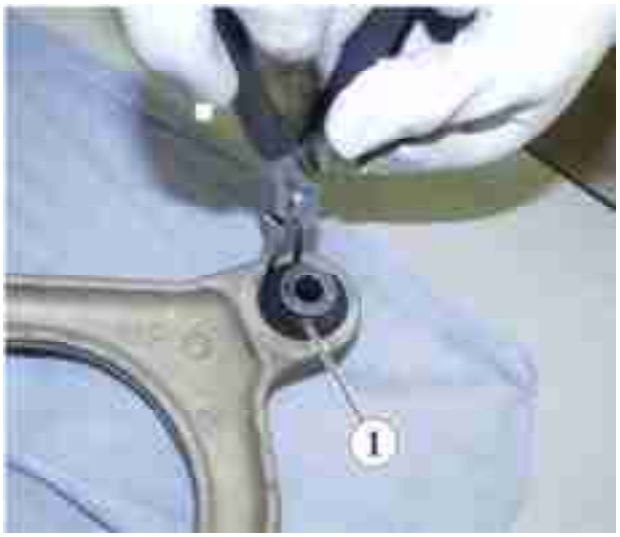
Lower arm



- Test the rotation of the internal component manually: If there is excessive clearance or the rotation is jammed, it must be replaced.
- Check the state of the protective boots. If they are torn or damaged, replace them.

Replacing the ball joint and protection boots

- Remove the boots **(1)**, on the upper lever (2) **and** the lower one, working on both sides of the joint with Seeger pliers.



- Place the lever under the press, resting it on tool **AV 3281** or **AS 10723-07** (for the upper lever) and **AV 3427-14** or **AV 3189** (for the lower lever).
- Position tool **AV 3189** (for the upper lever) or **AV 1651** (for the lower lever), on the joint, then heat the joint area with a hairdryer (40-60 °C) to facilitate removal.

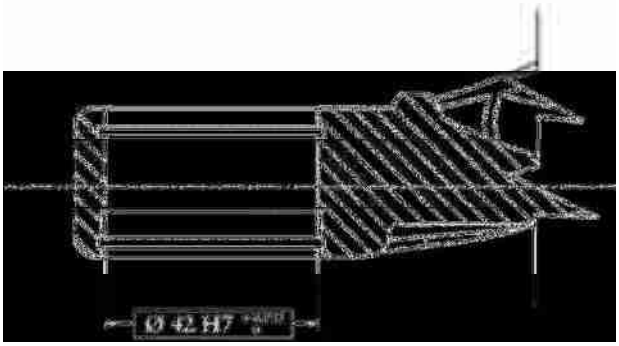
IMPORTANT

*The lower lever must be positioned under the press as shown in **Fig. 1**, as the lever and ball joint have a ledge on the side opposite the shock absorber coupling.*

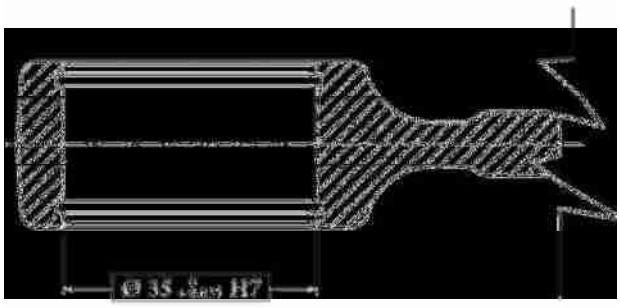
- Make sure it is centred and operate the press until the joint is completely extracted.

- Dip the ball joint seat found on the lever in a pan filled with nitrate diluent, in order to remove any residual adhesive from the housing.
- Leave the lever in the solvent for approx. **3 hours**, then remove all traces of residual adhesive, using a scraper and abrasive steel wool pad.
- After carefully cleaning the joint seat, check the diameter of the joint housing using a gauge or a bore meter and then compare the measurements with those given in **Fig. 2**.
- If the measurements taken do not fall within the tolerance limits, replace the lever.

Leva superiore

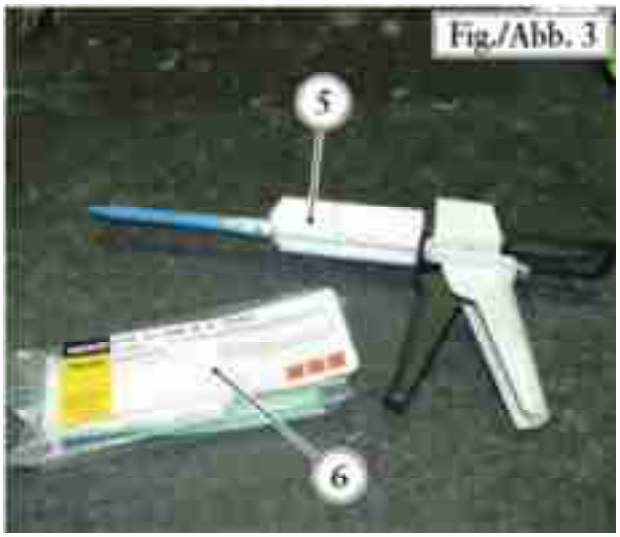


Leva inferiore



- Clean the contact area on the seat and the new joint with isopropilic alcohol.
- After retrieving the stop rings from the original protection boots -**(3)** on the upper lever **and (4)** on the lower one- fit them in the housing on the lever to prevent the adhesive from running into the seats.

- Using an extrusion gun (**5**, **Fig. 3**), apply **LOCTITE Hysol EA 9360 50 ML SEMPAK** (**6** adhesive, code **184241**) to the bristles of a small brush (**Fig. 4**) then, spread it evenly over the external surface of the joint and the seat on the lever.



IMPORTANT
Make sure the adhesive does not corrode the inside of the joint.

- Fit the new joint in the upper lever, after removing the stop rings **(3)** fitted earlier.
- Fit the new joint in the upper lever, after removing the stop rings **(4)** fitted earlier on the side opposite the shock absorber coupling.
- Push the new joint until it is touching the other stop ring, then remove the latter from the lever.

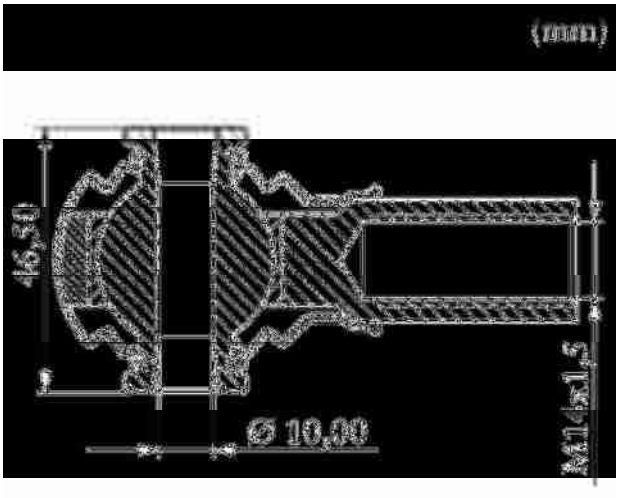
IMPORTANT
Make sure there are no traces of adhesive left inside the stop ring seats.

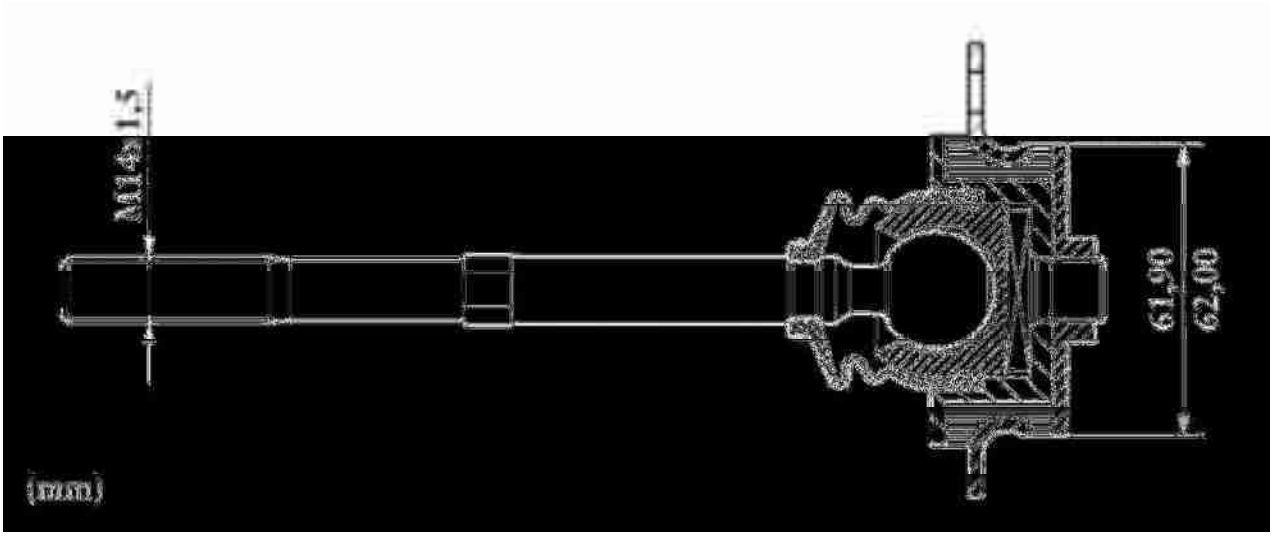
- Apply **FIAT TUTELA Z2** grease inside the new boots equipped with stop rings and fit them in their seats (**Fig. 5**).
- Rotate the stop ring to ensure the ball joint moves and engages correctly.

- Carefully clean the outside of the protection boots to remove any residual grease.
- To prevent infiltrations of water and dirt, we recommend you stop the two holes in the boots for the stop ring engagement with silicon.
- Remove any excess silicon.

IMPORTANT
Before refitting the lever in the vehicle, place it in a stove at 90 °C, for 45 minutes.

BALL JOINT ON REAR TOE-IN TIE-ROD
The rear wheel toe-in adjustment tie-rod has a ball joint with the same characteristics. It is found on the fastening point on the hub-holder. On the side where it is fastened to the chassis, the tie-rod is equipped with a spherical head that operates inside a seat, anchored to the flexible support frame. Said parts cannot be disassembled. If there is excessive clearance, replace the entire tie-rod.





Prior to any re-assembly procedures, clean all joints and the respective boots and then lubricate with **FIAT MR3 grease**.

F2.05 SHOCK ABSORBERS

Tightening torques		Category	Product
Screw fastening shock absorber to lower arm	**60** **80 (**		
Upper shock absorber fastening screw	**50**	**A**	
Shock absorber ring nut	**65**	**B**	
Shock absorber head	**60**	**A**	Thread lock material **OMNIFIT 230M**
Securing the ball tie-rod to the front and rear stabiliser bar	**50**	**B**	

(1) FROM Ass.ly No. 51426

The shock absorbers are double-acting of the hydro-pneumatic type, with electronically controlled variable setting and coaxial to the flexible element (helical spring).
The stop in the compression phase is blocked by a rubber bumper that is coaxial to the rod. The stop in the extension phase is blocked by a flexible pad, inside the shock absorber.
The upper part of the shock absorbers is fitted with flexible bushings of the silentbloc type, with an integrated support for fastening them to the chassis. In the case of replacement of these bushings, they must be installed on the shock absorber with the prescribed camber **(G)**. This system has been adopted in order to improve operating noise level and wear of the bushings.

Shock Absorber	*Tilting (G)*
Front	**28°45' ±1°**
Rear	**26°1 ' ±1°**

On vehicles **FROM Ass. No. 120058**, the upper rubber bushings for the front and rear shock absorbers are fastened directly onto the chassis cast, thereby eliminating the removable mounting used on previous models.

Rear

Front

The lower part of the shock absorbers is fitted with special composite joints that are capable of rotating on the fulcrum axis.

The shock absorbers have three setting levels, which correspond to the different supply currents **(Amp)** (F 4.02).

Spring

The front and rear shock absorbers are originally fitted with springs of the same size category. Springs are available in the three size categories based on the test load allowance. Each one is identified by a colour marked on a coil.

Ll Free length
Ld Length with dynamic load
Cs Static load
Df Wire diameter
Ls Length with static load
De Spring outer diameter
Cd Dynamic load
φm Flexibility

		Front	*Rear*
Part no.		**190676**	**190677**
	(mm)	**240**	**245**
Cs	(kg)	**462,50$^{\pm 13,88}$**	**639,0$^{\pm 19,0}$**
L	(mm)	**159,9**	**185,2**
Cd	(kg)	**713,0**	**1100**
L	(mm)	**115,9**	**142,2**
Df	(mm)	**12,0**	**14,25**
	(mm)	**94,1$^{\pm 0,94}$**	**98,4$^{\pm 0,98}$**
φm	(mm/kg)	**0,1740$^{\pm 0,0052}$**	**0,0935$^{\pm 0,0027}$**

C

Colour categories		*Front*	*Rear*
Yellow	g)	**448,62÷457,9**	**619,83÷632,6**
White (no colour)	g)	**457,9÷467,1**	**632,6÷645,4**
Red	g)	**467,1÷476,38**	**645,4÷658,17**

Shock Absorber Length Adjustment

The height **(L)**, from the washer to the lower fulcrum axis, must be adjusted on the basis of the size category of the spring assembled (see table).

Front Shock Absorber

		Spring	
gories	Yellow	White (no colour)	Red
L(mm)	**149,2÷150,2**	**147,7÷148,7**	**146,2÷147,2**

Rear shock absorber

		S ring	
Colour categories	Yellow	White (no colour)	Red
L(mm)	**172,8÷173,8**	**171,7÷172,7**	**170,6÷171,6**

- Loosen the ring nut **(A)** locking the washer, using a standard pin wrench.
- Tighten or unscrew the spring rest washer **(B)** until reaching the height **(L)**.
- Keep the washer locked in this position and tighten the ring nut to the prescribed torque.

Detaching the Shock Absorber

- Remove the supporting bracket **(1)** and detach the shock absorber connection.

For connection to the system, see Table **A** and **L** - ELECTRICAL SYSTEM.

- Unscrew the upper screws **(2)** fastening the shock absorber to the chassis.

- Detach the ball tie-rod from the fulcrum screw fastening the shock absorber to the lower arm.
- Unscrew the fastening nut and slide off the lower shock absorber fulcrum screw on the lower arm.

- Remove the shock absorber.

Rear

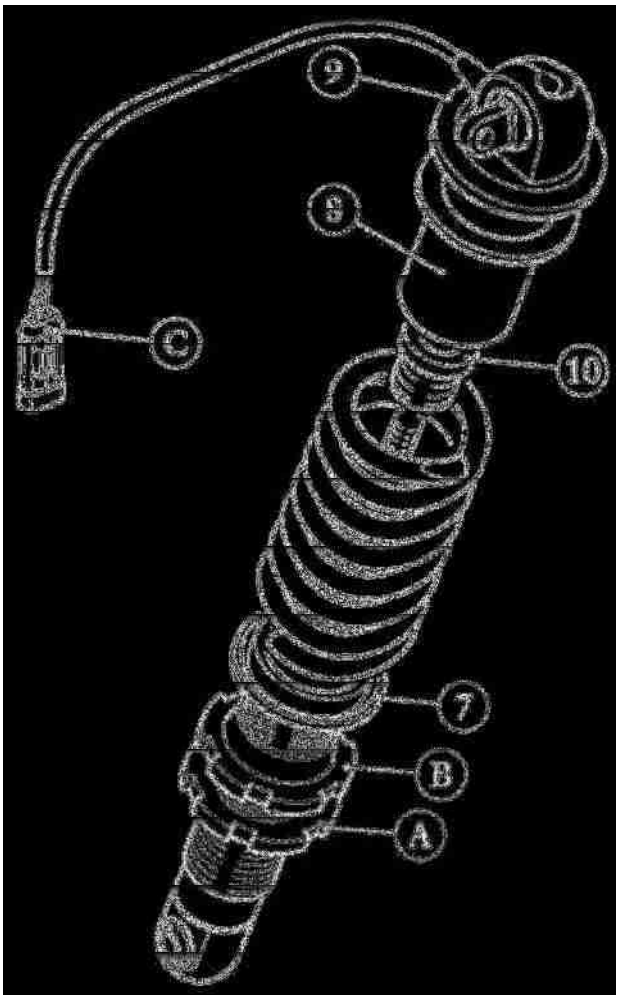
- Remove the front part of the gravel guard (M 2.05).
- Remove the support bracket **(3)** and detach the shock absorber connection.
- Unscrew the upper screws **(4)** fastening the shock absorber to the chassis.

- Unscrew the fastening nut **(5)** and slide off the lower shock absorber fulcrum screw on the lower arm.
- Remove the shock absorber and remember to keep the spacer **(6)**.

Disassembly of Spring Support Parts

Replacement of spring supporting parts is possible for all shock absorbers. Proceed as follows for this procedure.

- Remove the connector **(C)** from the shock absorber connecting cable.
- Remove the ring nut **(A)**, the washer **(B)**, the lower spacer **(7)**, the spring and the upper spacer **(8)**.
- Lock the stem in a vice, using the **AV3304**'s jaws.
- Unscrew the head **(9)** of the shock absorber, using **AV3304**'s hub, and slide it out of the cable which connects it to the system.
- Slide off the stop pad **(10)**.



Re-assembly notes

- When re-assembling the shock absorber head **(9)** onto the stem, use the specified thread-lock material on the threading and tighten the head to the prescribed torque using the **AV3304**'s hub together with a torque wrench.

- When installing the rear shock absorber on the lower arm, the original spacer **(6)** must be inserted, positioning it between the shock absorber and the hub-holder, on the side of the nut.

- Tighten the screws and lock nuts to the prescribed torque.

To prevent excessive suspension noise, which may occur if the vehicle travels on loose ground or paving, **FROM vehicle Ass.ly No. 51428** fastening screws have been introduced for the shock absorber on the suspension lever, which are sprayed with Molykote product in the area where it is coupled to the lever, and the tightening torque has been increased (from 60 to **80 Nm**).

For the use of these screws (F 2.03).

- Re-assemble all parts removed previously for this procedure.

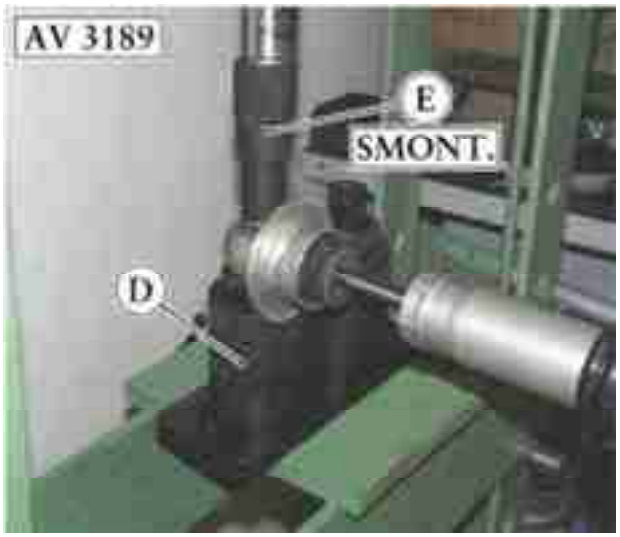
Replacing the upper flexible bushing

For disassembly and re-assembly of the flexible bushing it is necessary to use a press, along with the **AV 3189** tool.

- In order to remove the worn bushing, rest the head of the shock-absorber on the base's support cable **(D)** and use the punch **(E)** as a rest for the press.

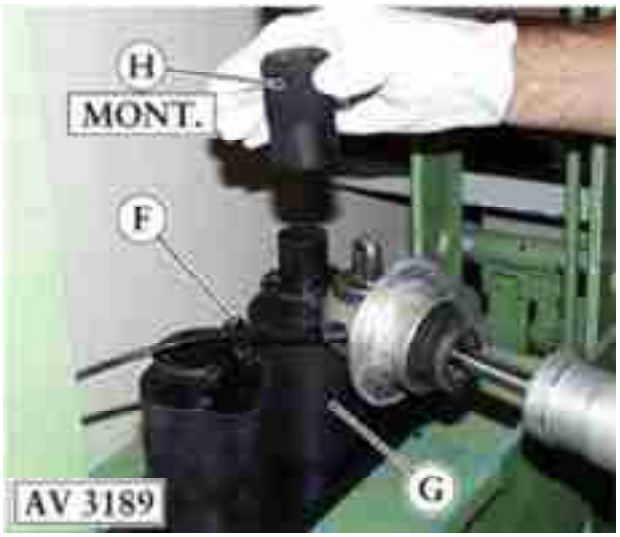
IMPORTANT

Position the shock-absorber's housing horizontally in respect of the press's axis, in order to avoid damaging the bushing's seat. Support it adequately.

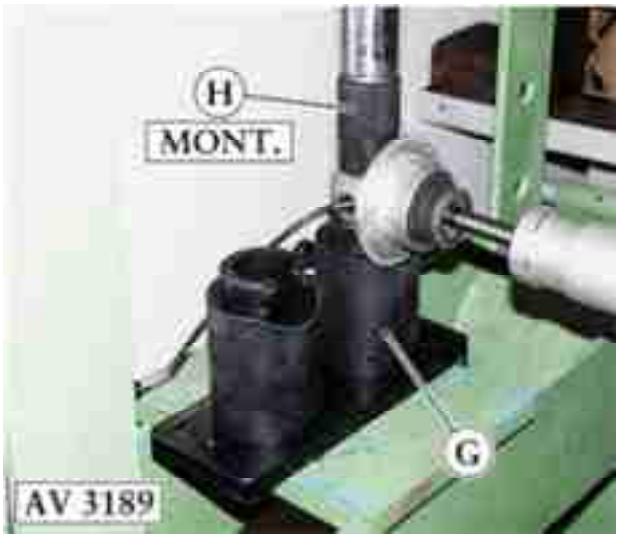


The positioning of the flexible bushing in respect of the seat determines the shock-absorber's assembly position (right or left-hand side).

- Un-lock the knob **(F)** and turn the support's central pin **(G)** to obtain the desired positioning; lock the knob.



- Place the shock-absorber's head on the support **(G)** and the bushing in the central pin's notch.
- Rest the punch **(H)** on the bushing and start-up the press.



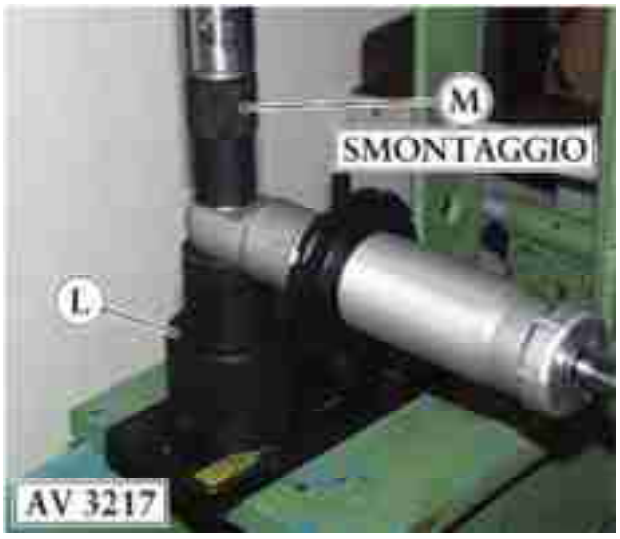
Replacing the lower joint

For disassembling and re-assembling the joints, the **AV 3217** tool must be used in addition to the press.

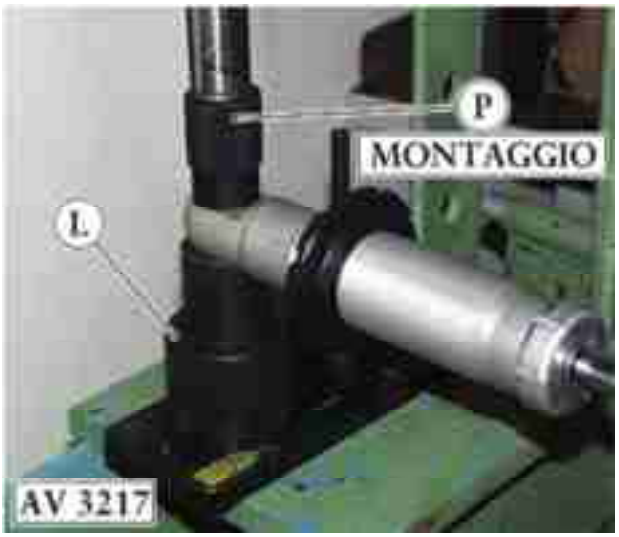
- To remove the worn joint, position the shock-absorber's housing on the base's support **(L)** and use the punch **(M)** as a rest for the press.

IMPORTANT

Position the shock-absorber's housing horizontally in respect of the press's axis, in order to avoid damaging the joint's seat. Support it adequately.



- When assembling the new joint position the shock-absorber's head on the support **(L).**
- Insert the joint in the tool's central pin and use the punch **(P)** as a rest for the press.
- Start-up the press.



F2.06 STABILIZER BARS

Tightening torques		Nm	Category	Product
Screw fastenin	pport	**25**	**B**	
Screw fastenin		**35**	**B**	
Ball tie-rod to bar		**50**	**B**	
Nut fastenin	rear shock absorber to lower arm	**6**		
Nut fastenin	rear shock absorber to lower lever **(**			**Molykote U-N** Paste

(1) FROM vehicle Ass.ly No. 51428

The front stabilizer bar consists of one piece, supported on the chassis by two removable supports equipped with a flexible pad.
The rear bar is made up of a steel part with a curved tip, which is inserted from the right-hand side in the lower chassis connecting cross member, and connected on the left-hand side, to an aluminium alloy arm. The flexible pads supporting the rear bar are fitted directly on the chassis.
Both bars are constrained to the lower suspension system arms by means of ball tie-rods.

Bar Disassembly

Front
- Detach the stabilizer bar from the ball tie-rods.
- Unscrew the screws **(1)** fastening the supports to the chassis.

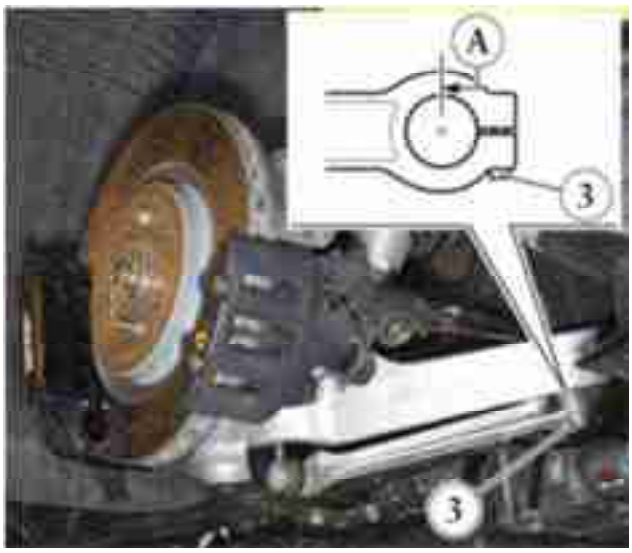
- Slide the bar, complete with supports, off of the car.

NOTES
It advisable to remove the rear panel of the luggage compartment (M 3.06) to avoid damaging the parts that could

Rear

- Detach the bar and the arm from the ball tie-rods, unscrewing the fastening nut **(2)**.

- Before proceeding with disassembly, the two bar elements on the left-hand side must be marked (see References **A**) in order to position them properly when re-assembling.
- Unscrew and remove the screw **(3)** fastening the arm on the end of the bar.



- Apply the **AV 3206** tool on the left-hand brake disc in order to support the suspension.
- Unscrew the nut **(4)**.
- Slide out the lower fulcrum screw as needed to detach the shock absorber from the lower arm. Keep the spacer **(5)**.

- Lift the suspension using the tool and slide out the bar arm.
- Slide the rear stabilizer bar out from the right-hand side.
- Slide the flexible support pads off of the chassis.

Re-Assembly Notes

Front

- The front bar must be positioned with the folded ends facing upwards. **(see red, B sticker)**.

- Tighten the screws **(1)** and the ball tie-rods at the prescribed tightening torque.

Rear

- Insert the bar from the right-hand side and connect the arm on the end, matching the marks **(A)**.
- Tighten the arm fastening screw **(3)** to the prescribed torque.

- Re-assemble the shock absorber on the lower arm, inserting the spacer **(5)** on the rear side between the shock absorber and the support on the arm.

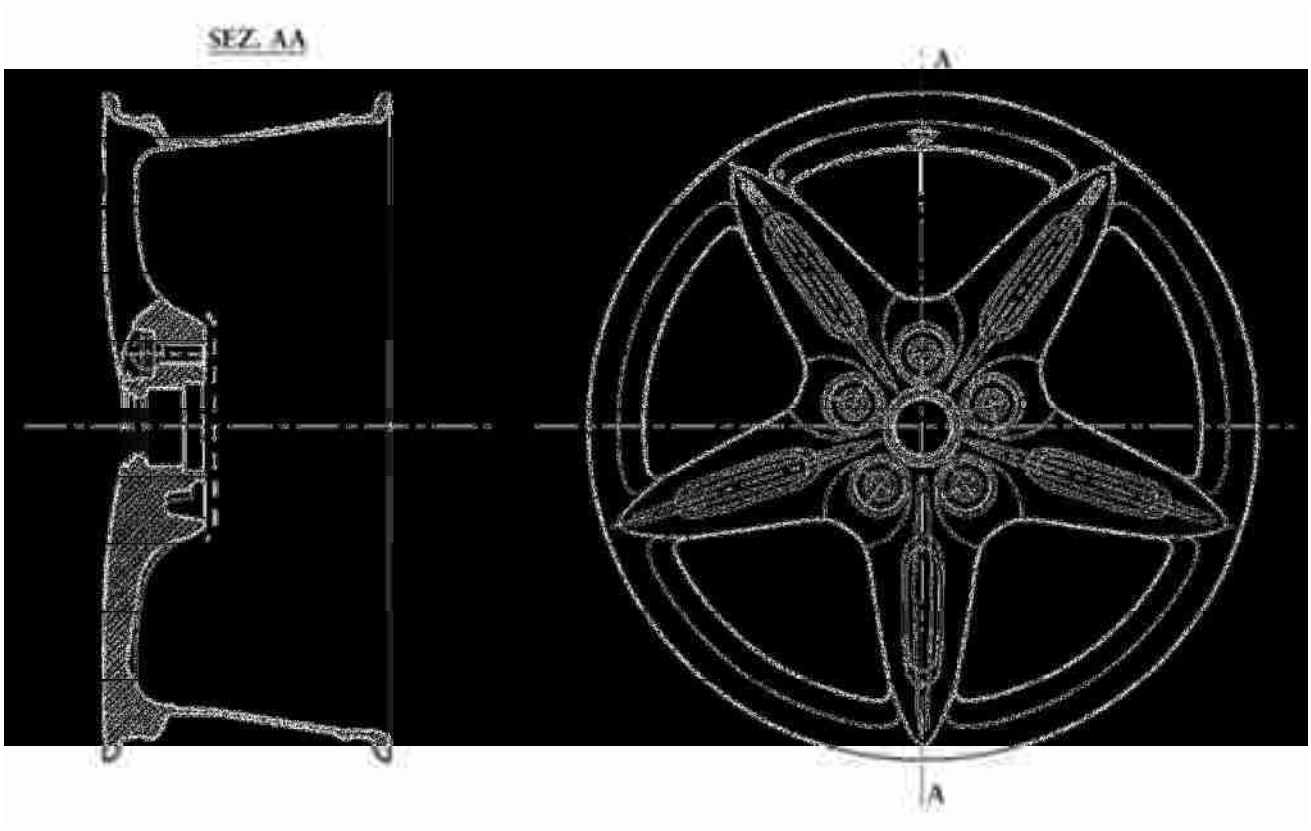
To prevent excessive suspension noise, which may occur if the vehicle travels on loose ground or paving, **FROM vehicle Ass.ly No. 51428** fastening screws have been introduced for the shock absorber on the suspension lever, which are sprayed with Molykote product in the area where it is coupled to the lever, and the tightening torque has been increased (from 60 to **80 Nm**).

For the use of these screws (F 2.03).

- Tighten the nut **(4)** to the prescribed torque.

- Tighten the ball tie-rods to the p ue.

F2.07 WHEEL RIMS



Check the state of the wheel rims when carrying out periodical maintenance work, or when tyres are being changed.
Visually check the outer and inner surfaces of the rim. Rims must be replaced if cracks or deep grooves are present.
To remove stains, scaling and traces of tar, clean without using aggressive products and metallic brushes which could mark the surface, thereby damaging the external protective layer.
Protect the stud bolt seats while cleaning in order to avoid removing the anti-seizure material originally applied to the rim
It is absolutely forbidden to alter the wheel rim dimensions by removing and/or building up the material.

CAUTION
The rim cannot be repainted.

The brake disc coupling surfaces require special attention. In this area, the cataphoretic layer is the only treatment present. This paint does not last long as the film tends to disappear over time, due to the micro-movements (fretting) to which the surfaces are subjected. This zone cannot be re-painted and the rims presenting such defects must be replaced.

In any case, prior to each re-assembly job, ensure that the rim and brake disc coupling surfaces are perfectly clean.

IMPORTANT

The use of equipment that is unsuited to disassembly and re-assembly can result in damage to the rim, impairing the protective layer.

Balance the rim, without the tyre. If the static grams exceed **36** after having removed the balancing counterweights (including those for bumps and side-skids), the rim must be replaced.

F2.08 TYRES

Check the state of the wheels when carrying out periodical maintenance work.

- Check tyre pressure. Tyre pressure should be checked when the tyres are cool and it should match the prescribed pressure levels.

CAUTION

Pressure increases with increases in tyre temperature. Insufficient pressure can lead to overheating of tyres, seriously affecting driving and possibly damaging the tyres.

Never reduce the pressure of a tyre that has been checked when warm.

- Check the tyres for signs of damage (e.g. scratches, cuts, cracks, bulges, etc.). Impact against kerbs, holes and obstacles of varying nature, as well as long trips on rough roads, can cause tyre damage that may not be visible to the naked eye. Foreign objects that have penetrated the tyres in these situations, may cause damage that can be detected only by removing the tyre from the wheel rim.

CAUTION

Carefully examine the severity of the damage as such damage may seriously limit the life of the tyre and cause serious accidents.

- Tyres will deteriorate with age even if the car is used infrequently or not at all. Cracks in the tread and side-walls, possibly accompanied by bulging, are signs of ageing.

CAUTION

Avoid fitting tyres showing these defects. If the same tyres have been on your car for over 3 years, always check them carefully for signs of ageing.

- Check the depth of the tyre tread. (Minimum allowed: **1.7 mm**, which can be checked by the wear limit identification marks.
- Check the entire tread surface for wear. If any deformity is found in the tread depth, carry out static and dynamic balancing of the wheel (F 3.07).

CAUTION

Avoid fitting tyres that show even just one area with a tread depth below the prescribed limit.

- Always change any tyres that have been punctured and/or inflated using the tyre repair spray bottle supplied with the car. Repairs on punctured tyres are not advised for safety reasons.

Changing and Breaking in Tyres

The tyres are of the "unidirectional" type and bear an arrow on the side to indicate the rolling direction. In the event of a tyre being changed, to maintain optimal performance, the rolling direction must match that indicated by the arrow.
To obtain the best performance from the new tyres, you should comply with the following recommendations for the **first 500 km (310 miles)**:

- do not drive at the maximum speed limit;
- turn corners at a slow speed;
- avoid sharp steering manoeuvres;
- avoid sudden acceleration;

Tire quality grade (US version)

All passenger car tires must conform to Federal Safety requirements, in addition to these grades.

DOT Quality Grades

Tires type	*Tread wear*	*Traction*	*Temperature*
Good Year Eagle F1 GS Fiorano	**—**	**—**	**—**
Pirelli P Zero	**—**	**—**	**—**
Bridgestone Potenza S02A	**140**	**A**	**A**
Michelin Pilot Sport	**220**	**AA**	**A**

Treadwear

The treadwear grade is a comparative rating based on the wear rate of the tire when tested under controlled conditions on a specified government test course.
For example, a tire graded 150 would wear one and one-half (1 1/2) times as well on the government course as a tire graded 100.
The relative performance of tires depends upon the actual conditions of their use, however, and may depart significantly from the norm due to variations in driving habits, service practices and differences in road characteristics and climate.

Traction

The traction grades, from highest to lowest, are **"AA"**, **"A"**, **"B"**, and **"C"**. Those grades represent the tire's ability to stop on wet pavement as measured under controlled conditions on specified government test surfaces of asphalt and concrete. A tire marked **"C"** have poor traction performance.

CAUTION

The traction grade assigned to this tire is based on straight-ashead braking traction tests, and does not include acceleration, cornering, hydroplaning, or peak traction characteristics.

Temperature

The temperature grades are **"A"** (the highest), **"B"**, and **"C"**, representing the tire's resistance to the generation of heat and its ability to dissipate heat when tested under controlled conditions on a specified indoor laboratory test wheel. Sustained high temperature can cause the material of the tire to degenerate and reduce tire life, and excessive temperature can lead to sudden tire failure. The grade **"C"** corresponds to a level of performance which all passenger car tires must meet under the Federal Motor Safety Standard No. 109. Grades **"B"** and **"A"** represent higher levels of performance on the laboratory test wheel than the minimum required by law.

CAUTION

The temperature grade for this tire is established for a tire that is properly inflated and not overloaded. Excessive speed, under-inflation, or excessive loading, either separately or in combination, can cause heat buildup and possible tire failure.

F3.01 DETACHING THE ENTIRE FRONT SUSPENSION

Tightening Torques

Nut fastening upper shock absorber	**50 Nm**
Nut fastening upper arm to chassis	**25 Nm**
Nut fastening lower arm to chassis	**55 Nm**

NOTES

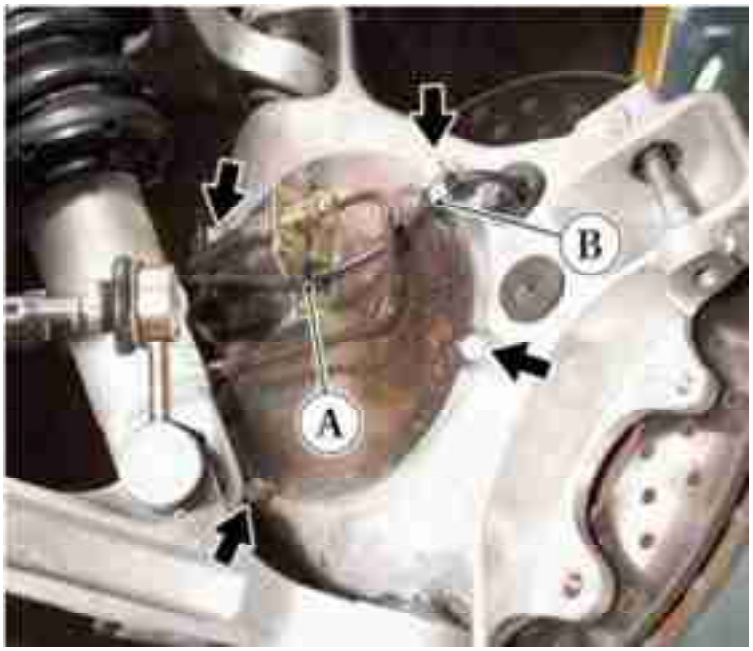
This procedure describes how to detach and re-attach the entire suspension from or to the chassis. This procedure is necessary for example, for chassis inspections.
See the specific chapters for information on removing the individual suspension parts.

Preliminary Operations

- Remove the front wheels (F 3.06).
- Detach the brake caliper from the stub axle, leaving it connected to the system (G 3.01).
- Detach the ball tie-rod from the stabilizer bar (F2.06).
- Detach the ball joint of the steering tie-rod from the stub axle (E2.02).

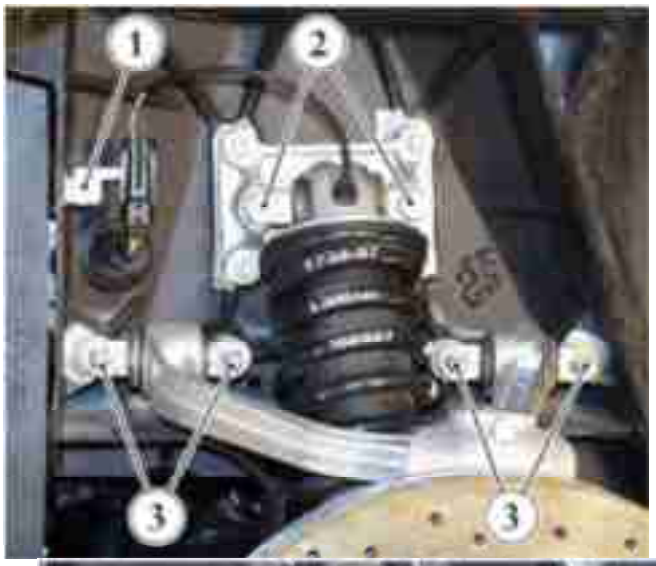
Detaching

- To avoid having to detach the brake pipe from the caliper, the cover must be removed from the stub axle by unscrewing the fastening screws.
- Detach the ABS sensor core hitch **(A)** from the bracket on the cover and leave the latter constrained to the brake pipe.

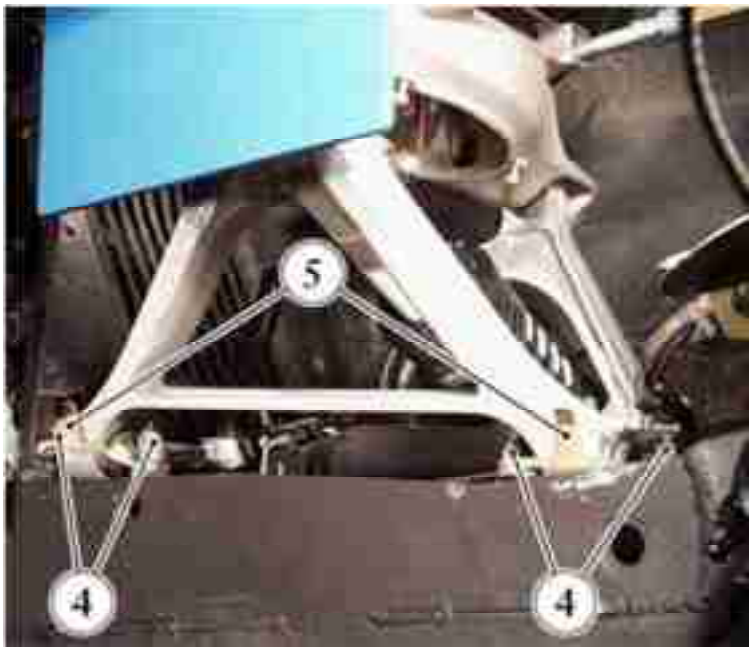


- Disconnect the ABS sensor connection.
- Install the **AV3206** suspension support tool.

- Remove the support bracket **(1)** and disconnect the shock absorber connection.
- Unscrew the upper screws **(2)** fastening the shock absorber to the support.
- Unscrew the nuts **(3)** fastening the upper arm to the chassis.



- Unscrew the nuts **(4)** fastening the lower arm to the chassis.

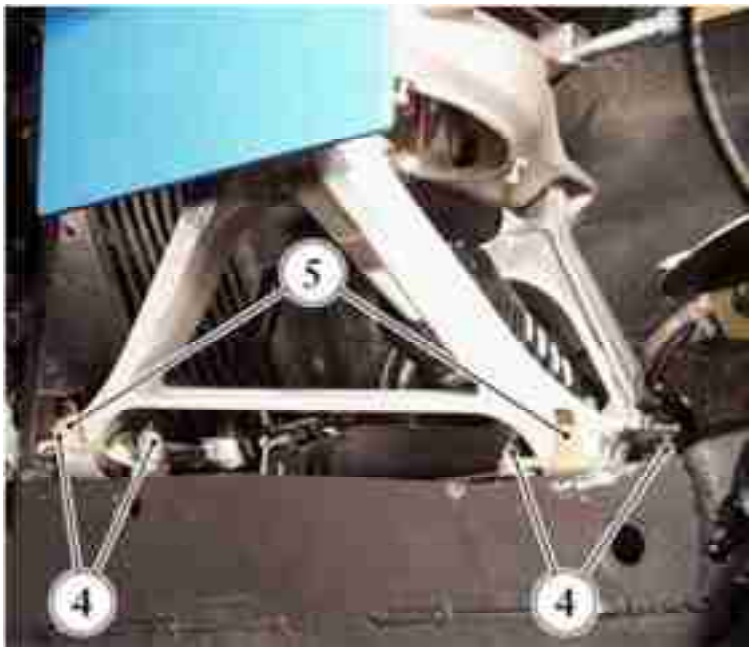


- Record the positions of the washers and of the camber adjustment shims in order to re-fit them later in the same positions.
- Remove the entire suspension from the chassis, making sure to keep the washers and camber adjustment shims.

Re-attaching

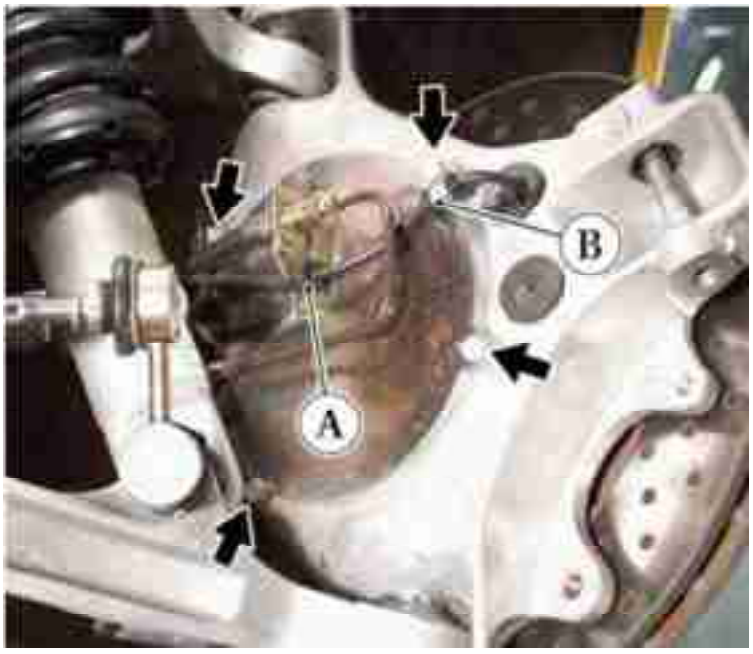
- Install the original washers on the upper arm fastening stud bolts.
- Position the upper arm and the fastening nuts **(3)**.

- Insert the camber adjustment shims **(5)** on the lower stud bolts.
- Position the lower arm and the fastening nuts **(4)**.



- Secure the upper part of the shock absorber to the support wuith the screws **(2)**.
- Tighten the screws and the nuts to the prescribed torque, in the following order: shock absorber, upper arm and lower arm.

- Re-fit the stub axle cover, positioning the core hitch **(A)** and the support clamp **(B)** for the ABS sensor cable.



- Proceed by making the connections between the shock absorber and the ABS sensor.

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.

- Re-assemble all parts that have been detached or removed.

F3.02 DETACHING THE ENTIRE REAR SUSPENSION

Tightening Torques

Ball tie-rod fastening screw	**50 Nm**
Nut fastening upper shock absorber	**50 Nm**
Nut fastening upper arm to the chassis	**25 Nm**
Nut fastening lower arm to the chassis	**60 Nm**

NOTES

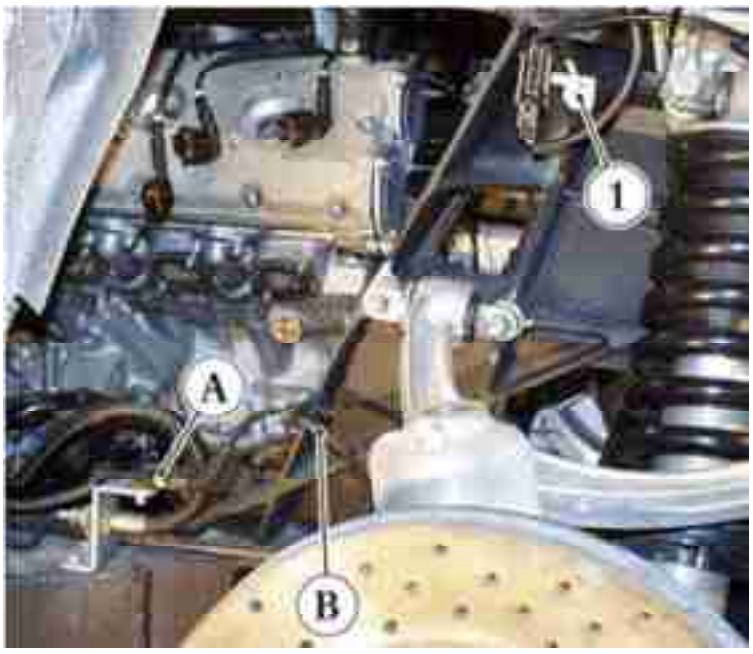
This procedure describes how to detach and re-attach the entire suspension from or to the chassis. This procedure is necessary for example, for chassis inspections.
See the specific chapters for information on removing the individual suspension parts.

Preliminary Procedures

- Remove the rear wheels (F 3.06).
- Detach the rear component of the underfloor (M 2.12).
- Detach the rear gravel guard (M 2.05).
- Detach the brake caliper from the hub-holder, leaving it connected to the system (G 3.01).
- Detach the parking brake caliper from the hub-holder, leaving it connected to the control cable (G 3.04).
- Detach the axle shaft from the differential flange (D 5.02).

Detaching

- Detach the ABS sensor connector **(A)** and free the core hitch **(B)** from the fastening on the chassis.
- Remove the support bracket **(1)** and disconnect the shock absorber connection.



- Detach the ball tie-rod from the stabilizer bar by unscrewing the fastening nut **(2)**.

- Install the **AV3206** suspension support tool.

- Unscrew the upper screws **(3)** fastening the shock absorber to the support.
- Unscrew the nuts **(4)** fastening the upper arm to the chassis.

- Working from underneath the car, unscrew the nuts **(5)** fastening the lower arm to the chassis.

- Record the positions of the washers and the camber adjustment shims in order to re-fit them later in the same positions.
- Remove the entire suspension from the chassis, making sure to keep the washers and camber adjustment shims.

Re-attaching

- Install the original washers on the upper arm fastening stud bolts.
- Position the upper arm and the fastening nuts **(4)**.

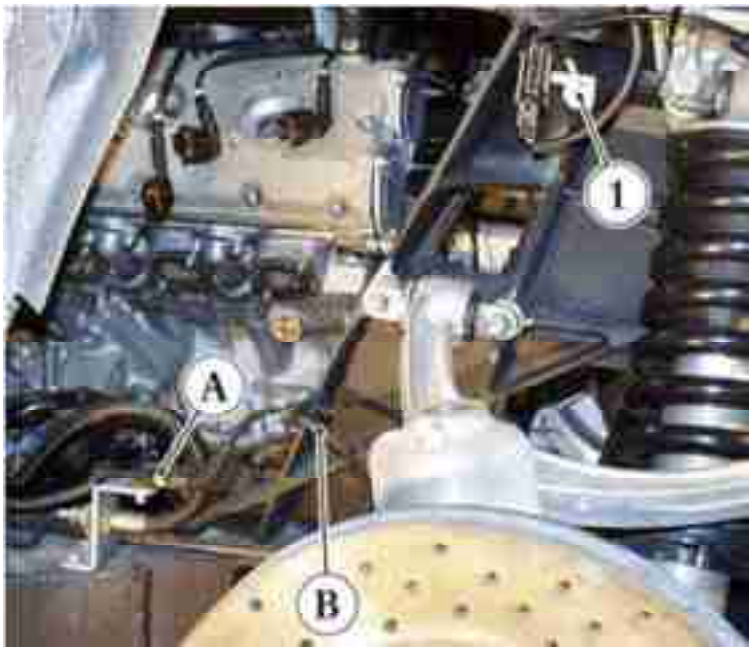
- Position the lower arm, inserting the fastening screws in the chassis seats.
- Insert the camber adjustment shims on the lower arm fastening screws from the lower chassis holes. Position the shim horizontally on the front screw of the rear attachment.
- Position the stop nuts **(5)**.

- Secure the upper part of the shock absorber to the support wuith the screws **(3)**.

- Tighten the screws and the nuts to the prescribed torque, in the following order: shock absorber, upper arm and lower arm.
- Assemble the ball tie-rod on the stabilizer bar, tightening the nut **(2)** to the prescribed torque.

- Position the ABS sensor core hitch **(B)** on the chassis bracket and link the connector **(A)**.
- Fit the support bracket **(1)** for the shock absorber cable connector and link it.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.



- Re-assemble all parts that have been detached or removed.

F3.03 REPLACING THE FRONT WHEEL BEARING

Tightening Torque		Product
Central pin nut	**275 Nm**	**TUTELA Z2**
Bearing fastening screw	**65÷75 Nm**	
Upper arm fastening screw	**65 Nm**	**TUTELA Z2**
Lower arm fastening screw	**85 Nm**	**TUTELA Z2**

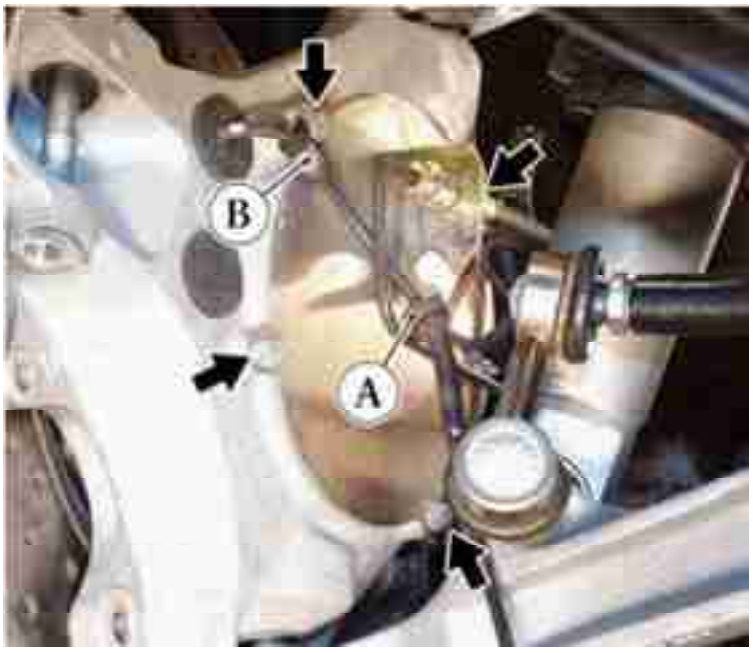
NOTES
The operating clearance should be checked with the bearing assembled (F 2.02).

Preliminary Procedures

- Remove the front wheel (F 3.06).
- Detach the ball joint of the steering tie-rod from the stub axle (E 2.02).
- Detach the brake caliper from the stub axle, leaving it connected to the system (G 3.01).

NOTES
*To avoid having to detach the brake pipe from the caliper, the cover must be removed from the stub axle by unscrewing the four screws, one of which fastens the ABS sensor cable support clamp **(B)**.*

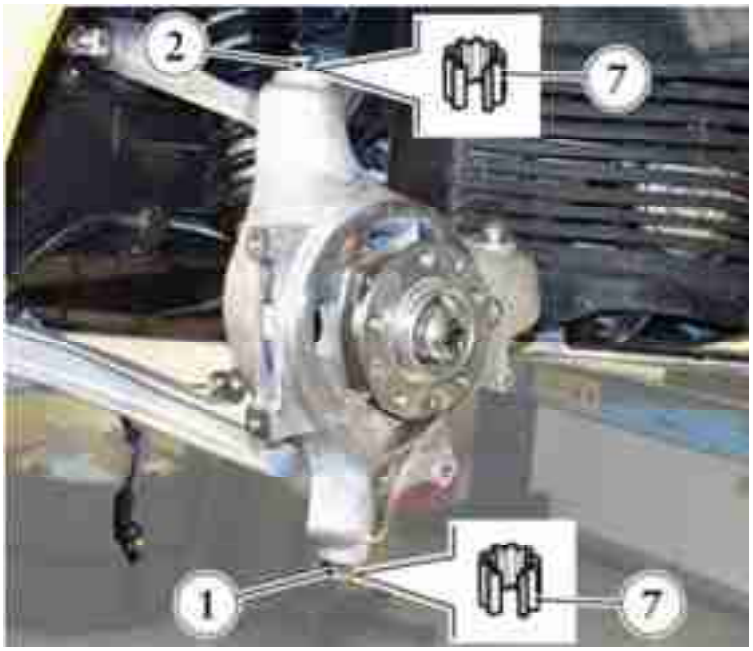
- Detach the ABS sensor core hitch **(A)** from the bracket on the cover and leave the latter constrained to the brake pipe.



- Disconnect the ABS sensor connection.
- Detach the brake disc from the bearing (G 2.05).

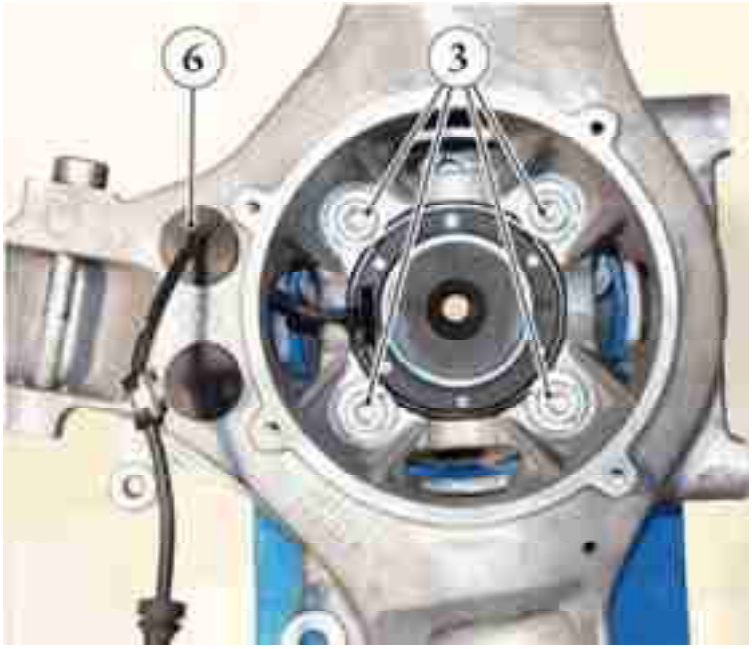
Disassembly

- Detach the lower suspension arm from the stub axle by unscrewing the screw **(1)**.
- Detach the upper suspension arm from the stub axle by unscrewing the screw **(2)**.



- Remove the stub axle together with the bearing.
- Secure the stub axle with bearing to the **AV 3206** support tool. Free the nut on the central pin from the calking.
- Unscrew the nut and slide the central pin off the bearing.

- Unscrew the screws **(3)** fastening the bearing to the stub axle.

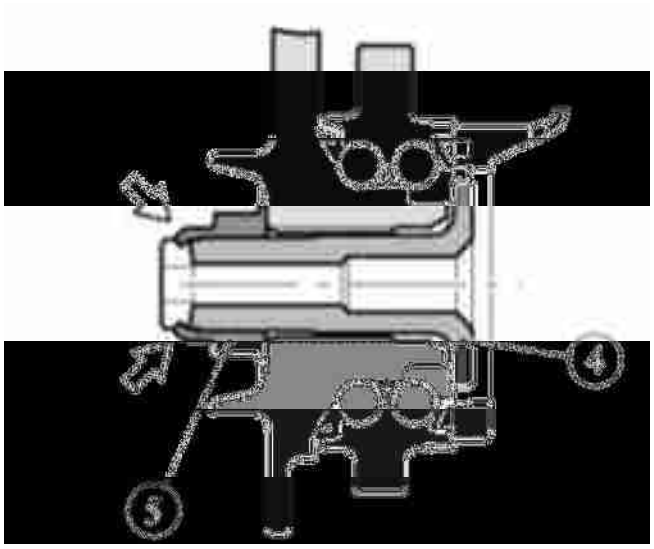


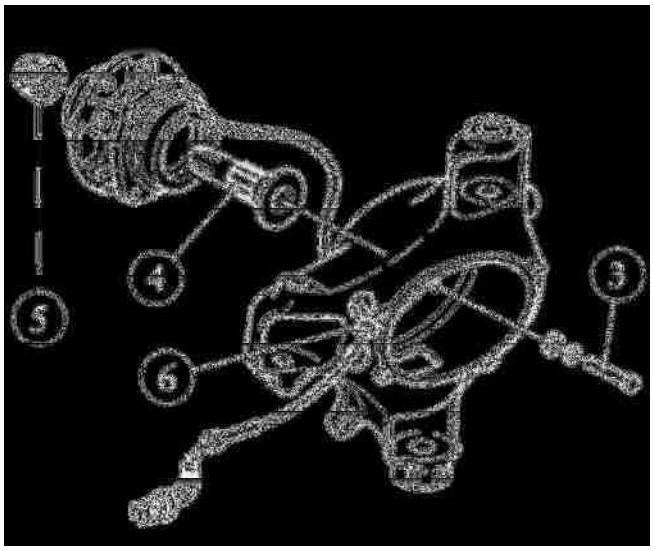
- Remove the stub axle from the bearing.
- Detach the bearing from the support tool and proceed by replacing it.

Re-assembly

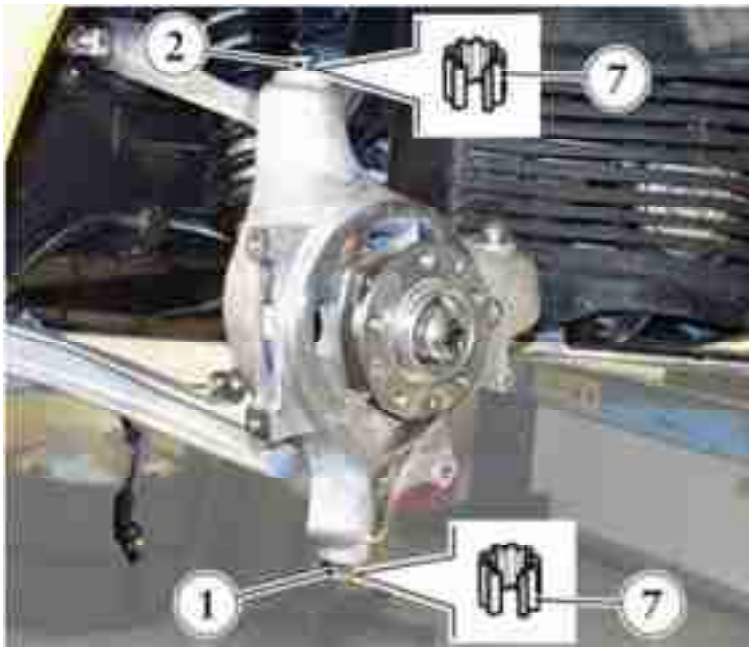
Ensure that the bearing and stub axle coupling surfaces are in good condition, eliminating any residue or traces of grime.

- Install the new bearing on the **AV 3206** support tool.
- Insert the central pin **(4)** in the bearing.
- Fit a new nut **(5)** and tighten it to the prescribed torque.

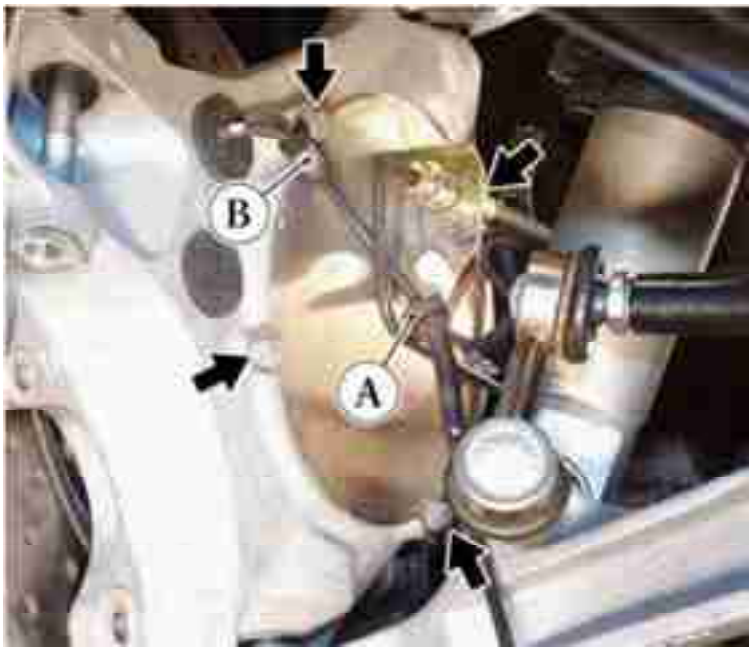




- Caulk the nut on the pin at the point of the nut grooves.
- Insert the stub axle on the bearing, passing the ABS sensor cable through the upper hole.
- Secure the stub axle on the bearing by tightening the four screws **(3)** to the prescribed torque.
- Insert the ABS sensor core hitch **(6)** into the stub axle seat.
- Lubricate the heads of the fastening screws, the boots of the suspension arm joints and the boot of the steering ball joint, using the prescibed grease.
- Re-assemble the entire stub axle, inserting suspension arm joints into their seats.
- Insert the balancing ring **(7)** into the stub axle fastening screw seats.



- Secure the upper suspension arm to the stub axle with the screw **(2)**.
- Secure the lower suspension arm to the stub axle with the screw **(1)**.
- Tighten the screws to the prescribed torque.
- Secure the steering box ball joint to the stub axle (E 2.02).
- Re-fit the brake disc on the bearing (G 2.05).
- Re-fit the stub axle cover, positioning the core hitch **(A)** and the ABS sensor cable support clamp **(B)**.



- Connect the ABS sensor cable to the harness.

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.

- Re-assemble the brake caliper on the stub axle (G 3.01).
- Re-assemble all components that have been detached or removed.

F3.04 REPLACING THE REAR WHEEL BEARING

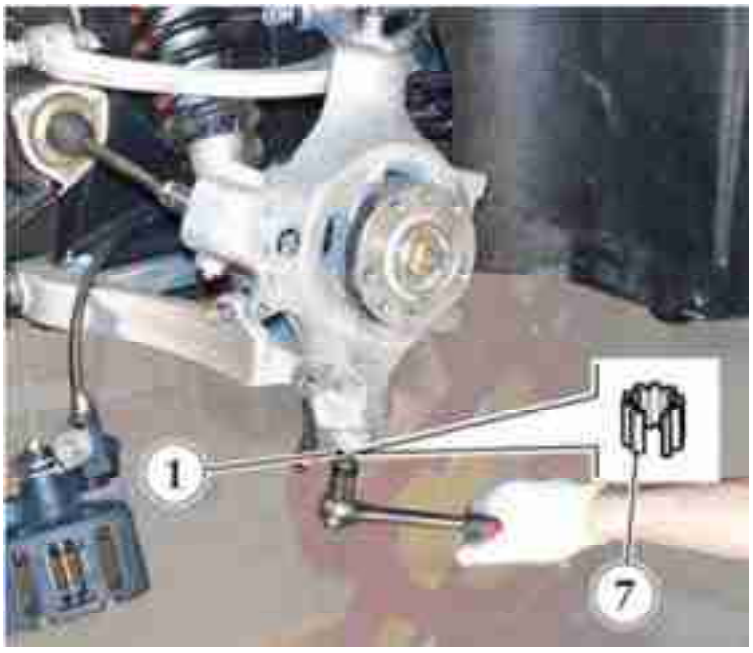
Tightening Torques		Product
Axle shaft fastening nut	**275 Nm**	**TUTELA Z2 Grease**
Bearing fastening screw	**65÷75 Nm**	
Upper arm fastening screw	**65 Nm**	**TUTELA Z2 Grease**
Lower arm fastening screw	**85 Nm**	**TUTELA Z2 Grease**

Preliminary Procedures

- Remove the rear wheel (F 3.06).
- Detach the rear part of the underfloor (M 2.12).
- Detach the axle shaft from the differential flange (D 5.02).
- Detach the brake caliper from the hub-holder, leaving it connected to the system (G 3.01).
- Detach the parking brake caliper from the hub-holder, leaving it connected to the control cable (G 3.04).
- Detach the brake disc from the bearing (G 2.05).

Disassembly

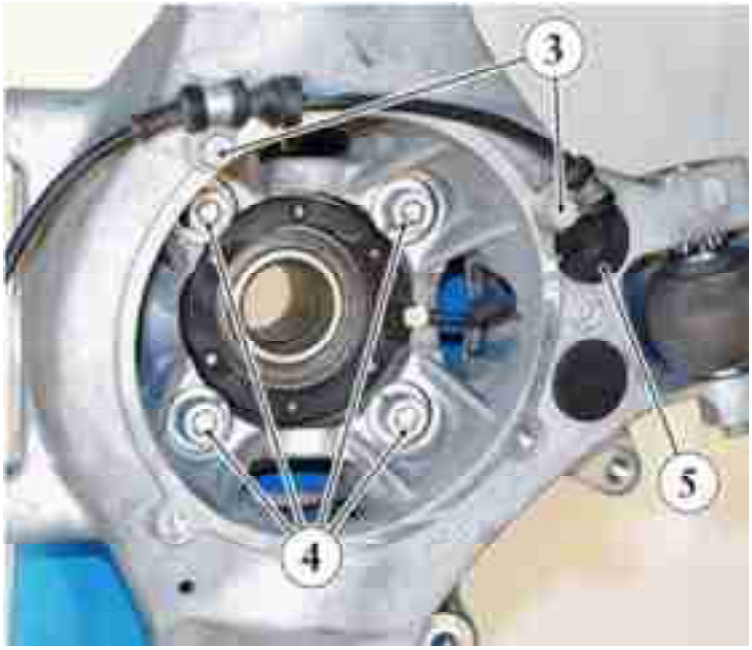
- Disconnect the ABS sensor connection.
- Unscrew the screw **(1)** fastening the lower suspension arm to the hub-holder.



- Support the suspension with the **AV 3206** support tool.
- Detach the upper suspension arm from the hub-holder by unscrewing the screw **(2)**.

- Remove the hub-holder together with the axle shaft, toe-in tie-rod and bearing.
- Free the nut on the axle shaft pin from caulking.
- Unscrew the nut and slide the axle shaft off the bearing.

- Unscrew the screws **(3)** for the ABS sensor cable support clamps on the hub-holder.
- Unscrew the screws **(4)** fastening the bearing to the hub-holder.

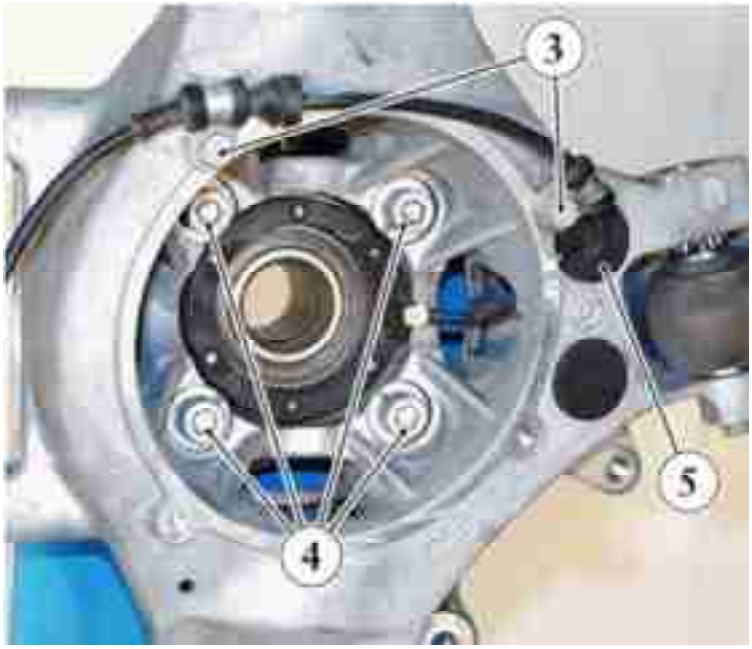


- Remove the hub-holder from the bearing.
- Detach the bearing from the support tool and perform inspection check or replace (F 2.02).

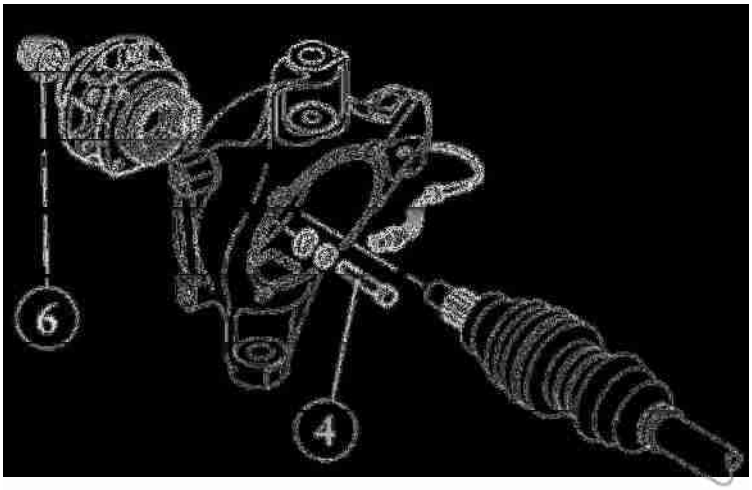
Re-assembly

Ensure that the bearing and hub-holder coupling surfaces are in good condition, eliminating any residue or traces of grime.

- Install the new bearing on the **AV 3206** support tool.
- Fit the hub-holder on the bearing, passing the ABS sensor cable through the upper hole.
- Secure the hub-holder on the bearing, tightening the screws **(4)** to the prescribed torque.
- Insert the ABS sensor core hitch **(5)** into the hub-holder seat and secure the ABS cable support clamps with the screws **(3)**.



- Insert the axle shaft into the bearing.
- Fit a new nut **(6)** and tighten it to the prescribed torque.



- Caulk the nut on the axle shaft pin at the point of the nut grooves.
- Lubricate the heads of the fastening screws and the suspension arm joint boots, using the prescribed grease.
- Re-assemble the entire hub-holder, inserting suspension arm joints into their seats.
- Insert the balancing rings **(7)** into the hub-holder fastening screw seats.

- Secure the upper suspension arm to the hub-holder with the screw **(2)**.
- Secure the lower suspension arm to the hub-holder with the screw **(1)**.
- Tighten the screws to the prescribed torque.
- Re-fit the brake disc on the bearing (G 2.05).
- Connect the ABS sensor cable to the harness.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

- Re-assemble the brake caliper on the hub-holder (_____).
- Re-assemble all components that have been detached or removed.

F3.05 CHECK AND ADJUSTMENT OF WHEEL ALIGNMENT

Wheel Alignment Data

Car height with static load (checked on Master Point machine SpM for cast suspension mounting frame)

- front	**125 mm**
- rear	**147 mm**

Wheel camber

- front wheels	**– 1° 00' ±10'**
- rear wheels	**– 1° 30' ±10'**

Total toe-in (diameter size 495 mm)

- front wheels	**2,5 ±0.5 mm**
- rear wheels	**3,0 ±0.5 mm**

Front caster (fixed) **6° 00' ±10'**

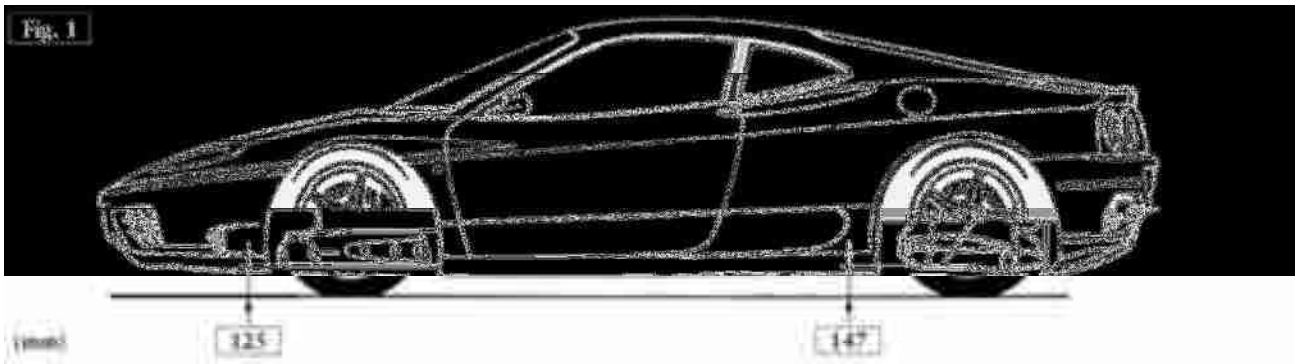
Tightening Torques

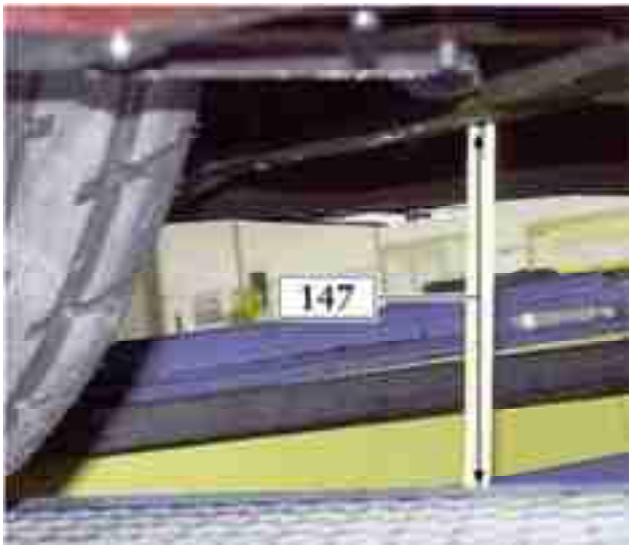
Nut for front suspension lower arm	**55 Nm**
Lock nut fastening joint on steering wheel tie-rod and rear toe-in	**60 Nm**
Nut for rear suspension lower arm	**60 Nm**

Checks and Preparation of the Vehicle

Before checking the wheel alignment, the following has to be inspected:

- tyre pressure (F 1.01);
- clearance between pinion and rack and ball journals for steering tie-rods on steering rack (E 2.02);
- clearance between stub axle and ball joint of the steering tie-rod and between hub holder and ball joint of the rear toe-in tie-rod (F 2.04);
- good working conditions of shock absorbers (F 2.05).
- park the car, with **"static load"**, on a level ground. Heights must be measured from the ground and in position with the spot-facings on the lower surfaces of the cast suspension mounting frame (see **Fig. 1**).





- Pull the parking brake and simulate the passengers' weight on the seats and on the floor panel using sacks filled with sand **(C)** making up a weight of **80 kg** in total for each seat.

NOTES
To check and/or modify the wheel alignment parameters, it is necessary to be endowed with a suitable equipment

Front Wheel Camber

- Check that the lower arms and suspensions are positioned correctly.
- In the event that the check results do not lie within the prescribed values (see "Wheel alignment data"), the thickness of adjustment shims' **(A)** must be varied accordingly.

IMPORTANT
When performing any adjustment, to prevent the suspensions from straining, the thickness of both the shims under the lower flamblocs must always be equal.

- Loosen the nuts **(1)** fastening the lower suspension arm and replace the adjustment shims **(A)**.

- Lock the nuts to the prescribed tightening torque.
- Check camber once again.

Front Wheel Toe-in

In the event that the check results do not lie within the prescribed values (see "Wheel alignment data"), make sure that the steering box is in central position and that the steering wheel is exactly horizontal. To check this condition, it is necessary to be equipped with a bearing **(D)** with level.

In this position, the two side tie-rods of the steering box must be of the same length (E 2.02).
If this requirement is not met, the tie-rods must be adjusted.

- Set toe-in by loosening the lock nuts **(2)** of the ball joints and rotating the side tie-rods **(3)**.

- Adjust the tie-rod lengths equally, until reaching the prescribed toe-in.
- Tighten the lock nuts **(2)** to the prescribed tightening torque.

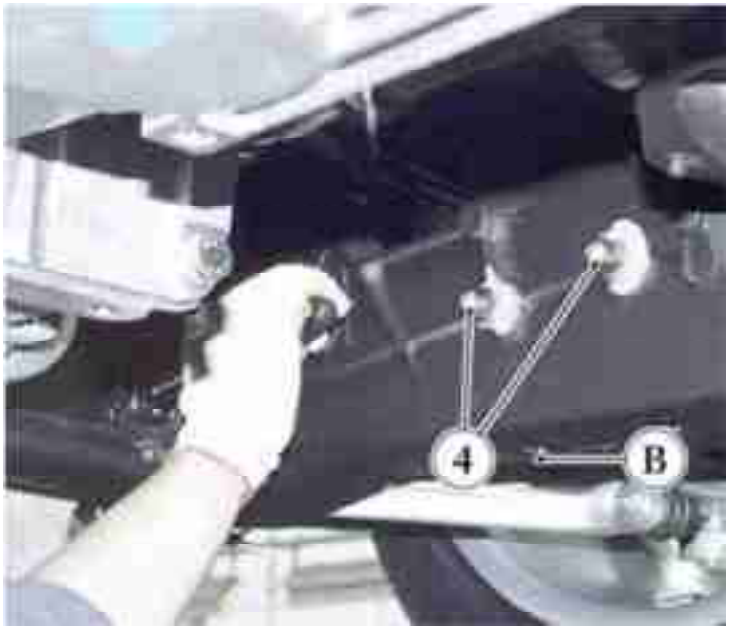
Rear Wheel Camber

If the checked values do not lie within the prescribed limits (see "Wheel alignment data"), the thickness of the adjustment shims **(B)** must be varied accordingly.

IMPORTANT

When performing any adjustment, to prevent the suspensions from straining, the thickness of both the shims under the lower flamblocs must always be equal.

- Loosen the nuts **(4)** fastening the lower suspension arm and slide out the adjustment shims **(B)** from underneath.

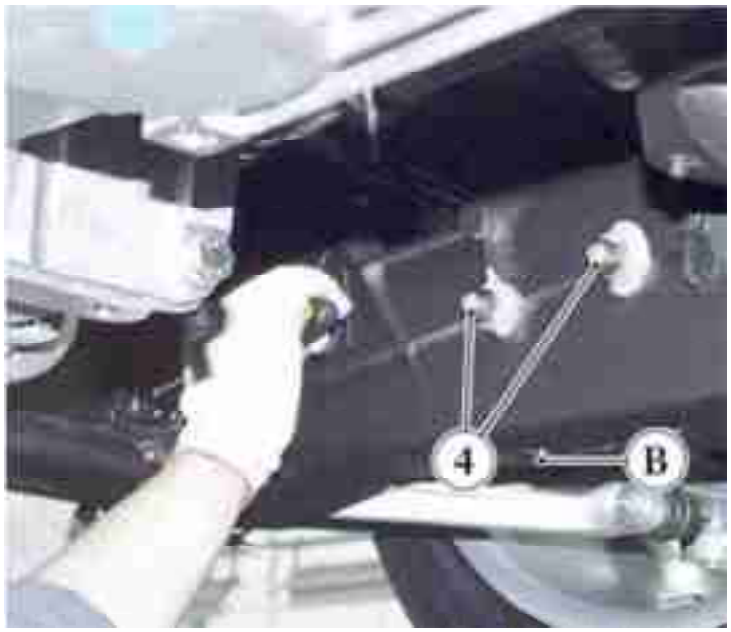


- Replace the shims with other shims of the suitable thickness and fit them between flambloc and chassis.

NOTES

*Turn the appendix **(E)** of the shim located on the front screw for the rear flambloc towards the front one. The shims' profiling permits to keep them properly positioned on the screw.*

- Tighten the nuts **(4)** to the prescribed tightening torque.



- Check camber once again.

Rear Wheel Toe-In

In the event that the check results do not lie within the prescribed values (see "Wheel alignment data"), before carrying out any intervention, make sure that the two rear tie- rods for toe-in **(5)** feature the same length, which must also reflect the prescribed length (_____). If this requirement is not met, they have to be adjusted.

- Set toe-in by loosening the lock nuts **(6)** of the ball joints and rotating the tie-rods **(5)**.

- Adjust the tie-rod lengths in equal size, until reaching the prescribed toe-in.
- Tighten the lock nuts **(6)** to the prescribed tightening torque.

F3.06 WHEEL REPLACEMENT

Tightening Torques

Pre-tightening stud bolts	**25÷45 Nm**
Final tightening of stud bolts	**100 Nm**

IMPORTANT
Use tools very carefully in order to prevent damaging the painted surfaces of the wheel rims.
Tyres that have been on the car for over 3 years should be inspected to determine whether they are suited for use (F 2.08).

Removal

- Loosen the five stud bolts **(1)** fastening the wheel.

- Jack up the car.
- Remove the entire wheel.

Checks

- Check the tyre (F 2.08) and wheel rim (F 2.07) for wear.

- If the tyres or rims are being changed, have the wheels statically and dynamically balanced (F 3.07).
- Ensure that the rim and brake disc resting surfaces are perfectly clean.
- replace the stud bolts whose threaded or tapered part have been damaged.
- carefully clean the stud bolts before fitting them.
- avoid at all costs to lubricate the contact surfaces between the stud bolt and the wheel rim, and between the rim and the disk brake.
- In order to prevent the anti-locking product from being removed, do not use solvents or aggressive products on the wheel rim tapering.

Re-mounting

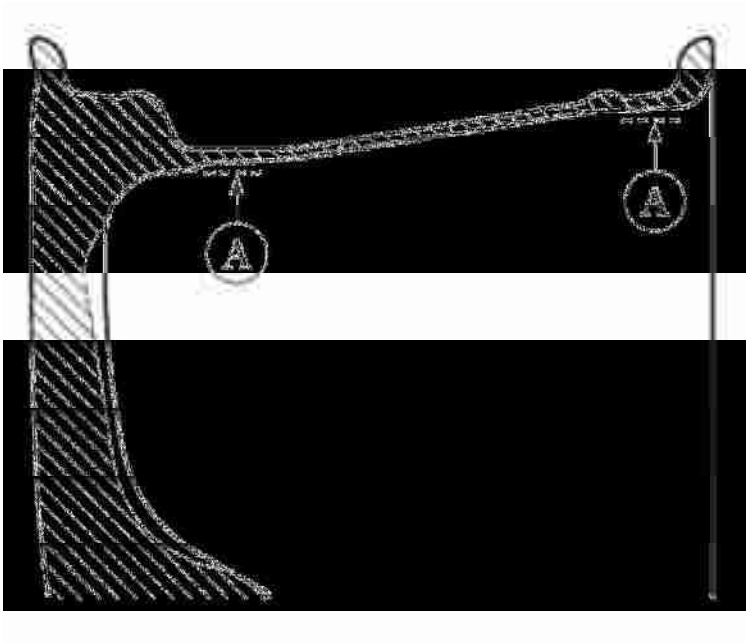
- Mount the entire wheel, inserting the dowel in the rim seat.
- Block the stud bolt opposite the dowel first and then the others. Proceed by pre-tightening the stud bolts **(1)**, proceeding crosswise.
- Lower the car and carry out the final tightening of the stud bolts to the prescribed torque.

F3.07 WHEEL BALANCING

After replacing the tyre or rim, or both, the wheel must be balanced statically and dynamically with a balancing machine, using precision counterweights.
Manufacturers identify the heaviest part of the wheel rim and the tyre with a reference mark. When mounting the tyre on the rim, always set these reference opposite to each other in order to limit to the barest minimum the counterweights to be fitted in the balancing phase.

IMPORTANT
Use self-adhesive counterweights only. Besides damaging the rim, the use of counterweights of other types can interfere with suspension parts or become unattached when the car is in use.

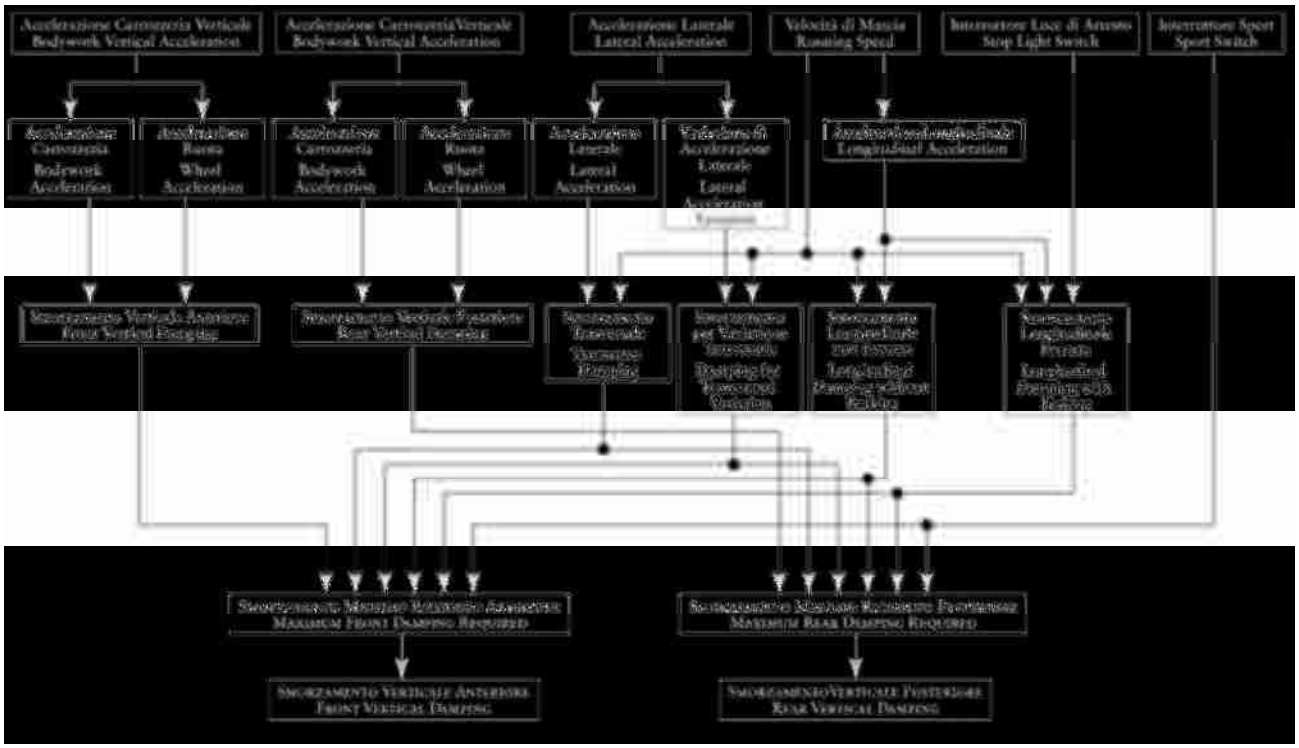
- The counterweights must be fitted on the flat surface, the on the flat surfaces **(A)**, of the inner profile of the rim.



- Use heptane to thoroughly clean the rim surface on which the counterweight will be fitted.
- Remove the protective paper and attach the counterweight to the rim, pressing evenly to ensure it adheres perfectly.

IMPORTANT
To prevent counterweights from becoming detached when the car is being driven, do not attach counterweights that have been used previously or that do not have protective paper.
Do not touch the adhesive surface of the counterweight prior to attachment on the rim.

F4.01 SYSTEM

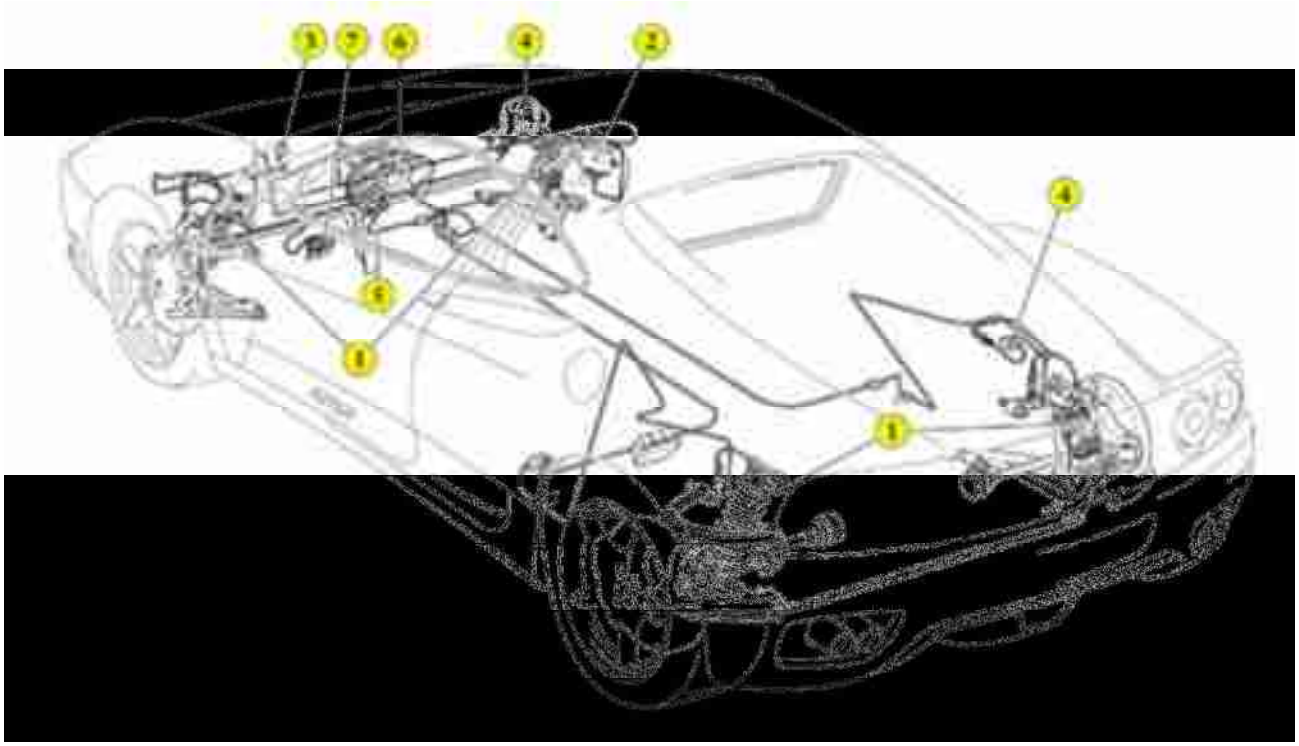


This system makes it possible to obtain optimal shock absorber setting, under all driving conditions, thus optimizing the car's hold on the road.
The system utilizes shock absorbers with continuous setting variation and which are electronically managed by means of internal valves.
The Electronic Control Unit **(ECU)** selects the shock absorber setting according to one or more of the following parameters (see flow diagram):

- driving speed;
- vertical acceleration (front and rear);
- side acceleration;
- braking in progress;
- SPORT or normal mode.

The system is controlled by means of the control of the valves that shut the inner fluid passage area while absorbing the shocks.
The cone valves are connected in series of pairs: front and rear.
The diagram illustrates the manner in which the two front and rear shock absorber control signals are processed.

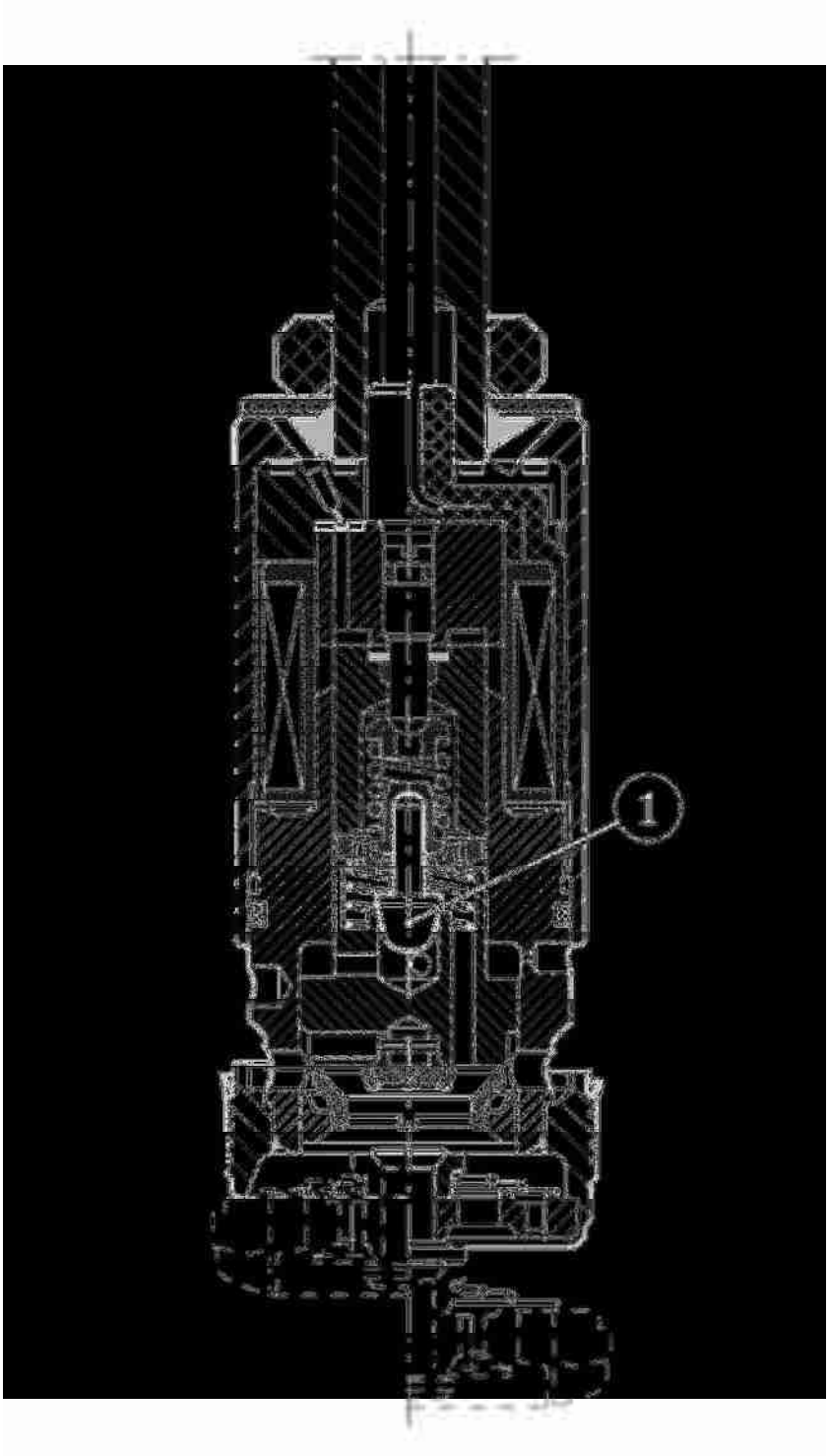
The system is made up of the following components:



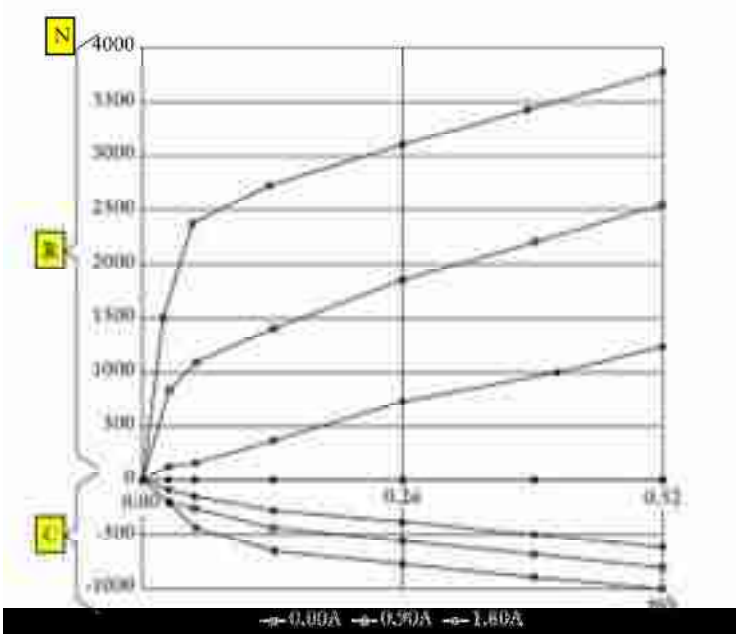
1 - Variable-setting shock absorbers with internal control valves (F 2.05)
2 - Electronic control unit (F 4.03)
3 - Side acceleration sensor (F 4.03)
4 - Vertical, front and rear acceleration sensor (F 4.03)
5 - Brake pedal switch (G 3.06)
6 - Failure signal on instrument panel multi-function display
7 - "SPORT" selection switch on side instrument panel

F4.02 SYSTEM OPERATION

The ECU adjusts the shock absorber settings on the basis of the detected acceleration and of the driving speed.
The curves shown represent the maximum shock absorption (expressed in **N**) of the shock absorber at various stem movement speeds **(m/s)** and with various power supplies to the internal valve **(1)**.



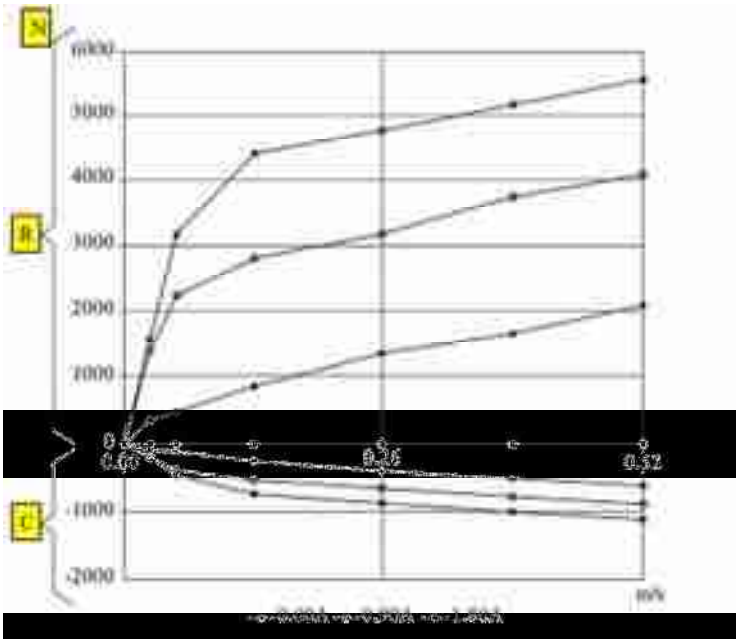
Front shock absorbers



R - Damping forces
C - Compression
N - Shock absorption

Rear shock absorbers

R - Damping forces
C - Compression
N - Shock absorption



Failure Signaling by Means of the Multi-Function Display

Whenever malfunctioning of the system is detected, the pertinent signal is activated on the instrument panel multi-function display.
The ECU for the shock absorber setting adjustment system transmits a signal to the ECU managing the instrument panel, which then provides for controlling the multi-function display.

F4.03 SYSTEM COMPONENTS

IMPORTANT
Following replacement of a system component or a connecting cable, a system check cycle must be performed (F 4.04).

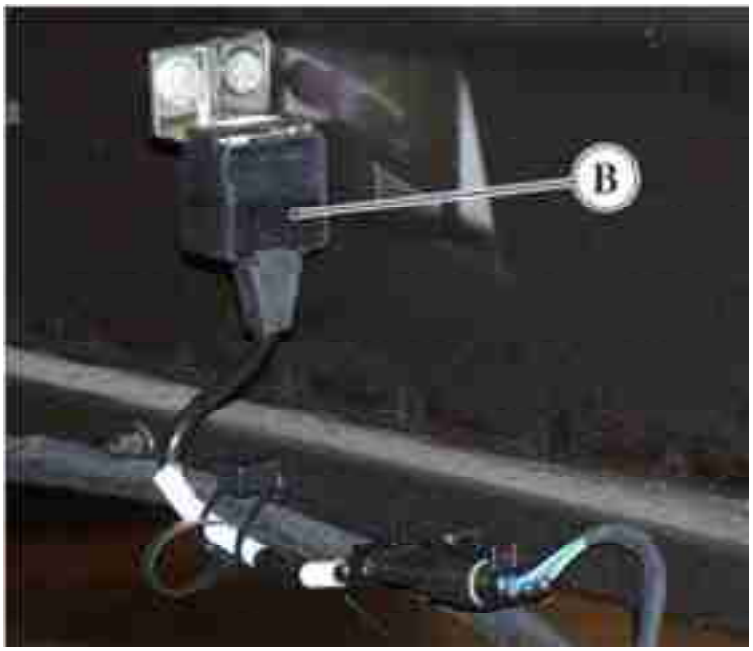
Electronic Control Unit (A)

The ECU is located in the passenger compartment, under the dashboard and secured to the chassis on the right-hand side.
For connection to the system, see Table **C** - ELECTRICAL SYSTEM.

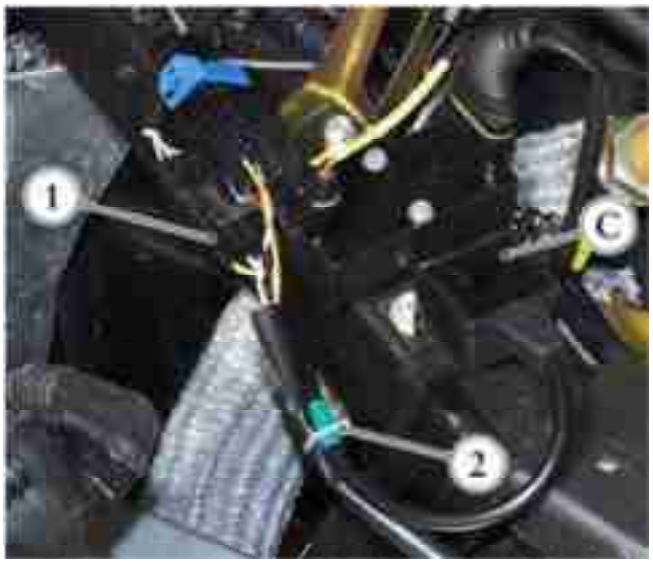
Starting from the parameters detected by means of the sensors (driving speed, vertical and side acceleration, brake pedal switch and SPORT or normal mode position), the system ECU processes the suspension control algorithm and controls the output signals to the valves regulating the shock absorber settings.
Part of the ECU memory is dedicated to system diagnostics and designed for connection with the SD-2 tester (F 4.04).

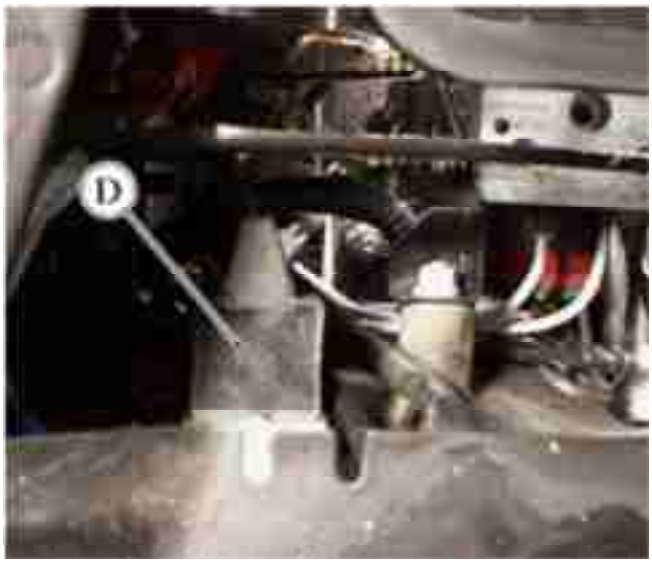
Acceleration Sensors

The side acceleration sensor **(B)** is secured to the front side of the chassis and is protected by the front bumper.



The vertical acceleration sensors are positioned as follows: the rear one **(C)**, on the side member of the chassis, on the right-hand side of the engine compartment; the front one **(D)**, on the right-hand side of the luggage compartment.





Through the specific signal-filtering circuits, these sensors detect the intensity and frequency of the oscillations (vertical or lateral).

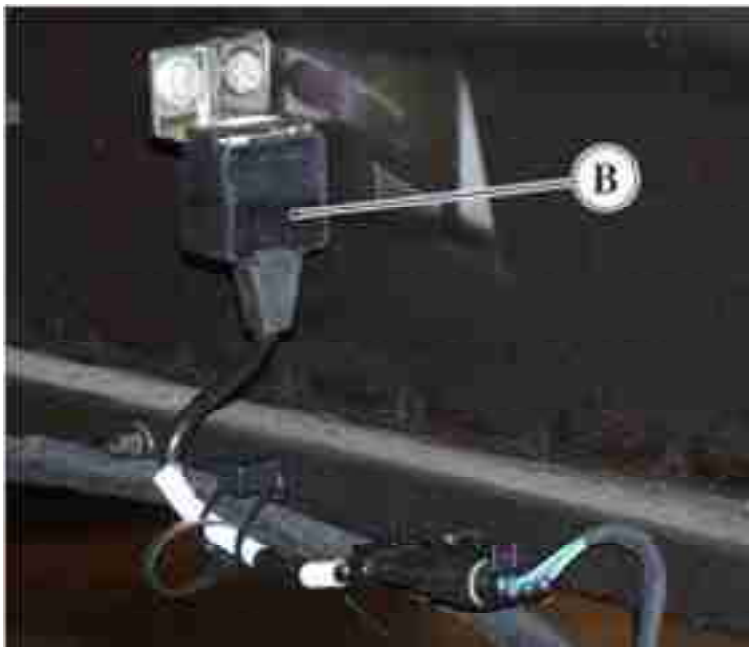
For the purpose of avoiding undesirable vertical or lateral oscillations of the car, the control unit detects the levels of acceleration on the car body, it estimates the wheels' accelerations and, on the basis of the accelerations and of the other signals (driving speed etc.), will consequently control the valves designed for setting the shock absorbers.

REPLACEMENT

To gain access to the side acceleration sensor, the front bumper (M 2.03) and the window-washer fluid tank (M 2.08) must be removed.

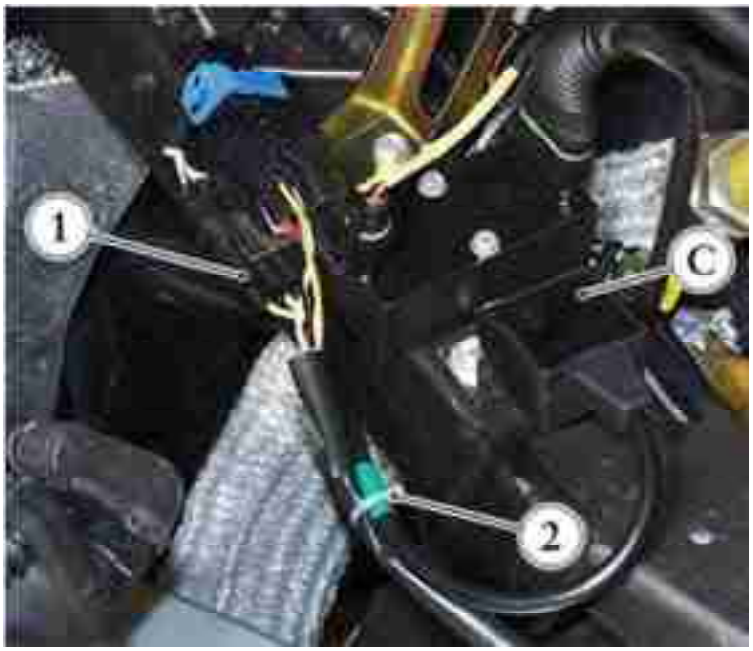
- Disconnect the sensor **(B)** from the front harness and remove it from the support bracket.

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.



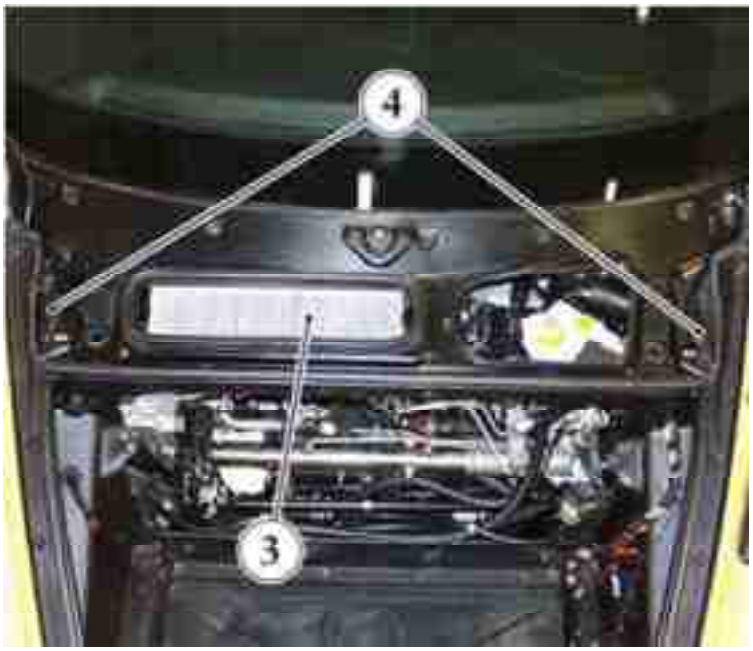
- To gain access to the rear vertical acceleration sensor **(C)**, the right-hand side guard of the engine compartment must be disassembled (M 2.13).
- Disconnect the connector **(1)** and remove the sensor **(C)** from the support bracket on the chassis.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

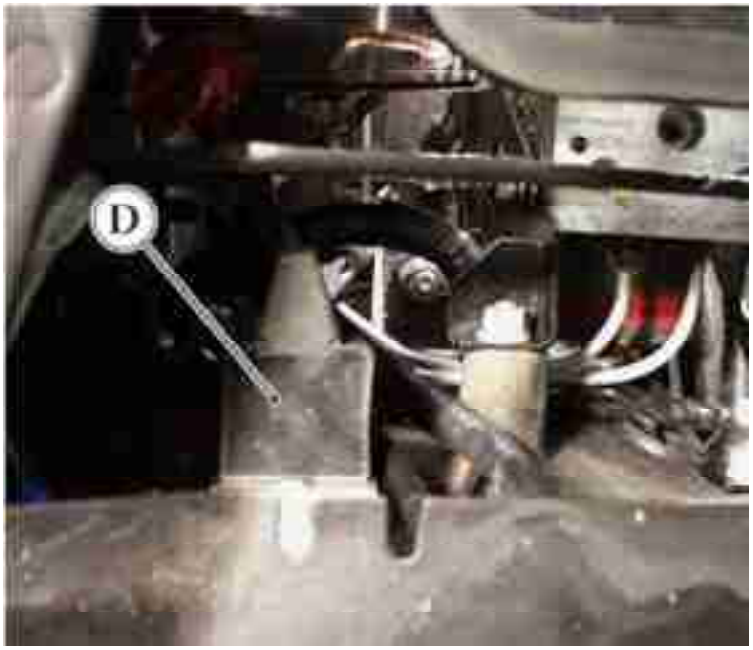


- When fitting the replacement sensor, secure the cable to that of the front oxygen sensor with a tear strip **(2)**.

- To gain access to the front vertical acceleration sensor **(D)**, the following must be removed:
  - windscreen wiper arms (M 2.07);
  - the support with the air conditioning system filter **(3)**;
  - the two brackets securing the luggage compartment stays **(4)**;
  - the nine screws fastening the bulkhead under the windscreen and slide it out from under the peripheral lining strip of the windscreen, together with the drain pipes.



- Detach the connector from the dashboard harness and remove the sensor **(D)** from the support bracket. For connection to the system, see Table **A** - ELECTRICAL SYSTEM.



- When re-assembling, it is essential that the rear end of the bulkhead under the windscreen is inserted under the peripheral lining strip of the windscreen, in order to prevent infiltration of water in the luggage compartment.

"SPORT" selection switch (H 2.03)

Brake pedal switch (G 3.06)

F4.04 DIAGNOSTICS

The ECU managing the shock absorber system is capable of performing the diagnostics test of the system components and of communicating with the SD-2 diagnostics system for the management of the following environments:

- errors;
- parameters;
- active diagnostics;
- acquisition;
- automatic cycle.

The connector for the SD-2 tester connection is found under the dashboard, where the steering column is located (L 2.12).

Errors

System operation is constantly controlled by the ECU, which is thus capable of identifying any malfunctions. The ECU is capable of identifying the following errors:

- front vertical acceleration sensor (short circuit, open circuit, constant signal);
- rear vertical acceleration sensor(short circuit, open circuit, constant signal);
- side acceleration sensor (short circuit, open circuit, constant signal, offset);
- SPORT switch (false contact);
- sensor power supply (under/over voltage);
- valve power supply (under voltage);
- front axle valve (short circuit to earth or power supply, open circuit);
- rear axle valve (short circuit to earth or power supply, open circuit).

These conditions are tested in cycles every **10ms** and any errors diagnosed are permanently stored by the ECU. All errors are diagnosed if the error conditions thereof continue for times exceeding the pre-established thresholds (ranging from **1** to **10** seconds).

In the case of system malfunctions, besides storing the error detected internally, the message for switching on the corresponding failure ideogram on the multi-function display is transmitted. It is evident that in the case of a valve malfunctioning, and with no possible access to it from the outside, the conditions could be created in which one or two of the four shock absorbers have a fixed setting (jammed valve).

In any case, safe driving of the car is always ensured.

If the failure that has occurred is temporary and does not prove to be present the next time the system is started, the multi-function failure display will not light up. However, the error is stored in the memory until deletion through the SD-2 system.

NOTES

The memory containing the errors can be deleted solely by utilizing the SD-2 diagnostic system.

Should malfunctioning occur when the car is being used, and the display switches on, it is best to:

- stop the car;
- disconnect power supplied to the ECU by turning the ignition key to the **"0"** position;
- restore power to the ECU again, by turning the ignition key to the **"II"** position.

If the problem is no longer present (for example, a false contact), the multi-function display will not switch on again and the system will resume normal operation. Otherwise, the system remains in the failure mode.

Parameters

Input/output data whose trend can be stored and displayed by the system control unit include the following:
- driving speed;
- transverse (side) acceleration;
- front wheel and car body acceleration;
- rear wheel and car body acceleration;
- front valve power supply;
- rear valve power supply;
- braking in progress;
- SPORT or normal modes.

Active Diagnostics

Programs to execute the guided diagnostics tests of several system components are stored in the SD-2.
The active tests that can be performed include:
- SPORT light switching-on activation;
- failure signal light switching-on activation.

Automatic Cycle

In this environment, it is possible to perform a guided check on the entire suspension system.
It is recommended that it be performed each time a component or harness is replaced, in order to ensure that it is operating properly and to check the whole system.
The system check cycle procedures are the following:
1- Code ISO: the ISO code of the diagnosis line is checked;
2- Deletion of errors present;
3- Self-test: when the key is turned to the **II** position, the system performs the self-test in the automatic mode;
4- Generation of the car speed signal: the test requires the connection of the second diagnosis plug (cable ISO2) for the purpose of sending a car speed signal by means of the instrument panel ECU;
5- Checking efficiency of the brake pedal switch;
6- Checking the SPORT switch: the tester requires activation of the **"SPORT"** switch for the purpose of checking its efficiency;
7- Error deletion: the tester will request that the key be turned to **"OFF"** and then to **"ON"**, for the purpose of detecting any errors and will then perform the deletion;
8- Printout: a report is printed including the results of the various phases of the system check cycle.

G1.01 TECHNICAL SPECIFICATIONS

Technical Data

Service brakes

Type	**Self-ventilated disc brake**
Material	**Alloyed cast iron**
Brake disc diameter	**330 mm**
Brake discs' nominal thickness	**28 mm**
Minimum thickness (wear limit)	**26 mm**
Max. tolerance for circumferential flatness on disc surfaces	**0,025 mm**
Max. tolerance for circumferential parallelism on disc surfaces	**0,015 mm**
Max. circumferential/radial superficial roughness	**1,2/2,4 µ**

Brake calipers

Type	**Fixed 4 pistons**
Brand	**BREMBO P4 38/42 h**
Pistons diameter	**38/42 mm**

Brake pads

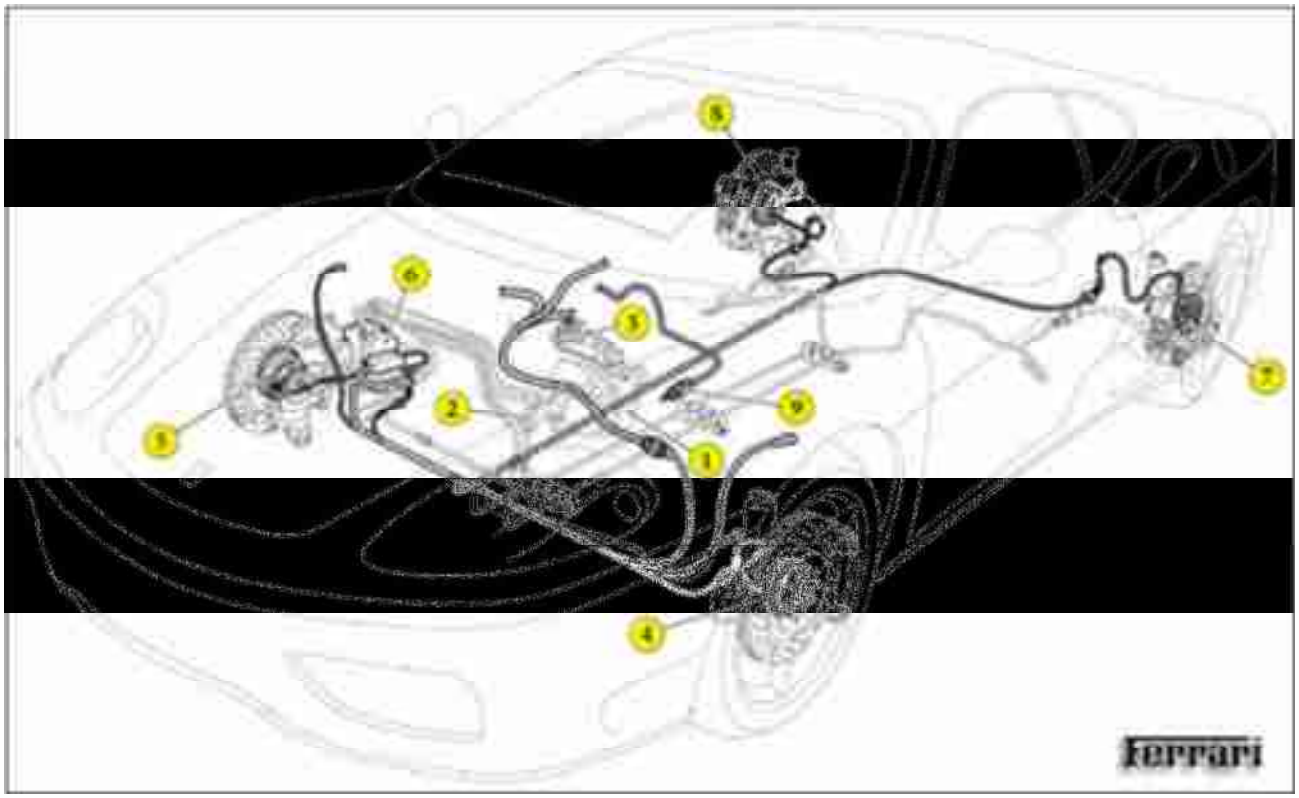
Brand and type	**GALFER 3321 GF (49)**
Average braking surface for a pair of pads	**103 cm²**
Minimum thickness wear limit (with anti-noise plate)	**7,5 mm**

Hand brake

Type	**Disc with mechanically-controlled caliper**
Control	**Mechanical lock lever**
Transmission	**With steel wires**
Caliper	**Floating with backlash recovery**
- Brand	**BREMBO PFM 9d**
- Piston diameter	**36 mm**
Brake pads	**FRENDO 222**
Average braking surface for a pair of pads	**40 cm²**
Minimum friction material thickness at wear limit	**5,5 mm**

The braking system is made up of the following main parts:
- Disc brakes on the four wheels.
- Hydraulic pump/servo brake tandem
- Independent hydraulic circuits on the four wheels
- Anti-lock braking system (ABS).
- Electronic brake-force distribution (EBD).
- Engine braking torque regulator (MSR).
- Anti-skidding regulator during acceleration (ASR).
- Brake/clutch fluid pan with float indicating minimum level,
- Hand brake with a mechanically-driven caliper, operating on the rear brake discs. Manual control lever provided with mechanical lock.
- Warning lights on the instrument panel to signal any ossible system failure (H1.01).

G1.02 SYSTEM OUTLINE



1 - Servo brake
2 - Brake master cylinder
3 - Brake/clutch fluid tank (mechanically controlled gearbox)
Brake fluid tank (electronically activated gearbox)
4 - Front, left-hand wheel bearing fitted with ABS sensor and toothed wheel
5 - Front, right-hand wheel bearing fitted with ABS sensor and toothed wheel
6 - ABS/ASR electro-hydraulic control unit
7 - Rear left-hand wheel bearing fitted with sensor and ABS toothed wheel
8 - Rear right-hand wheel bearing fitted with sensor and ABS toothed wheel
9 - STOP lights switch

G1.03 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category
Nut fastening pedal board mount to bodywork	**20**	**B**
Wheel centring pin and disc fastening screw	**15**	**C**
Screw fastening calipers to hub carrier and stub axle	**85**	**B**
Screw fastening parking brake caliper (M10x1.25)	**70**	**B**
Screw fastening arking brake caliper (M8x1.25)	**30**	**B**
“Torx” fastening screw on ECU	**2 9 ±0,5**	
Nut fastening electro-hydraulic unit to chassis and bracket	**20**	**B**
Brake pipe unions (M10)	**14**	**B**
Brake pipe unions on electro-hydraulic unit intake (M12)	**15**	**B**
Brake pipe union on caliper	**14-17**	**B**
Connection union between rigid pipe and hosing	**14**	**B**
Draining union	**12-16**	**A**
Nut fastening brake servo to pedal board mount	**20**	**B**
Screw fastening fork to pedal	**2**	

G2.01 SERVO BRAKE / PUMP

Technical Data

Servo brake	
T pe	**Vacuum**
Brand	**BOSCH**
Pump	
Type	**Hydraulic tandem**
Brand	**BOSCH**
C linder diameter	**23,8 mm**
Front piston stroke	**16,4÷18,3 mm**
- displaced liquid volume	**= 6,88 cm**
piston stroke	**16,3÷18,2 mm**
- displaced liquid volume	**= 6,65 cm³**
Power stroke	**34 mm**

NOTES

The pump-servo brake unit is a single assembly and its parts should not be separated from each other, detaching the pump from the servo brake.

Brake servo system

The brake servo system has been modified: the number of check valves on the vacuum pipe connecting the intake manifold to the brake servo has been reduced to two.

In the **pre-modification design** the two valves **(A)** were fitted in position with the front unions on the intake manifold bank and a rigid pipe **(B)** acted as a 3-way line for the pipe connecting up with the brake servo.

Pre-modification design

With the new design, the only valve fitted in the system **(C)** is located in position with the brake servo and the rigid pipe **(D)** with union is only connected to the right-hand intake manifold bank, while the hole on the opposite bank is stopped with a plug **(E)**.

Tightening torques		Category
Screw fastening fork to pedal	**2**	
Brake pipe unions (M10)	**1**	
Nut fastening servo brake to pedal board support	**2**	**B**

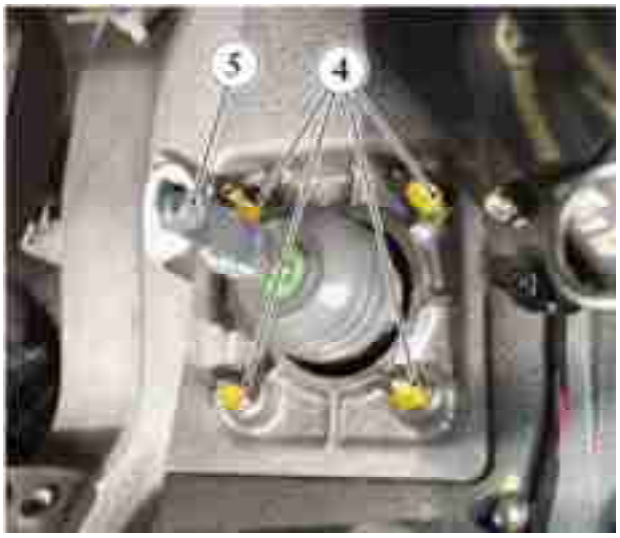
Disassembly

- Remove the movable rear panel from the luggage compartment (M 3.06).
- Drain the braking system(G 3.02).
- Detach the pipes **(1)** connecting the brake/clutch tank and the vacuum pipe **(2)** from the brake master cylinder.
- Unscrew the braking system pipe unions **(3)** from the cylinder.

IMPORTANT

Arrange the pipes so that they do not interfere with the subsequent procedures, taking care not to bend or twist them.

- Working from the passenger compartment, detach the cylinder fork from the foot-brake pedal, unscrewing the screw **(5)**.
- Unscrew the nuts **(4)** fastening the servo brake to the pedal board.
- Detach the cylinder fork from the foot-brake pedal, unscrewing the screw **(5)**.



- Slide off the entire servo brake from the luggage compartment.

Re-assembly notes

- Lock the nuts **(4)** fastening the servo brake to the pedal board support to the prescribed torque.
  Lock the screw **(5)** fastening the fork to the pedal to the prescribed tightening torque
- Lock the brake pipe unions **(3)** onto the cylinder to the prescribed tightening torque. Mount the pipes connecting the pump and the servo brake, tightening the clamps.
- Fill and drain the system (G 3.02).

If the servo brake is being replaced, the position of the foot-brake pedal and of the STOP switch must be regulated (G 3.06).

G2.02 BRAKE FLUID TANK

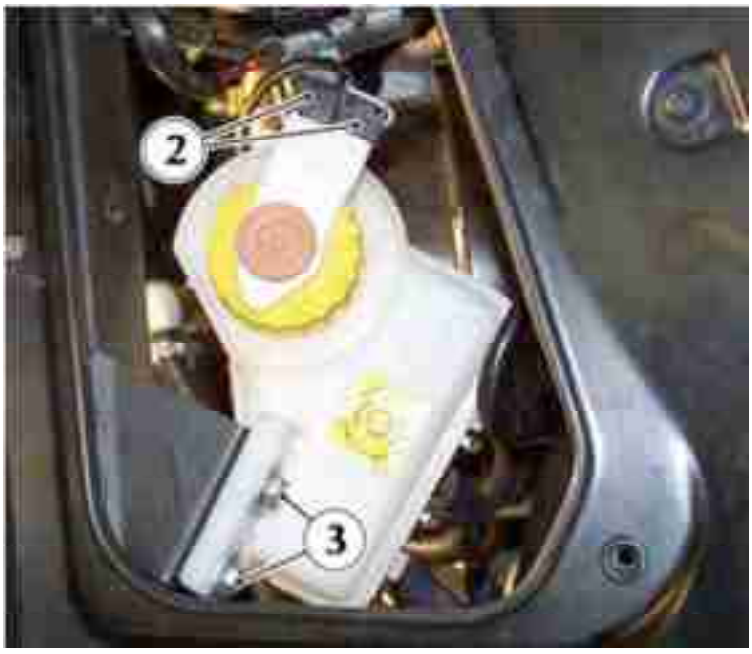
It is located under the windshield upholstery and it is accessible by removing the inspection lid (A 3.18).
The brake fluid shares the same tank with the clutch system.
Make sure the fluid in the tank is always near the highest level notch.

CAUTION
The fluid used in the braking and clutch system can cause injury to eyes and skin; in case of contact, rinse the body part involved with abundant running water. In addition, the fluid may damage the car's painted parts.

Disassembly

- Remove the movable rear panel of the luggage compartment (M 3.06).
- Drain the braking system(G 3.02) and the clutch system (only for mechanical transmission) (D 3.04).
- Loosen the clamps **(1)** and slide off the pipelines connecting the brake master cylinder to the clutch from the tank.

- After having removed the inspection lid, detach the connections **(2)** from the tank cap.
- Unscrew the two fastening screws **(3)** and remove the tank.



NRe-assembly notes

- Once the tank and its connections are re-assembled, fill and drain the braking system (G 3.02) and the clutch system (only for mechanical transmission) (D 3.04).

G2.03 PEDAL BOARD

It consists of an aluminum alloy cast piece, on which the foot-brake pedals, the clutch, the servo brake and the clutch cylinder are mounted on fulcrum pivots.

NOTES
The pedal and the clutch cylinder are not present in the electronically controlled version.

These parts can be removed separately with the pedal board installed in the car (see relevant paragraphs).

Tightening torques	Nm	Category
Screw fastening fork to pedal	**24**	**B**
Screw fastening pivot	**7,4**	**B**
Pipe union for clutch pump		**A**
Nut fastening edal board mount to bodywork	**20**	**B**

Replacing the Foot-Brake Pedal Bushes and Clutch Pedal Bushes

In case of excessive backlash of the pedals on the relative fulcrum pivot, the bushes within the pedals may be replaced.

Valid for Euro 2 - US M.Y. 1999 version
- Detach the connector (**1**, **RED** cables) from the switch for the foot-brake pedal.
- Detach the connector (**2**, **WHITE-BLACK** cables) from the clutch pedal switch.

Valid for Euro 3 - US M.Y. 2000 version
- Detach the connector (**1**) from the switch for the foot-brake pedal.
- Detach the connector (**2**, **GREY-BLACK** cables) from the clutch pedal switch.

NOTES
*In the **US M.Y. 2000** version the switch on the clutch pedal is the same as the one on the brake pedal.*

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

- Loosen the screws **(3)** in position with the pedal fulcrum pivot supports.
- Unscrew the screws **(4)** which fasten the clutch and the brake master cylinder forks to the respective control pedals.
- Detach the recovery spring **(5)** from the clutch pedal.

- Rivet the pivot **(6)** towards the left side, enough to remove the foot-brake pedal and the side shimmings.
- Slide off the clutch pedal switch support **(7)** from the pivot and the clutch pedal with the side shimmings.

- With a pivot of the proper diameter, rivet the worn bushes from within the pedal.
- Mount the new bushes onto the pedal, using a press and aligning them with the external surfaces of the pedal.

- Before re-assembling, lubricate the pivot and the pedal bushes with **molybdenum bisulphide grease** and install the original shims.
- The pivot **(6)** has 2 threaded holes which must be positioned onto the holes of the support.
- Lock the screws **(3)** fastening the pivot to the pedal board support and to the clutch pedal switch support **(7)** to the prescribed torque.

- Re-fit the recovery spring **(5)** and install the cylinder forks onto the pedals, tightening the screws **(4)** to the prescribed torque.
- Fit the connectors **(1)** and **(2)** onto the pedal switches.

NOTES

If the control pedals are being replaced, check the position and regulate the distance of the switches (G 3.06 and D 3.02).

Replacing the entire pedal board

- Remove the lower part of the dashboard (M 3.01).
- Remove the steering column (E 2.05).
- Remove the windscreen wiper control motor together with the support (_____).
- Detach the brake/clutch tank connection from the relevant cylinders (_____).
- Detach the steering box from the chassis, (E 2.02) keeping it in the car.
- Detach the braking system pipes from the cylinder and the vacuum pipe from the servo brake (_____).

IMPORTANT

Arrange the stiff pipes of the braking system so that they do not hamper the subsequent procedures, without folding or twisting them.

- Detach the clutch pipe union from the clutch cylinder.
- Remove the shield underneath the pedals and unscrew the nuts **(8)** which fasten the pedal board support to the body.
- Slide off the entire pedal board from the luggage compartment.
- When re-assembling, use a new gasket and install the support bracket **(9)** for the shield under the pedals, placing it in position with the left-hand, lower stud bolt.

- Tighten the nuts **(8)** to the prescribed torque.
- Tighten the clutch pipe union and the brake pipe unions onto the relevant cylinders, to the prescribed torque.
- Fill and drain the braking system (G 3.02) and the clutch system (D 3.04).
- Re-assemble all the parts removed or detached during the procedure.

G2.04 BRAKE CALIPERS

Ferrari, considering the importance in terms of safety and reliability held by these components, suggests avoiding all interventions inside the brake calipers. An improperly carried out intervention may seriously harm the occupants of the car. The procedures that can be carried out on the calipers only involve the replacement of the brake pads, the boots and a few external parts: drainage union and connection pipe.

IMPORTANT
After replacing the drainage union and/or the connection pipe, the system must be drained (*G 3.02*).

Ti htening torq		Categ
Drainage union	**12÷16**	**A**

Boots Replacement

After having removed the brake pads (A 3.21), check the condition of the boots **(A)** since if they are damaged they may cause leakages due to the entrance of foreign matter in the piston area.

- Clean the caliper with pressure steam to remove the dust which appears when the brake pads wear out. Dry with compressed air.

IMPORTANT
When cleaning, avoid using petrol, gas oil or other aggressive solvents which may damage the internal seals and the boots.

- Using a small screwdriver, slide off the worn out boots and install the new boots (**A**, see section), fitting them in place by hand, without damaging them. If the brake fluid continues leaking, the entire caliper must be replaced (G 3.01).

Pad Centring Check

When a single pad is excessively worn out, check that the disc is centred with respect to the friction surfaces of the pads.
- With the foot-brake pedal in the resting position, fit a feeler gauge blade between the disc and each pad.
- The maximum tolerance allowed for pad centring with respect to the brake disc is **0.9 mm**. Higher values may be due to poor sliding of the pistons in the caliper seats. In this case, the caliper must be replaced (G 3.01).

G2.05 BRAKE DISCS

The brake disc must be perfectly clean, without traces of oil, grease and rust, and must not show any grooves.
If the car braking performance is poor, independently of the pads' and brake calipers' condition, some dimensional checks on the wheel discs must be carried out (G 1. 01).
- With the disc mounted on the wheel hub, check the flatness level by means of a dial gauge,.
- Using a micrometer, measure the parallelism between the contact surfaces and the pads on various parts of the braking band.
- Using the special instrument, check for surface roughness in the pads' area.

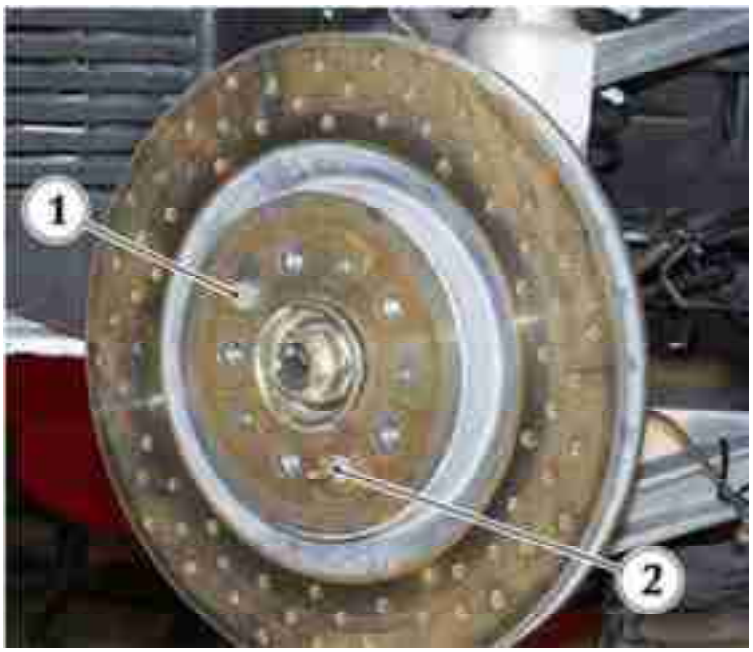
In case of off-gauge values, the disc may be grinded, taking care not to reduce its thickness beyond the wear limit indicated on each disc brake rims.

Tightening Torques

Wheel centring pivot and screw fastening disc	**15 Nm**

Brake disc Replacement

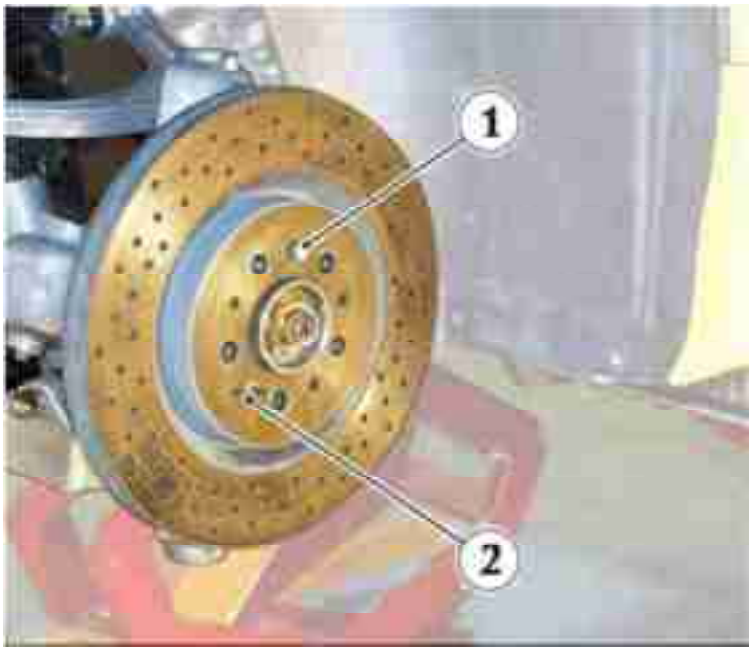
- After removing the wheel, detach the service brake caliper from the stub axle or the hub carrier, keeping it connected to the system (G 3.01). As far as the rear disc is concerned, the hand brake caliper must be removed as well (G 3.04).
- Unscrew the screw **(1)** and the wheel centring pivot **(2)**.



- Remove the disc from the wheel bearing.

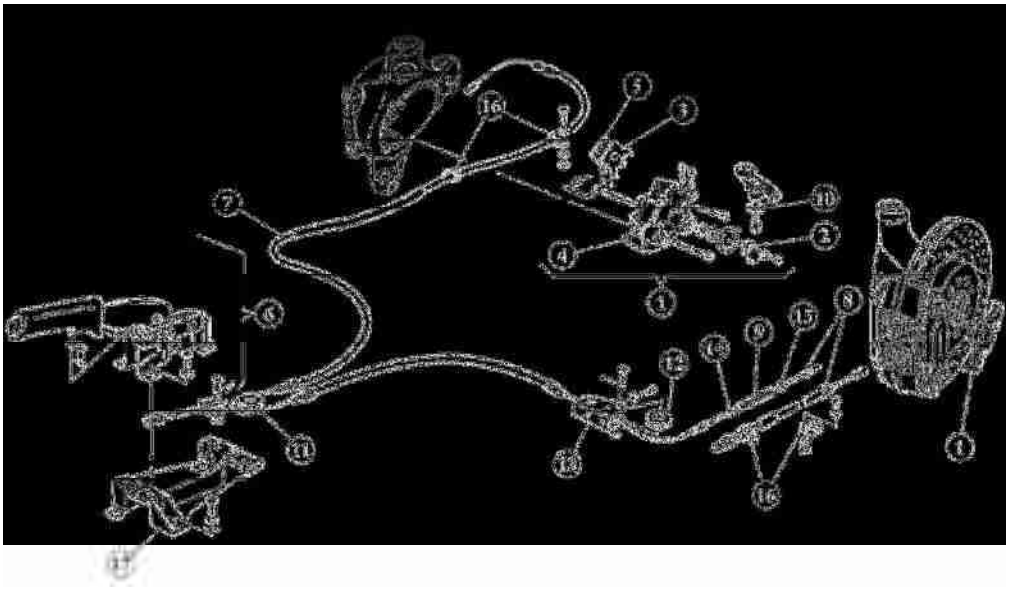
Before re-assembling, accurately clean the disc and the bearing contact surfaces.

- Mount the brake disc onto the bearing hub and fit the screw **(1)** and the wheel centring pivot **(2)**.



- Tighten the screw and the pivot to the prescribed tightening torque.
- As far as the rear disc is concerned, re-fit the service brake caliper (G 3.01) and the hand brake caliper (G 3.04), for the rear discs..

G2.06 HAND BRAKE



The braking effect is determined by a pair of calipers **(1)** which operate on the rear discs.
A lever **(2)** integral with the thrust piston, inside the caliper, transmits the movement to the external pad **(3)**.
The reaction on the disc allows the caliper structure **(4)** to move outwards, thereby pushing the pad **(5)** with its internal brackets and thus locking the wheel.
The transmission from the control lever **(6)** to the calipers uses metal wires which run inside the sealed protection sheaths.
The right cable **(7)** is connected to the left one **(8)** through an adjustable rod **(9)** which regulates the system's backlash (G 3.05).
For the proper working of the system, the transmission wires and their respective sheaths must be in good conditions, they must not be bended or crushed.
Periodically lubricate the wire part touching the pulleys **(10)**, **(11)** and **(12)**, on the calipers, on the control unit and on the transmission support **(13)**.
Replace the wire if it slides poorly within the sheath.

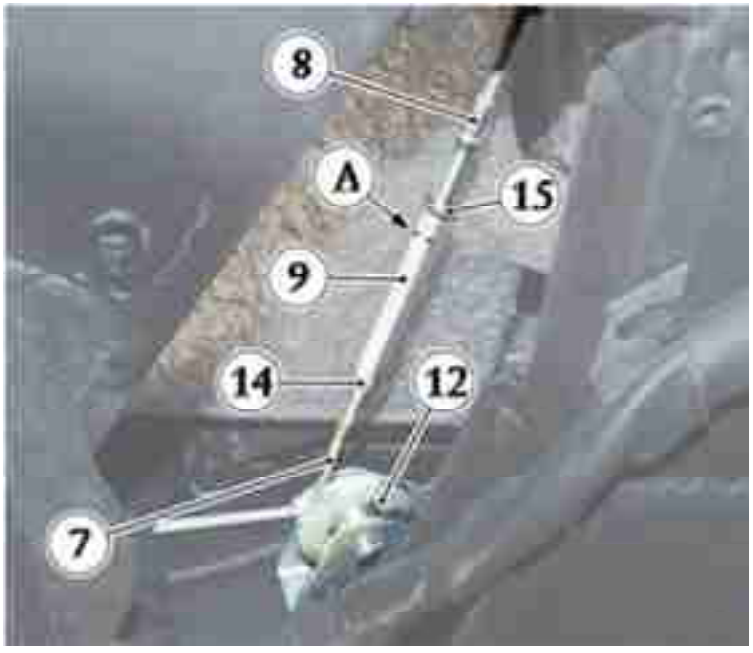
Wires replacement

Disassembly

- Remove the rear wheels (F 3.06).
- Remove the rear gravel guards (M 2.05).
- Remove the rear part of the underfloor (M 2.12).
- Detach the control lever together with the support bracket (H 2.10).
- Remove the ECU coverings behind the seats (M 3.04).

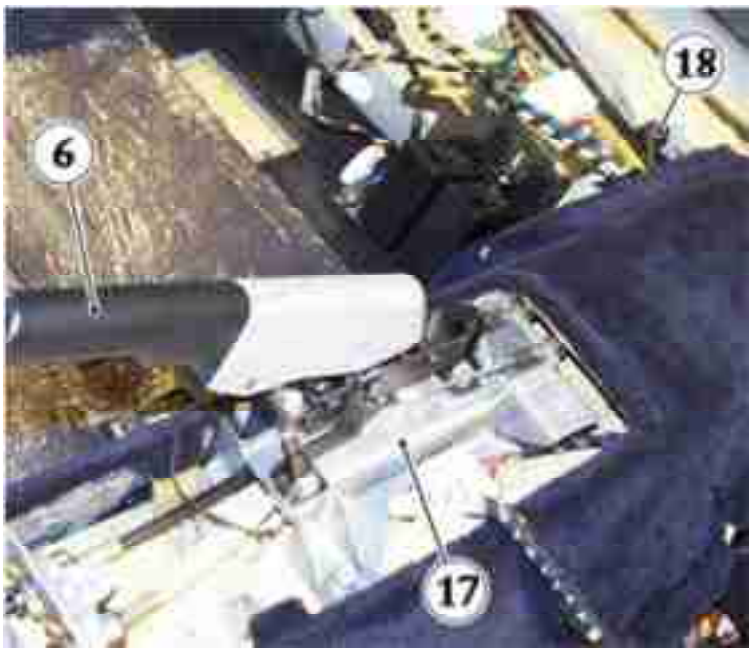
- Detach the transmission wires' joint from the levers **(2)** on the calipers.

- Loosen the lock-nuts **(14)** and **(15)** and rotate the adjustable rod **(9)** until the transmission cables joints are removed.
- Detach the support brackets **(16)** on the chassis.
- Remove the left-hand wire **(8)**.
- Slide off the right wire check bushes from the support **(17)** of the control lever **(6)**.
- Slide off the right wire **(7)** from the core hitches **(18)** on the car floor panel.

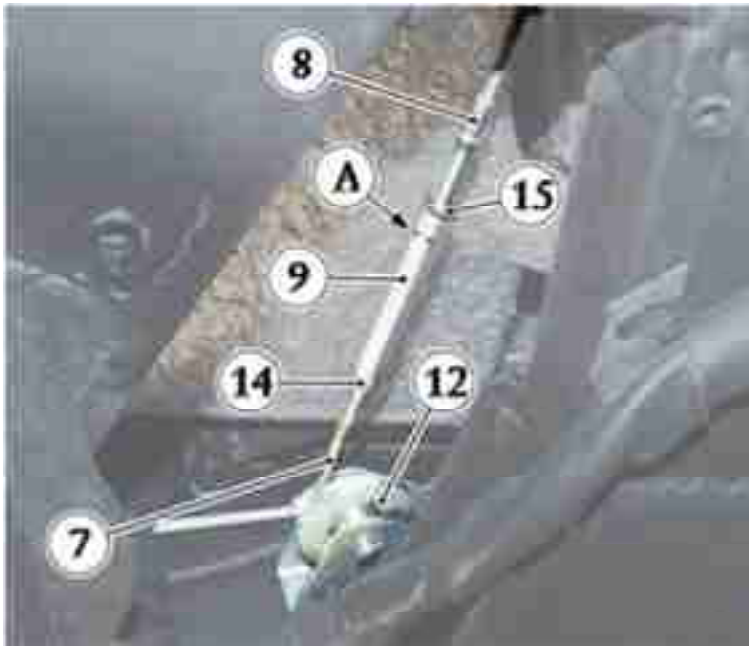


Re-assembly

- Fit the new right-hand wire into the core hitches **(18)** within the passenger compartment and lay it on the chassis structures; insert the check bushes into the support **(17)**.



- Fit the wire into the pulley **(11)** and mount the entire control lever once again.
- Position the brackets **(16)** onto the wires and fasten them to the chassis, without crushing the sheaths.
- Connect the wire terminals to the caliper levers **(2)**.
- Screw the lock-nut **(14)** onto the threaded terminal of the right wire **(7)** and the left-hand lock-nut **(15)** onto the left wire **(8)**.
- Screw the adjustable rod **(9)** onto the wire ends, placing it with the marked side **(A)**, which is endowed with lefthand thread, towards the wire **(8)** and then regulate the backlash (G 3.05).



- Re-assemble all the parts removed during the procedure.

G2.07 ABS/ASR ELECTRO-HYDRAULIC UNIT

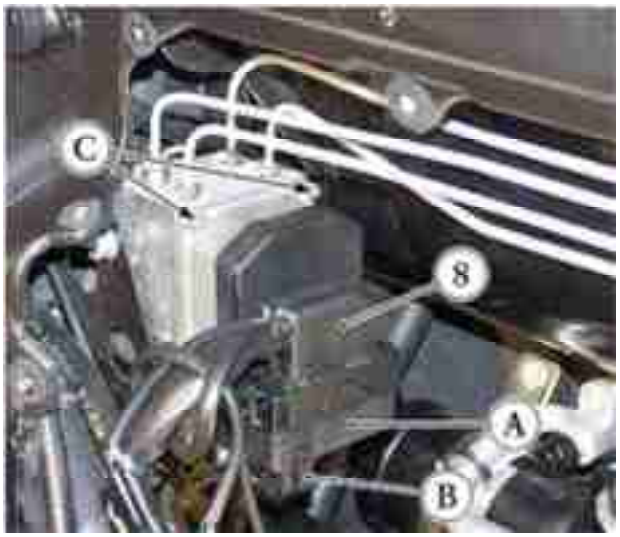
It is housed behind the luggage compartment's movable rear panel and is composed of a hydraulic part with an integrated cylinder and electro-magnetic valves, along with an ECU: the two parts can also be replaced separately.

NOTES

The operation and the description of the electro-hydraulic unit's and of the ABS/ASR ECU's internal parts are contained in the "ABS/ASR System" chapter of this section.

Tightening torques	Nm	Category
(M 10) unions		
Brake line unions for electro-hydraulic unit inlet (M 12)	**15**	**B**
Electronic ECU "Torx" fastening screws	**2,9 ±0,5**	
Dadi fissaggio gruppo elettroidraulico a telaio e staffa	**20**	**B**
Raccordo di spurgo	**14**	**B**

Replacing the ECU (A)



WARNING

Defects in the protective seal against external elements can cause the corrosion of the ECU components and magnetic valves as well as of the hydraulic unit. This can result in long-term uncontrollable damages which are not detected or displayed during the diagnosis.

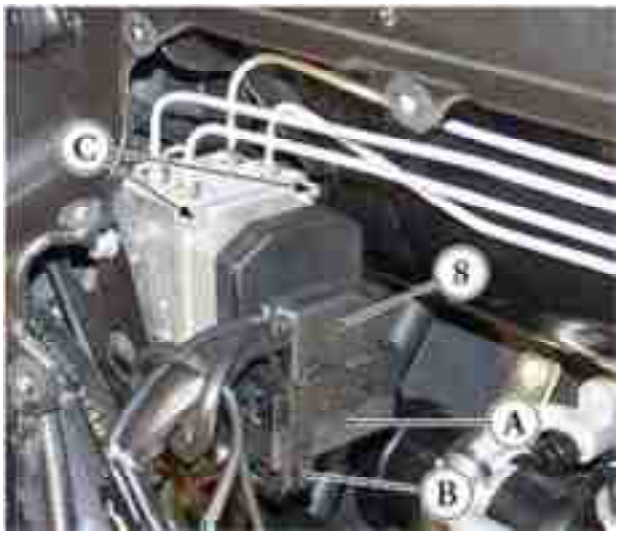
In the worst scenario, they can cause failures in the braking circuit or adjustment interferences in the ABS/ASR system, which play a major role for driving safety.

The tightness of the electro-hydraulic unit mainly depends on the state of the rubber seal, fitted between the two parts, and on the coupling surfaces.

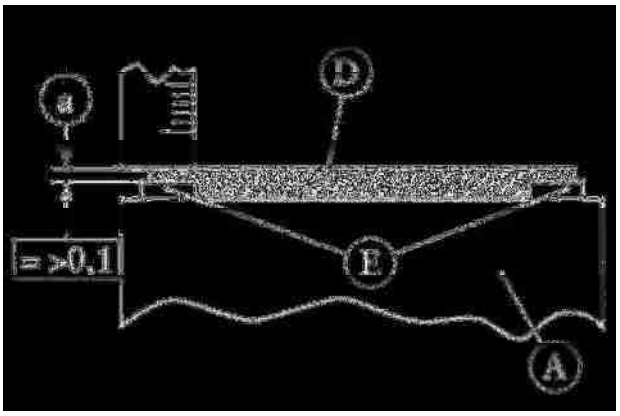
It is possible to replace the ECU only if the seal is in perfect condition and if the coupling surfaces are smooth, without grooving or scratches and without traces of the seal.

- Make sure that the ignition key is in the "OFF position".
- Remove the luggage compartment's movable rear panel (M 3.06).
- Detach the terminal board **(8)** from the ECU.
- Unhook the lock tang for the cylinder motor's power supply cable connector **(B)** and remove the said cable from the retaining clamp fitted under the electro-hydraulic unit.
- Unscrew the six "Torx" screws **(C)** which fasten the electronic ECU to the hydraulic unit.

IMPORTANT
These screws can be used a maximum of five times. Re-tapping the seats is not permitted.



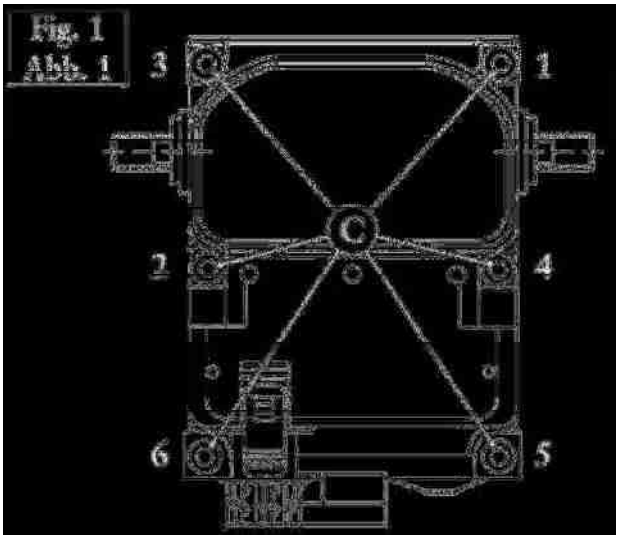
- Remove the ECU by detaching it in an upwards direction.
- Protect the open hydraulic unit to avoid damaging the internal valves and to avoid foreign bodies getting-in.
- Clean the coupling surfaces with a cloth which does not leave fluff.
- By running a finger along the surface, check the seal **(D)** for cracks and surface roughness and make sure the material has maintained its original elasticity.
- Using a cursor gauge, check the thickness **(a)** of the seal in respect of the relief eyelets **(E)**, which represent the ECU's seal surface's most protruding points **(A)**, is **= > 0,1 mm**.



- In fact, it is the consistency of the seal's thickness, in respect of these eyelets, which determines the tightness of the seal itself. If it is damaged, the ECU must be replaced, as the seal is an integral part of it and cannot be replaced individually.
- Check that the there are no residual traces of the seal on the hydraulic unit's coupling surfaces: if necessary, clean it with a plastic scraper and alcohol.

IMPORTANT
Do not use files, abrasive paper or metallic scrapers to restore the seal's surface.
Do not clean with aggressive solvents (tricloroetilene, petrol, etc) or compressed air.

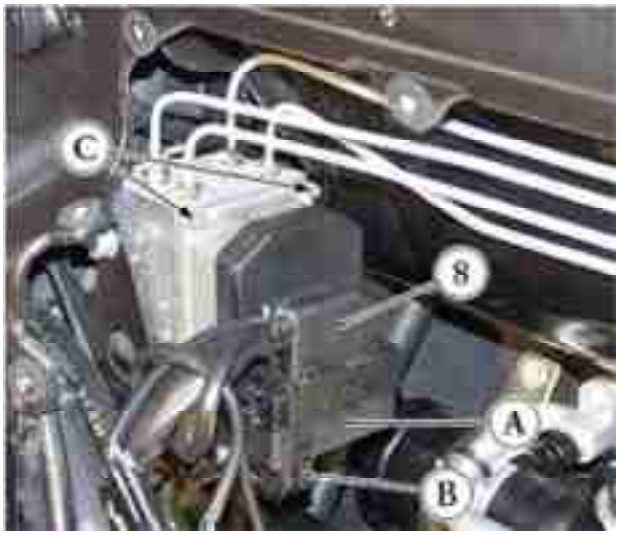
- Help the introduction of the ECU by positioning it with its coil side facing downwards, on the valve bodies, until it is flush.
- Use new "Torx" screws, supplied with the ECU replacement kit, and insert them into the specific seats, bringing them flush using a hand wrench. For the final tightening use a torque wrench with **1 Nm** precision and a range of **1÷12 Nm,** combined with a "Torx" screw extension, **T20** internal, **49 mm** in length.
- The screws **(C)** must be tightened gradually, working crosswise according to the diagram and following the sequence illustrated in **Fig. 1**, until the prescribed torque is attained.



IMPORTANT

Do not tighten the screws to an excessive torque as this could damage the seat's threading and make it necessary to replace the entire electro-hydraulic unit. On the other hand, an insufficient torque could cause the screws to loosen when the car is running and result in a malfunctioning of the braking system.

- Fit the power supply cable connector **(B)** for the cylinder pump onto the ECU, until the lock tang clicks in place. Position the cable in the specific retaining clamp. ECUs supplied as spare parts are not equipped with this clamp: in this case, remove the original one from the replaced ECU and reuse it.



- Once assembly is completed, turn the ignition key to "**ON**": the system's diagnosis warning light will come on and then turn off after **about 10 seconds**: this confirms that the system is working correctly.

IMPORTANT
After assembly, it is necessary to carry out a complete check cycle and possibly also a brake drainage (G 5.01).

Replacement of the Electro-hydraulic Unit

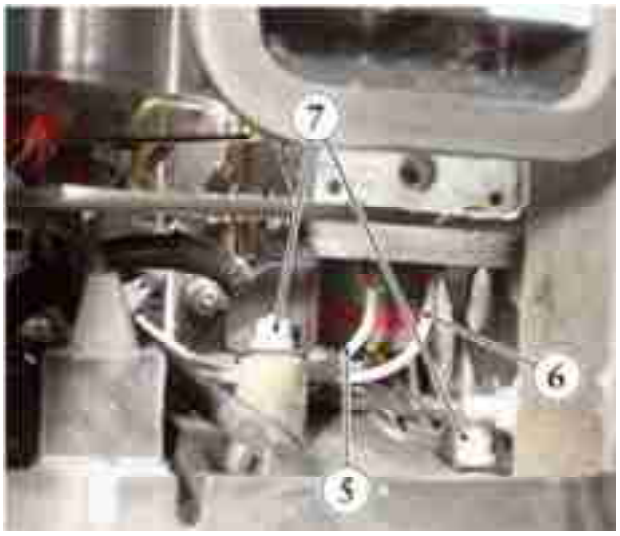
Preliminary procedures
- Remove the movable rear panel of the luggage compartment (M 3.06).
- Remove the windscreen wiper arms (M 2.07).
- Remove the support with the air conditioning system filter **(1)**.
- Remove the two brackets **(2)** fastening the lid's lock hook.

- Unscrew the nine screws fastening the windscreen shield.
- Remove it, sliding it off from under the windscreen outer strip, together with the drain pipes.
- Detach the positive terminal from the battery (A 3.28).
- Remove the battery master switch (_____).

Disassembly
- Drain the brake fluid by detaching the pipes **(3)** and loosening the drainage union **(4)** on the cylinder.

CAUTION
The fluid used in the braking system can cause injury to eyes and skin; in case of contact, rinse the body part involved with abundant running water. In addition, the fluid may damage the car's polished parts.

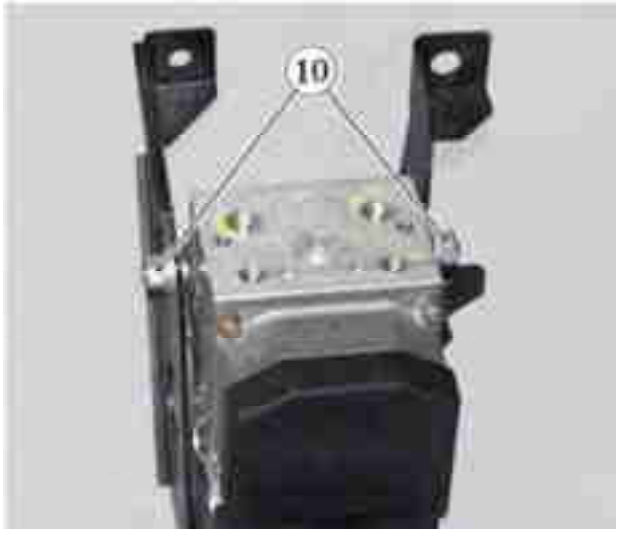
- Detach the pipes **(5)** and **(6)** connecting the front brake calipers from the right side panel of the electro-hydraulic unit.
- Slide them off the support brackets of the chassis and detach the pipes connecting the brake master cylinder to the rear calipers from the electro-hydraulic unit.
- Unscrew the two nuts **(7)** fastening the electro-hydraulic unit support to the chassis.



- Detach the terminal board **(8)** from the electro-hydraulic unit.

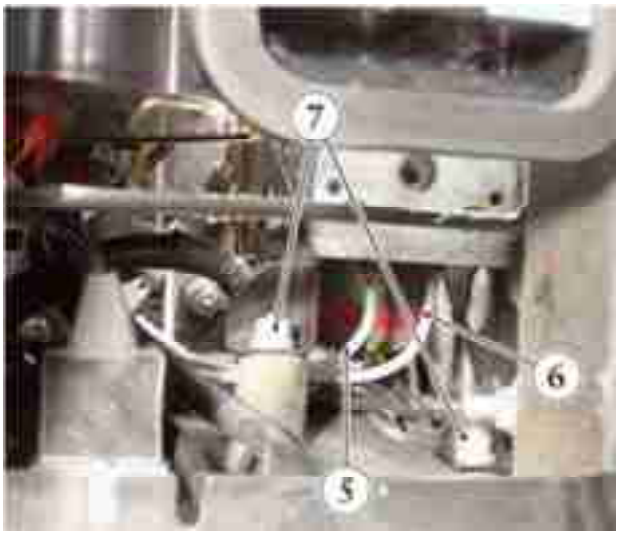
- Working from inside the mudguard, unscrew the nut **(9)**.

- Slide off the electro-hydraulic unit together with the support.
- Detach the unit from the support by loosening the side nuts **(10)** and sliding it off of the lower fastening pivot.



Re-assembly

- Position the entire unit in the car, fitting the support stud bolt into the chassis hole and tightening the nut **(9)**.
- Position the pipe unions **(5)** and **(6)** in the seats without locking them.
- Fasten the mount on the unit to the chassis with the nuts **(7)** and lock the nut **(9)** and the nuts **(7)** definitively to the prescribed torque.



- Tighten the pipe unions **(5)** and **(6)** to the prescribed torque.
- Connect the upper pipes to the electro-hydraulic unit, respecting the original position and inserting them into the support brackets.
- Tighten the unions to the prescribed torque.

- Re-fit the pipes **(3)** on the brake master cylinder, tightening the unions to the prescribed torque.

- Install the terminal board **(8)** onto the electro-hydraulic unit.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

IMPORTANT
The electro-hydraulic unit is supplied as a spare part with a complete oil refill. After assembly, a complete system check cycle must be carried out (G 5.01).

- To avoid infiltrations of water into the luggage compartment, when mounting the windscreen shield once again, the rear end must be inserted under the windscreen outer strip.
- Fill and **"electronically"** drain the braking system using the SD-2 system (G 3.02).
- Re-assemble all the parts removed during the procedure.

G3.01 REPLACING THE SERVICE BRAKE CALIPERS

Tightening torques	Nm	Category
Pipe union on caliper	**14÷17**	**B**
Coupling union between rigid pipe and flexible pipe	**14**	**B**
Screw fastening calipers to hub carrier and stub axle	**85**	**B**
Draining union	**12÷16**	**A**

CAUTION

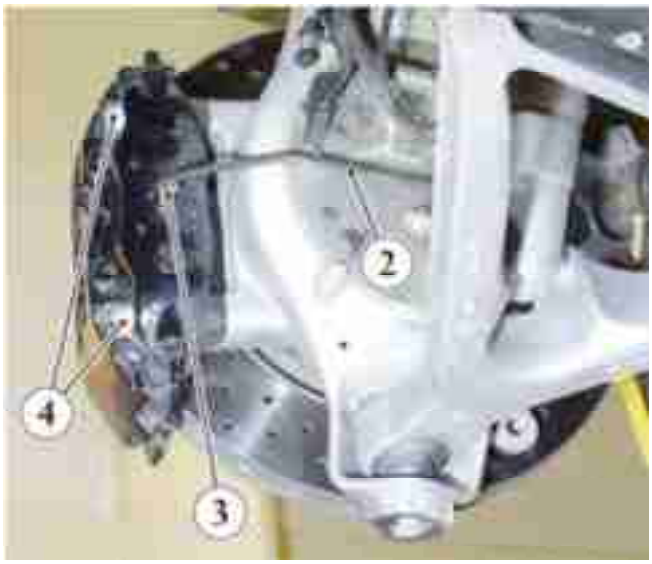
The fluid used in the braking system can cause injury to eyes and skin; in case of contact, rinse the body part involved with abundant running water. In addition, the fluid may damage the car's painted parts.

Front Caliper

Disassembly

- Detach the wheel and remove the brake pads (A 3.21).
- Slide off the clamp **(1)** fastening the hose union to the stub axle cover, in order to give play to the stiff pipe **(2)**.

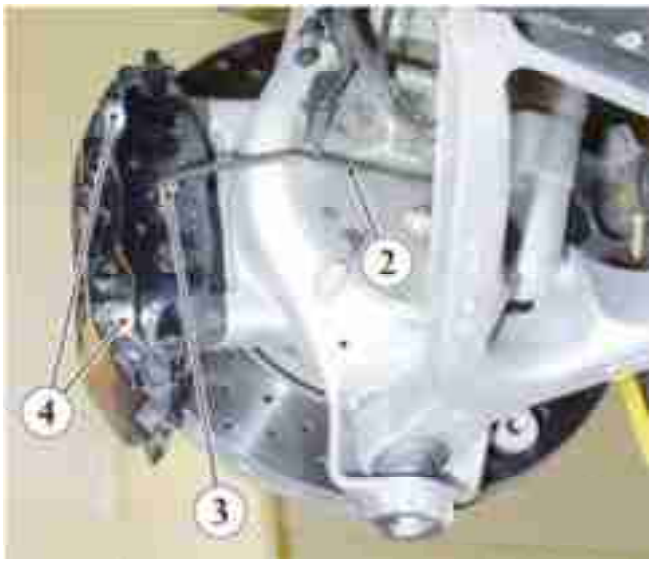
- Detach the stiff pipe **(2)** from the caliper by unscrewing the union **(3)** and then immediately plug the pipe or completely drain the fluid in the system.



- Unscrew the screws **(4)** fastening the brake caliper to the stub axle and remove the caliper.

Re-assembly

- Make sure the caliper and the axle supporting surfaces are clean and then insert the caliper into the disc and position the fastening screws **(4)**.
- Tighten the screws to the prescribed tightening torque
- Mount the stiff pipe **(2)** onto the caliper, locking the union **(3)** to the prescribed tightening torque.



- Mount the clamp **(1)**.

- Fill and drain the braking system (G 3.02).

Rear Caliper

Disassembly

- Detach the wheel and remove the brake pads (A 3.21).
- Unscrew the stiff pipe union **(5)** from the caliper's hose (**7**).
- Release the hose (**7**) from the retaining spring (**1**).

- Detach the hose (**7**) from the caliper.

- Unscrew the screws **(6)** fastening the brake caliper to the hub carrier and remove the caliper.

Re-assembly

- Make sure the caliper and the hub carrier supporting surfaces are clean and then fit the caliper into the disc and position the fastening screws **(6)**.
- Tighten the screws to the prescribed tightening torque.
- Fit the hose (**7**) on the caliper and tighten the union to the prescribed torque.

- Insert the end of the pipe into the bracket and fasten it using the spring (**1**).
- Mount the stiff pipe **(5)** onto the hose, locking the union to the prescribed tightening torque.

- Fill and drain the braking system (G 3.02).

G3.02 FILLING AND DRAINING OF THE BRAKE SYSTEM

Tightening Torques

The fluid used in the braking system can cause injury to eyes and skin; in case of contact, rinse the body part involved with abundant running water. In addition, the fluid may damage the car's painted parts.

- Remove the wheels (F 3.06) and the brake/clutch oil tank inspection cover (A 3.18).
- Always use new fluid, of the prescribed type and quantity, (A 1.02), drawn from unopened containers

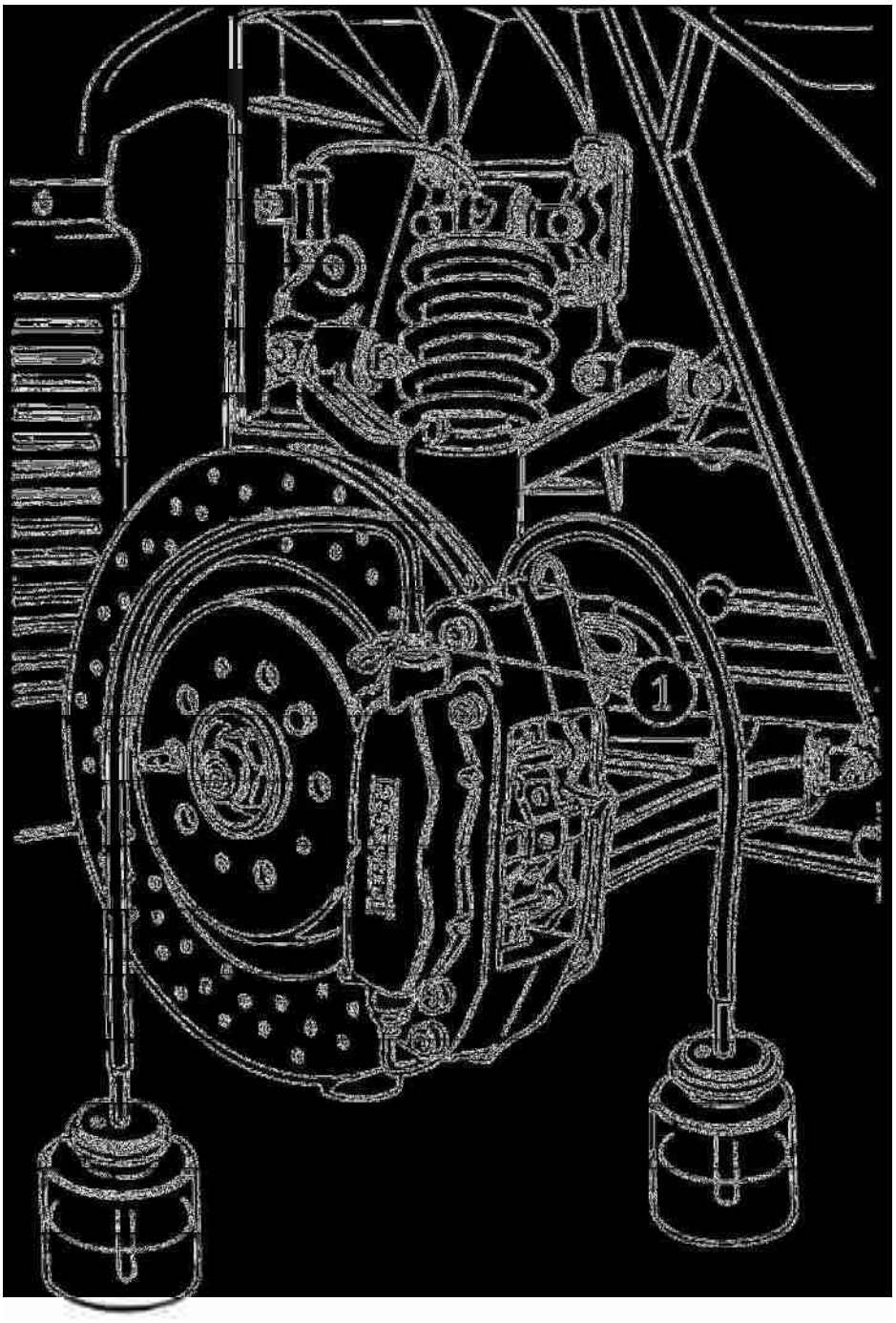
IMPORTANT

The (A) symbol on the tank indicates the presence of synthetic fluid in the circuit. The use of mineral fluid may irreparably damage the rubber gaskets in the system.

- Fill the tank, keeping in mind during the draining procedure that the level must not drop under the MIN level notch indicated on the tank.

- The **"electronic"** draining of the braking system must be carried out with the help of the SD-2 tester by means of the special active diagnosis function (G 5.01).
- Carry out the procedure by starting preferably with the rear brakes, draining one caliper at a time.
- Install a transparent plastic pipe on each caliper drainage union **(1)**.

Note
When draining the ASR system, it is advisable to use the drainage unions inside each rear caliper.



- Dip the end of the pipe into a brake fluid container.
- Control the sequence of pulses through the SD-2 tester and work on the brake pedal, to deliver pressure to the circuit, until the air present in the circuit itself is completely eliminated and the circuit is filled.
- Tighten the drainage unions **(1)** to the prescribed torque and fit in the special hood.

If the system has been completely drained and, following the caliper draining, the pedal seems elastic, the brake master cylinder - which represents the highest point of the circuit - must be drained.

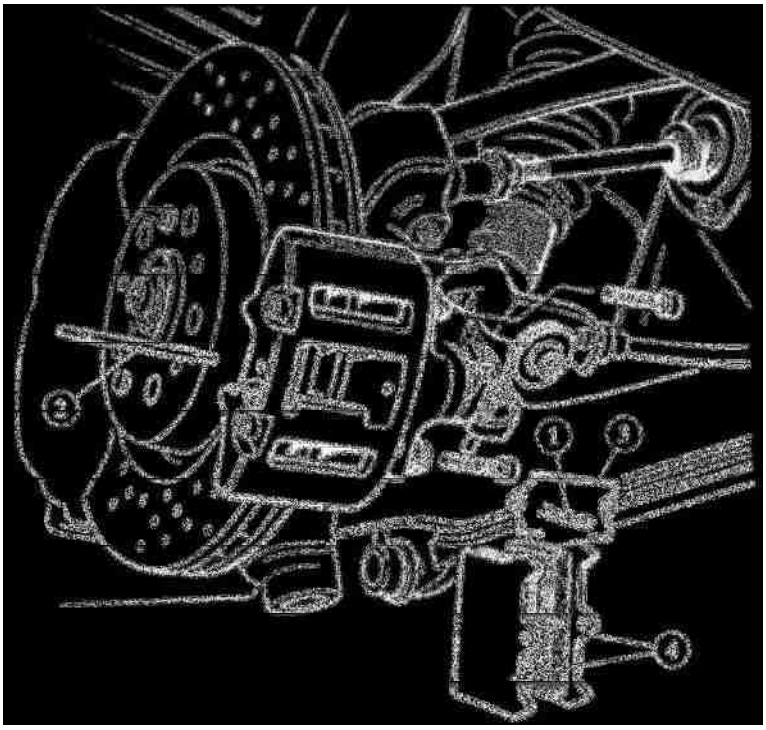
- Remove the movable rear panel of the luggage compartment (M 3.06).
- Fit in the transparent pipes used for the caliper draining onto the cylinder unions **(2)**.

- Drain the cylinder, using the SD-2 tester.
- Tighten the drainage unions **(2)** to the prescribed torque and fit in the special hoods.
- Top-up the fluid in the tank to the MAX level and re-assemble all the parts removed during the procedure.
- When the procedure has been completed, the pedal should not prove to be elastic and the braking effect must be progressive, soon after the short idle travel of the pedal.

IMPORTANT

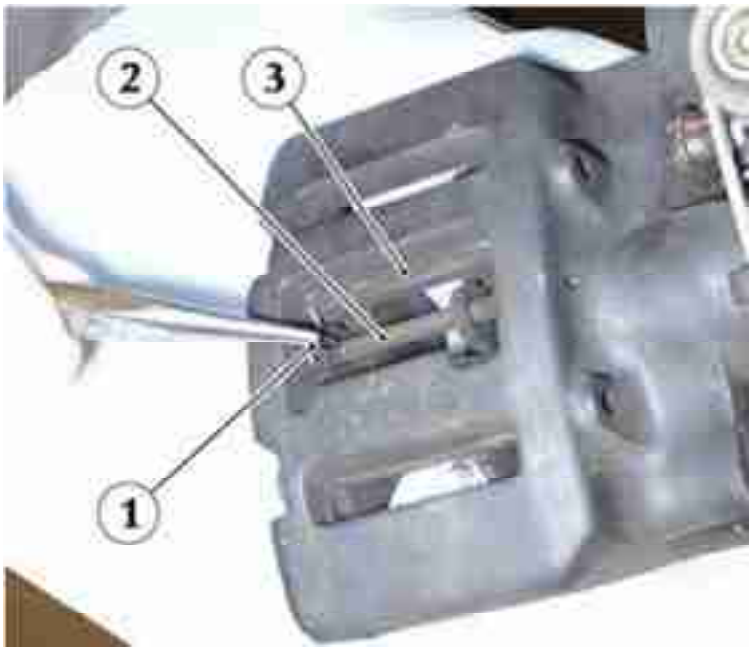
If mounting new pads, the bedding procedure must be carried out, (A 3.21) in order to increase the grip of the friction surfaces and to keep the braking performance constant during the whole life of the pads.

G3.03 REPLACING THE HAND BRAKE PADS

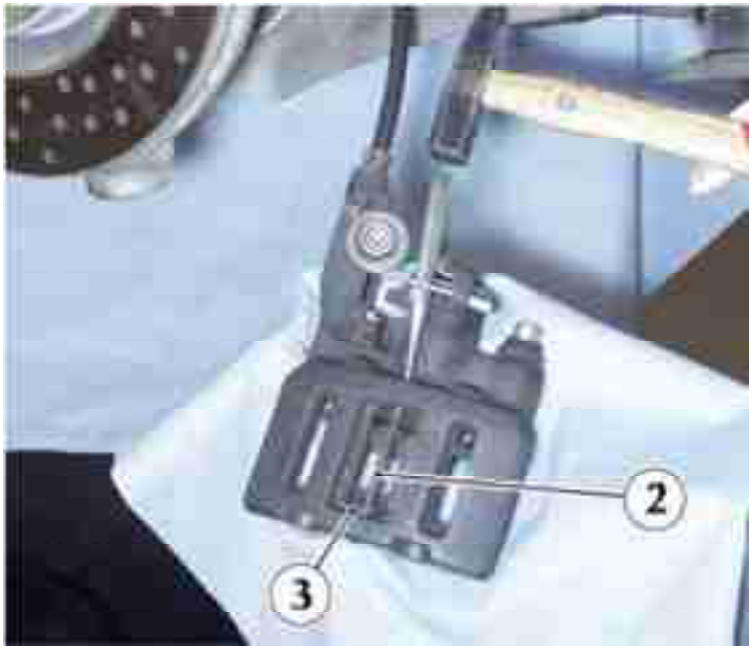


Disassembly

- Remove the rear wheel (F 3.06).
- Make sure the control lever is in the resting position.
- Detach the brake caliper from the hub carrier, (G 3.04), keeping it connected to the control wire.
- Slide off the check split pin **(1)** of the pivot **(2)**.



- Rivet the pivot **(2)** from the inside of the caliper and remove the retaining clamps **(3)** on the pads.



- Remove the worn out brake pads from the caliper.

Re-assembly

- Fit the new pads **(4)** into the caliper.

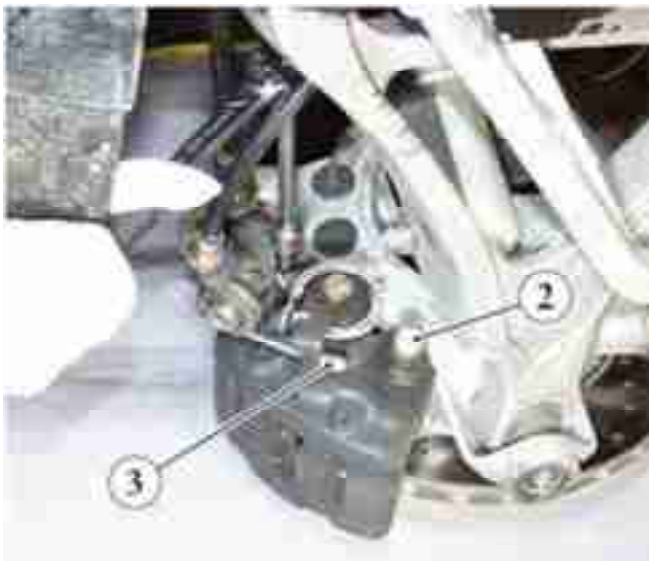
- Position the pad holding clamp **(3)** in the caliper seat and mount the pivot **(2)** from the outside, until it is tightly fitted in its seat.
- Fit a new split pin **(1)** into the pivot seat.
- Re-fit the caliper onto the hub carrier (G 3.04).
- Check to see if the control functions properly, making sure the disc rotates freely with the lever in the resting position, and that it stops when the lever is engaged (G 3.05).

G3.04 REPLACING THE HAND BRAKE CALIPER

Tightening torques	Nm	Category
Screw fastening tie-rod for toe-in regulation to chassis	**25**	**B**
Screw fastening parking brake caliper (M8x1,25)	**30**	**B**
Screw fastening parking brake caliper (M10x1,25)	**70**	**B**

- Before disassembling, clean the caliper with pressure steam to remove the dust which appears when the brake pads wear out. Dry with compressed air.

Disassembly
- Remove the rear wheel (F 3.06).
- Make sure the control lever is not been engaged.
- Detach the transmission wire terminal **(3)** from the lever driving the piston.



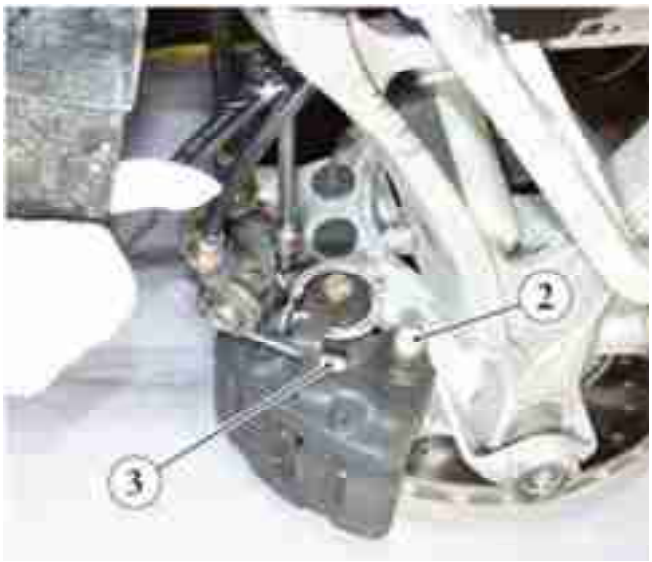
- Detach the rear toe-in regulation tie rod from the chassis, unscrewing the three fastening screws **(1)**.

- Rotate the side with the hub carrier caliper towards the outside, in order to have access to the screws fastening the caliper.
- Unscrew the upper and the lower screw **(2)**.
- Slide off the caliper from the hub carrier.
- Under these conditions, the brake pads can be replaced (_____).

Re-assembly

- Make sure the contact surfaces on the caliper and the hub carrier are clean and mount the caliper.
- Tighten the fastening screws to the prescribed torque.
  Mount the rear toe-in regulation tie rod once again onto the chassis, tightening the fastening screws **(1)** to the prescribed torque.

- Insert the wire terminal **(3)** into the control lever.

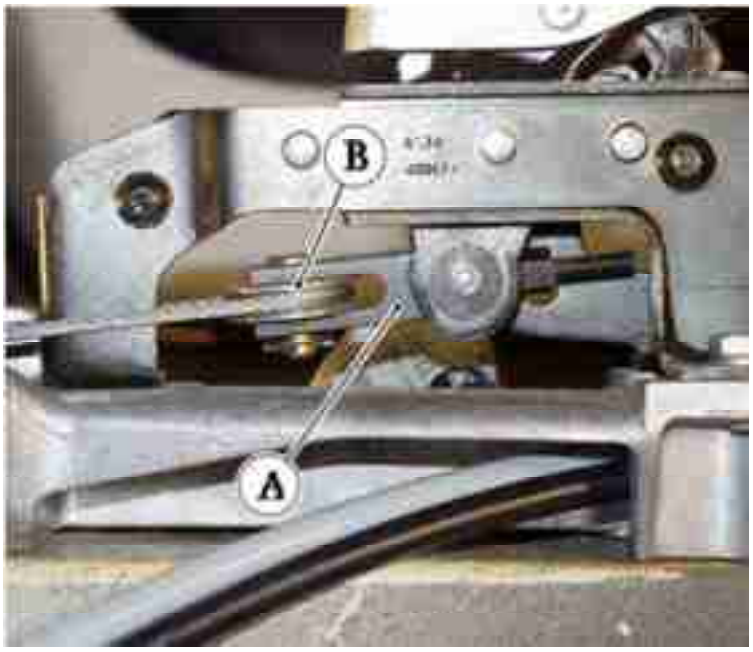


- Check to see if the control functions properly, making sure the disc rotates freely with the lever in the resting position, and that it stops when the lever is engaged (G 3.05).

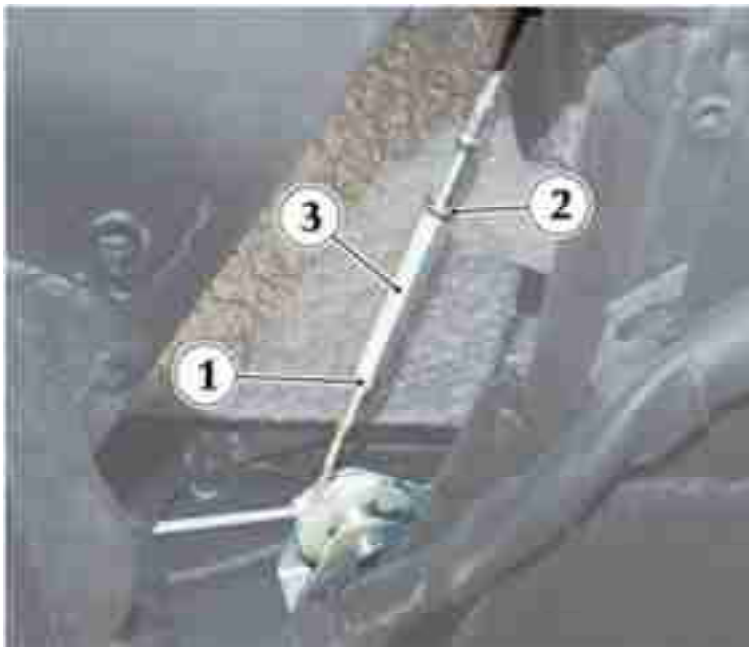
G3.05 HAND BRAKE ADJUSTMENT

Before proceeding, check for the failure causes.

- Remove the rear part of the underfloor (M 2.12).
- Make sure the control lever is in the resting poisiton (zero clicks).
- Adjust the position of the fork **(A)** so that there are no interferences with the pulley **(B)**.



- Move the control lever to the second click.
- Working from under the car, loosen the lock-nuts **(1)** and **(2)**.
- Screw down the adjustable rod **(3)** until the rear brake discs are locked.

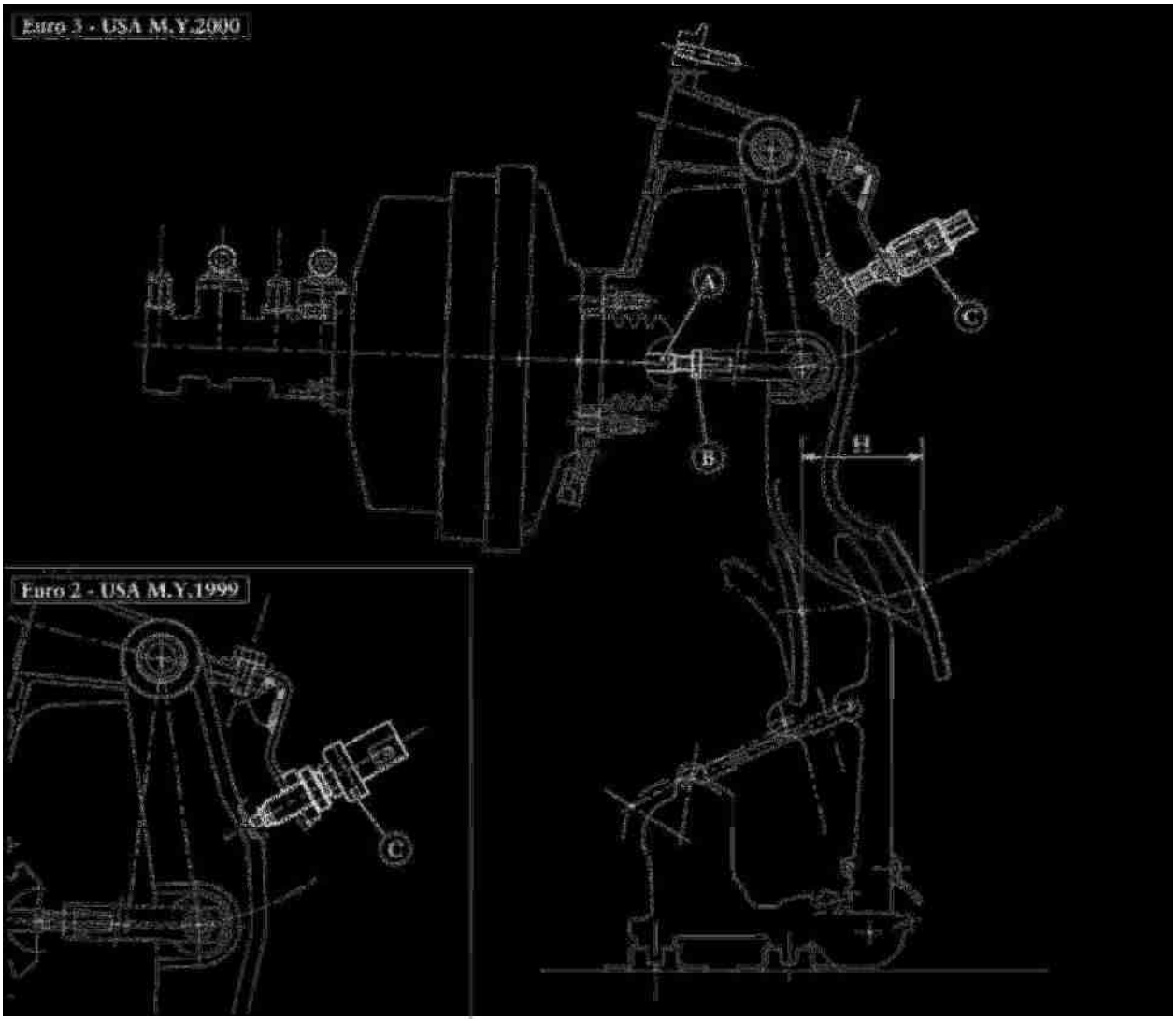


NOTES

Due to the friction of the wires, the left disc usually locks first: this has to be considered a regular working order.

- Move the control lever once again to the resting position (zero clicks).
- Make sure both discs rotately freely.
- Tighten the lock-nuts **(1)** and **(2)**, bucking with the sleeve.
- Re-assemble all the parts removed during the procedure.

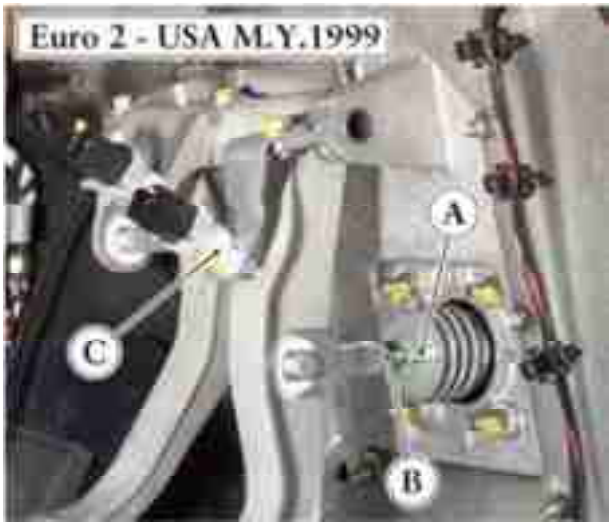
G3.06 ADJUSTING THE BRAKE PEDAL AND BRAKE SWITCH POSITION



If the control pedal and/or the servo brake is being replaced, the pedal resting position must be adjusted.

- The total stroke **(H)** of the foot-brake pedal, measured at the centre line of the foot rest plate, must be **74.6 mm**.

- To modify the pedal resting position, loosen the lock-nut **(B)** and turn the adjusting screw until the pedal is in the right position; then tighten the lock-nut.

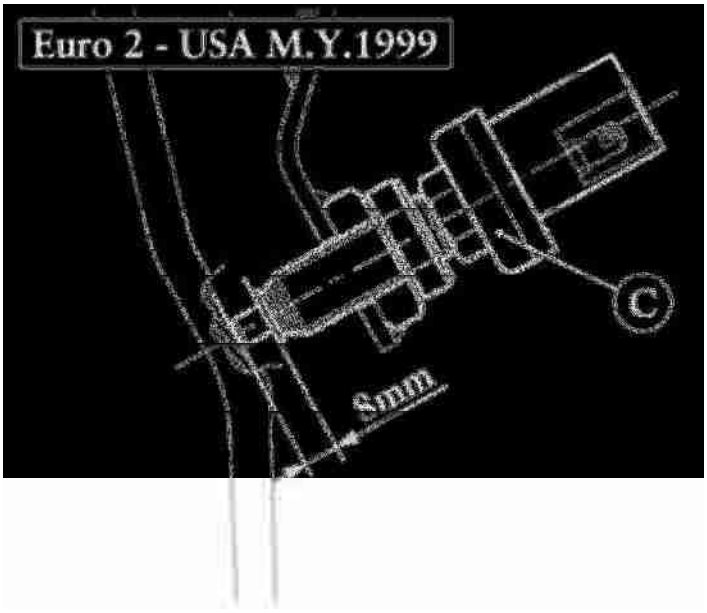


- After modifying the position of the brake pedal, adjust the switch **(C),** as described in the following chapter.

Adjusting the brake switch

Euro 2 - US M.Y. 1999 version

- With the foot-brake pedal in the resting position, the lower end of the switch **(C)** must be positioned at **8 mm** from the push button on the pedal.



From Euro 3 - US M.Y. 2000 version

The twin contact brake switch **(C)** is fitted on the pedal board mount by means of a mounting bracket **(D)**, near the brake pedal coupling on the pedal board mount.

To adjust the switch, proceed as follows:

- Without disconnecting the wiring from the switch, turn the switch **(C)** 90° anticlockwise until it detaches from the mounting bracket **(D)**.
- Completely remove the switch from its mounting bracket.

- Grip the body of the switch with one hand and the black button with the other and pull hard to remove it completely.

- Using a **2 mm** blade of a feeler gauge, rest it on the brake pedal body, in position with the hole of the switch mounting bracket **(D)** .

- Fit the switch back into its mounting bracket .
- Push the switch so that the black button touches the suitably positioned feeler gauge.
- Push until the white body of the switch touches the mounting bracket. The black button will simultaneously self-adjust to the correct position (you should hear the adjustment clicks of the button).

- Holding the feeler gauge firm, turn the switch 90° clockwise, so that it locks into place on the mounting bracket.

- Remove the feeler gauge taking care to pull it parallel to the resting surface, in order not to affect the switch adjustment.

Inspection

- Connect the SD2 tester, access "Motronic/Parameters/FLAG Parameters" and check that, with the foot only resting on the brake pedal, the switch status is “NOT PRESSED”
- Then press the brake pedal and check that the status changes to “PRESSED

G4.01 ASR THEORY

The braking system is supported by the ABS/ASR **Bosch 5.3** system.
This system, integrated in a single electro-hydraulic control unit, is able to carry out four different functions:

- **ABS:** wheels' anti-lock braking system
- **ASR:** anti-skidding regulation during the acceleration phase
- **EBD:** electronic brake-force distribution, for the rear axle
- **MSR:** rear wheels' anti-lock system during gears down-shifting

Accordingly, the four systems shall be described separately.
In addition, to guarantee sufficient safety in case of ABS/ASR system failures, these systems only integrate and do not replace the normal mechanical braking system.

ABS system

The ABS anti-lock system actively enhances driving safety by intervening in those emergency situations where the driver tends to lock the wheels by pressing the foot-brake pedal too strongly.
In fact, when braking causes the wheels to lock, the road-tire grip coefficient decreases dramatically, the car is practically out of control and the braking distance increases considerably.
The purpose of the ABS system is therefore to help the driver modulate braking in extreme conditions, i.e. in situations where he/she would cause the wheels to lock.

Therefore, an electronic system which controls skidding during braking offers the following advantages:
1-Driving stability (no skidding) even with sudden braking, up to the wheel-lock threshold.
2-Manoeuvrability (no side-skidding with sharp deviations). This means that even if braking in an emergency case, the driver has the possibility to avoid the obstacle. Furthermore, it is possible to brake in a curve without jeopardising the car's stability.
3-Optimum braking distance: a wheel which continues to rotate features a higher grip than a locked wheel. Depending on the type of road bed, the braking distance may be reduced by as much as **40%**.

CAUTION
The ABS device does not exempt the driver from driving carefully. It cannot, in fact, make up for excessive speed with respect to the traffic conditions, the road bed, worn out tires or brake parts, or even driving errors.

The variables detected by the ABS system to intervene "strategically" are essentially two:

- Car speed **(Vf)**
- Wheel peripheral speed **(Vr)**

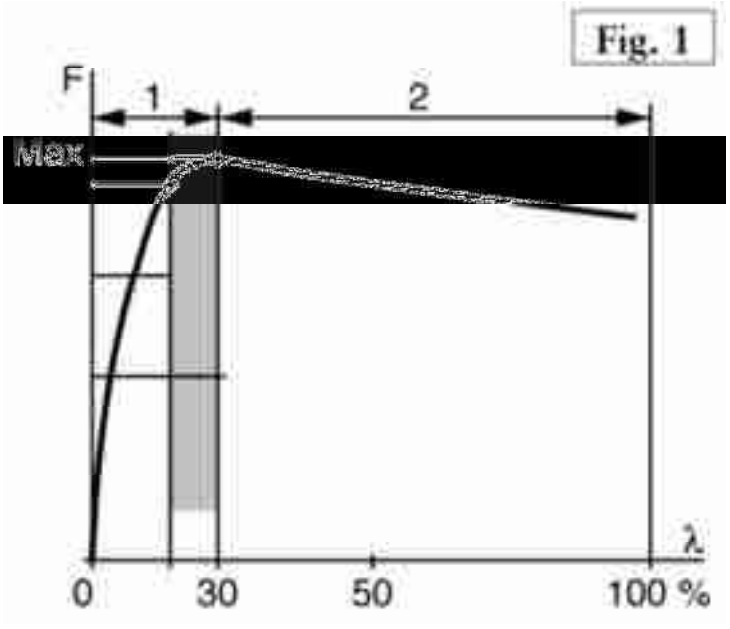
A third variable, obtained from the above ones, expresses skidding between tire and road bed. The skidding **(I)** can be expressed in mathematical terms with the formula:

$$\lambda = \frac{Vf - Vr}{Vf} \times 100$$

The formula shows that:
λ **= 0** when the wheel is turning at the car running speed **(Vf = Vr)**
λ **= 100** when the wheel is locked.

Four sensors, located on the four wheels, constantly signal the velocity of each wheel to the ECU, while the car speed **(Vf)** is obtained from the velocity of two diagonally opposite wheels.

Experimentally, it is possible to develop a diagram of the brake force as a function of the skidding **(Fig**. **1)**, considering a specific value for the friction coefficient - that is, considering a certain coupling between tire and road bed.



*Keys to **Fig. 1***
F - Brake force
λ Skidding
1 - Stable brake force-skidding characteristic
2 - Instable lateral force-skidding characteristic

This diagram shows that when λ **= 0** (wheel speed = car speed) the brake force is obviously zero.

When λ **= 100** (locked wheel) the brake force takes on a high value, which is however lower than the maximum obtainable value - that is, the point where the maximum brake force is transmitted, which corresponds to a skid value of approximately **10-30%**.

Braking remains stable with all skid values preceding this one, while it becomes unstable with the values following skidding.

The ABS system must therefore adjust braking so that the brake force is kept within the stability values.

To understand the changes occurring when the road bed varies, please see **Fig**. **2** diagram. This diagram shows the various trends of the brake force with respect to the various friction coefficients.

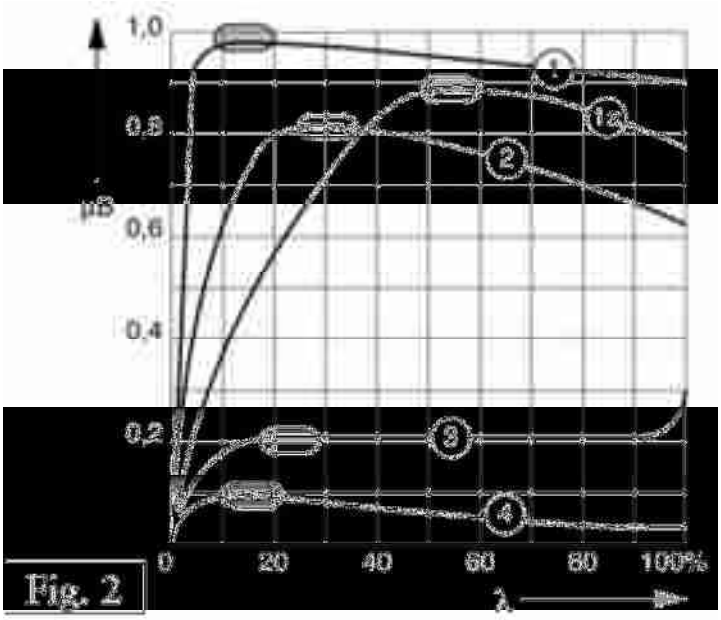


Fig. 2

*Keys to **Fig. 2***
μB - Brake force
λ - Skidding
1 - Dry asphalt
1a - Dry asphalt with 10∞ steering angle
2 - Dry asphalt with snow tires
3 - Roadbed with fresh snow or sand
4 - Iced roadbed

Note that the maximum value of the braking moment is reached, depending on the different conditions of the road bed, for skid values comprised between **10** and **50%**.

Therefore, if a braking adjuster must provide the optimum braking distance at all times, it must not be activated at a pre-established skid value; it must instead regulate the braking power so that the maximum curve-braking force-skidding ratio is obtained under the different existing conditions.

For this reason, the electronic logic of the ABS system calculates deceleration or acceleration on the basis of the in the car speed **(Vf)** time variation, it obtains the skidding value **(λ)** and recognizes the road bed grip. According to the road bed conditions, it gauges the skidding thresholds allowed, in order to decide how to intervene.

The ABS system is also able to recognize an **"acquaplaning"** condition. Under this condition, greater skidding is allowed. In fact, since aquaplaning is a transitory phenomenon, it would be dangerous to decrease the breaking power too much, as the braking distance would be lengthened, once the acquaplaning condition is exhausted.

With locked wheels, improved braking efficiency is obtained only with fresh snow. This is due to the snow wedge piling-up in front of the wheel. In any case, the greatest advantages of the ABS system are driving stability and above all the possibility of changing direction.

The ABS system is considered as an addition to the normal braking system since it operates with the same fluid used in the traditional mechanical circuit, without altering its basic characteristics.
It is activated when the velocity exceeds **12 km/h** and it is de-activated when the speed drops below **6 km/h**.
The reference datum is the wheel speed, detected by the sensors: when one of the wheels reaches the start-lock condition, the ABS acts on the braking hydraulic circuit pressure through a cycle which essentially consists of 3 phases:
- Reduction (if necessary)
- Maintenance.
- Increase.

These adjustment phases are cyclically repeated in case of braking with the ABS system, until the car is at a standstill or until the pressure on the pedal decreases and the skidding values exceeding the threshold levels are reset.

The adjustment takes place by controlling the front wheels separately and using the **"select-low"** principle for the rear wheels to help the car stability.

ASR System

This system, integrated with the ABS, prevents the driving wheels from skidding during acceleration.
This goal is obtained by reducing the driving wheels torque, on the basis of the skidding conditions, by means of two different control systems:

- *Brake intervention*

When the two driving wheels skid very differently, the system operates on the hydraulic pressure in the brake calipers of the driving wheels, amplifying the effect of the self-locking differential. This way the traction is improved.

- *Engine intervention*

When the driving wheels feature the same skidding conditions, the system also communicates with the engine injection-ignition ECU in order to adjust the driving torque, automatically and independently from the position of the accelerator pedal and under the existing grip conditions. This procedure is carried out by the engine ECU, which operates on the following parameters:
A: reduction of the spark advance
B: injection-ignition cut-out
C: reduction of the throttle opening angle

The ASR system helps increasing the car stability and safety when driving, especially under the following conditions:
1- skidding on a curve due to the dynamic variations of the vertical load and the excessive acceleration (avoids power oversteering);
2- excessive power transmitted to the wheels based on the roadbed conditions, especially on average-low grip roadbeds (water, snow, ice).

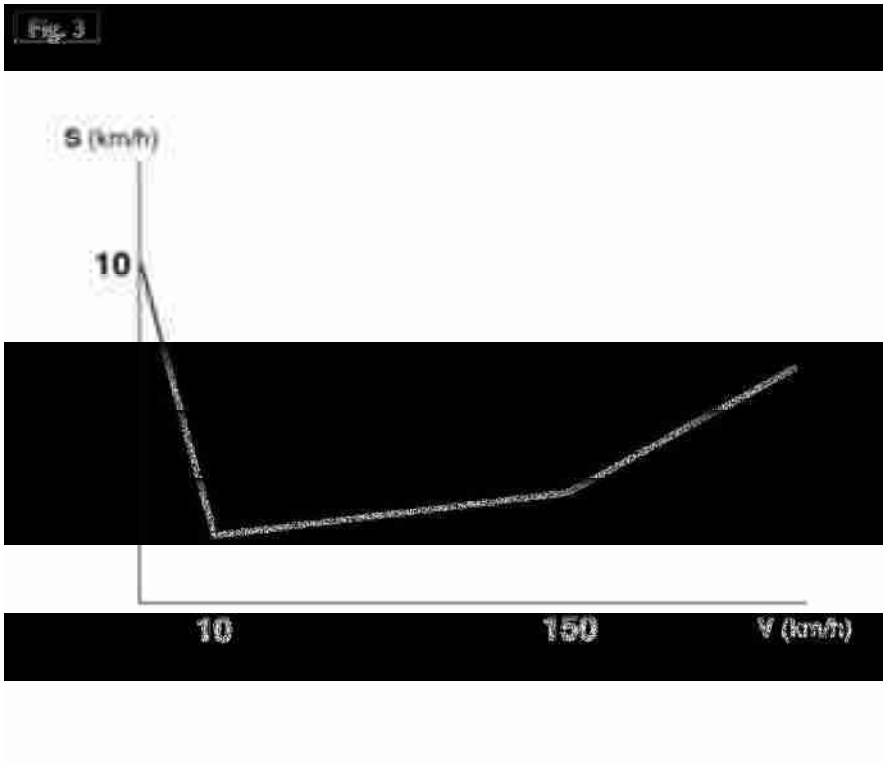
ASR Theory

The variable that the ASR system checks and detects as adjustment reference is the skidding value **(S)** between the rear and the front wheels. This value is defined as follows:

S = **V**rw - **V**fw
where:
Vrw is the velocity of the rear wheel;
Vfw is the velocity of the front wheel.

Starting from the wheel speed levels, the ECU continuously monitors the skidding value. If **(S)** exceeds specific, predefined thresholds (**Fig. 3** and **4**), the control unit operates on the brakes and/or the engine in order to bring the skidding level back to the prescribed thresholds.

Under particularly low grip conditions (ice), with frequent ASR intervention, the engine ECU **(Motronic ME7.3)** cuts out the fuel to protect the catalytic converters.
This occurs because frequent intervention on spark advance may overheat the main catalytic converters.



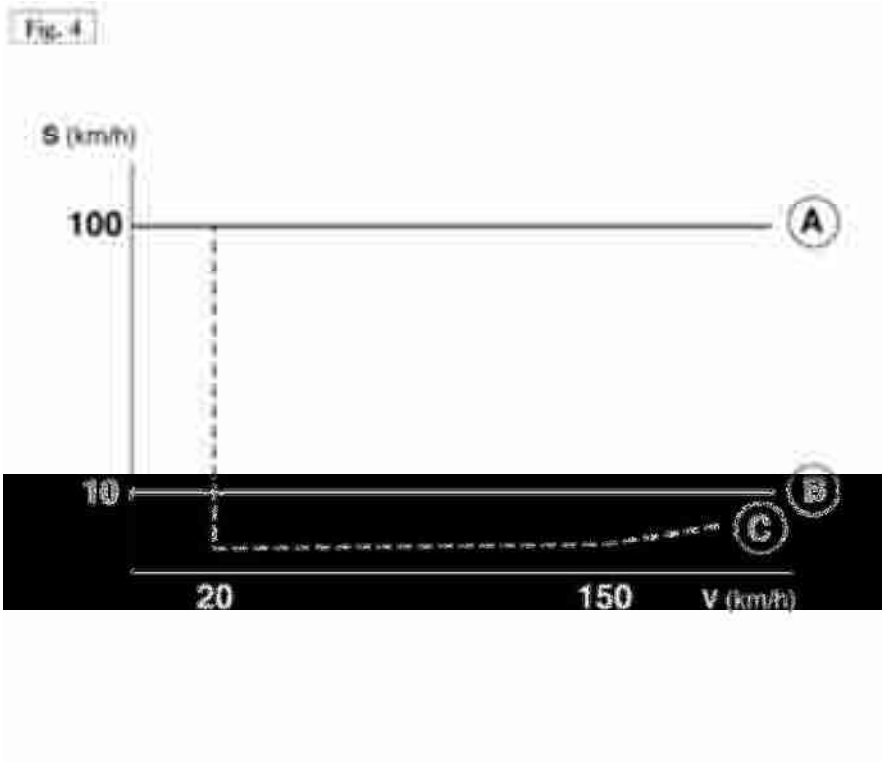
*Keys to **Fig. 3** (NORMAL skidding threshold)*
S - Skidding
V - Car speed

ASR Operation

The ASR system is activated each time the ignition key is turned to the **"II"** position.
The device provides two setting curves for the skidding thresholds, that may be selected by means of the switch **SPORT** (**1**).

The ASR works in parallel with the suspensions and gearbox (only the electronically-controlled version) regulation system:

- with push button on the off position (lever 1 up: **NORMAL**),the ASR intervention supports stability under low and average grip conditions;
- with the push button activated (lever 1 down: **SPORT**) the system works straight-line only on the brakes and supports traction, optimizing the performance of the car and simultaneously maintaining, in any case, a sufficiently safe margin (only on high-grip road beds) for power skidding.



*Keys to **Fig. 4** (SPORT skidding threshold)*
A - Straight-line intervention on engine
B - Straight-line intervention on brakes
C - Intervention on engine and curve brakes
S - Skidding
V - Car speed

CAUTION
Do not select the SPORT setting in case of low and average grip (eg. on icy, wet, or sandy roads) in order to prevent reckless manoeuvres from compromising the car's stability.

ASR intervention on the brakin stem

Should one or both of the driving wheels start to skid, the ECU will **(11)**:
- supply the hydraulic unit cylinder **(1)**;
- excite the pilot solenoid valve **(3)** "NO"
- excite the intake solenoid valve **(2)** "NC"

The pressure generated by the cylinder **(1)** reaches the brake caliper **(4)** passing through the supply solenoid valve **(6)** **(Fig. 5)**.

*Keys to **Fig. 5** (ASR ON)*
1 - Cylinder
2 - Intake solenoid valve
3 - Pilot solenoid valve
4 - Caliper
5 - Exhaust solenoid valve
6 - Supply valve
7 - Electric control motor
8 - High pressure accumulator (dampening chamber)
9 - Check-valve
10 - Low pressure accumulator (reservoir)
11 - Electronic Control Unit (ECU)
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

At this point, the modulation of the brake caliper's control pressure **(** takes place through the opening and closing of the intake **(6)** and exhaust **(5)** solenoid valves.
In practice, the ECU**(1)**, which exerts a lower pressure on the brake caliper, excites the intake solenoid valve **(6)** "NO" and the exhaust solenoid valve **(5)** "NC". In this way, it opens the secondary circuit, thereby causing the pressure to drop **(Fig. 6)**.

*Keys to **Fig. 6** (ASR ON)*
1 - Pump
2 - Intake solenoid valve
3 - Pilot solenoid valve
4 - Caliper
5 - Exhaust solenoid valve
6 - Supply valve
7 - Electric control motor
8 - High pressure accumulator (dampening chamber)
9 - Check-valve
10 - Low pressure accumulator (reservoir)
11 - ECU
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

ASR cut-out

By means of the ASR cut-out switch **(2)**, it is possible to deactivate the skidding control function during acceleration.

The control unit which manages the cut-out signals the request to the ABS/ASR ECU. This state remains stored as long as the key is in the **"II"** position: when the car is re-started, the device resets, thereby restoring the system's operation.

This does not take place when the SPORT switch is turned on: in case of average-low grip, the car's stability in reckless manoeuvres is not guaranteed.

IMPORTANT

In any case, it is advisable to keep the ABS/ASR integrated system always activated when driving the car.

EBD Electronic Brake

The peculiarity of the ABS/ASR **Bosch 5.3** system lies in that its management software includes an EBD (electronic brake-force distribution) control device which distributes the brake force between the rear and the front wheels.
The presence of this control increases the car stability, thereby guaranteeing the car's maximum deceleration, on the basis of the existing grip conditions.
As shown in the graph (**Fig. 7**), the force on the rear calipers is modulated in order to follow the ideal grip curve. In addition, the graph shows the recovery of the brake force which, with a traditional mechanical control device, would be unused.

*Keys to **Fig. 7***
BFra – Rear axle brake force
BFfa – Front axle brake force
μ_{ra} – Rear wheel grip
μ_{fa} – Front wheel grip
A – Ideal brake force distribution
B – Distribution realized by the braking system
C – EBD intervention
D – Brake force distribution using traditional mechanical distributors
Z_{max} – Brake force maximum value
Z_{crit} – Critical point for brake force distributor intervention start

In case the ABS system fails to work properly, the warning light on the dashboard lights up, but the EBD system still functions, allowing the driver to reach the first service workshop in reasonably safe conditions.

If the ASR/ABS and brake failure warning lights turn on simultaneously, this means that the EBD no longer functions. In this case, the driver should stop the car and have it towed to the nearest service centre. The car can still run without the EBD system but in the event of a deceleration exceeding **0.5 g** approximately, the rear wheels would lock.

MSR System

This system is integrated in the ASR system and prevents the rear wheels from locking due to the engine brake, in case the accelerator pedal is released suddenly or gears are down-shifted, especially on roadbeds with average to low grip conditions.

ATTENZIONE

By cutting out the ASR function, by means of the push button on the instrument panel, also the MSR function will be automatically cut out.

The system interacts with the engine, accelerating the car in accordance with the negative skidding of rear wheels.

G4.02 COMPONENTS

The main components of the ABS/ASR **Bosch 5.3** system are:

- an electronic control unit;
- an electro-hydraulic unit;
- 4 wheel rotation sensors
- K and L diagnosis line
- CAN communication line
- ASR cut out switch and SPORT/NORMAL mode activation switch
- stop lights switch signal
- electronic control unit supply and earth **(10A)**;
- electrohydraulic control unit supply and earth **(60A)**;

Electronic Control Unit

The electronic control unit is located behind the movable rear panel of the luggage compartment (G 1.02)), inside the ABS/ASR electro-hydraulic unit (to replace it (G 2.07).
The ECU represents the intelligent part of the ABS/ASR **Bosch 5.3** system since its task is to control all the system's functions:

- storage and processing of the control software;
- acquisition of signals from the speed sensors;
- contol of braking process phases
- storage of control parameters;
- communication with the other control units;
- data processing for diagnosis purposes and failure signal control.

IMPORTANT
In the event of welding operations, the terminal board must be detached from the ECU.
*The electronic control unit must not be exposed to temperatures over **85 °C** (e.g. a painting kiln).*
In case the accumulator is removed, when re-fitting always check to make sure the terminals are perfectly tightened after re-assembly.

Electro-Hydraulic Unit

All the parts for the management of the two cross braking-hydraulic circuits are integrated in the electro-hydraulic unit. Front right/ rear left and front left/rear right.
The connection of the hydraulic part to the braking devices is made through stiff pipes.
The unit contains the following parts (**Fig. 1**):

- 12 solenoid valves with relevant control relays (**8** for ABS and **4** for ASR);
- 2 recovery motor pumps with electrically-driven motor
- 8 check valves;
- 2 pressure accumulators.

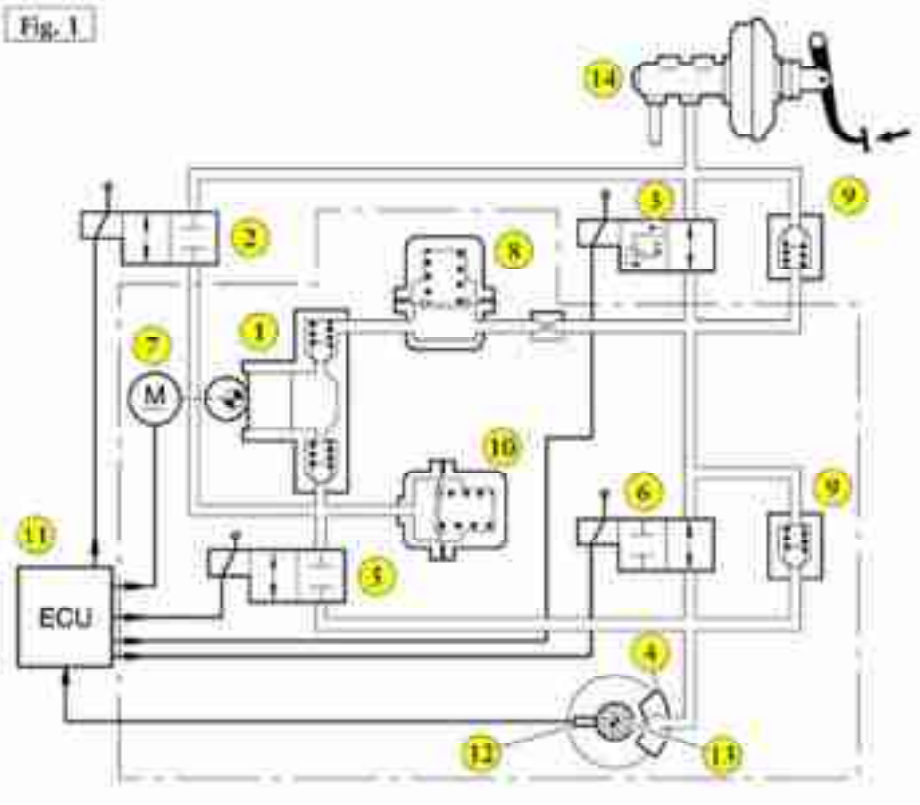


Fig. 1 *- Internal hydraulic system outline key*
1 - Scavenge pump
2 - Intake valve
3 - Pilot valve
4 - Caliper
5 - Exhaust valve
6 - Power supply valve
7 - Electric motor
8 - High pressure accumulator
9 - Rapid pressure reduction valve
10 - Low pressure accumulator
11 - ECU
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

Speed sensors

These are induction sensors: that is, they exploit the electromagnetic induction.
The system is integrated in each wheel support bearing (F 2.02) and it consists of a magnetic core (toothed wheel) and by a coil (sensor). When the bearing rotates, the teeth - obtained on an internal ring- give rise to a pulsating magnetic field which induces a pulsating voltage into the coil.
The frequency of the impulses generated is proportional to the speed of the wheel and is therefore the signal which allows the electronic control unit to measure said velocity.
These sensors, integrated in the wheel support bearing, cannot be replaced separately (F 3.03 and F 3.04).

K-L diagnosis line

This is a double wire serial line of the **9141 ISO 8** type which serves for communications between the control unit and the SD-2 tester.

CAN Line

The CAN (Controller Area Network) line is a communications protocol particularly suitable to be used inside the car for the dialogues among the electronic control units since it guarantees high interference resistance and communications in real time.
By means of the support used (plaited bipolar cable with **0.5 mm^2** section), this line reaches a communication velocity of about **1 Mbps**.
The CAN line connects the ABS/ASR electronic control unit to the ECUs controlling the injection-ignition, the instrument panel and the electronically-controlled gearbox.

Safety circuit

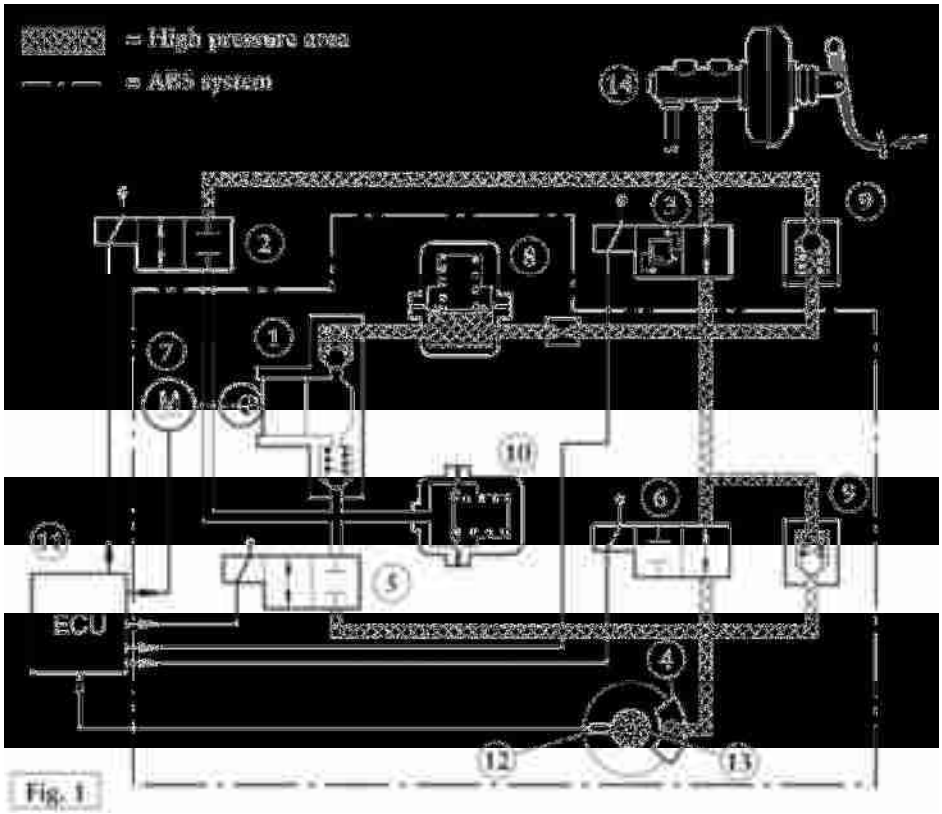
The ECU is equipped with a safety circuit which serves to safeguard the system's efficiency and to carry out a self-test cycle each time the car is started.
The safety circuit controls:
- the presence of the sensors;
- the presence of the signal enabling the pump's operation;
- the presence of the control signal for the solenoid valves;
- the duration of the solenoid valve control;
- the accumulator voltage;
- the pressure measured by the sensor inside the accumulator.

If function proves to be defective, depending on the detected failure the safety circuit may:
- turn on the ABS warning light and deactivates it
- turn on the ASR warning light and deactivates it
- turn on the ASR, EBD and ABS warning lights and deactivate them
- etc…

G4.03 ABS ADJUSTMENT PHASES

When the ECU starts working, it controls the hydraulic pressure supplied to the brake calipers by means of the solenoid valves (one for pressure intake and the other for pressure exhaust) with the following phases:

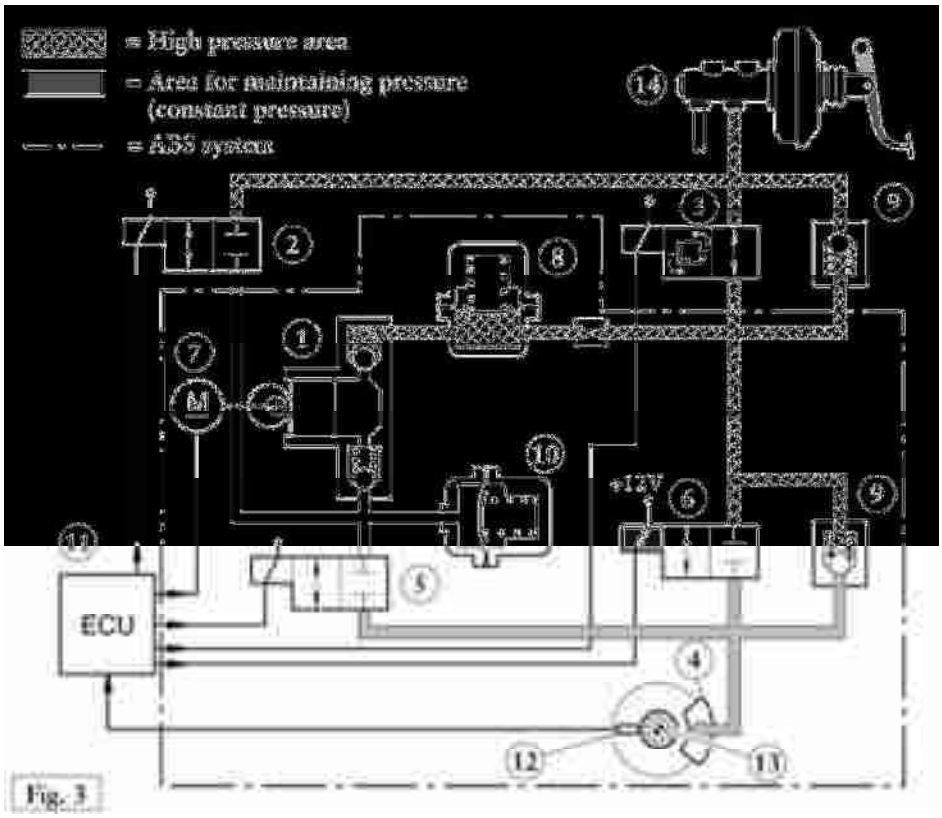
Pressure generation (Fig. 1)



*Keys to **Fig. 1***
1 - Scavenge pump
2 - Intake valve
3 - Pilot valve
4 - Caliper
5 - Exhaust valve
6 - Supply valve
7 - Electric motor
8 - High pressure accumulator
9 - Rapid pressure reduction valve
10 - Low pressure accumulator
11 - ECU
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

The supply solenoid valve **(6)** "NO" is not energised (current **I=0**) so that there is a direct connection between the brake master cylinder **14** and the calipers **4** (the so-called main circuit): the force applied to the foot-brake pedal will increase the hydraulic pressure.
At this stage the exhaust solenoid valve **(5)** "NC" is not excited.

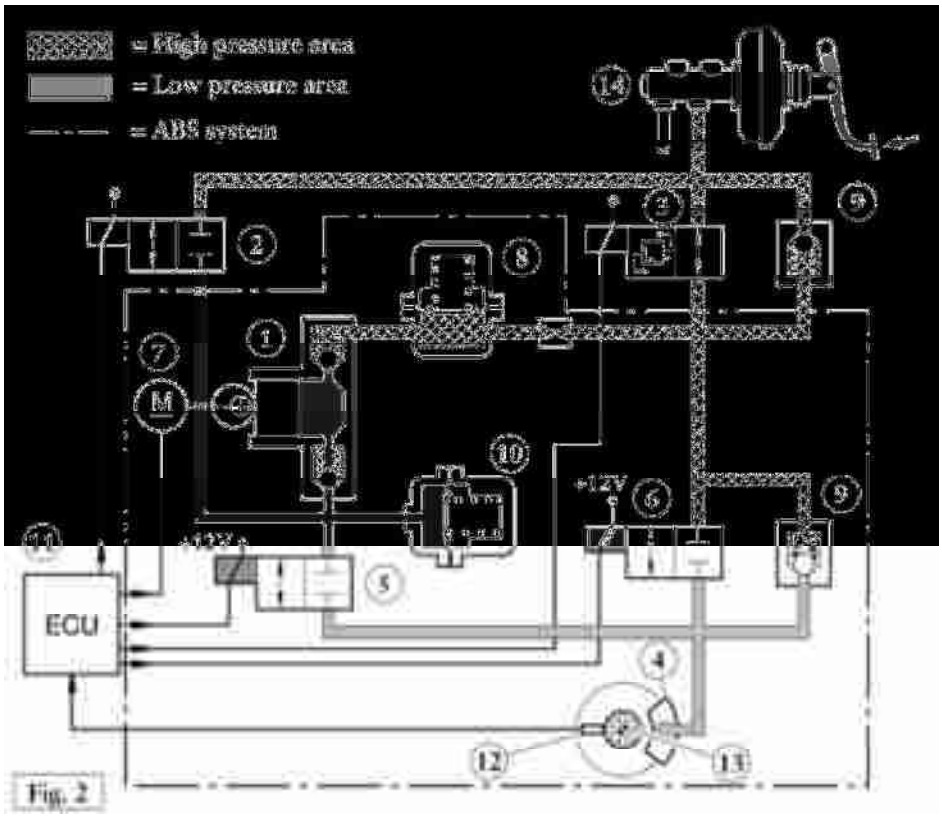
Pressure maintenance (Fig. 2)



*Keys to **Fig. 2***
1 - Scavenge pump
2 - Intake valve
3 - Pilot valve
4 - Caliper
5 - Exhaust valve
6 - Supply valve
7 - Electric motor
8 - High pressure accumulator
9 - Rapid pressure reduction valve
10 - Low pressure accumulator
11 - ECU
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

The solenoid intake valve **(6)** "NO" is activated by the ECU with a **I=12 A** current. This way, both the main and the secondary circuits are interrupted: the pressure in the calipers is therefore kept constant even when pressure on the brake pedal is increased.

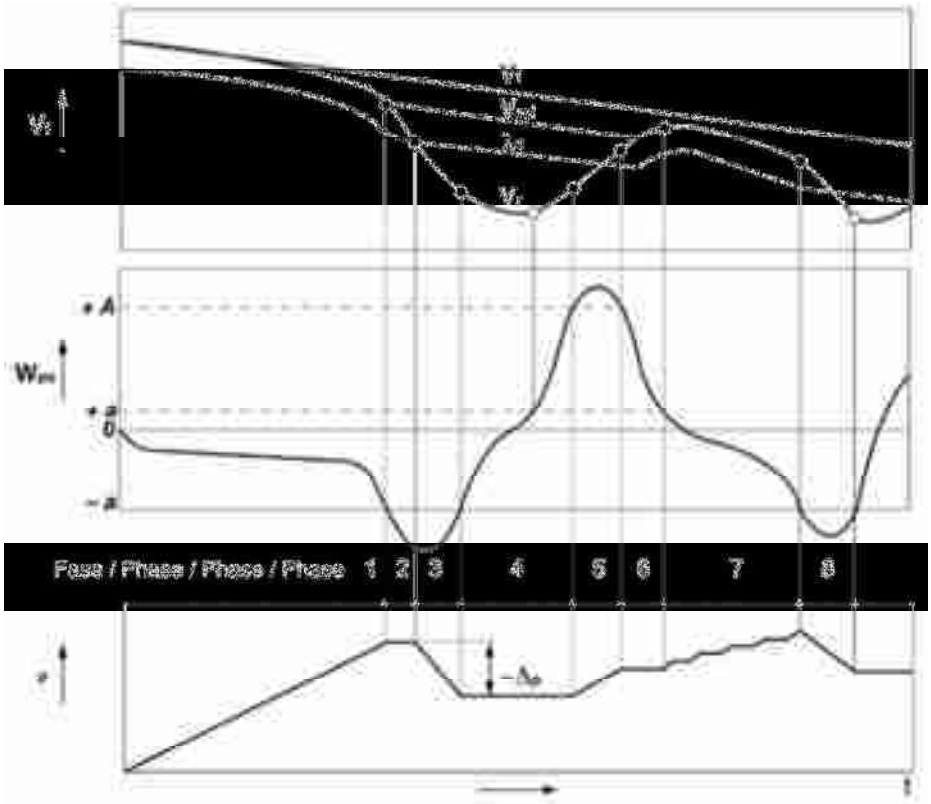
Pressure reduction (Fig. 3)



*Keys to **Fig. 3***
1 - Scavenge pump
2 - Intake valve
3 - Pilot valve
4 - Caliper
5 - Exhaust valve
6 - Supply valve
7 - Electric pump
8 - High pressure accumulator
9 - Rapid pressure reduction valve
10 - Low pressure accumulator
11 - ECU
12 - RPM sensor
13 - Toothed wheel
14 - Brake master cylinder

Upon receiving the signal indicating that a wheel tends to lock, the exhaust solenoid valve **(5)** (NC) is energised through a **I= 12A** current.
This way, the main circuit is cut-out and the calipers are connected to the low pressure accumulator **(10)** and the cylinder **(1)** thereby giving rise to the so-called secondary recirculation circuit.
Furthermore, power is supplied to the control motor **(7)** for the cylinder **(1)**, in order to reintroduce the fluid extracted from the brake calipers into the main circuit.
The fluid passes through the high pressure accumulator **(8)** which carries out a dampening function.

G4.04 ABS ADJUSTMENT CYCLE



Keys
Vf - Car speed
Wpa - Wheel peripheral acceleration
p - Caliper pressure
Vref - Reference velocity
Vr - Wheel peripheral speed
λ1 - Skidding threshold
+A, +a - Wheel peripheral acceleration thresholds
–a - Wheel peripheral deceleration threshold
Δp - Reduction of the braking power
t - Time

The drawing shows the simplest case in which the ABS system intervenes by decelerating the wheel peripheral speed, and using the latter as the sole adjustment datum. This case is typical for straight-line braking on level roads and with average to high brake force values.
In extreme situations, as braking on a curve with high transversal acceleration values or with engine braking and variations of the brake force, skidding is also used as regulation datum.
When braking, the brake power **(p)** in the wheel brake cylinder and the wheel peripheral deceleration **(Wpa)** increase.

At the end of **phase 1**, the peripheral deceleration exceeds the pre-established threshold **(a)**. Consequently, the respective magnetic valve commutes to the **"pressure maintenance"** position. The braking power should not yet be lowered since the threshold **(–a)** could already have been exceeded in the stability range of the curve for the brake force-skidding coefficient, thus determining a loss in the braking distance. At the same time, the reference velocity decreases on the basis of a predefined ramp.
The threshold skidding value **"λ1"** is obtained from the reference velocity **(Vref)**.

At the end of **phase 2**, the wheel velocity drops under the **"λ1"** threshold. Consequently, the magnetic valve commutes to the **"pressure reduction"** position, (G4.03)therefore the braking power decreases until the wheel peripheral deceleration has exceeded the **(–a)** threshold.

At the end of **phase 3**, the value is once again lower than the **(–a)** threshold and the **"pressure maintenance"** phase starts. During this time, the wheel peripheral acceleration is so increased that the **(+a)** threshold is exceeded. The pressure still remains constant.

At the end of **phase 4**, the peripheral acceleration exceeds the relatively high **(+A)** threshold. The braking power increases up until the **(+A)** threshold is exceeded.

During **phase 6**, the braking power is once again kept constant, since the **(+a)** threshold has been exceeded. At the end of this phase, the wheel peripheral acceleration drops below the **(+a)** threshold. This means that the wheel has entered the stability range of the brake force-skidding coefficientand that braking is slightly too weak.

The braking power now is gradually increased **(phase 7)** until when the wheel rim deceleration exceeds the **(–a)** threshold (end of **phase 7**).
This time the braking power is decreased immediately without generating the **"λ1"** signal.
Depending on the grip conditions, there are **4** to **10** adjustment cycles per second.

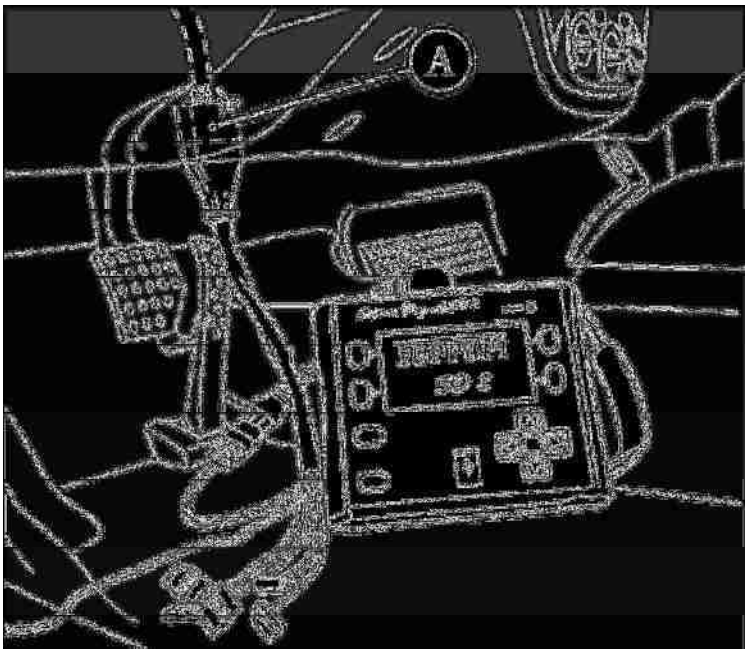
The electronic processing of the signals must therefore take place very rapidly and the magnetic valves used to control the braking power must have a response time of a few thousandths of a second.

G5.01 SD-2 TESTER SYSTEM

The ABS/ASR Bosch 5.3 ECU is able to carry out the diagnosis of the system's components and to communicate with the SD-2 diagnosis system for the management of the following environments:

- parameters
- errors
- active diagnosis
- acquisition
- automatic cycle

The connector **(A)** for the connection to the SD-2 tester is located on the driver's side, under the lower covering of the dashboard (L2 .12).



Parameter display

The parameters of the system, whose value may be displayed, are the following:

• Binary number parameters

- Foot-brake switch
- Pump motor
- Valve supply
- ASR switch position
- SPORT switch position

• Continuous value parameters

- Front LH wheel speed
- Front RH wheel speed
- Rear LH wheel speed
- Rear RH wheel speed
- RPM

• Percentage value parameters

- Present torque (i.e. the engine torque supplied by the Motronic ECU)
- Requested torque (i.e. the torque requested by the software to reduce the torque itself)

Error signalling

The errors that the ECU can identify and store as well as the parts concerned are listed below together with the interventions to be carried out:

Part

- *Front right wheel sensor: intermittent signal*
- *Front left wheel sensor: intermittent signal*
- *Rear right wheel sensor: intermittent signal*
- *Rear left wheel sensor: intermittent signal*

This signals a possible error on the wheel rotation sensor. Depending on the sensor indicated, carry out the following checks:
=> check the wheel bearing with the integrated sensor (F 3.03 or F 3.04)

- *Rear right wheel sensor: no signal*
- *Rear left wheel sensor: no signal*
- *Front right wheel sensor: no signal*
- *Front left wheel sensor: no signal*

When an error occurs within the engine speed sensor indicated:
=> check the sensor's electrical connection (F 3.03 o F 3.04)

- *Toothed wheel error*

When a toothed wheel shows a failure:
=> check the wheel bearing with the integrated toothed wheel; replace it if necessary (F 3.03 o F 3.04)

- *ABS front left valve (intake)*
- *ABS front right valve (intake)*
- *ABS rear left valve (intake)*
- *ABS rear right valve (intake)*
- *ABS front left valve (exhaust)*
- *ABS front right valve (exhaust)*
- *ABS rear left valve (exhaust)*
- *ABS rear right valve (exhaust)*
- *Primary valve 1*
- *Primary valve 2*
- *Pilot valve 1*
- *Pilot valve 2*
- *Recovery pump*
- *ECU error*
- *Valve supply*

These are all the errors concerning the electronic and electro-hydraulic control unit:
=> If the problem persists, replace the entire ABS/ASR electro-hydraulic unit (G 2.07)

- *Battery voltage*

The voltage value is anomalous and beyond the permissible range.

=> make sure the battery voltage falls within the prescribed range (L 3.02)

- *Temporary interference*

In the event of interferences on the wheel rotation sensor line, it is necessary to:
=> check the cable route
=> move the sensor cables out of the way of the high voltage/frequency cables (eg. ignition cables)

- *CAN line*

A general error has occurred in the CAN line:
=> check the electrical connection between the engine control unit, the ABS/ASR control unit and the dashboard

- *Engine failure message*

- *Engine speed failure message*

If there is a (possible) error on the CAN line, it is necessary to check:
=> if the engine control unit is correct/enabled for the ASR mode or if it contains stored errors
=> if the engine control unit is faulty; if so, replace it (C 5.01)

- *Instrument panel anomaly message*

In the event of breakdown on the CAN line, concerning the instrument panel:
=> check to see if the instrument panel works properly (H 1.01)
=> check the errors' storage

- *Foot-brake switch*

The stop lights switch, connected to the foot-brake pedal, is defective:
=> check the electrical connection
=> check the lights
=> check the other ECUs connected to a switch (MOTRONIC, BOGE, electronically controlled gearbox)

The cables, the connectors, the electrical diagrams and other useful information to detect and solve the problem, make up a "help" environment which can be accessed to simply by pushing the (enter) key, once the cursor is positioned on the error type found.

Active diagnosis

The SD-2 tester contains programs which carry out a guided testing cycle (diagnosis) of the components. It is possible to enter the guided diagnosis upon ECU error signalling or autonomously, by selecting the desired parameter on the **"Errors"** page and pressing **[enter]**.

The active tests that can be carried out are:

- *Front left wheel speed sensor*
- *Front right wheel speed sensor*
- *Rear left wheel speed sensor*
- *Rear right wheel speed sensor*

By turning the wheel manually, the test reveals its speed and with an acoustic sound informs when the 2,75km/h threshold is exceeded

- *Front left solenoid valve*
- *Front right solenoid valve*
- *Rear left solenoid valve*
- *Rear right solenoid valve*

The test consists in carrying out a few guided procedures in order to check the correct operation and the solenoid valves tightness.

- *Pump motor*

The test controls the pump motor to make sure it works properly.

- *Static test on all the actuators*

The tester energises all the system's components, issuing a list of irregularities found.

- *Parameters*

The system's parameters are shown and the operator has the possibility of controlling them.

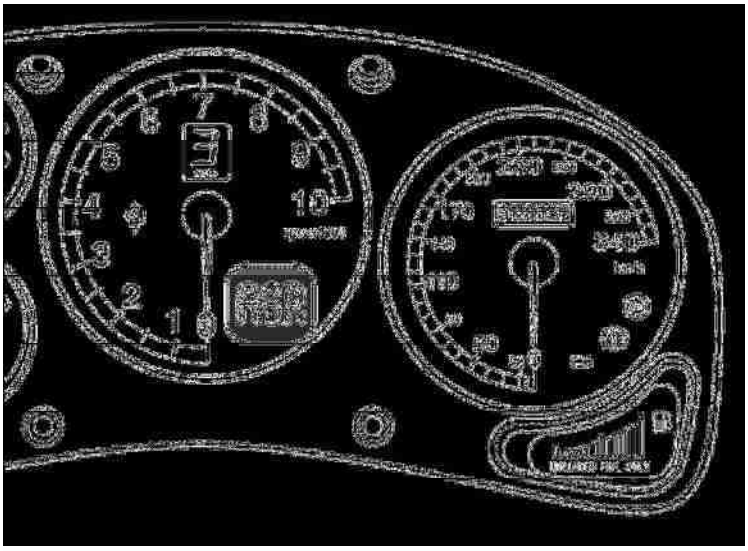
- *Draining*

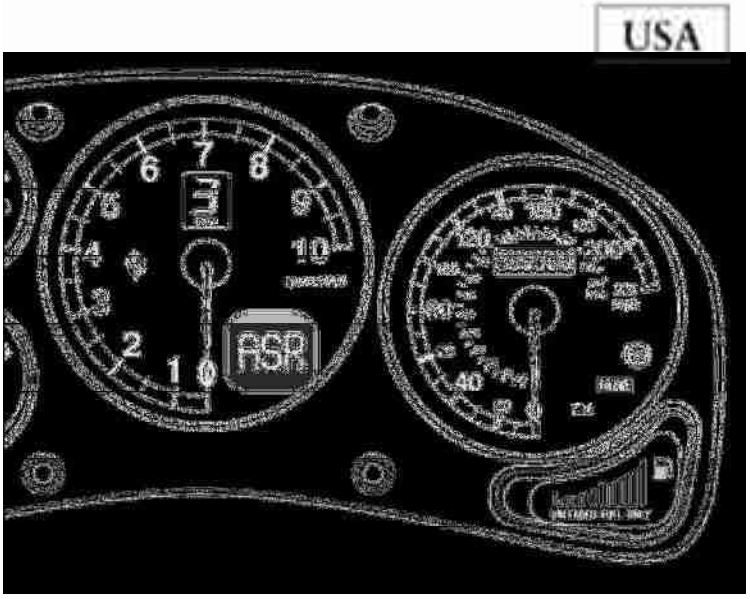
The braking system is drained: the PC sends an anergizing command for the valves, while the operator must operate on the foot-brake pedal and on the calipers as for a normal brake draining procedure (G 3.02).

Acquisition

The diagnosis system allows acquiring and displaying the states of one or more (**max 4**) parameters and errors simultaneously by means of graphs that may be printed and stored on the PC.
This is a useful support instrument to resolve malfuntions and to set the banks since these acquisitions may be displayed at all times and combined with others, if needed.

G5.02 ABS/ASR AND BRAKE WARNING LIGHTS





Brake Warning Light

This warning light is located on the dashboard and lights up when at least one of the following cases occurs:
- the fluid level within the tank drops under the minimum level;
- the front brake pads are excessively worn;
- during the self-test cycle, in the ignition phase;
- irregularity on the EBD system, when the warning light turns on simultaneously with the ABS warning light.

CAUTION

In the latter case, sudden braking should be avoided (decelerations over **0.5 g**) and the system should be checked *(*A 3.20*).*

ABS/ASR Warning Light

The warning lights on the dashboard pertaining to the ABS/ASR system are:
- ABS warning light
- ASR warning light (multi-function light);

These lighted warning lights take on different meanings depending on the different lights which turn on at a time.
The failures corresponding to the various lighting combinations are illustrated below.

ABS Lighting

It lights up in the following cases:
- to inform the driver of possible failures in the ABS device. With the warning light on, the anti-lock function is automatically disconnected while the normal braking system is still enabled.
- when carrying out the self-test, for about 3 seconds, in the ignition phase

ASR Lighting

If the ASR system does not function or is disconnected, an amber-coloured ASR message appears on the multi-function display and, therefore there will be no ASR intervention, neither on the engine nor on the brakes.
The errors which cause the lighting up of the sole ASR warning light can be:
- interferences on the wheel rotation sensor line
- CAN line.

To identify the precise malfunction and the interventions to be carried out, carry out the diagnosis cycle by means of the SD-2 tester system.

ASR and ABS Lighting

Both the ABS and the ASR systems are not functioning.
When braking, locking of the wheels may therefore occur and, in particular, locking of the front axle before the rear one. This is due to the action of the EBD which limits the pressure on the rear axle.
The malfuntions which make both these warning lights turn on are:
- intermittent signal from one or more wheel speed sensors;
- no signal from one or more wheel speed sensors;
- wrong toothed wheel on one of the 4 wheels;
- recirculation pump failure.

To identify the precise malfunction and the interventions to be carried out, carry out the diagnosis cycle by means of the SD-2 tester system.

ASR, ABS and brake lighting

These lights signal that none of the systems (ABS, ASR, EBD) is working, therefore in this case, the braking power will not be regulated.

CAUTION

In this situation the rear wheels can lock when braking exceeds 0.5 g.

The malfuntions which make all these warning lights turn on are:

- failure of one or more solenoid valves in the ABS unit;
- failure of one or more solenoid valves in the ASR unit;
- anomalous supply voltage.

To identify the precise malfunction and the interventions to be carried out, carry out the diagnosis cycle by means of the SD-2 tester system.

Failures with no warning lights turned on

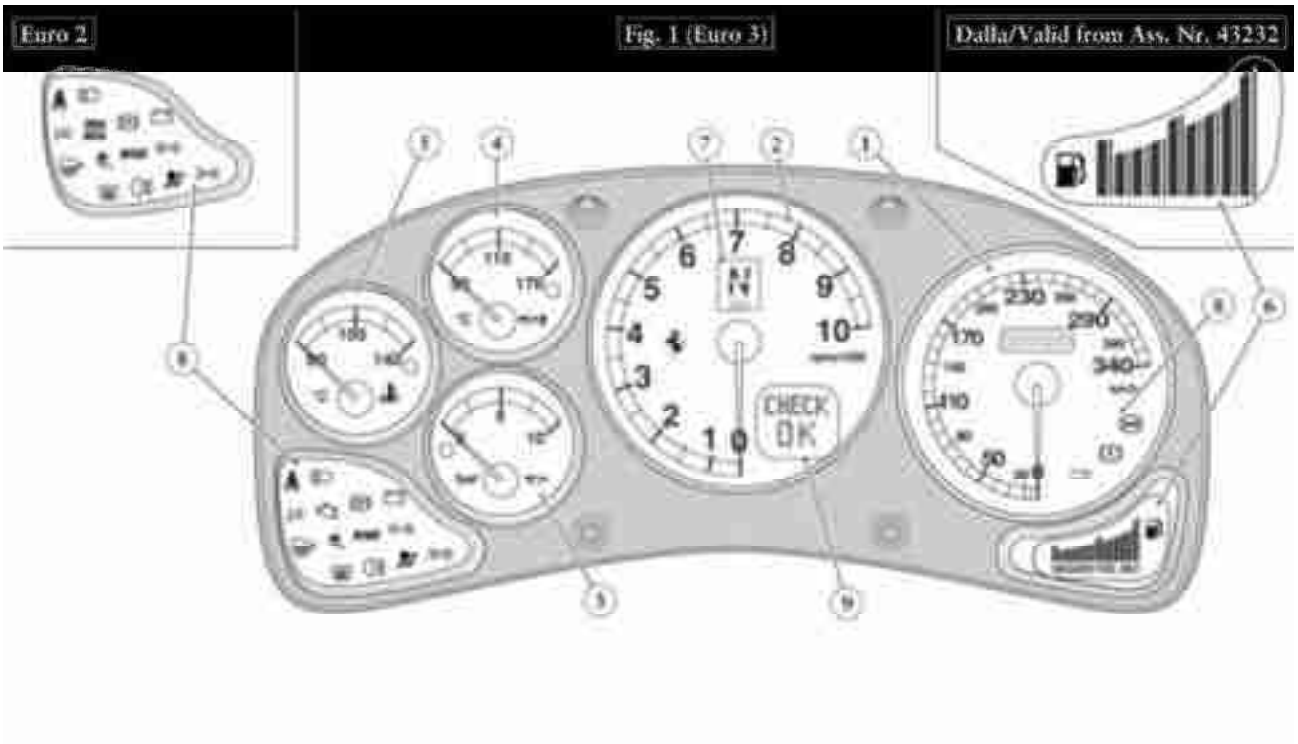
There are two cases of malfunctioning which do not cause the warning lights to turn on:

- breakdown of the control unit (ECU);
- breakdown of the stop light switch.

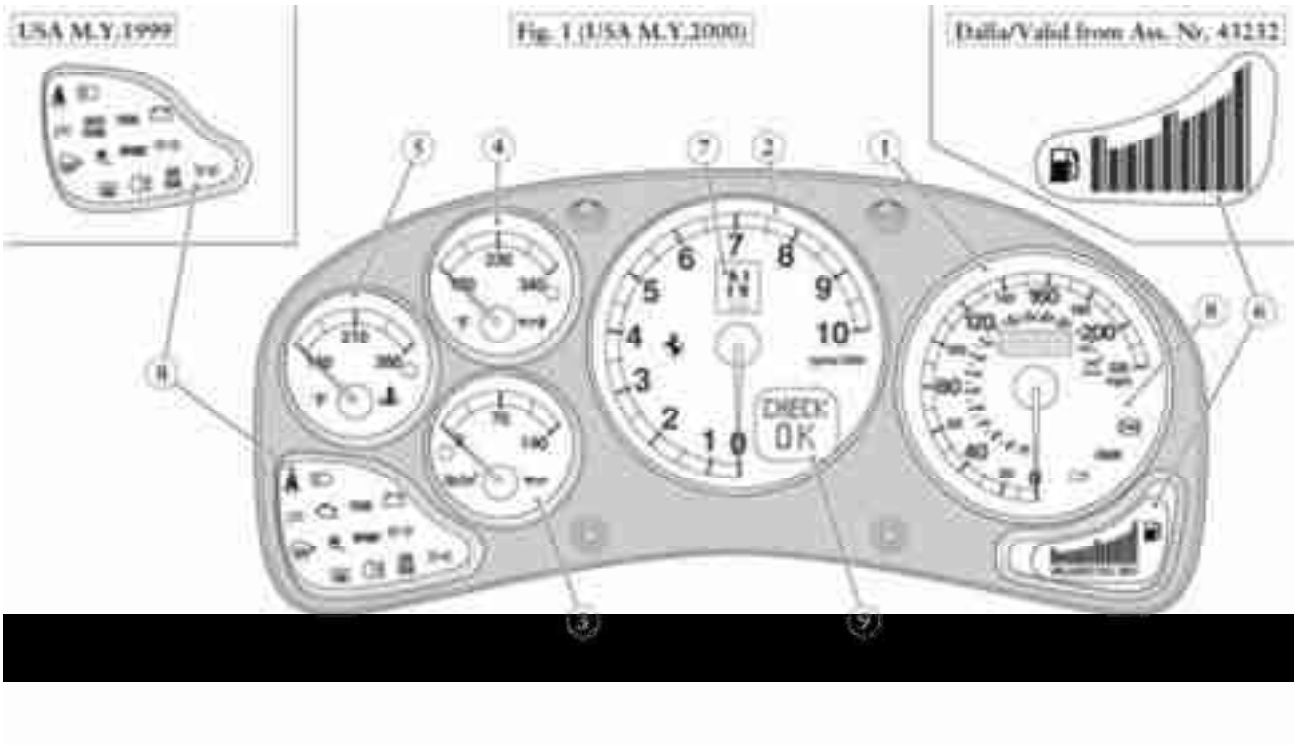
To identify the precise malfunction and the interventions to be carried out, carry out the diagnosis cycle by means of the SD-2 tester system.

H1.01 INSTRUMENT PANEL

On the instrument panel are located (**Fig. 1**):



*Keys to **Fig. 1***
1 - Electronic tachometer
2 - Revolution counter
3 - Oil pressure indicator
4 - Oil temperature indicator
5 - Water temperature indicator
6 - Fuel level indicator
7 - Engaged gear display *(only for electronically-controlled gearbox)*
8 - Warning lights
9 - Multifunction display



*Keys to **Fig. 1** (**US** version)*
1 - Electronic tachometer
2 - Revolution counter
3 - Oil pressure indicator
4 - Oil temperature indicator
5 - Water temperature indicator
6 - Fuel level indicator
7 - Engaged gear display *(only for electronically-controlled gearbox)*
8 - Warning lights
9 - Multifunction display

The instrument panel has been designed in order to avoid any maintenance, therefore it is not possible to replace lights, instruments etc.
The panel operation is controlled by a microprocessor electronic board, which is able to perform all of the functions required, and namely:
- control of digital and index instruments;
- instrument panel lights control;
- communication with ECUs for the engine area and bodywork functions;
- management of multi-function display signals and control of warning lights;
- diagnosis cycle by means of the Ferrari SD-2 Tester;
- storage of historical and statistical car data.

The ECU ensures that the instruments work continuously and according to the operational electrical features described below, when the temperature ranges between **–18 °C** and **+70 °C**.
- Operating voltage (working instrument): **9±16 V**
- Parametric operating voltage (in compliance with the specifications): **10±15 V**
- Nominal operating voltage: **13.5 ± 0,1 V**
- Overvoltage protection: **18 V for 1h –24 V for 1 min**
- Consumption with key extracted (no functions performed with **Key-OFF**): **1mA**
- Protection against power supply polarity reversal: **continuous**

Index instrument

The instruments fitted with a needle indicator use stepper motors without spring-back winding.
Every time the key is turned to the **"Key-ON"** and **"Key-OFF"** position, the indicators are reset by means of a low current control of the motors, so that the user does not see the operation in progress.
The indicators setting allows for an indication error which is lower than **±0.5 degrees**, above the zero value on the scale, and lower than **±1.5 degrees** on the rest of the scale.
The data relating to the figures to be displayed are transmitted via CAN line, which is dedicated to the engine area. If no information is transmitted for a **> 0.5 sec.** time period, the error is stored and the indicator remains set on the last valid value received.

LCD digital instruments

Odometer

This function shows the total or trip kilometres on a single LCD display: **7** segments with **6** digits.
Once the distance of **999999 Km** has been reached, the total kilometre odometer permanently **"freezes"** this indication.
The trip kilometres odometer counts from **000,0** to **999,9 Km**, increasing the digits every **100 m (or 1/10 ml)**. Once this value is exceeded, the counter starts from **000,0** once again.
The trip kilometres are reckoned as speed integral calculus, in accordance with the below formula which complies with the regulations provided by law LE 101/73.C:

Speed integral $\leq$ **displayed trip** $\leq$ **speed integral x 1.03**

To select the different display functions for the trip kilometres and the related reset, press the push-button **(**

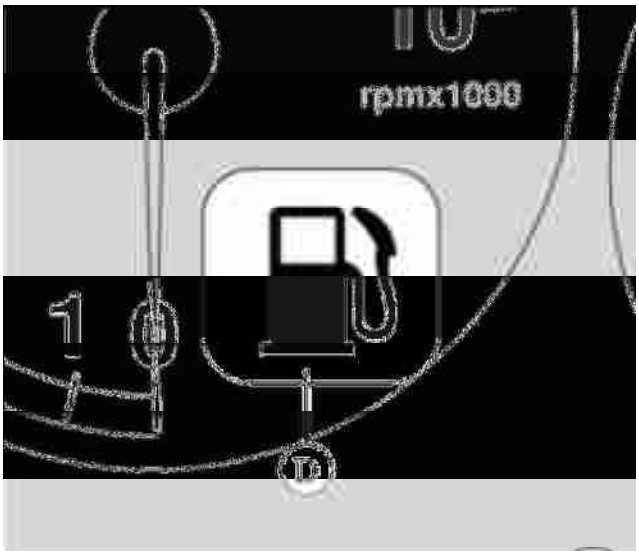
H 1.05). This operation can be performed three times maximum, if the total kilometres do not exceed **500 Km**. Upon overcoming this threshold, no further modification of the total kilometres will be allowed.

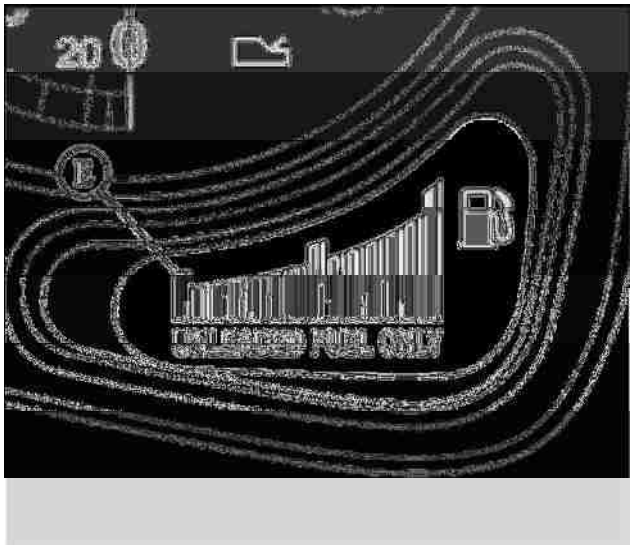
Only in the event that the instrument panel is replaced with a new one, will it be possible to use the SD-2 tester to set the total kilometres run as at the time when the instrument was replaced.

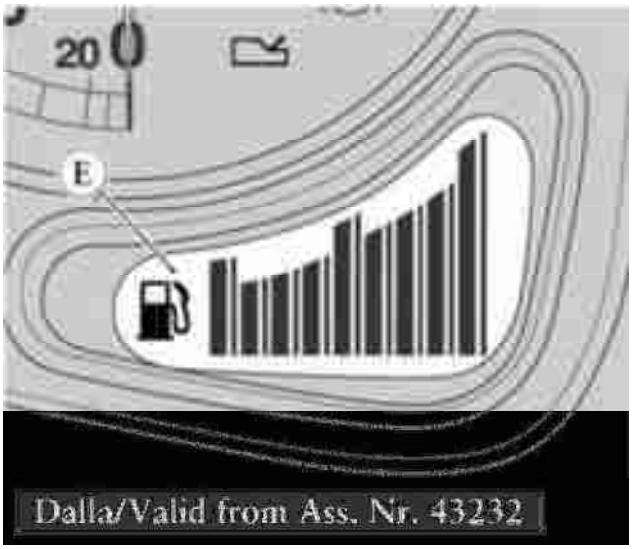
Fuel level indicator

This is an LCD indicator consisting of **14 bars** (9, **From Ass. No. 43232**), each one corresponding to a linear subdivision of the fuel level into the same number of sections. The threshold values for switching the bars on and off feature hysteresis.
The low-fuel symbol on the multifunction display **(D)** switches on when only the two last bars of the level indicator are displayed. The last bar **(E)** starts flashing to signal that the minimum level of fuel (**11 litres**) contained in the tank has been reached.

From Ass. No. 43232
When around 18 litres of fuel are left in the tank, the fuel reserve indicator on the multi-function display **(D)** switches on and the last bar **(E)** begins to flash. When there are less than 9 litres of fuel, the multi-function display remains lit and the last bar of the indicator switches off.

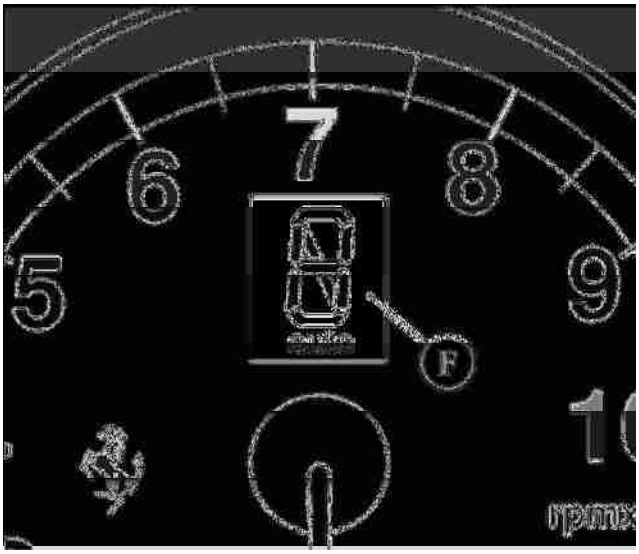






The ECU can detect if the floating resistive sensor has been disconnected or short-circuited, and in this event it generates a correspondent error signal.

Gearshift Indicator (for electronically-controlled cars)



It consists of a LCD display **(F)** with **9** segments, which can display the following information relating to the electronically controlled gearbox:to:
N - Neutral
R - Reverse
F - Fault
1, **2**, **3**, **4**, **5**, **6 - E**ngaged gear

The information relating to the gear come from the ECU for the electronically-controlled gearbox via the CAN line.

NOTES
On cars which are not equipped with the electronically-controlled gearbox, the instrument display is not activated.

After turning the key to **"Key-OFF"**, the robotized gearbox display shows the gear/position of the gearbox lever for further **10 seconds** after receiving the last valid and related message through the CAN line.

Acoustic signaller

This instrument performs the following functions:
- Acoustic repeater for direction indicators;
- Speed limit signaller (for the Gulf instrument version);
- Door opening signaller with key inserted (for the US instrument version);
- Seatbelt unfastened on the driver's side;
- Failure of the electronically-controlled gearbox ECU systems.

The different market-versions for the instrument signalling the door opening, when the key is still in the ignition, are realized by means of the wiring harness. As a matter of fact, depending on the market the car is destined to, the key ignition block can either be connected or not connected to the instrument itself.
The signal **"driver's side seatbelt unfastened"** remains on for **15 s.** after turning the key to the ON position.

Lighting

The dials are lit from the backside by means of a single electro-luminscent panel, while the indicators and the LCDs are lit from the backside by LEDs.
The instrument lighting, (excluding the LCD crystals) is activated by turning on the dipped lights and it can be adjusted using the multi-function control switches (H 1.03).
The LCD's crystal lighting instead, is activated upon turning the ignition key to the ON position. When the dipped lights are switched on, the LCD crystal lighting is dimmed, thereby featuring the so called "night setting". The LCD crystals have therefore two different setting levels (a day and a night one). Furthermore, the night setting can be programmed stepwise, on the basis of the instrument adjustment.

Pin-out

Three **AMP Multilock** connectors, series **040**, double-row type, are used to connect the instrument panel. This type of connector ensures great reliability and top quality (**Fig. 2**):

- **12**-way connector —> **AMP 040 Multilock P/N 174973-2**
- **8**-way connector —> **AMP 040 Multilock P/N 174971-2**
- **16 + 20**-way connector —> **AMP 040 Multilock P/N 174977-2**

The **16 + 20** connection is made up of:
- a male connector with **2** sections **16 + 20** in a single housing, on the board side;
- two female **16**- and **20**-way connectors, on the harness side.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

IMPORTANT
*The **12**-way connector is a vital component for the instrument panel operation. If it is not connected, the dashboard will remain off .*

Disassembly

- Remove the coverings from the steering column.
- Unscrew the screws **(G)** fastening the instrument panel to the dashboard.

- Unscrew the screw **(H)** fastening the steering column end-travel plate and the support bracket for the dashboard cable.
- Fully lower the steering column and gently remove the instrument panel, detaching the four connectors on the dashboard cable.

- When re-assembling, check that the connectors are properly fitted into their seats on the instrument panel and tighten the screws **(G)** to the **4.1 Nm** torque.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

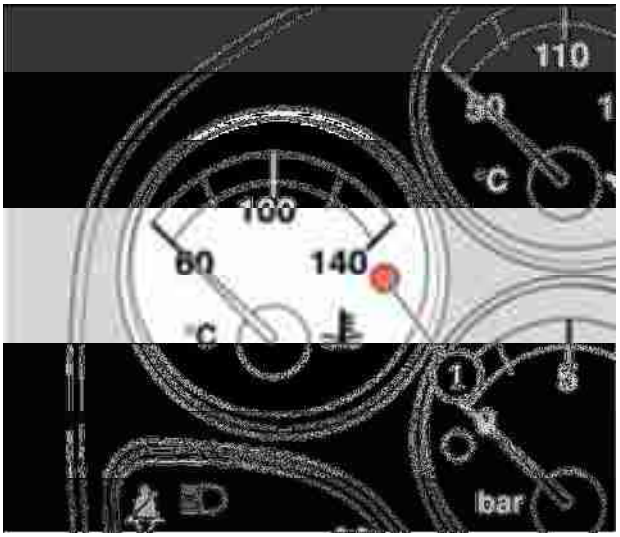
IMPORTANT
After replacing the instrument panel, an acquisition cycle must be carried out (H 1.05).

H1.02 WARNING LIGHTS

There is a series of high efficiency LED warning lights on the instrument panel, which are used to signal faults or unusual operating conditions

Some of these (oil pressure and oil and water temperatures) are located inside the relevant indicators, while the others are grouped together on the left side of the instrument panel and inside the electronic tachometer.

Max Water Temperature Light



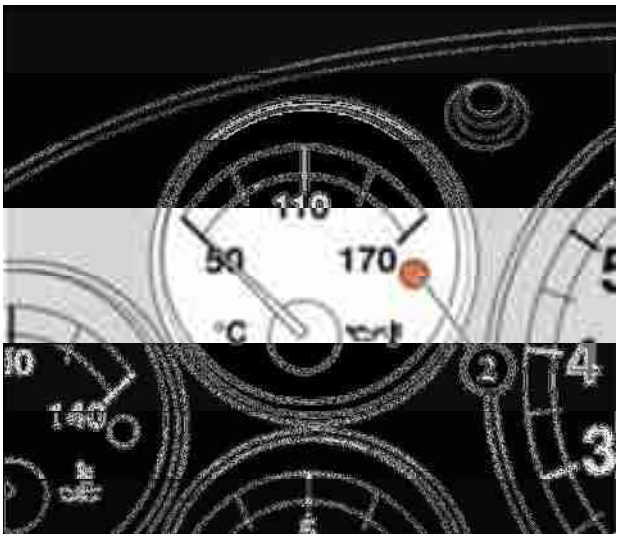
Red light **(1)** ON indicates the temperature is too high.

The light is switched on when the temperature reaches **120 °C** while it is switched off when the temperature is **115 °C**.

The water temperature data come from the engine area via the CAN line.

If this light is switched on, reduce the engine revolution speed immediately: if the said temperature persists, turn the engine off and carry out the necessary checks.

Max Oil Temperature Light

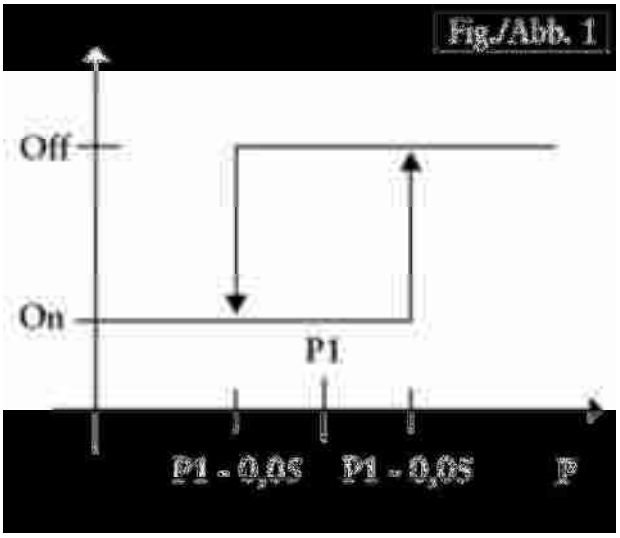


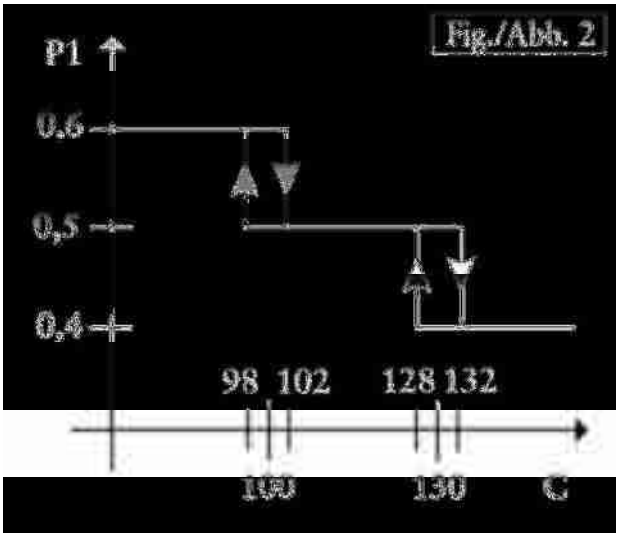
Red light **(2)** ON indicates the temperature is too high.
The light is switched on when the temperature exceeds **155 °C** and switched off when it decreases to below **153 °C**.
This information comes from an NTC device, that is from a resistance whose value decreases as the temperature to which it is exposed increases.
If this light is switched on, reduce the engine revolution speed immediately; if the said temperature persists, turn the engine off and carry out the necessary checks.

Insufficient Oil Pressure Light

Red light **(3)** ON indicates insufficient engine oil pressure.

This light is switched on in accordance with the law shown in **Fig. 1**, in which a hysteresis of **±0,05 bar** around the value of the threshold **P1 is highlighted**. This value is not fixed, but it is conditioned by the engine oil temperature in accordance with the law shown in **Fig. 2**, in which, a hysteresis of **±2 °C** must be added to the commutation values of **100 °C** and **130 °C**.





In normal conditions, this light switches on before the self-checking phase is started up.
In failure conditions, it lights up when the engine is running and the pressure is insufficient. In this case, turn off the engine immediately and carry out the necessary checks.

Other Lights

Besides the self-checking phase, the lights may also switch on in the following cases:

- **ABS** *Colour: amber*

When the car is running, this signals a fault in the ABS system.
The normal braking system functions as usual.

- **Brake failure** *Colour: red*

To indicate the level of the brake/clutch liquid in the tank is insufficient.
To indicate the excessive wear of the front brake pads.
If this light is on at the same time as the ABS light and the ASR symbol on the multi-function display, this indicates a failure of the electronic braking distributor EBD.
If the light switches on while the engine is running, stop the car and check the level of liquid in the tank.

- **Gearshift failure (for electronically-controlled cars)** *Colour: red*

If this light is on continually and there is also a warning buzz, a gearshift operating error has been identified.
If the failure allows it, clear the car from the road and look for the cause of the failure.
Flashing: low system pressure.

- **Parking brake** *Colour: red*

When the parking brake is engaged.

- **Air bag** *Colour: red*

When the car is running, this signals a malfunctioning of the AIR BAG system and/or the seatbelt pre-tensioners.
If the light does not switch on for the self-checking phase or it lights up while the car is running, carry out the necessary checks to identify the cause.

- **Seatbelts** *Colour: red*

When the key is in position **"II"** and the driver's seatbelt is not fastened.

- **Generator** *Colour: red*

In the event of a fault in the recharging system.
When the battery is insufficiently charged or overcharged (flashing).

- **Check Engine or Engine control system fault** *Colour: amber*

When the engine is running, this indicates a fault in the emission

control system and/or in the ignition/injection system.

*Note for the **US** version*
While the car is running:
- flashing light: to signal a misfire error.
- fixed light: to signal a defect in the emission control system and/or in the ignition/injection system.

It remains lit for a self-check until start-up.

- **Direction indicator** *Colour: green*

When the direction lights are activated.
When the hazard warning lights are engaged.

- **Dipped lights** *Colour: green*

When the low beams are turned on.

- **High beams** *Colour: blue*

When the high beams are turned on.
When the high beams are used to flash.

- **Parking lights** *Colour: green*

When the parking light control switch is activated.

- **Rear fog lights** *Colour: amber*

When the rear fog lights are in use.

- **Rear window heater and wing-mirror defrosters** *Colour: amber*

When the rear window heater and wing-mirror defroster button is pressed. Thirty minutes after they have been activated, they will cut out automatically.

- **"SPORT" mode** *Colour: amber*

When the button which sets the car in the **SPORT** mode is pressed.
The **SPORT** mode varies the car's driving features.

- **Low grip** (for electronically-controlled cars) *Colour: amber*

When the **"low grip"** mode has been selected.
This mode has priority over the **AUT** e **SPORT** sport functions.

- **Several Lights Switched on at Once**

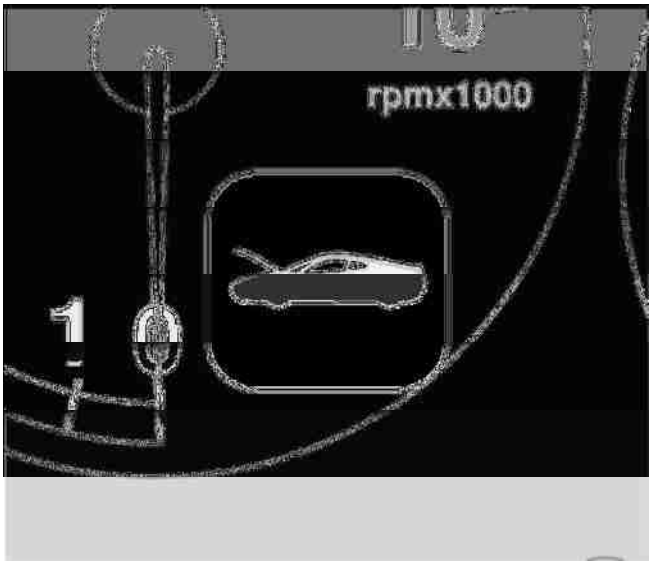
Failure of all the braking systems **ABS - EBD - ASR**

When all three of the corresponding lights are on at once. In these cases, there is a risk that the rear wheels may lock because of the electronic braking distribution inefficiency.

Stop the car, avoiding braking sharply. Do not continue driving the car. It is possible, however, to drive the car at low speed **(max. 40 Km/h)** in order to clear the road.

H1.03 MULTI-FUNCTION DISPLAY

This component is made up of a LCD display with a 36 x 32 point matrix, with background lighting from LED diodes.



The multi-function display is located on the instrument panel and its function is to display the ideograms related to the fault conditions and the state of the car with different background colours:

- **Green**: general information for the user;
- **Red**: a fault has been detected;
- **Amber**: if one of the car's systems has been activated.

If several indicator lights are switched on at once, these are displayed cyclically one after the other for a period (**Tv** = display period) determined by their priority:

- **High** priority **Tv = 4 sec.**
- **Medium** priority **Tv = 3 sec.**
- **Low** priority **Tv = 2 sec.**

The following functions are incorporated in the multifunction display:

- **Fuel reserve** *Colour: amber —> Low priority*

This lights up if fuel is low (**18÷20 litres** of fuel available), if there is a fault in the indicator level or if there is an interrupted wiring harness error.

- **Slow down** *Colour: red —> High priority*

This lights up while the car is running to indicate the exhaust system temperature is too high.

- **ASR** *Colour: amber —> Low priority*

ASR system check and malfunction

This lights up when the car is running if a fault has been detected in the ASR system.

- **Suspension system** *Colour: amber —> Low priority*

Variable setting shock absorber system check and malfunction.

This light comes on when the car is running in the event that a fault has been detected in the system.

- **Inertia switch** *Colour: amber —> Low priority*

The inertia switch intervenes if the fuel supply is cut-off in the event of an accident.

- **Engine compartment lid open** *Colour: red —> Medium priority*

This lights up to signal the engine compartment lid is either open or incorrectly closed.

- **Luggage compartment lid open** Colour: red —> Medium priority

This lights up to signal the luggage compartment lid is either open or incorrectly closed.

- **Engine and luggage compartment lids open** *Colour: red —> Medium priority*

This lights up to signal both compartment lids are either open or incorrectly closed.

- **Left-hand door open** *Colour: red —> Medium priority*

This lights up when the left-hand door is either open or incorrectly closed.

- **Right-hand door open** *Colour: red —> Medium priority*

This lights up when the right-hand door is either open or incorrectly closed.

- **Right and left-hand doors open** *Colour: red —> Medium priority*

This lights up when both the doors are either open or incorrectly closed.

- **Fuel tank flap open** *Colour: green —> Low priority*

This lights up to signal the fuel tank flap is open.

- **ASR active** *Colour: green —>High priority*

This lights up when the car is running to indicate the intervention of the asr.

- **Hazard lights** *Colour: red*

This signals the activation of all the direction indicators simultaneously.

- **Windscreen washer liquid level** *Colour: red —> Low priority*

This indiactes a low windscreen washer liquid level.

- **External temperature** *Colour: green —> Low priority*

If this is selected with the relative button, it displays the external temperature.

- **Instrument panel lighting** *Colour: amber*

If this is selected with the relative button, the adjustable brightness value of the instrument panel is displayed.

- **CHECK OK** *Colour: green —> Low priority*

When the key is turned to the **"II"** position, the electronic system carries out a checking diagnosis of the car; if no faults are detected, the **check OK** ideogram allows the start-up to proceed.

From Ass. No. 43232

- **Battery charger connected** *Red colour*

The switching on indicates that the battery charger is still actively connected via the plug supplied (L3.03).

H1.04 BUTTONS FOR ADJUSTING FUNCTIONS AND INSTRUMENTS

On the dashboard panel, there are two buttons with the following functions:
- External temperature display
- Lighting adjustments
- Buzzer volume adjustment

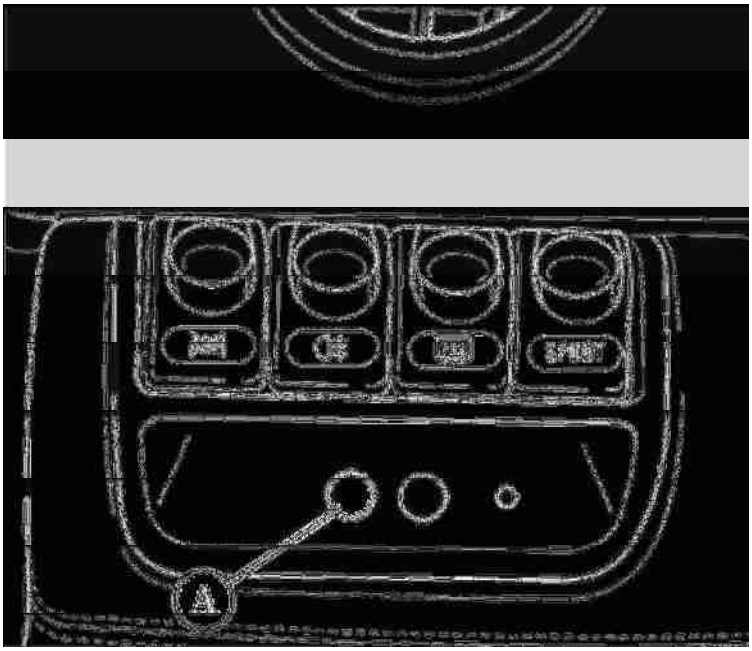
The buttons can be operated as follows:
- by pressing the left-hand button, you select the page within which you wish to work;
- by pressing the right-hand button, you modify the value found in the page selected.

The page selected and the values, are displayed on the multi-function display according to the rules summarised in the following table.

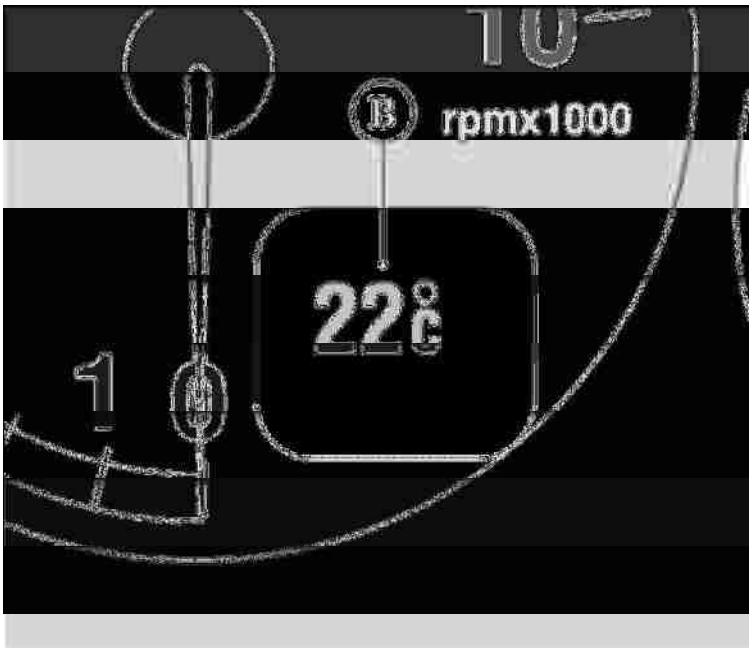
Function	*Operating the left-hand button*	*Operating the right-hand button*
External temperature display	**once every T ≤ 2 sec**	No Effect
Lighting adjustments	**once every T ≤ 2 sec**	Value change
Buzzer volume adjustment	**twice every T ≤ 2 sec**	Value change

External Temperature Display

To request the display of outside temperature, press the left-hand push-button **(A)** for **T ≤ 2 seconds.**



Once recognised the request, the external temperature becomes part of the display cycle on the multi-function display, with low priority: should failures occur that need be displayed on the multi-function display, the external temperature **(B)** will be displayed cyclically **for 2 seconds**; if, on the other hand, there are no failures, the outside temperature will be displayed permanently on the multi-function display.

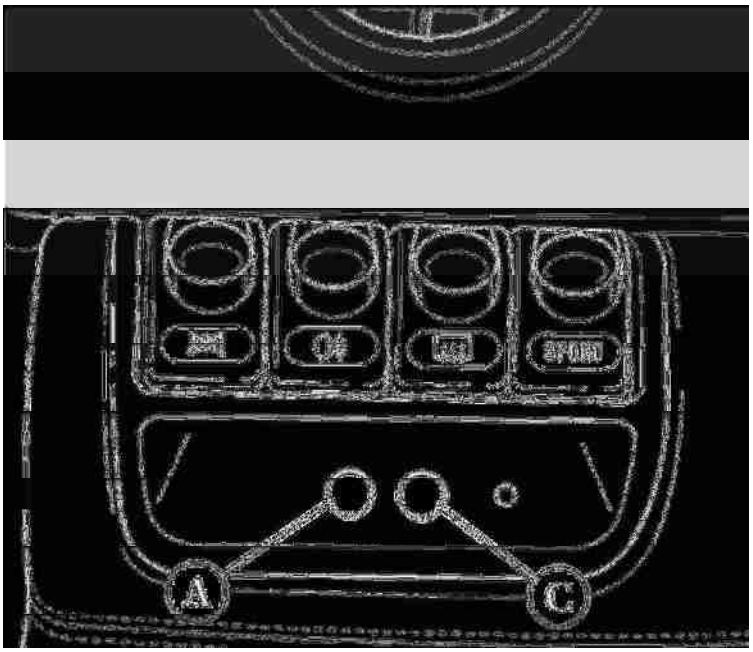


The request for external temperature display will be deactivated by pressing the left-hand push-button once again for **T ≤ 2 seconds.**

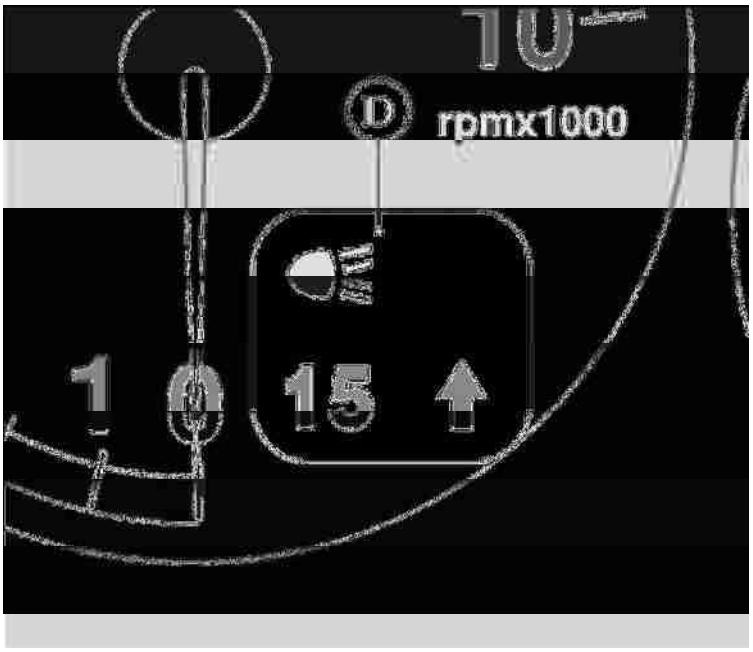
The information on temperature values is transmitted by the Air Conditioning ECU through the serial line: should the information not be available (communication error, air conditioning ECU error, etc…) the multi-function display will display the configuration "**- - -**".

Lighting Adjustments

By first pressing the left-hand push-button **(A)** for **T ≥ 2 seconds** the background lighting adjustment selection page will be displayed. By pressing the right-hand push-button **(C)** the lights' brightness can be adjusted according to a 30-steps scale.



If any symbol appears on the multi-function display, by pushing the left-hand push-button the lighting adjustment **(D)** is displayed **for 5 seconds**. If no key is pressed after this, the system is reset to its initial condition.



If a failure occurs while the lighting adjustment page is active, the latter is immediately closed and the display will show the symbol indicating the failure occurred.
The lighting adjustment page, however, always closes down **after 10 seconds** of inactivity.

NOTES
If the left-hand button is pressed for longer than 2 seconds, the system will detect it as a double pressure and, as shown in the table, the buzzer volume page will be activated.

Replacement

- Slide the switch panel out of the dashboard and disconnect the switch connection cables (M 3.01).

- Slide the white connector out of the button body **(1)**.

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.

- Remove the four fastening screws and then the button body from the panel.

H1.05 DIAGNOSIS

The instrument panel **"ECU"** can carry out all the diagnoses of the instruments and communicate with the SD-2 diagnosis tester to manage the following areas:

- parameters
- errors
- diagnosis active
- acquisition
- automatic cycle.

The connector for the connection to the SD-2 tester is located under the lower dashboard upholstery, on the left of the steering column (L 2.12).

Parameters	Corresponding values
Water temperature	°C
External temperature (CLIMATE)	°C
Oil temperature	°C
Oil pressure	mb
Battery voltage	12-14 Volt
Fuel level	lt
Car speed	Km/h
Engine revolutions	g/min
Shock absorbers check	OFF/ON
Front luggage compartment control	OFF/ON
ASR cut-out control	OFF/ON
Window defroster control	OFF/ON
Rear fog lights button	OFF/ON
Heated rear window control	OFF/ON
Engine compartment lid control	OFF/ON
Rear fog lights control (NOT for US)	OFF/ON
Hazard warning lights control	OFF/ON
Left-hand dashboard button	OFF/ON
Right-hand dashboard button	OFF/ON
"SPORT" button	ACTIVATED/NOT ACTIVATED
Crash stored by AIRBAG	NOT ACTIVE/ACTIVE
Tachometric Buzzer	DISABLED/ENABLED
Engine compartment	CLOSED/OPEN
Front luggage compartment	CLOSED/OPEN
Driver's seatbelt	FASTENED/UNFASTENED
Dipped lights	OFF/ON
Parking lights	OFF/ON
Right-hand direction indicators	OFF/ON
Left-hand direction indicators	OFF/ON
Low beams	OFF/ON
High beams	OFF/ON
Brake pad wear	OFF/ON
Alternator Charge	OFF/ON
Hand brake	OFF/ON
Key	OFF/ON
Left-hand door	CLOSED/OPEN
Right-hand door	CLOSED/OPEN
Fuel tank flap	CLOSED/OPEN
Windscreen washer level	OFF/ON
Oil pressure light	OFF/ON
Oil temperature light	OFF/ON
Water temperature light	OFF/ON
Generator light	OFF/ON
Airbag Light	OFF/ON
Gear shift malfunction signal light	OFF/ON
Brake wear light	OFF/ON

Dipped lights and low beams signal light	OFF/ON
High beams signal light	OFF/ON
Direction indicators signal light	OFF/ON
Rear fog lights signal light	OFF/ON
Parking lights signal	OFF/ON
ABS light signal	OFF/ON
Engine control system failure (Check Engine)	OFF/ON
Wing mirror defroster light	OFF/ON
Seatbelt light	OFF/ON
Low grip gearshift light	OFF/ON
"SPORT" light	OFF/ON
Hand brake light	OFF/ON
Rear window heater light	OFF/ON

Errors

The errors detected by the ECU are the following:

INTERNAL ERROR
DASHBOARD CAN
ENGINE GROUND
OIL PRESSURE SENSOR
FUEL LEVEL SENSOR
OIL TEMPERATURE
ALTERNATOR
BOGE SHOCK ABSORBERS
CAN
OIL PRESSURE
WATER TEMPERATURE
ENGINE CONTROL SYSTEM (CHECK ENGINE)
SLOW DOWN
CRASH STORED BY AIRBAG
LUGGAGE COMPARTMENT BOOT OUTPUT
REAR FOG LIGHT OUTPUT
HAZARD WARNING LIGHTS OUTPUT
REAR WINDOW HEATER OUTPUT
ODOMETER RESET
BRAKE FAILURE

Automatic Cycle

The actuatos controlled by the car's ECU can be activated by means of the diagnosis tester.

Instrument Panel Automatic Diagnosis

LIGHTS 1 2 3 18 19 20	The lights shown in the image switch on and off
LIGHTS 4 5 6 7 8 9	The lights shown in the image switch on and off
LIGHTS 10 11 12 13 14 15 17	The lights shown in the image switch on and off
MULTI-FUNCTION DISPLAY	The multi-function display leds switch on and off in the various chequered configurations
FUEL LED, HEX DISPLAY, BUZZER	Do the leds shown in the image and the buzzer switch on and off correctly?
POINTERS	The pointers move automatically
ECU CONFIGURATION – MARKET TYPE	The dashboard can be configured according to each country's specific standards
ODOMETER RESETTING	N.B.: The odometer can be set to zero only if its value is not over 999 Km. This operation can be carried out max. 3 times.

Set the odometer to zero only if strictly necessary.

VEHICLE INTERVENTIONS	Servicing and maintenance interventions can be stored by the system.

NOTES

After replacing the instrument panel, a harness or a connection, a check cycle on the system must be run.

Statistical Records

The statistical data acquisition system serves to store all input/output data in a fixed memory and in a statistical manner. The maximum value that can be stored on the counters listed below is **65535 minutes**:

- minutes with key operation
- engine running minutes
- low beams ON minutes
- engine ON with gear in neutral minutes
- number of days in use.

The counters for the above data increase by one unit per minute of operation, with the exception of the 'days in use' counter.

- number of engine start-ups
- number of gear shiftings
- number of lh door openings
- number of rh door openings
- number of engine compartment openings
- number of luggage compartment openings
- number of ASR interventions (asr active).

The counters for the above parameters are increased by one unit per single operation, with the exception of the counter for gear shifting, which is increased by one per **100** operations.

- max. distance covered
- max. time with engine on
- max rpm
- max speed
- max battery voltage
- min battery voltage
- max engine oil pressure
- max engine oil temperature
- max engine water temperature.

The maximum or minimum values stored are up-dated at Key-off each time that, during a working cycle, values higher/lower than previously stored max/min values are met.

- fuel litres filled in
- fuel re-fillings
- kilometres covered.

All the data stored can be read by the SD-2 diagnosis system or by computer through a serial line **(9141 ISO 8)**.

Resetting of the stored data can be carried out through the tester.

Statistical Percentage Histograms

The information detected concerns the following:

- engine water temperature (from **50 °C** to**130 °C** with step of **10 °C**)
- engine oil temperature (from **40 °C** to **160 °C** with step of **10 °C**)
- engine oil pressure (from **0 bar to 10 bar** with step of **1 bar**)
- battery voltage (from **12 Volt** to **15 Volt** with step of **0.5 Volt**)
- engine rpm (from **0 rpm** to **8500 rpm** with step of **500 rpm**)
- vehicle speed (from **0 Km/h** to **320 Km/h** with step of **20 Km/h**)
- gear shifting: (for manual gear shifting version: neutral, **1**, **2**, **3**, **4**, **5**, **6**)
  (for electronically-controlled gearbox: **N**, **R**, **1**, **2**, **3**, **4**, **5**, **6**)
- kilometres covered (from **0 Km** to **400 Km** with step of **20 Km**).

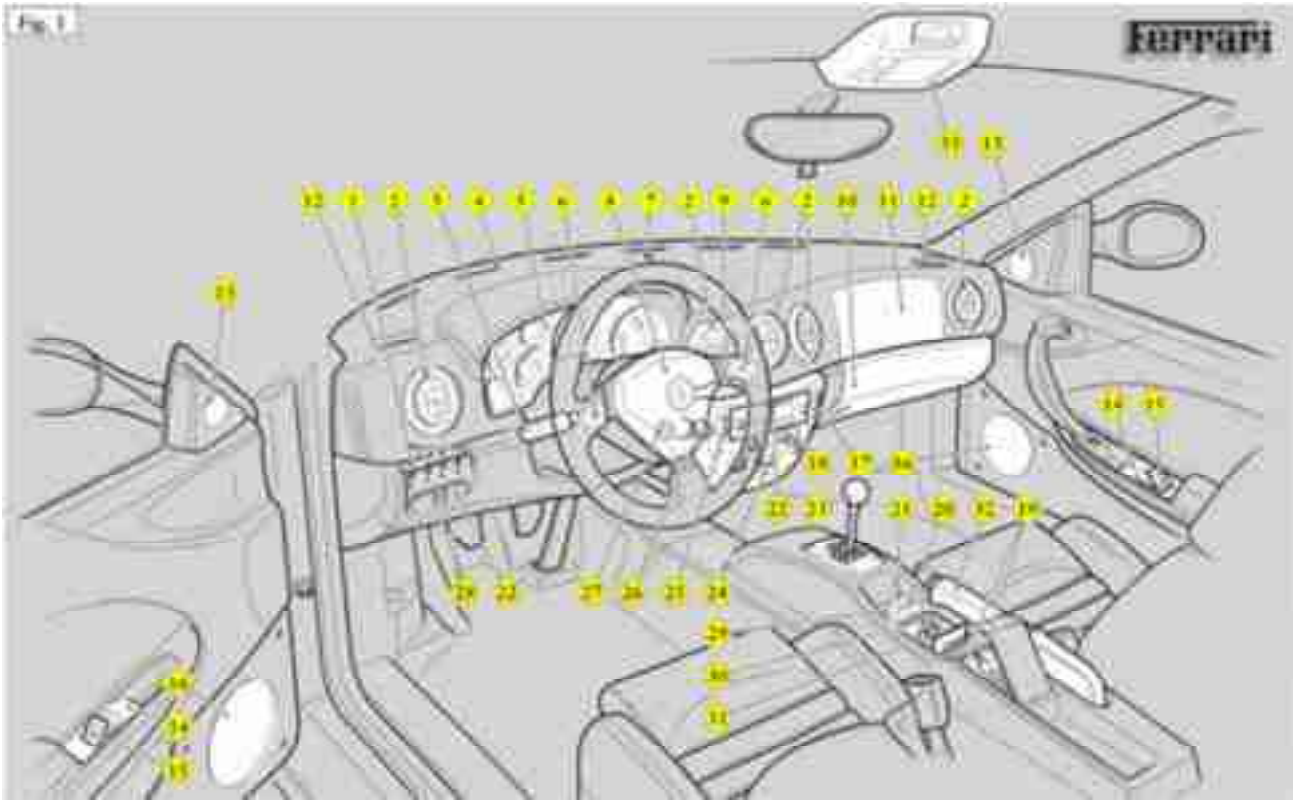
For each histogram, the value stored represents the **%** of time the parameter has been in the respective range.

Histograms are recalculated for each 'working cycle' exceeding 5 minutes and they are up-dated at Key-OFF.

H2.01 LOCATION IN THE CAR

The figures show where controls, instruments and devices needed during car driving are located.

Mechanically-controlled Gearbox Version (Fig1)



1 - Control switches/push-buttons
2 - Adjustable air vents
3 - Headlights and indicators' control lever
4 - Windscreen ventilation diffuser
5 - Instrument panel
6 - Horn
7 - Sun radiation sensor
8 - Driver's side airbag
9 - Windscreen wiper/washer control lever
10 - Glove compartment
11 - Passenger's side airbag
12 - Ceiling spot lights/clock
13 - Tweeter loudspeaker
14 - Internal door opening handle
15 - Door locking lever
16 - Woofer loudspeaker
17 - Passenger's side window control
18 - Stereo system
19 - Luggage compartment and fuel tank flap opening controls
20 - Parking lights switch
21 - Hazard lights switch
22 - Alarm system LED
23 - Mechanically-controlled gearbox lever
24 - Air conditioning controls
25 - Driver's side window control
26 - Ignition switch
27 - Passenger compartment temperature sensor

28 - Instruments control
29 - Wing mirrors adjuster
30 - Ashtray
31 - Cigar lighter
32 - Parking brake lever
33 - Ceiling spot lights and clock

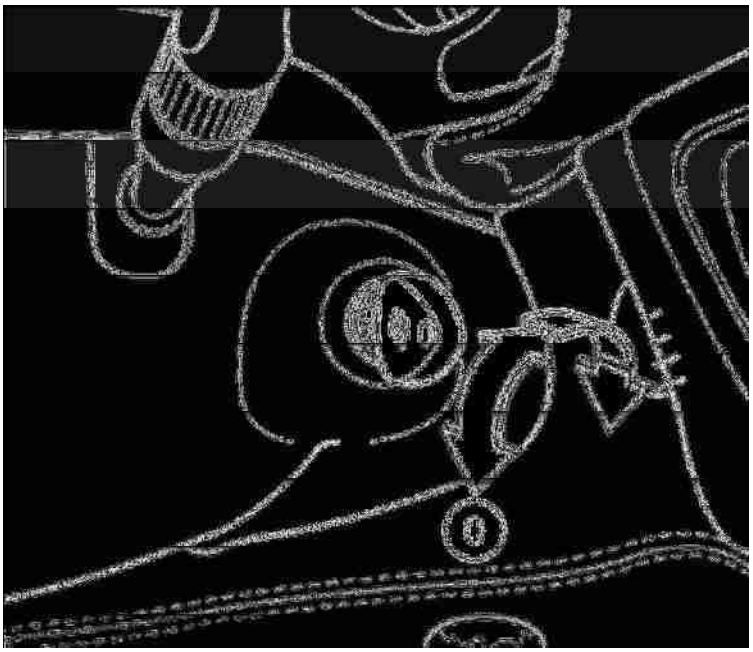
Only for the electronically earbox version (Fig

34 - Gearshift **"DOWN",** control lever
35 - Gearshift **"UP",** control lever
36 - Reverse gear control lever
37 - **"Automatic gear shift"** function switch
38 - **"Low grip"** function switch

H2.02 IGNITION SWITCH

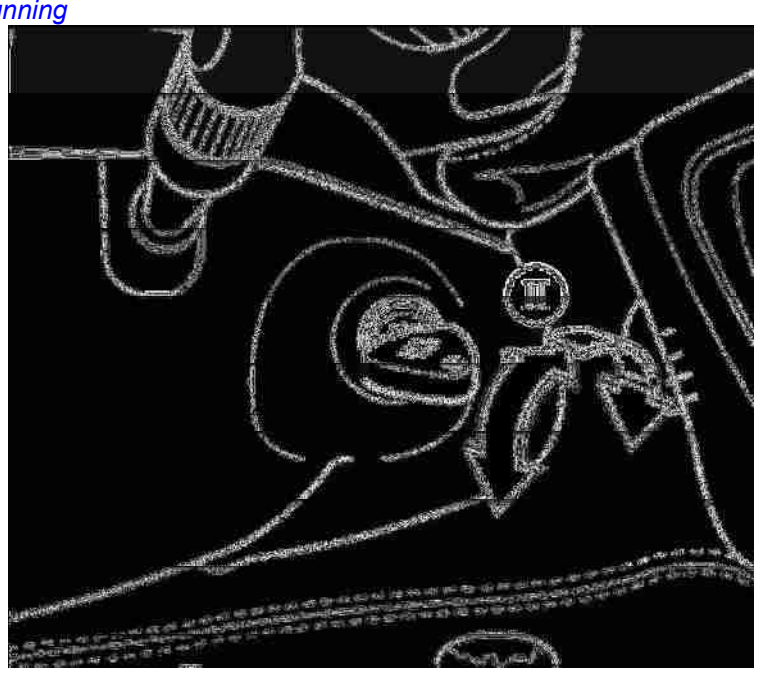
The ignition key can be turned to three different positions

- *Position 0 - Stop*



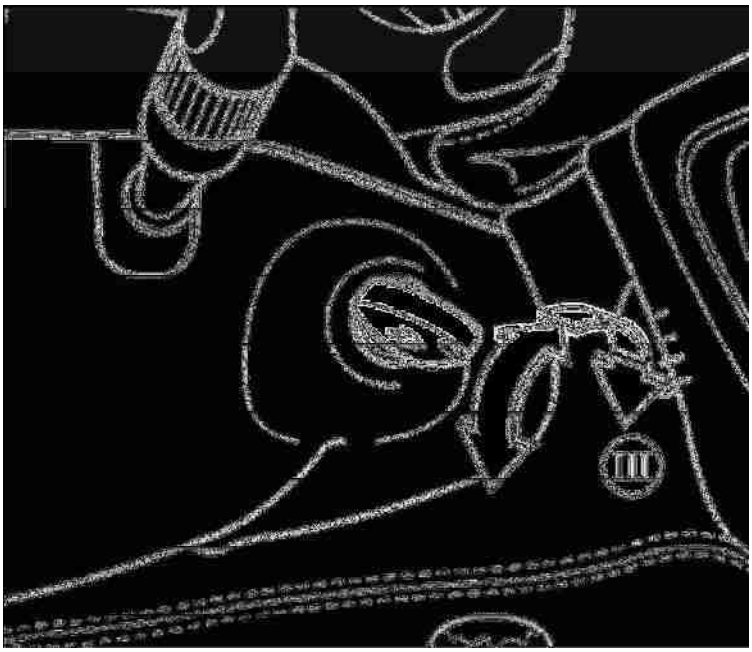
Engine off, key exctractable.
If the key is even only partially extracted, the steering will lock.
Hazard and parking lights may be switched on.
To help releasing the steering lock, move the steering wheel gently in both directions while turning the ignition key.

- *Key position II – Running*



Turning the key to this position, the multifunction display checks all the signals coming from the various car systems. If no failures are detected, the **"check OK"** message will be displayed.

- *Key position III – Start-up*



CAUTION

Never remove the key unless the car is stationary: the steering lock will engage as soon as you steer. Remove the key from the ignition block whenever you get out of the car.

Replacement

The anti-theft block is supplied as a spare part together with the door locks.

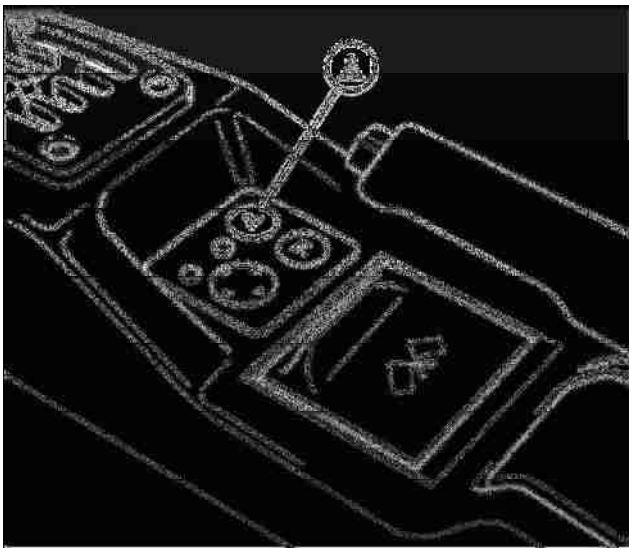
- To replace it (E 2.05).

H2.03 SWITCHES/PUSH-BUTTONS

External lights

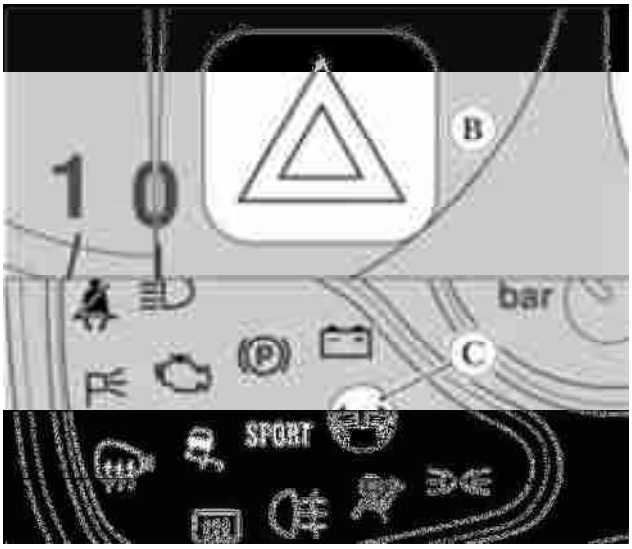
Hazard caution lights

Press switch **(A)** to turn on the hazard lights.



All direction indicators will light up simultaneously and flash intermittently.
Hazard warning lights can be switched on regardless of the ignition key position.

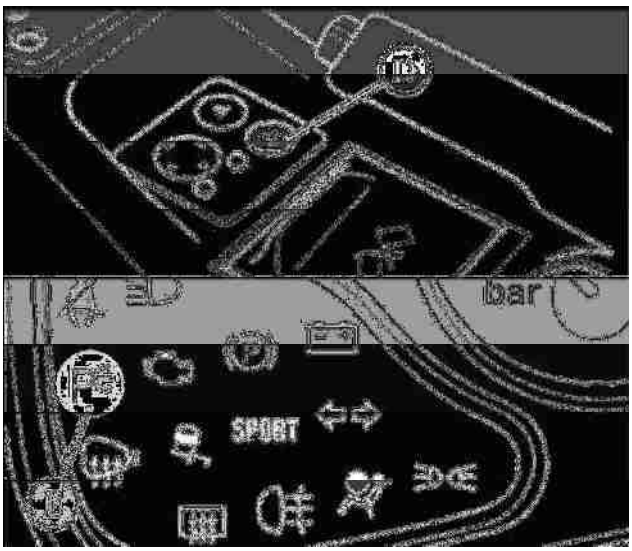
When these lights are on, the symbol **(B)** will appear on the multifunction display and the warning light **(C)** and switch **(A)** will flash intermittently.



To turn off the hazard warning lights, press push-button again.

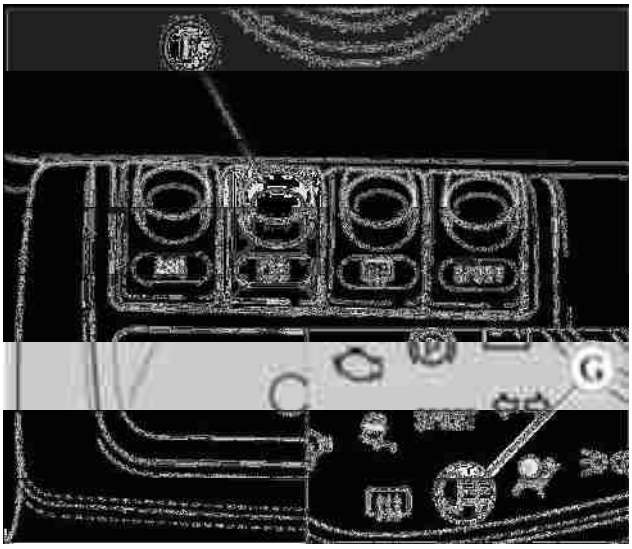
- To replace the light bulbs (L 2.08).

Parking lights
By pressing switch **(D)** the parking lights will turn on.
They can be switched on regardless of the ignition key position.
The warning light **(E)** indicates that these lights are on.



To turn them off, press the switch again.
- To replace the light bulbs (L 2.06) and (L 2.07).

*Rear fog lights (not available on the **US** car version)*
Rear fog lights can be switched on only when the high beams or low beams are on and using switch **(F)**.
The warning light **(G)** indicates that these lights are on.



IMPORTANT
Use the rear fog lights only under poor visibility conditions.

- To replace the light bulbs (L 2.07).

Replacement

- To replace the hazard lights **(A)** switches and parking lights **(D)**, remove the central console and the left-hand dashboard (M 3.02).
- To replace the rear fog lights switch **(F)**, lever it out of its seat with a small flat screwdriver.
- Detach the connector and replace the switch.

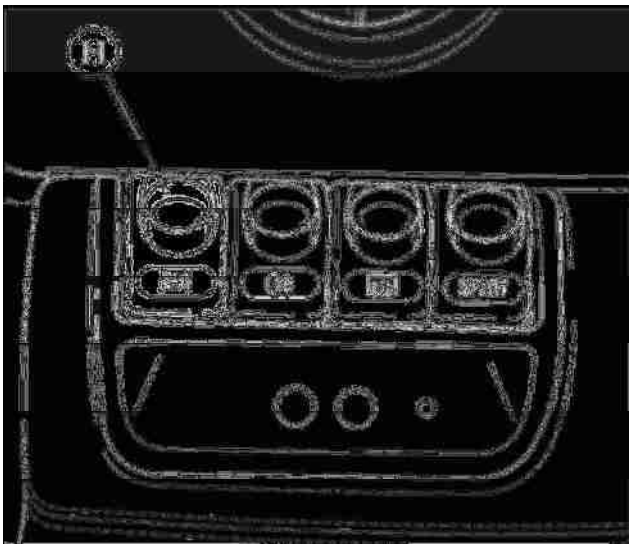
For connection to the system, see Table **D** and **F** - ELECTRICAL SYSTEM.

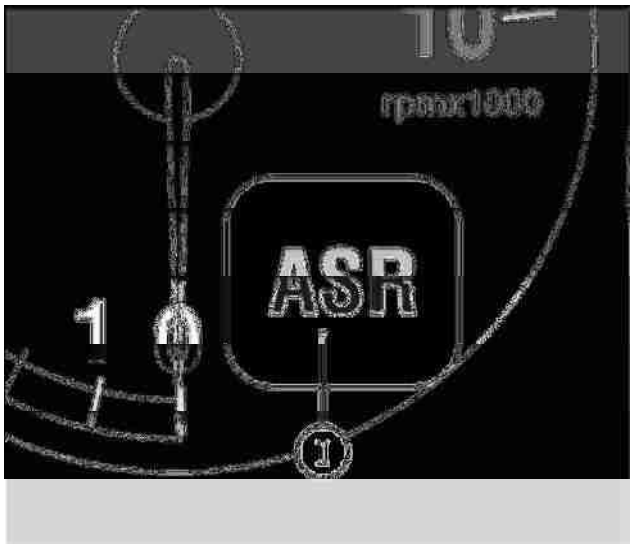
ASR system cut-off, heated rear window and SPORT mode

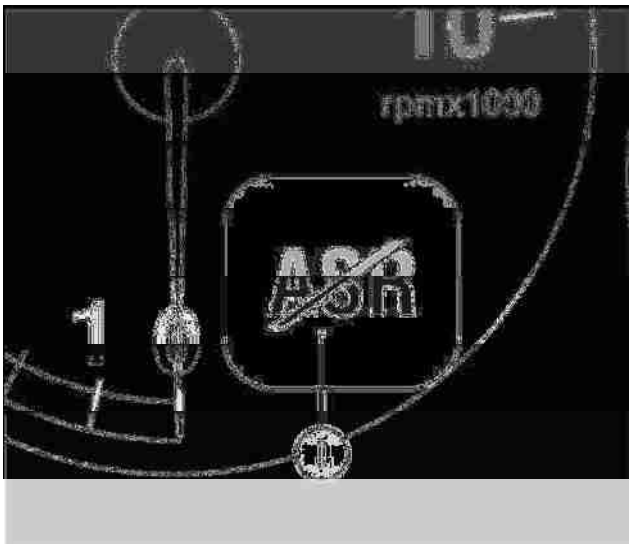
These switches are located within the instrument panel frame.

Asr system cut-off

The ASR system (which is always activated upon ignition) can be de-activated by pressing switch **(H)**: the ideogram ASR **(I)** will appear on the multifunction display







With the ASR system on, whenever the anti-skid system is activated, the ideogram ASR active **(**

Heated rear window and wing mirror defrosting
To set these functions on, press switch **(M)**.

The warning lights **(**

SPORT mode

The driver can modify the car setting according to the desired driving style.

- By pressing switch **(P)**, the SPORT mode can be either activated or de-activated.

When on, light **(** indicates this setting is in use.

SPORT mode facilitates sporty driving in high grip conditions, whereas the **"normal"** mode facilitates relaxed driving and assures stability in medium to low grip conditions.
Whatever car setting is chosen, the driver must always respect general rules for safe driving.

Replacement
- To replace switches, lever them out of the panel frame with a small flat screwdriver.
- Detach the connector and replace the switch.

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.

Glove compartment opening

The glove compartment positioned on the dashboard, passenger side, is equipped with a key lock. Use the ignition key to release the lock, then press button (**W**) to open the compartment.

Upon opening the compartment, the courtesy light (**X**) will come on to illuminate it.
After having re-closed the compartment, turn the key and remove it from the lock.

Opening the Luggage Compartment Lid and the Fuel Tank Flap

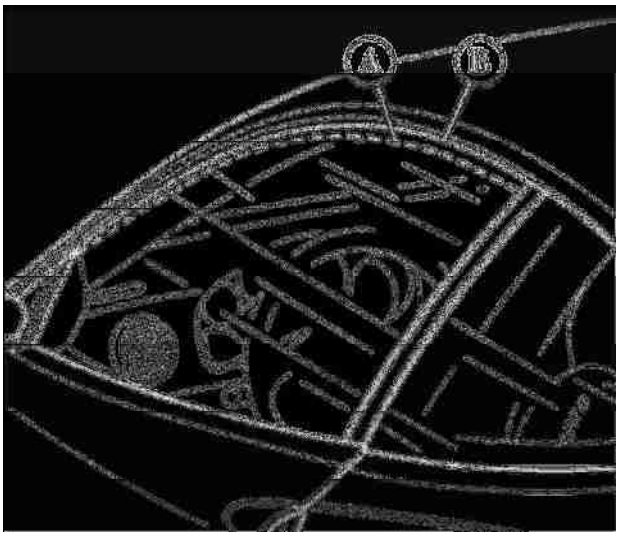
The respective switches are placed under a protective flap, on the console.
Switch **(R)** releases the luggage compartment lock. Switch **(S)** opens the flap to gain access to the fuel tank flap.

NOTES
For opening instructions (_____).
To replace switches (M 3.02).

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.

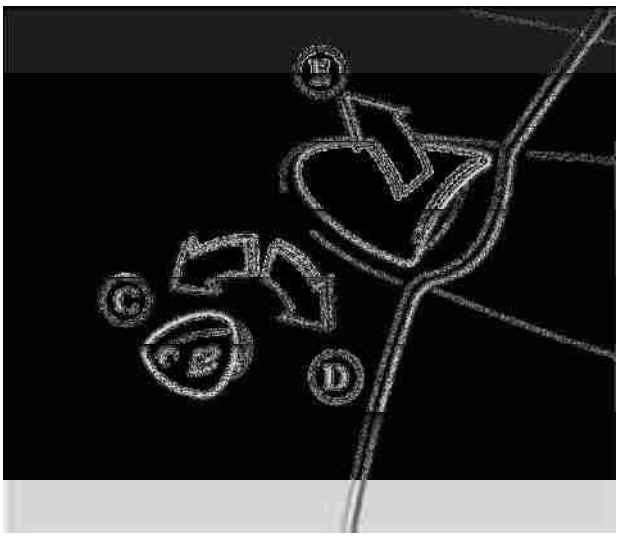
H2.04 DOOR CONTROLS

When opening/closing the doors, the windows will automatically lower by approximately 2 centimetres **(A)** to a **"pre-set limit"** that avoids any interference with the door weather strip.
Once the door is closed, the side window will rise automatically to reach the upper limit **(B)**, the so-called **"upper threshold"**.



Opening From the Outside

Disable the alarm system and the central door locking system using the remote control, or deactivate the central locking by turning the key in the lock.
(C) Opening.
(D) Closing.
When handle **(E)** is used to open the door, the window will lower by about 2 centimetres.



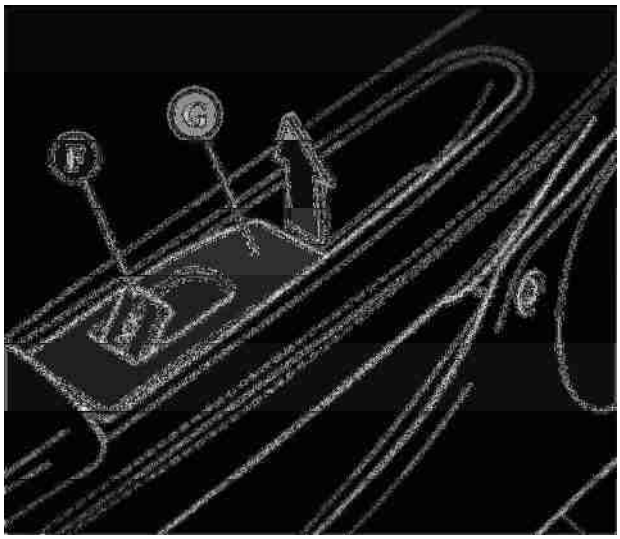
When closing the door, the window will rise to the "upper threshold".
- To replace the handle (M 2.11).

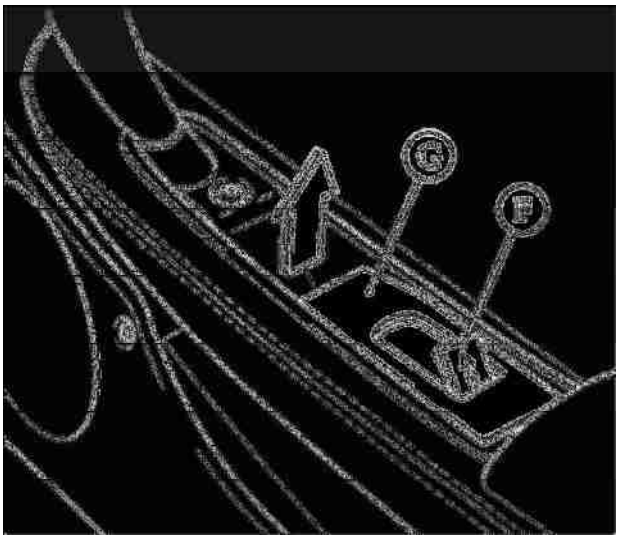
Internal door lock and opening from the inside

To lock/unlock both doors, use the small "**LOCK**" lever **(F)**.

FROM vehicle Ass.ly No. 52140, an electric door locking system activated from inside the vehicle has been introduced. Unlike the pre-modification system, to lock the doors, the new system uses an electrical signal produced by a micro-switch which is activated with the "**LOCK**" lever **(F)** and connected to the lock electrically. As it is no longer connected to the linking tie-rod mechanically, the small lever **(F)** only allows the door lock activation: it is deactivated by operating the internal door opening handle **(G)**.

When the handle **(G)** is used to open the door, the window will lower to the **"pre-set limit"**. When closing the door, it will rise to the **"upper threshold"**.





If the handle **(G)** is pulled without opening the door, the window will lower to the **"pre-set limit"** but after 20 seconds, if the door is not opened, it will rise to the **"upper threshold"**.

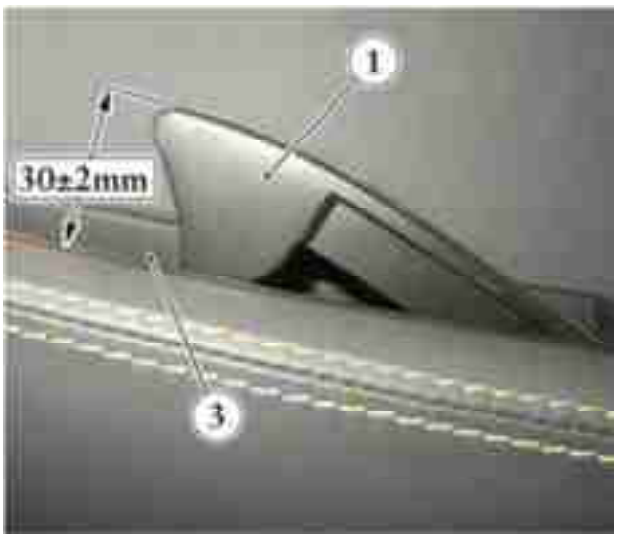
To open the door, let go off the handle and then proceed to pull it once again.

- To replace the entire handle (M 2.11).

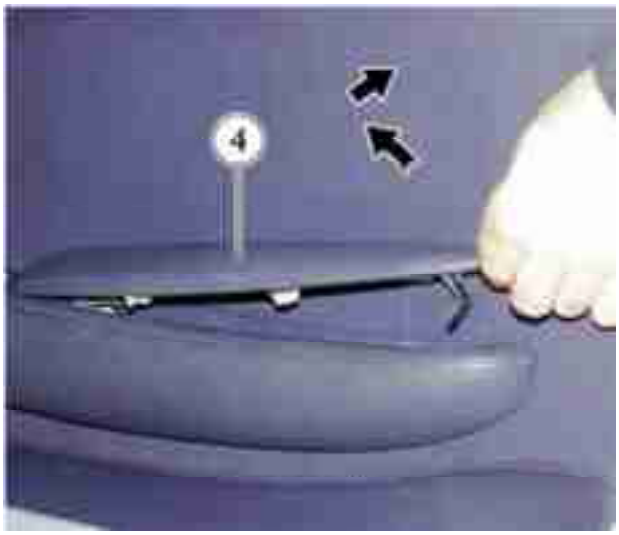
Internal opening handle position adjustment

The first part of the handle **(1)** opening stroke must activate the microswitch **(2)**, after which it must open the door lock.

Lift the handle **(1)** and check that the height reached, in relation to the fixing plate **(3)**, is the same as that shown in the figure. If this is not the case, proceed with the adjustment as outlined below.

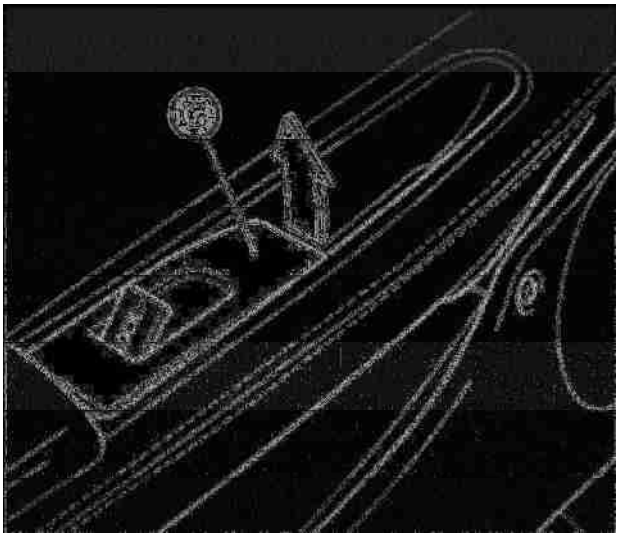


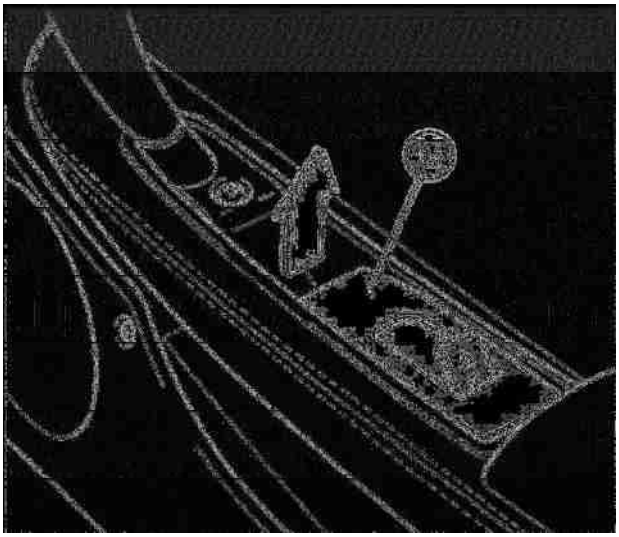
- Remove the armrest insert **(4)** by lifting its rear section and pulling it backwards to slide it out the front fastening on the door panel.
- Loosen the lock nuts on the control cable adjusting screw **(5)**.
- Rotate the adjusting screw until the prescribed handle opening height is reached.
- Lock the lock nuts on the adjusting nuts **(5)** and refit the armrest.



Emergency Door Opening

By using the handle **(G)**, the lock on both doors will be released.





Door Open Signal

Each door is fitted with a red light **(H)** that lights up automatically when the door is open.

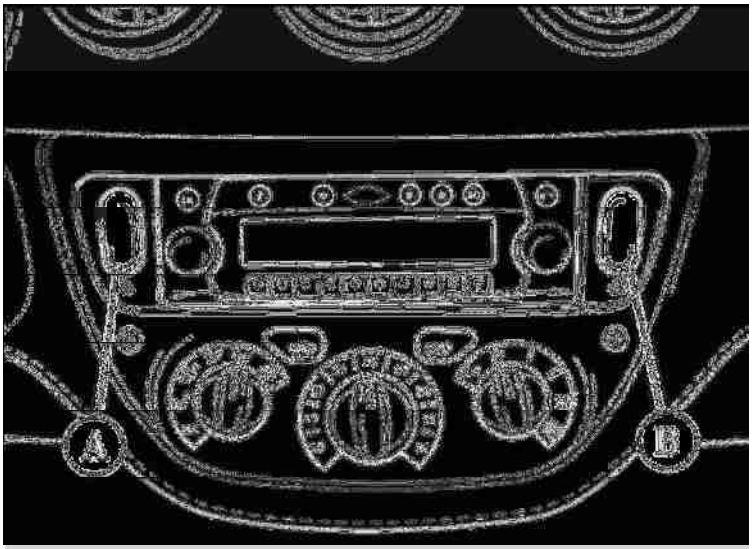
- To replace the bulb, unscrew the external screws **(1)**.
- Remove the entire support, including the light shield **(2)** and the gasket **(3)**, without disconnecting it from the door cable.

- Detach the shield from the bulb-holder and replace the bulb by rotating it to slide it out of its seat.
- When re-assembling, place the gasket **(3)** properly underneath the shield's **(2)** support and tighten the screws **(** .

H2.05 POWER WINDOWS

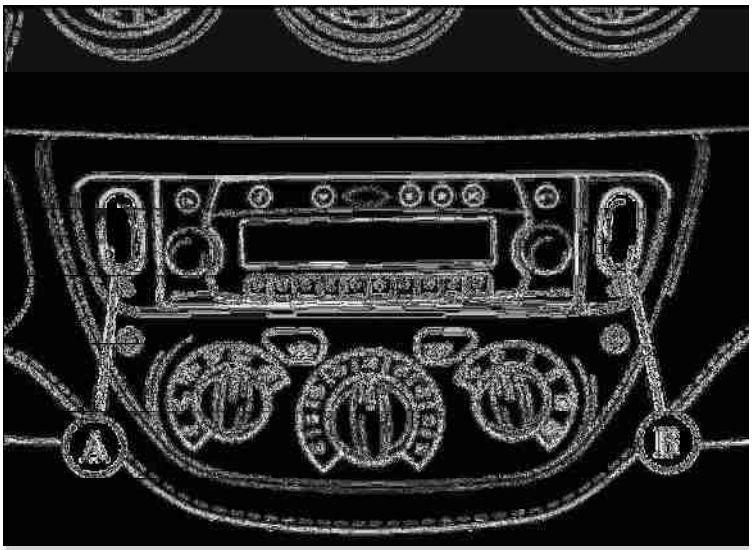
IMPORTANT
The electric power windows can only be operated when the ignition key is in running position.

Driver's side power window



If button **(A)** is pressed, the window opens or closes.
This power window can be operated both manually (partial opening/closing) and automatically (full opening/closing).
To activate the manual control, press shortly on button **(A)**. To activate the automatic control, press the button for more than **300 ms.**: the window will only stop at the end of the stroke, or if the button is pressed again for a time ranging from **20 ms.** to **300 ms.**

Passenger's Side Power Window



If button **(B)** is pressed, the window opens or closes.
This power window can only be operated manually: when switch **(B)** is released, the window stops moving.
Both power windows can only be operated manually if one of the doors is open and the ignition key is inserted. In this case the windows will rise only as far as the **"pre-set limit"** (H 2.04), in order to avoid interference between the door and the weather strip during when closing the door.

CAUTION
Improper use of the power windows can be dangerous. Before using them, always make sure that they are clear of people or objects..
Take particular care when the driver's side window is moved automatically.
To protect a passenger who has been left alone in the car from any unintentional movements of the windows, always remove ignition key.

General information and system components

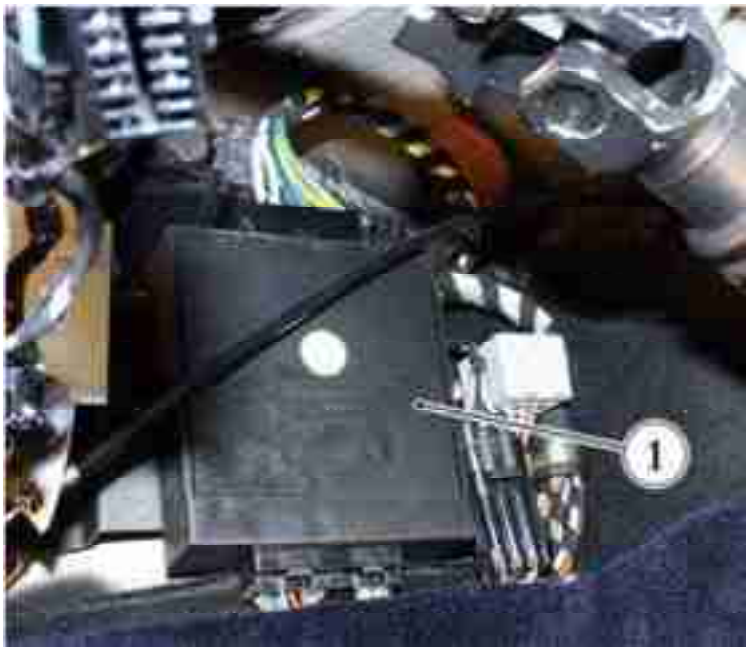
This system, which controls both power window and door lock functions, consists of the following:
- microprocessor ECU with optional interface connection to the tester SD-2;
- door lock module;
- electric motors for rising/lowering the windows, with self-adjusting voltage double check (during pickup and steady state);
- switches for automatic and/or manual operation of door power windows, placed on the small A.C. instrument panel on the car radio sides;
- micro-switches fitted on the power window leverage, to detect **"pre-set limit"** that window reaches when the door is being opened.

"Automatic operation" means opening/closing the window by keeping the button pressed for a time **>= 300 ms**.
"Manual operation" means moving the windows only as far as the control button is pressed.
To avoid any interference between the glass and the door weather strips while closing the door, when the door is open the window can be risen only up to approximately **2 cm** from the upper threshold.

Replacing the electronic control unit

- The power window ECU **(1)** and the door lock/release unit are mounted on the chassis, on the left-hand side of the passenger compartment, under the dashboard lower covering, and they are protected from water infiltration by a rubber sheet. To remove them, it is necessary to detach the connectors from the instrument panel cable (**12F - 13F - 14F**, see Table **F** - ELECTRICAL SYSTEM) and unscrew the fastening screws.

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.



Replacing the threshold position micro-switch

- To gain access to the power window motor **(2)** and to the micro-switch **(3)**, it is necessary to remove the door panel (M 2.11).
- Remove the power window motor (M 2.11).
- To remove the micro-switch **(3)**, it is necessary to detach the connector **(4)** from its fastening bracket and to disconnect it from the door cable.

CAUTION

*As the interruption of the micro-switch connection **(3)** may cause a lowering of the power-window device, it is important to first detach the motor connection, in order to prevent the operator from getting injured.*

- Unscrew the nuts **(5)** and remove the micro-switch and its bracket from the power window leverage frame.

- Separate the micro-switches from the bracket by unscrewing fastening screws (**C**).

- During re-assembly, make sure the micro-switch is correctly positioned so that the slider squeezes it when the window has lowered by **10 mm**.
- Once the micro-switch has been properly positioned, tighten the nut **(5)**.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.

Replacing the switches

- To replace the power window switches, it is necessary to remove the small A.C. instrument panel (M 3.01).
- Detach the bulb-holder **(** from the switch **(** **(** .

- Remove the switch from the instrument panel, by moving it towards the inside.

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

Operation

The operation logic of the system is based on the following:

- doors condition (open/closed, locked/released);
- ignition key's position:
  with doors closed, power windows may be moved only if the ignition key is in running position;
  with doors opened, only manual control of windows is possible (only for the EUROPEAN VERSION).

By pulling the external door handle when the doors are locked, the power window will not move. By releasing the doors using the remote control or the car key, the window will lower as far as to permit the door opening (i.e., down to the **"pre-set limit" = 22±2 mm**). By closing the door, the window will rise up to the **"upper threshold"** after **200** to **400 ms.**: this is the time span needed by the ECU to detect the door closing.

NOTES

After releasing/closing the door, this automatic function is not activated in the event that the window is positioned below the "pre-set limit".

Car speed

If the driving speed exceeds **130 km/h** and the windows are closed, the ECU operates small movements of the windows in order to keep them always in the upper threshold position, thus avoiding lowering the windows and thereby letting air in.

Safety

If the power window system receives contrasting commands, the lowering command will prevail on the rising one. Should the opening button be pressed for more than **30 sec.**, the ECU will detect it as a short circuit and will give priority to the rising command, so as to allow the window closing.

NOTES

Each window movement can be controlled for 15 seconds max.. When this time is exceeded, the control is automatically reset.

The whole system is powered automatically only in the following cases:

a. if the door is locked, the ignition key has been extracted and the door closed;

b. if the (internal/external) door handle is pulled when the ignition key has been extracted and the door closed.

Specifically in case **a.**, the system will be disabled **3 minutes** after activating the lock control, whereas it will remain active for about **3 minutes** after activating the release control.

Case **b.** occurs even when the doors are locked: by operating on the external handle, the system is powered for **3 minutes** without moving the window.

The internal central door locking (lock) can be operated only if the system is on, i.e. only if the ignition key is inserted or within **3 minutes** from closing the door if the key has been extracted.

To prevent undesired window movements, in case one of the switches is pressed upon system activation, the ECU will ignore this command and consider it as a short circuit.

The motor power control software has been so designed to permit the whole system operate independently from the power window mechanics. The motor cut-out - which intervenes when the upper threshold is reached or an obstacle is met during motion - is actuated when, for a certain amount of time, the voltage input exceeds the threshold stored by the ECU.

The electrical, central door locking system is controlled by detecting a signal sent by the two micro-switches placed on the door locks.

The ECU also controls the door-lock motor feedback (i.e. a signal being fed-back by the motor to supply information on its state) in order to prevent any electrical activation if the command is confirmed, as well as the power window activation in the event that the external handle is pulled when the doors are locked.

The door lock feedback is checked upon completion of each operation: whenever a failure is detected, the command will be rejected, thereby informing the user of the malfunction.

The door lock system will reject the command even if one of the doors is open.

Furthermore, it has to be underlined that the system accepts only up to **18** subsequent operations of the door locking/release within a **20 sec.** max. time. After these attempts, it will not be possible to electrically activate the door-lock system for **30 sec.**. It will still be possible, however, to unlock the doors manually. This prevents overheating and possible failures of the actuator.

This latency time can be eliminated by inserting/extracting the ignition key.

Diagnosis

The system is constantly controlled by the ECU, so that any failures are immediately detected, parameters are stored and diagnosis procedures are carried out.

It is possible to make use of these powerful ECU's characteristics by means of the SD-2 Ferrari tester, which also permits to work on the ECU itself and to delete the errors stored when needed.

The errors that the ECU can detect are the following:

- Driver's side door –lock system status (short circuit)
- Driver's side door –lock system status (open circuit)
- Passenger's side door-lock system status (short circuit)
- Passenger's side door-lock system status (open circuit)

The parameters that the ECU can store are the following:

- Driver's side power window control
- Passenger's side external door handle
- Passenger's side internal door handle
- Passenger's side door-lock switch
- Passenger's door status
- Passenger's door -lock motor
- Power window "pre-set limit", passenger's side
- Immobilizer door status
- Tachometer sensor input
- Hysteresis battery voltage
- Driver's side internal door handle
- Driver's side door-lock control
- Driver's door status
- Driver's side door-lock motor
- Power window "pre-set limit", driver's side
- Passenger's side power window control
- Driver's side external door handle

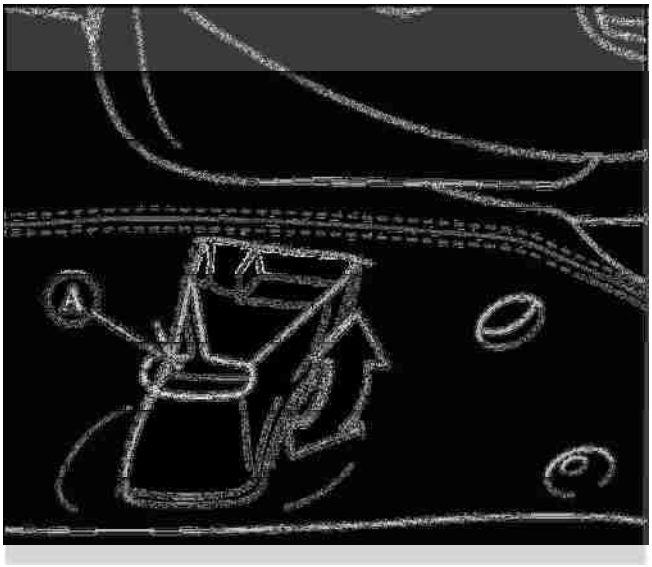
The following are the functions that can be carried out:

- Rising of driver's side window
- Rising of passenger's side window
- Lowering of driver's side window
- Lowering of passenger's side window
- Automatic rising of drivers' side window
- Automatic lowering of driver's side window
- Simulated actuation of driver's side handles
- Simulated actuation of passenger's side handles
- Doors' locking

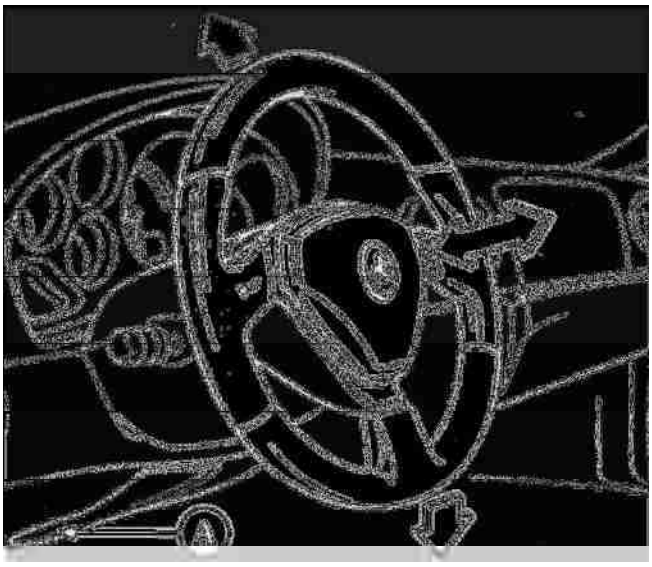
H2.06 STEERING WHEEL

The steering wheel's height and depth are both adjustable.

- Release lever **(A)** by pulling it towards the steering wheel.



- Adjust the steering wheel's position.

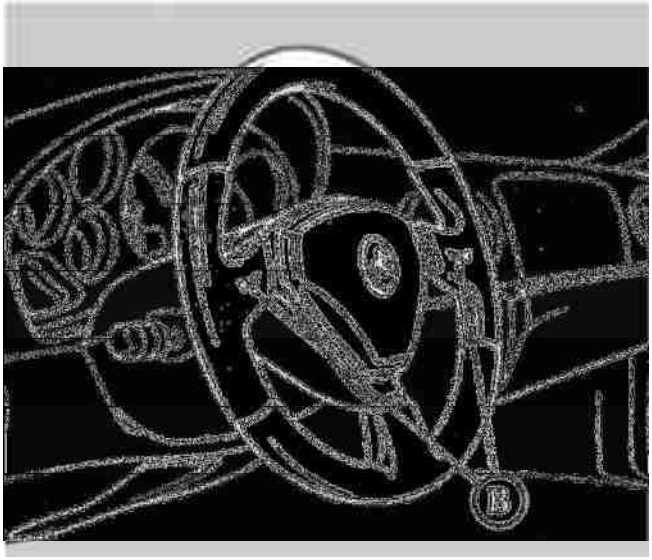


- Lock the steering wheel by pushing the lever **(A)** to its initial position.

CAUTION

Never adjust the steering wheel while the vehicle is moving.

- To use the horn, press the trumpet symbol **(B)** on the lateral spokes.



Disassembly

IMPORTANT
Always make sure that the ignition key is in Stop position, before disassembling or replacing airbag parts. We also recommend to switch the battery to the off position.

- Remove the airbag module from the steering wheel (H 3.02).

CAUTION
Handle and keep the airbag modules with extreme care, following in detail the instructions (H 3.02).

- Detach the connection **(1)** and the faston ground connector **(2)** of the horns control cable.
- Unscrew the fastening screws **(3)** and remove the steering wheel from the hub.

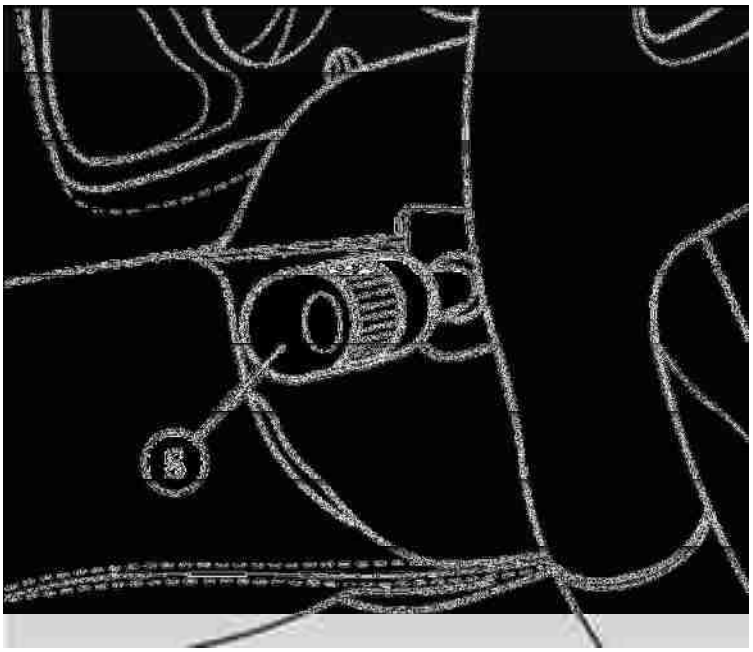
Re-assembly

- Fit the steering wheel on the hub securing it with the screws **(3)**.
- Tighten the screws to the **6÷7 Nm** (Category **B**) torque.
- Re-connect the horn's control harness by fitting the faston connector **(2)** in the grounding plate and re-attaching the connector **(1)**.
- Mount the airbag module following the instructions (H 3.02).

H2.07 STEERING WHEEL LEVERS

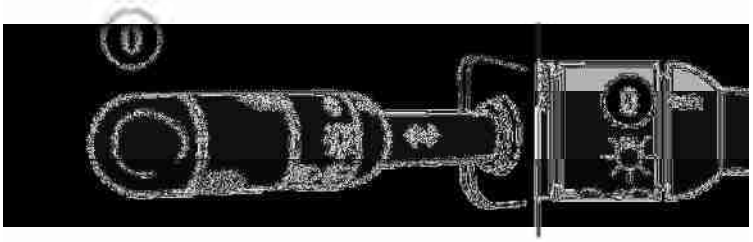
IMPORTANT
The devices controlled by means of the steering wheel levers can only work if the ignition key is in "running" position.

The lever **(S)** on the left-hand side of the steering wheel controls the external lights and the direction indicators.



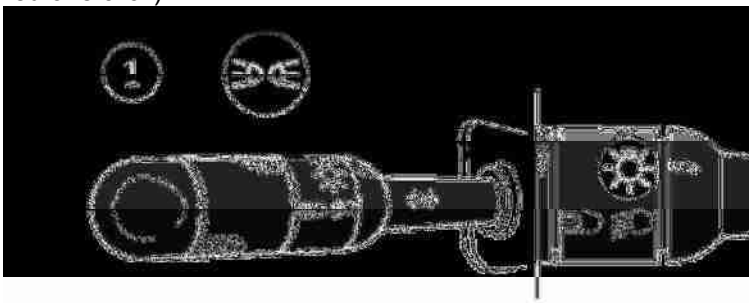
External Lights

- *Position 0*



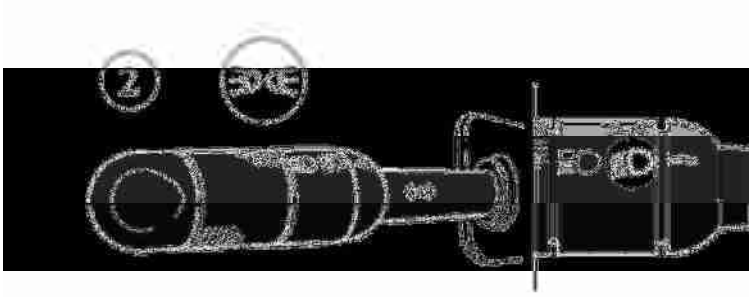
Lights off.

- *Position 1* (lever turned one click):



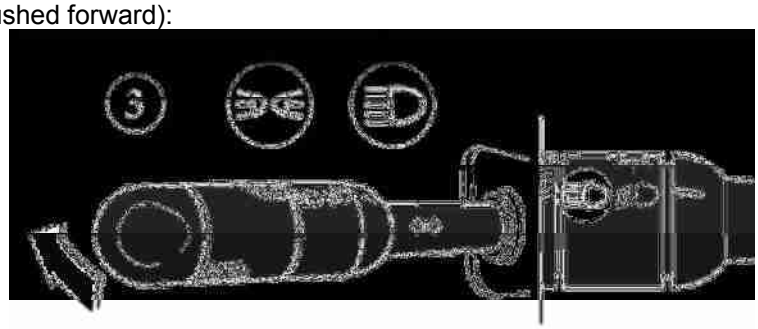
Dipped and license plate lights turned on (the respective warning lights are lit), the instrument panel is illuminated.

- *Position 2* (lever turned two clicks):



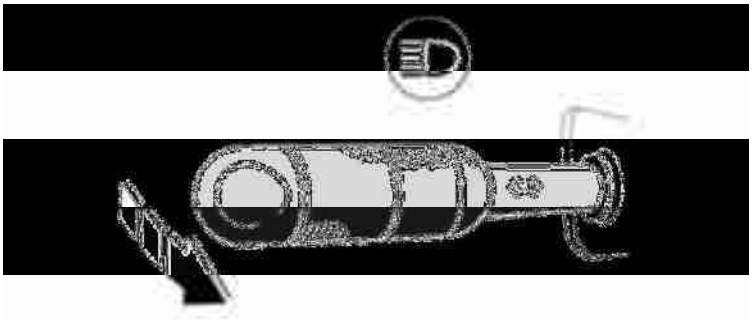
Low beams on.

- *Position 3* (lever pushed forward):



High beams on (the respective warning light lights up).
The high beams can only be switched on with lever in position **2**.

- *To flash the headlights:*

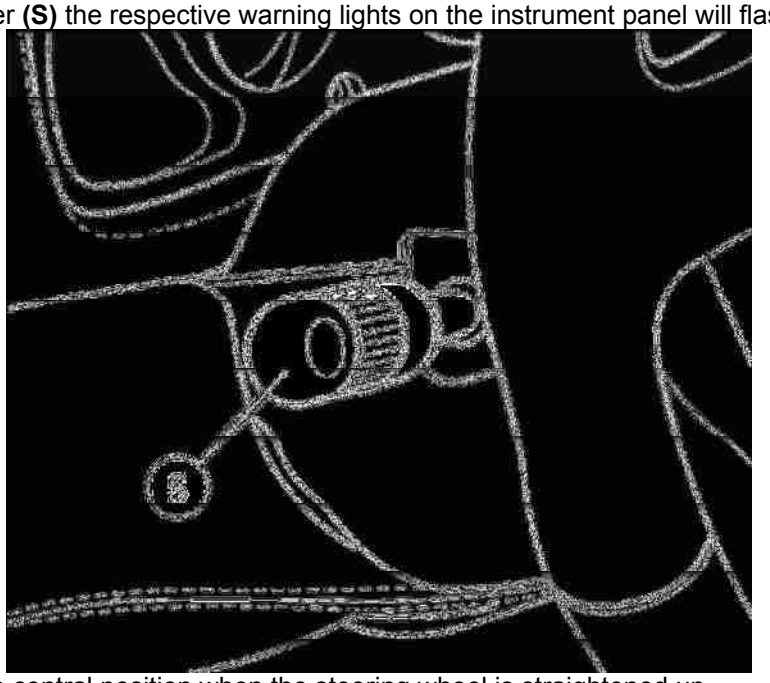


When the high beams are on, pull the lever towards the steering wheel (this function can be performed with the lever in all positions).

NOTES
*On vehicles bound for CANADA, when the ignition key is turned to position **"II"**, the dipped lights and the low beams are always switched on.*

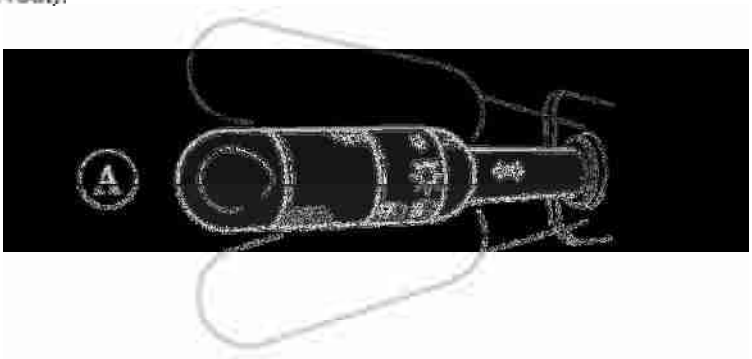
Direction indicators

Upon operating on lever **(S)** the respective warning lights on the instrument panel will flash intermittently.



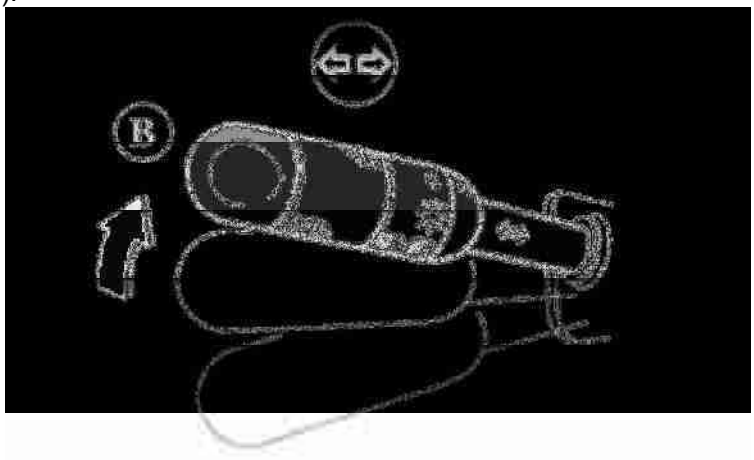
The lever returns to the central position when the steering wheel is straightened up.

- *Position A* (lever at rest):



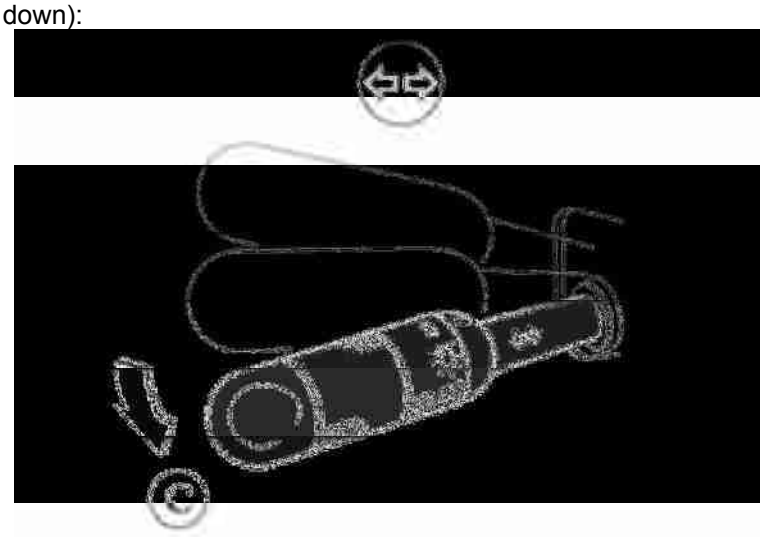
Direction indicators off.

- *Position B* (lever up):



Right –hand direction indicators

- *Posizione C* (lever down):



Left –hand direction indicators.

The lever **(D)**, on the right –hand side of the steering wheel controls the windscreen wipers and washers.

Windscreen wipers

- *Position 0*

Windscreen wiper still.

- *Position* (lever lowered one click)

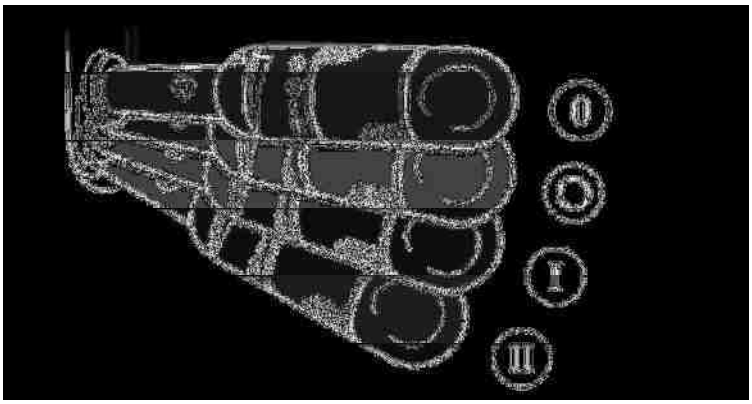
Adjustable intermittent mode.

- *Position I* (lever lowered two clicks)

Slow, constant mode.

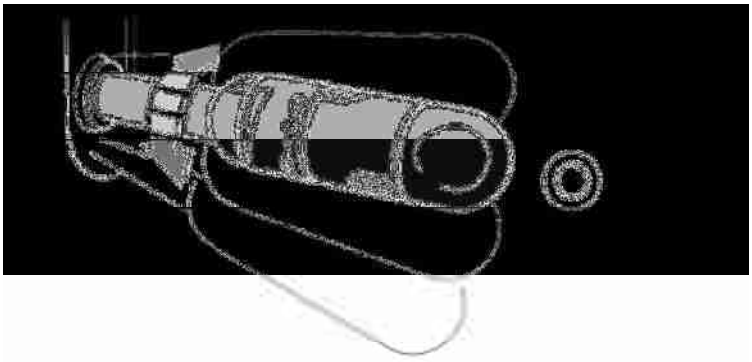
- *Position II* (lever lowered three clicks)

Rapid, constant mode.



- *Adjusting the intermittence:*

In position , rotating the lever will vary the intermittence frequency (clockwise = slower intermittence; anti clockwise = faster intermittence).



Windscreen washer

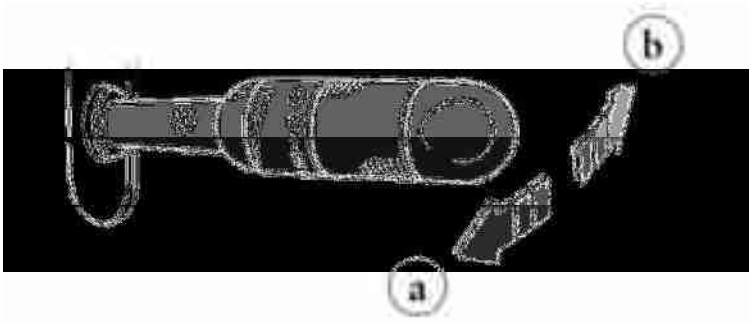
Pulling the lever **(D)** towards the steering wheel **(a)** will activate the windscreen washer at the same time as the windscreen wiper.Releasing the lever will stop the windscreen washer while the windscreen wiper will continue working for a few more strokes.

NOTES

The windscreen wiper will not start unless the luggage compartment is closed properly.

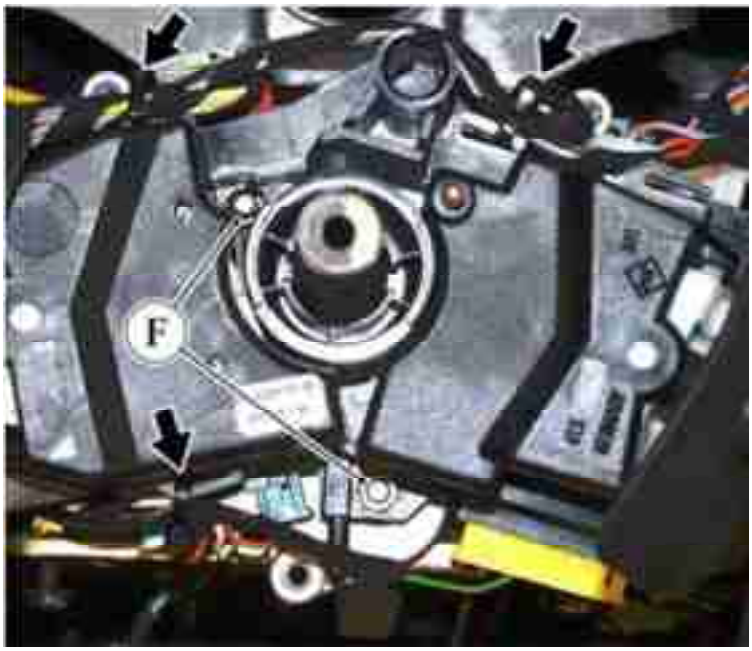
Head-lights' washer (optional)

Push lever **(D)** in the opposite direction of the steering wheel **(b)** to operate lights washers.
Upon releasing the lever, the spraying nozzles will retract into their housing.
To obtain a better cleaning action, we recommend to operate the headlight washers when the car speed is below **80 mph (130 km/h)**.



Replacing the Steering Column Switch

- Remove the driver side airbag module (H 3.02).
- Remove the steering wheel (H 2.06).
- Remove the steering column covers.
- Remove the steering wheel hub from the steering column upper shaft (E 2.05).
- Detach the five attachments connecting the instrument panel cable from the steering column switch.
- Unscrew the nuts **(F)** and remove the steering column switch.



- When reassembling, after having fitted the instrument panel cable connectors on the steering column switch, fasten the cables with tear clamps as shown in the figure.

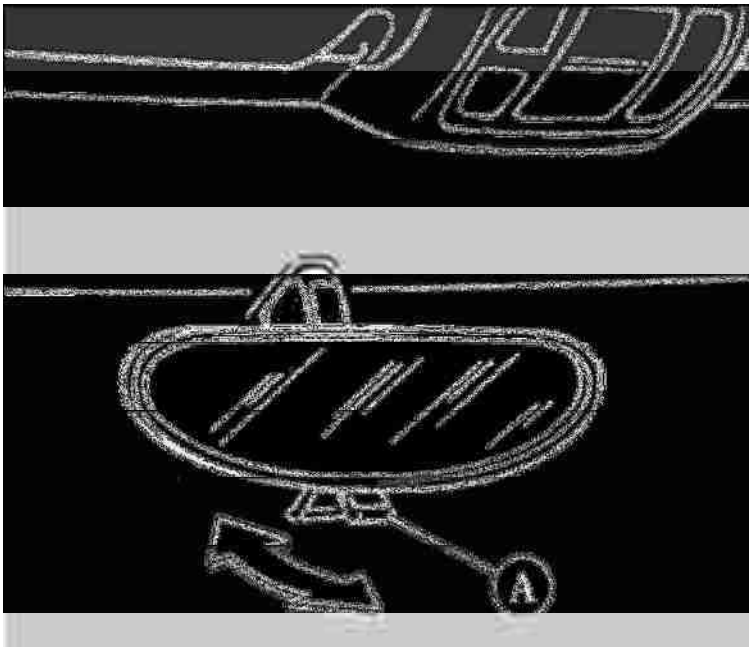
For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

- Re-assemble all the parts removed for this procedure.

H2.08 REAR VIEW AND WING MIRRORS

Rear view mirror

The rear view mirror can be adjusted manually.
To obtain the anti-dazzle effect, pull the small lever **(A)** forward.

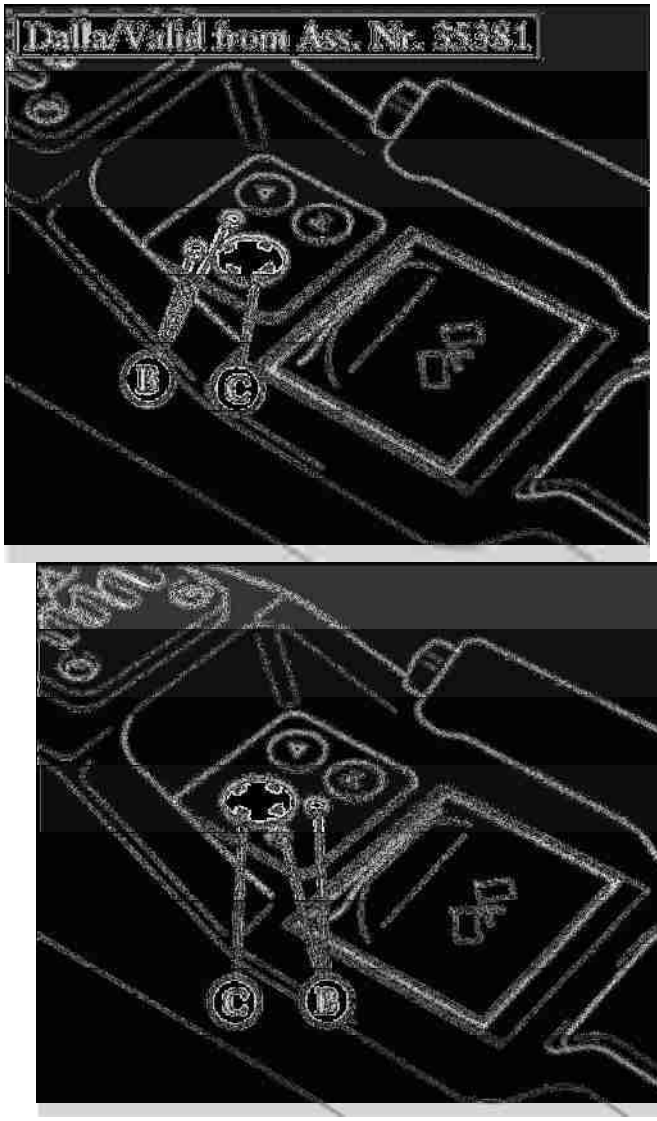


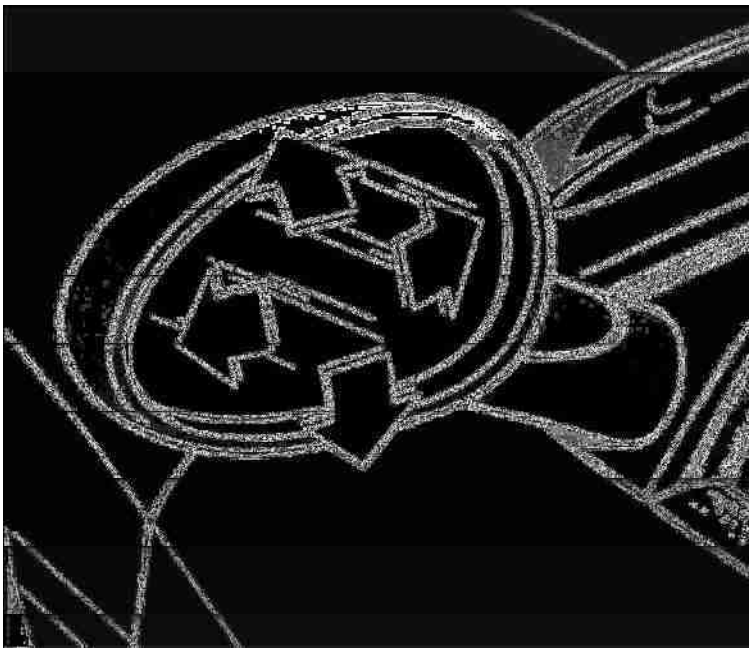
Replacement

To remove the rear view mirror, extract it from its supporting base on the windscreen (M 2.06).

Wing mirrors

Wing mirrors can be adjusted electrically.
Use the selector **(B)** on the console instrument panel to select the wing mirror you wish to position (right or left side).
Use button **(C)** to move the wing mirror vertically or horizontally.





If necessary, the wing mirrors can be folded inwards or backwards manually

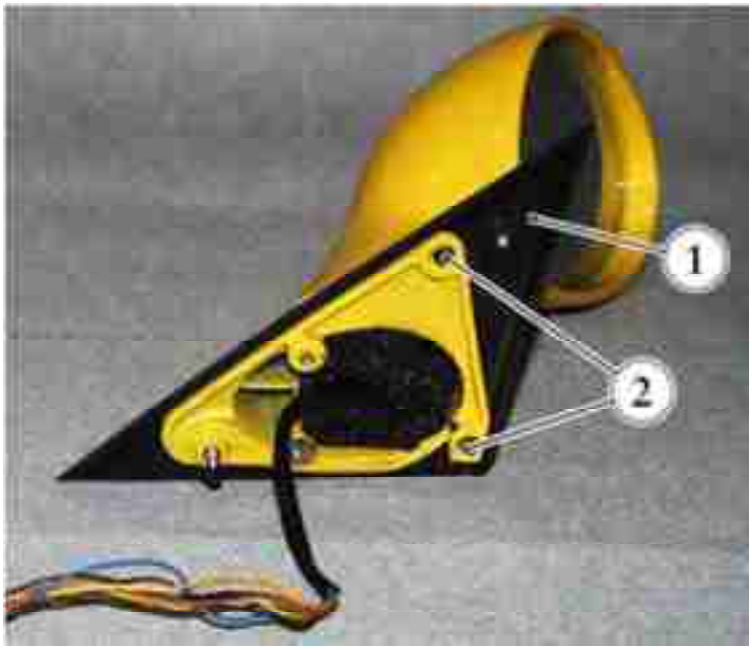
CAUTION
When the car is running, mirrors must always be in the correct position.
Do not adjust mirrors while the car is in motion.

NOTES
The outside temperature sensor is located under the movable part of the left wing mirror (I 2.09).

Replacement

The rear view and wing mirrors are supplied as spare parts as a single component and they cannot be disassembled.

- Once the mirror has been removed,(M 2.11) it is possible to replace the external frame **(1)** by loosening the two fastening screws **(2)**.

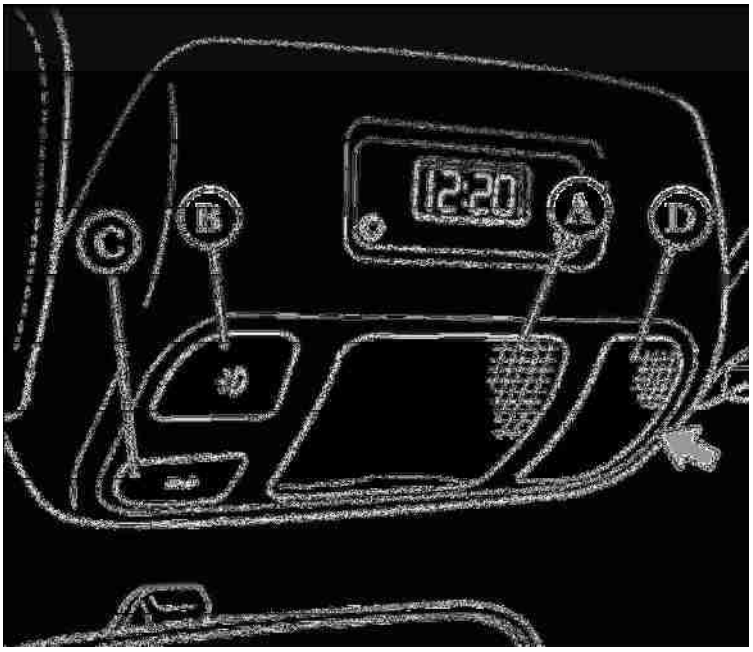


- To replace the control the central console and the switch console (M 3.02).

H2.09 INTERNAL LIGHTING AND CLOCK

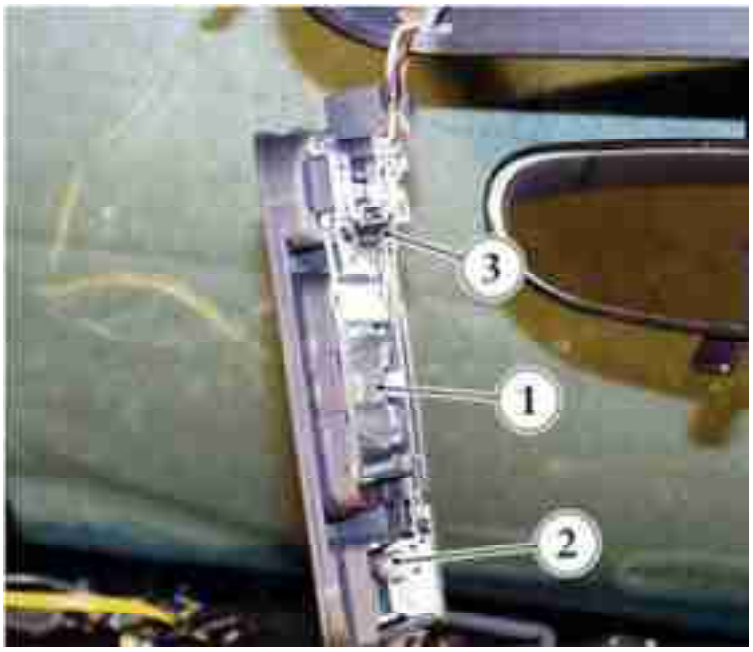
Internal lights

The dome light **(A)** switches on automatically when opening the doors. With the doors closed, this light can be turned on/off using switch **(B)**.
The ceiling light will remain on until the engine is started up or for a maximum of **20 seconds** after closing the doors.
The switch **(C)** turns on the spot light **(D)**.



Replacing the light bulbs

- With the aid of a small screwdriver to be positioned where indicated by the arrow, lever out the small lamp panel, taking care to leave it connected to the system.
- On the lamp panel you will find:
  - the ceiling light bulb **(1)**;
  - the spot light bulb **(2)**;
  - the LED **(3)** that lights up the switches.



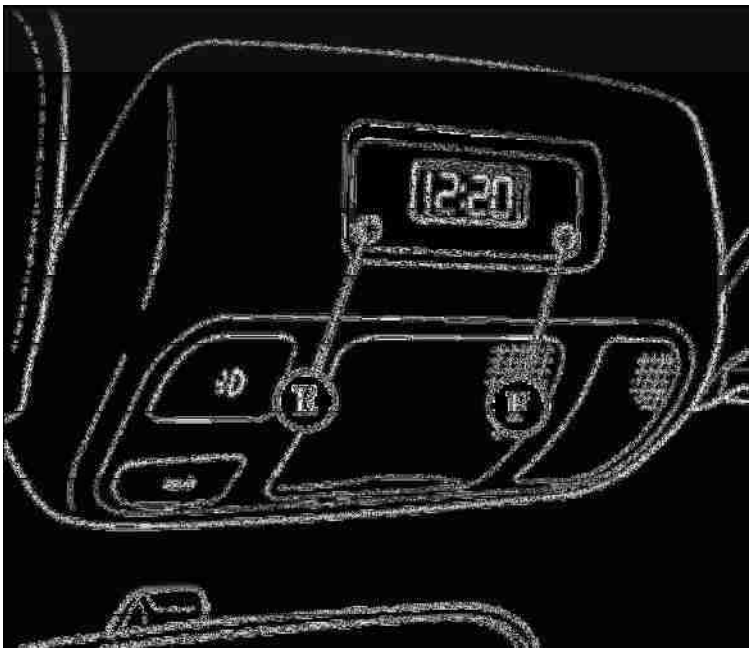
- Fit the new bulb, which must have the same characteristics of the one it replaces.
- Re-install the frame by positioning it on the panel, on the left-hand side, and by pressing the opposite side.

Clock

- Once the key is turned to the running position, the display lights up.

Setting the time

Pressing button **(E)** will make the hours glide. Pressing button **(F)** will make the minutes glide.



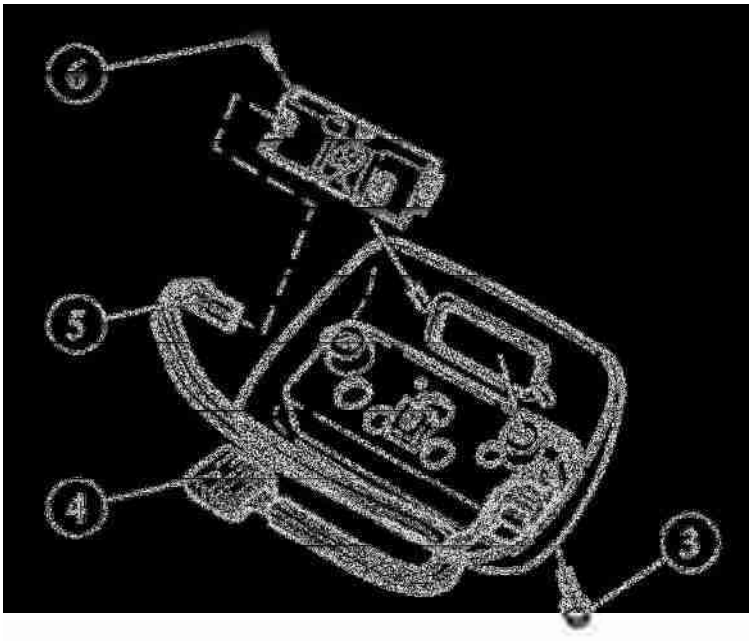
To check all the elements of the display are functioning correctly, press both buttons **(E)** and **(F)** simultaneously: this will set the clock to zero..

NOTES
In case the battery is disconnected, the clock must be reset.

Replacing the clock

- To gain access to the clock: remove the small lamp-holding panel as explained before.
- Unscrew the fastening screws **(3)** for the dome lights' and clock stand and detach the latter from the roof.

- Cut-off the devices from the system by detaching the connector **(4)**.
- Detach the connector **(5)** and remove the clock from its stand by unscrewing the two screws **(6)**.

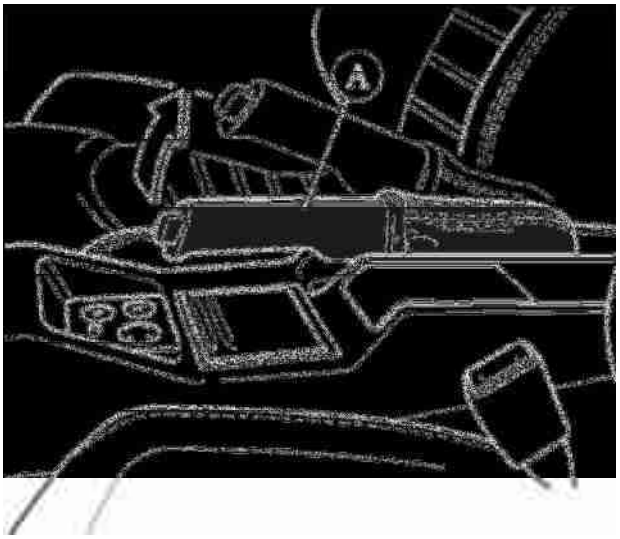


- During re-assembly of the dome lights' and clock stand, take care to properly lay the cables in their apposite seats, in order to avoid squeezing them while tightening the screws **(3)**.

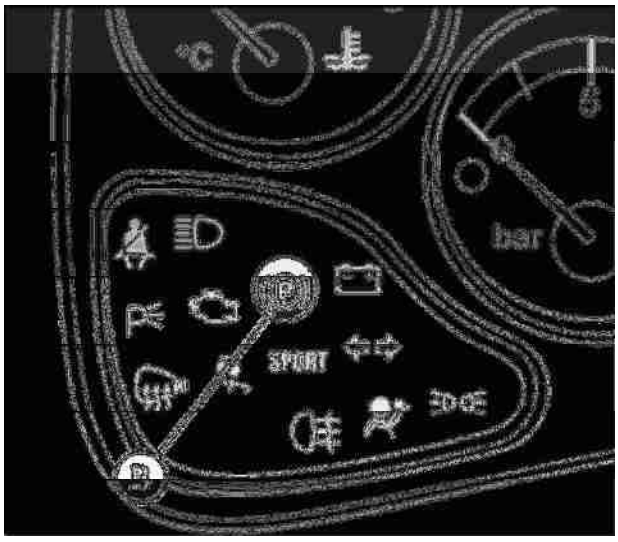
For connection to the system, see Table **C** - ELECTRICAL SYSTEM.

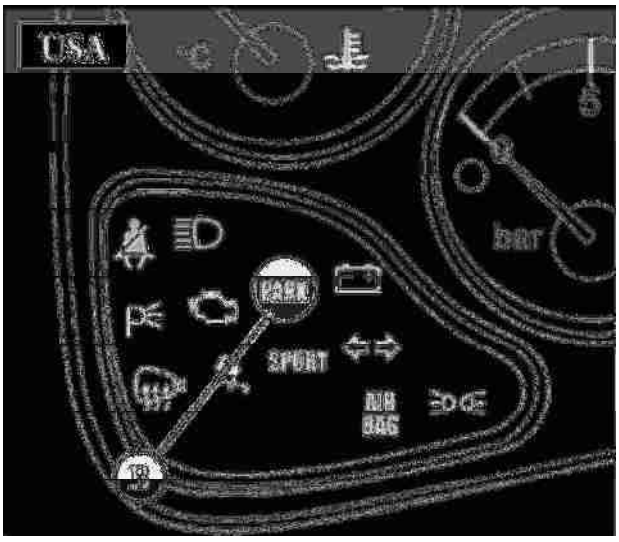
H2.10 HAND BRAKE LEVER

To operate the parking brake, pull the lever **(A)** upwards as far as possible, until the rear wheels are locked.

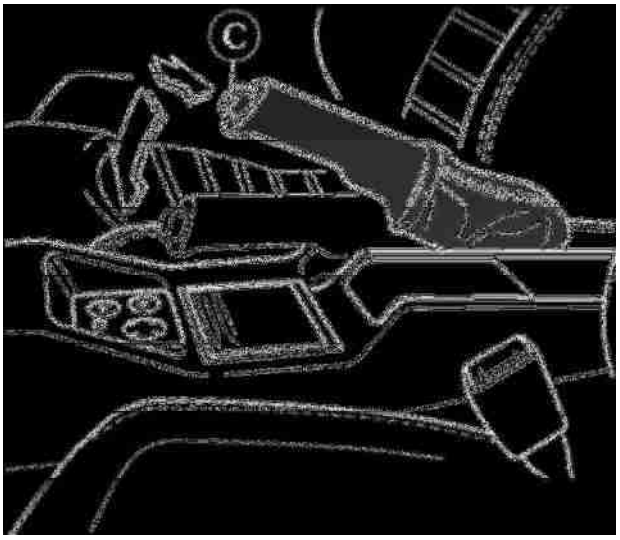


With the ignition key in running position, the hand brake engagement is signalled by the warning light **(B)**.





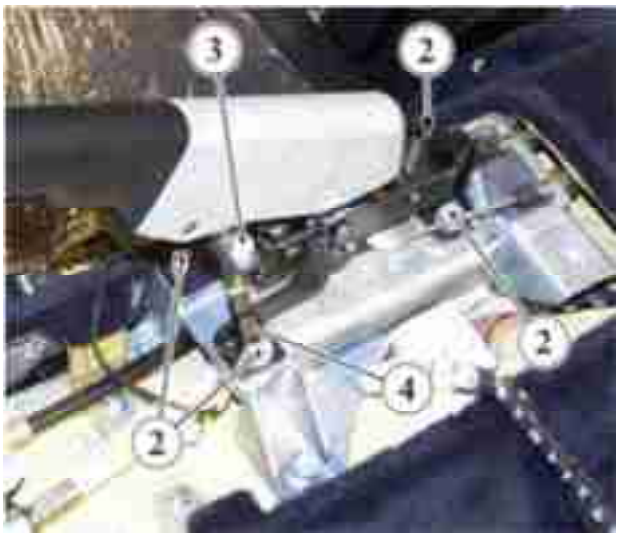
In order to release the hand brake, gently pull the lever upwards and press the release button **(C)**. Keep the button pressed down and lower the lever completely.



The warning light **(B)** switches off when the hand brake is completely disengaged.

IMPORTANT
Always engage the hand brake when the vehicle is parked.

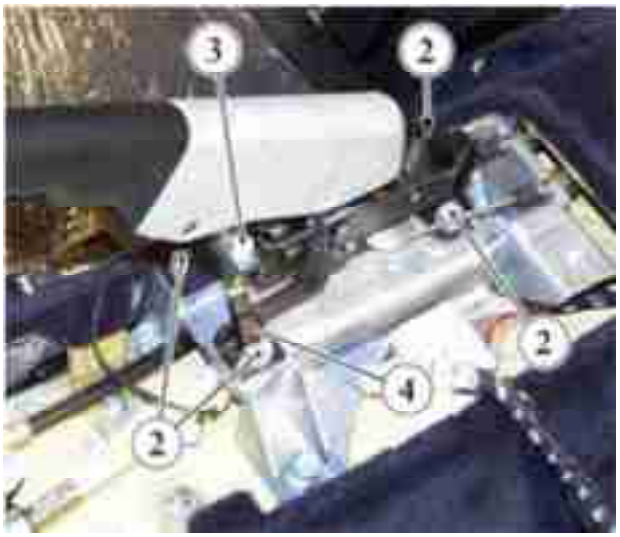
The warning light on the instrument panel is controlled by a switch **(3)** fixed on the bracket of the control lever.



Disassembly

- Remove the central console (M 3.02).
- Remove the nut **(1)** that tensions the control wires on the pulley supporting fork.

- Unscrew the screws **(2)** fastening the parking brake control to the lower support.
- Disconnect the connector **(4)** for the console harness from the switch **(3)**.



- Remove the entire control.
- To replace the switch **(3)**, it is necessary to detach it from its stand by unscrewing the fastening screw.

Re-Assembly

- Fit the fork with the pulley in its seat and partially tighten the nut **(1)**.
- Mount the control on the lower stand, tightening the screws **(2)** to the **20 Nm** (Category **B**) tightening torque.

- Tighten-down the nut **(1)** and check the hand brake is working properly (_____).

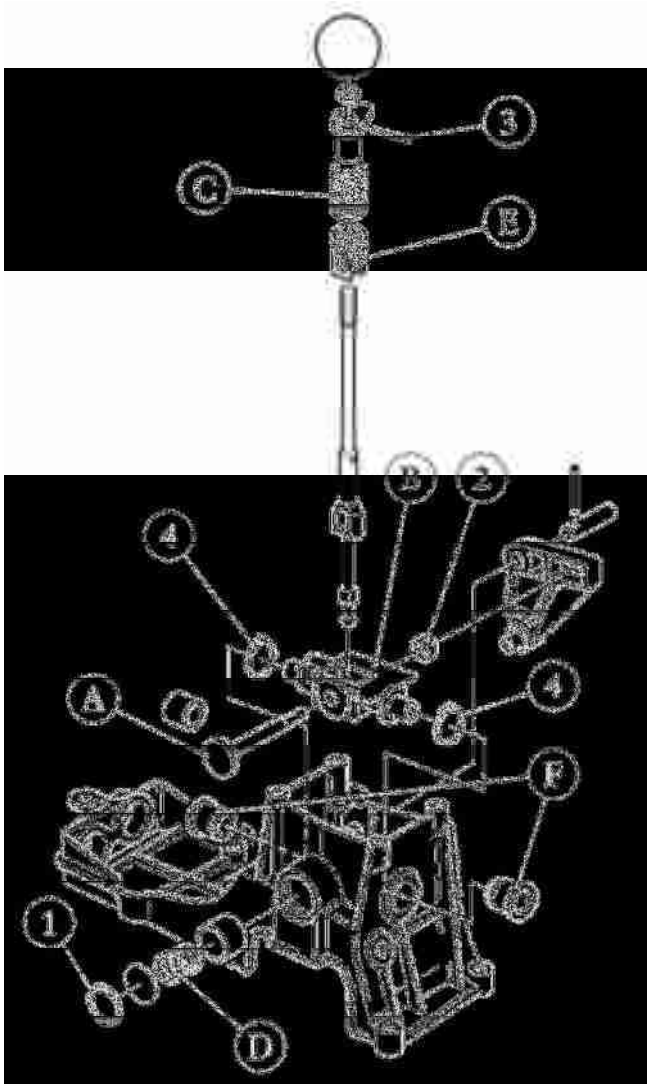
- Re-assemble all components removed.

H2.11 GEARSHIFT LEVER

NOTES
*For information on the use of these devices, see Caphter **H 4**.*

Mechanical gearbox control

The shifting lever is a basic component of the gearbox housing and does not need any particular maintenance.
During periodical inspections, check the lever clearance on the pivot **(A)** and the fulcrum clearance **(B)** on the shifting lever housing. Check also the conditions of the springs **(C)** and **(D)**.
In case of excessive backlash, the fork **(E)** and/or bushings **(F)** can be replaced.



- In order to operate on the shifting lever housing remove the central console and the lower cover (M 3.02).
- Detach the ball joint of the control lever wire (_____).
- Remove the external seeger ring **(1)** and extract the spring **(D)** with the relative stands.
- Take out the pivot **(A)**, locking the small block **(2)** on the opposite side.
- Remove the entire control lever by extracting it from the top.
- In order to remove the spring **(C)** and the fork **(E)**, it is necessary to take first pin **(3)** out.
- To replace the bushings **(F)**, first remove the inside seeger rings **(4)** and then draw them out from the outside.

- When re-assembling, lubricate all the sliding surfaces and adjust the control lever (D 4.02).

Electronically earbox control

Steering wheel levers

The system receives the request for gear shifting by means of two levers which are connected to the switches that determine positions **DOWN**, **UP** and **neutral** (D 6.09).
The control lever device is mounted on a bracket, fitted in the steering column.

- To gain access to this device, the steering wheel must be removed (H 2.06).
- Remove the hub from the steering shaft (E 2.05).
- Detach the connector **(G)** from the instrument panel cable.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

- Loosen the screws **(5)** fastening the lever device to the mounting bracket of the steering column.

- Remove the entire device.

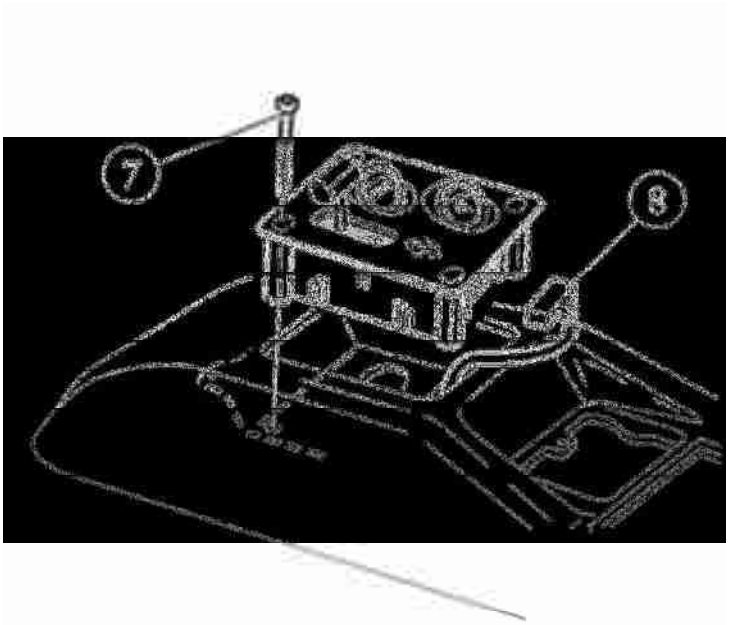
NOTES
If need be, it is possible to replace even only the control lever by simply unscrewing the screws **(6)**.

Small instrument panel

The small instrument panel for the electronically-controlled gearbox is supplied as a spare part as a single piece and must never be disassembled.

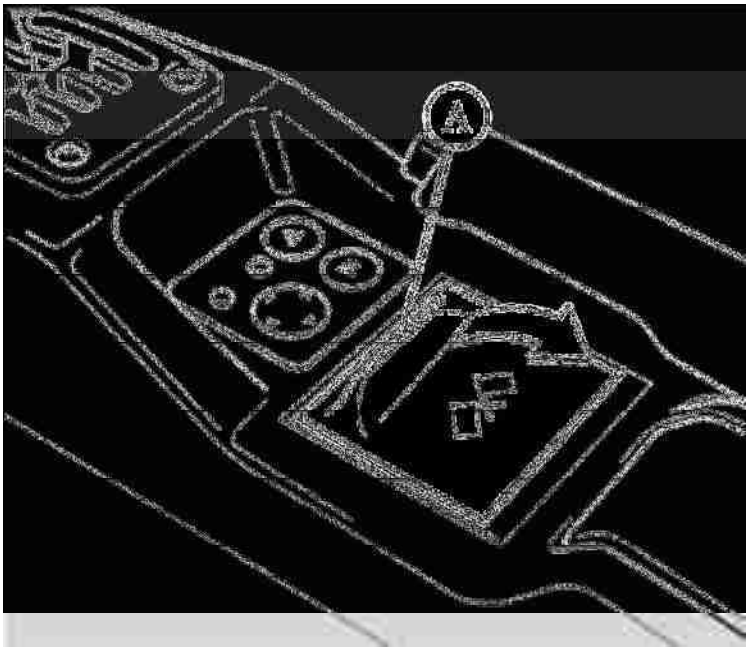
- To replace it, unscrew the four screws **(7)** fastening it on the lower bracket of the central console.
- Slide it out of its seat and detach the connector **(8)** for the electrically-controlled gearbox harness.

For connection to the system, see Table **P** - ELECTRICAL SYSTEM.



H2.12 ASHTRAY - CIGAR LIGHTER

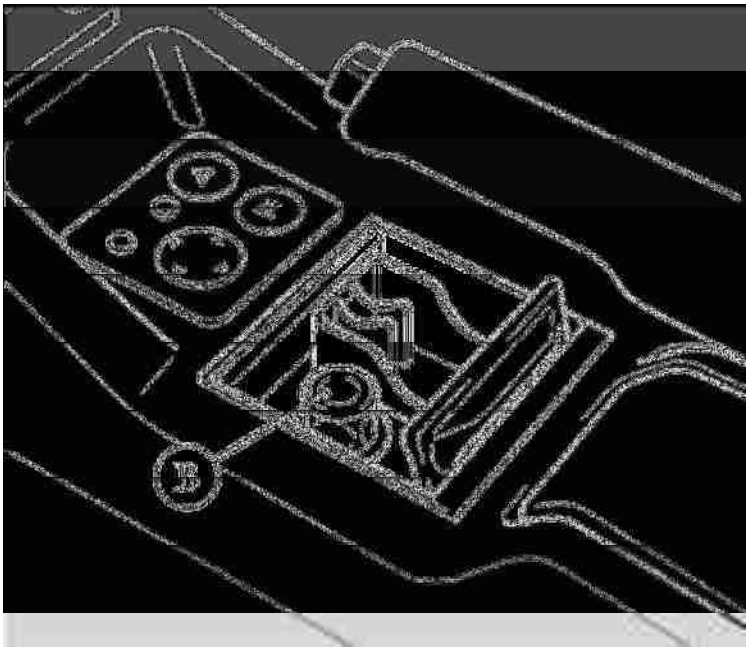
To gain access to the ashtray or the cigar lighter, push the cover **(A)** backwards.



To clean the ashtray, slide it out by pulling it upwards.

Cigar lighter

To turn it on, press down push-button **(B)** fully.



Once the necessary temperature has been reached, the cigar lighter will spring back to its original position automatically, where it is ready for use.

CAUTION

The cigar lighter reaches extremely high temperatures. Handle it with care to avoid risks of burns and fire.
The lighter works even if the ignition key has been extracted, therefore never leave children unattended in the car.

NOTES

To remove the ashtray-cigar lighter, (M 3.02).

H2.13 OPENING DEVICES FOR THE ENGINE/LUGGAGE COMPARTMENT LIDS AND FOR THE FUEL TANK FLAP

Tightening torques		Category
Fastening screws for engine compartment lock	**9,5**	**B**
Fastening screws for lugga e compartment lock	**14**	**B**

Engine compartment lid

Opening

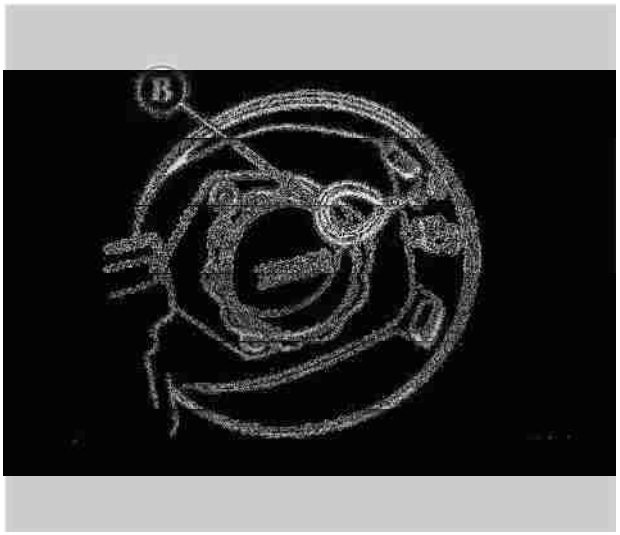
- Pull the release lever **(A)** on the door panel, driver's side. Lift the engine compartment lid.

- The bonnet is held open by two gas struts.

Closing

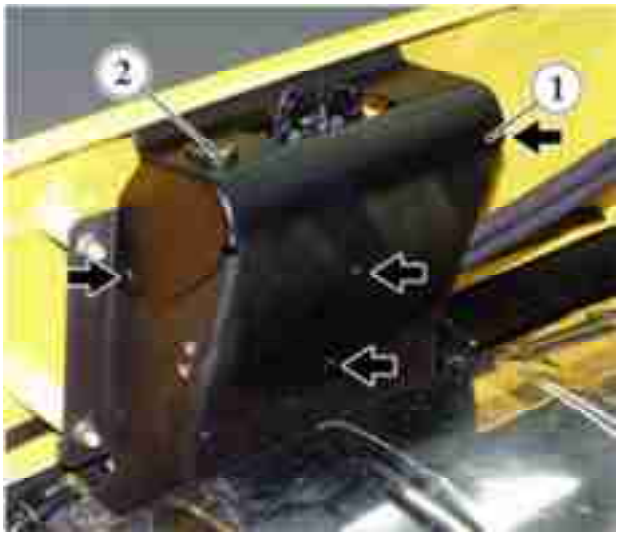
- Lower the lid to almost 20 centimetres from closing and let it go.
- Always check it is securely shut.

Emergency opening
Should lever **(A)** fail to work, pull the wire **(B)** located in the fuel tank cap compartment.



NOTES
To disassemble or replace the windscreen and re-fit the engine compartment boot, (M 2.01).

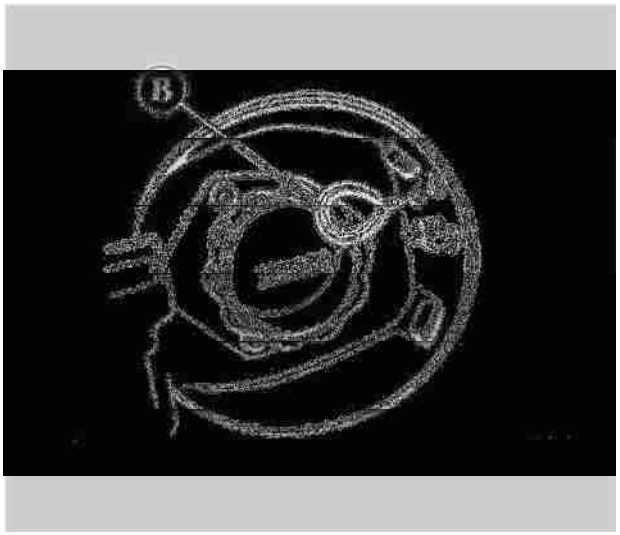
Replacing wires
- Unscrew the four fastening screws and remove the lock cover **(1)**, disconnecting the switch's connector **(2)**.



- Loosen the dowel on the clamp **(3)** and slide out the wires from the adjusting screws **(4)**.

- Unscrew the screw fastening the release lever bracket **(A)** and slide it out from the door panel.

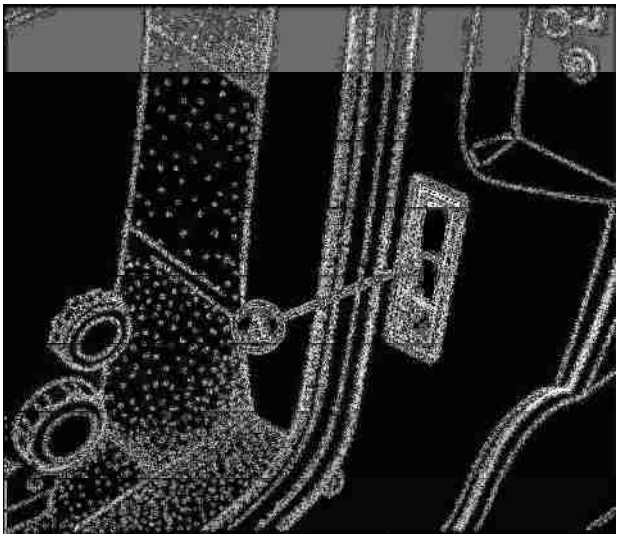
- Detach the ball joint of the control wire from the fastening pin on the lever.
- Extract the emergency opening wire **(B)** from within the fuel tank cap compartment.



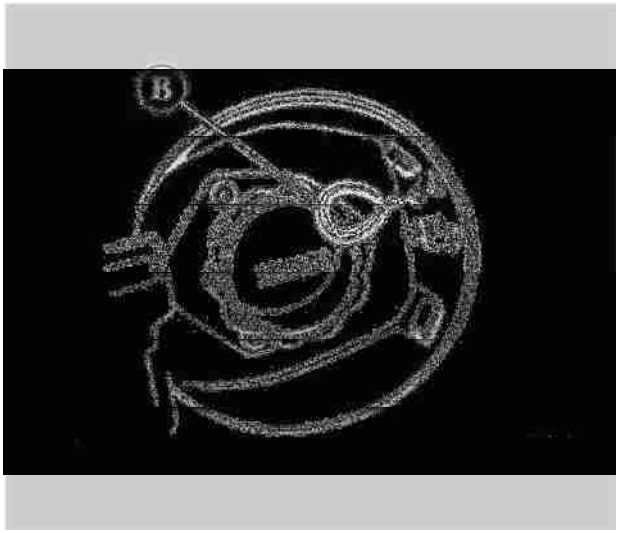
- Remove the LH side protection from the engine compartment (M 2.13).
- Remove the cables with their sheath, sliding them off from the restraining plastic clip **(5)** and from the clamp **(6)**.

NOTES
The releasing lever wire is also supported by springs inside the mud guards

- Fit the new opening wire taking care to position and to mount it as the one replaced, and secure the ball joint to the lever **(A)**.



- Fasten the release lever bracket on the door panel.
- Fit the emergency opening wire **(B)** starting from the fuel tank cap compartment and insert it in the sheath.



- Fit the cables with their sheath into the clamp **(6)** and into the restraining clip **(5)**.

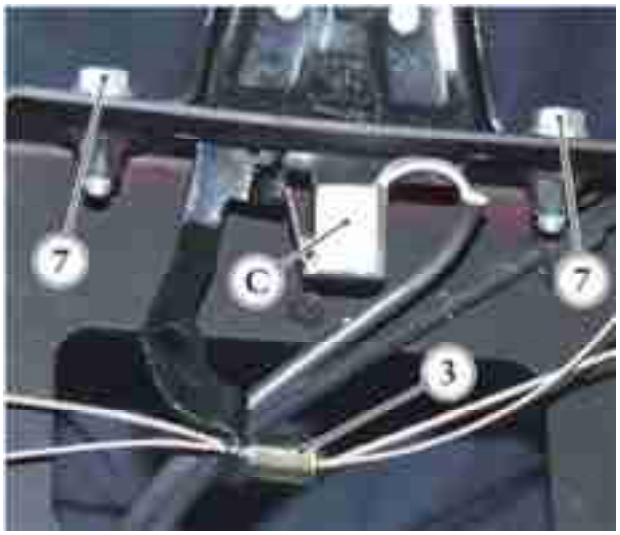
IMPORTANT
Avoid folding or tightening the control wires excessively.

- Fit the cable joints in the adjusting screws **(4)** and secure them to the lock lever using the apposite clamp **(3)**.
- Set the opening travel by adjusting the screws **(4)**, then tighten the lock nuts.

- Re-assemble all components removed for the procedure.

Replacing the lock

- Remove the lock cover and the clamp **(3)** fastening the control cables to the lever, as described above.
- Operating from the front opening of the lock's bracket, slide out the micro-switch connector **(C)** from the supporting clip on the rear chassis axle and detach it from the rear wire.
- Unscrew the screws **(7)** and remove the entire lock.

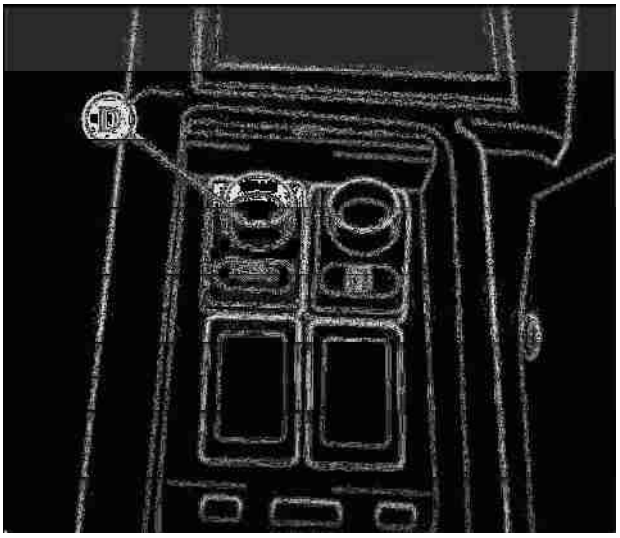


- When re-assembling, tighten the screws **(7)** to the prescribed tightening torque and adjust the control wires as previously described.
- Check that the boot profiling perfectly suits the bodywork and lies exactly in mid position with the latter (M 2.01).

Luggage compartment lid

Opening

- Use the release button **(D)** on the central tunnel.

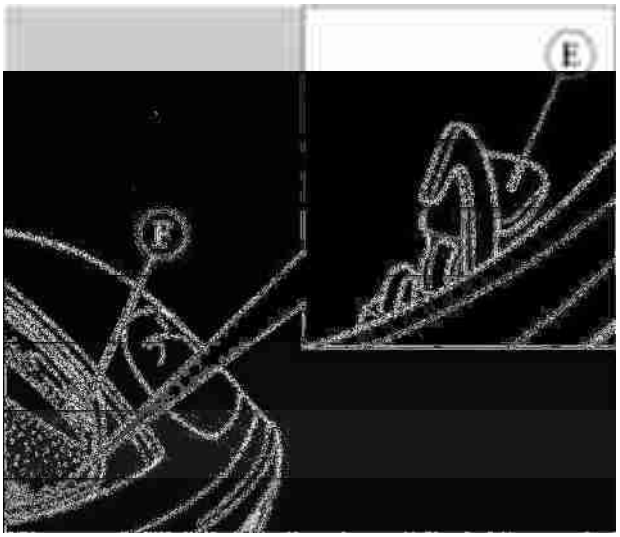


Valid UP TO Ass. No. 43983

▪ · · · · · · Push the safety hook lever **(E)** downwards and lift the luggage compartment lid.

Valid FROM Ass. No. 43984

▪ · · · · · · Push the safety hook lever **(E)** sideways, towards the lock, and lift the luggage compartment lid.



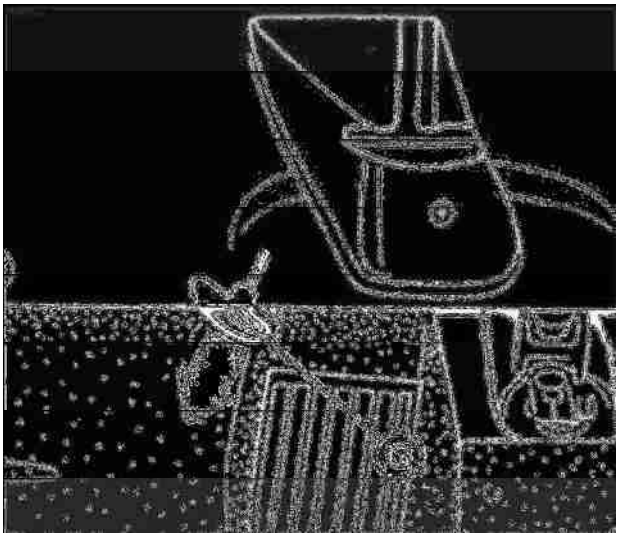
- The bonnet is held open by two gas struts.
- The luggage compartment is lit by a courtesy light **(F)**.

Closing

- Lower the bonnet until it is closed and press it down until the lock clicks shut.
  Always check that the bonnet is properly shut, in order to prevent it from opening while the car is in motion.

Passenger compartment emergency opening

If the button **(D)** fails to work, pull the small lever **(G)**, underneath the dashboard, on left-hand side of the steering column.

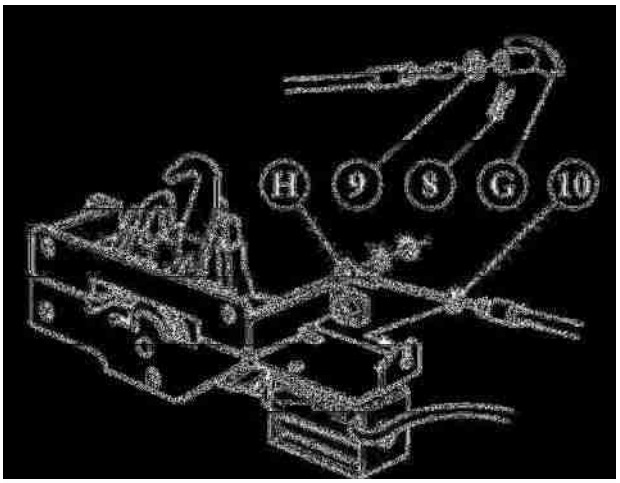


NOTES

To remove and re-install the luggage compartment lid, (M 2.02).
To replace the release push-button, (H 2.03).

Replacing the passenger compartment emergency opening wire

- Remove the shield covering the ECUs and the left-hand upholstery of the luggage compartment (M 3.06).
- Remove the split pin **(8)** restraining the lever **(G)**.
- Extract the seeger ring **(9)** and detach the wire from the mounting bracket.
- Extract the wire with its sheath from the luggage compartment, by removing it from the restraining plastic clips.
- Free the wire terminal **(H)** from its fixing on the lock's lever.
- By removing the seeger ring **(10)**, detach the wire from the bracket and replace it.



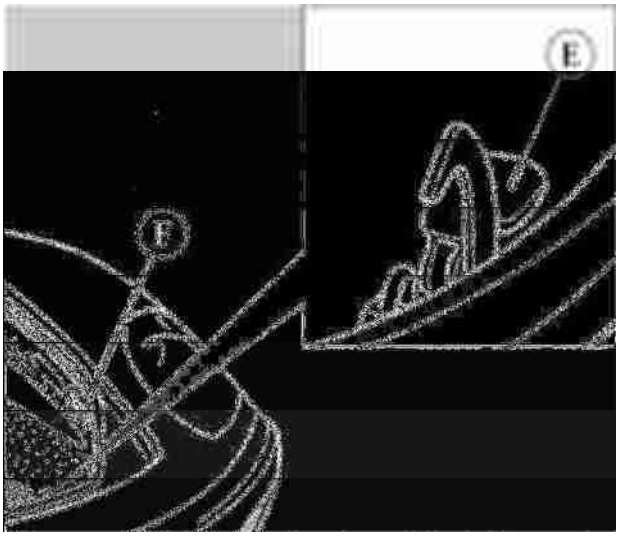
NOTES

The emergency wire is supplied with its sheath and does not need to be adjusted.

*Emergency opening from the luggage compartment (valid for **USA-CDN M.Y.'03** version)*

In the event that someone remains accidentally closed inside the luggage compartment, the lid can be opened from the inside by pulling the small lever **(K)**, found on the left-hand side, above the movable panel that covers the fuse and relay boxes.

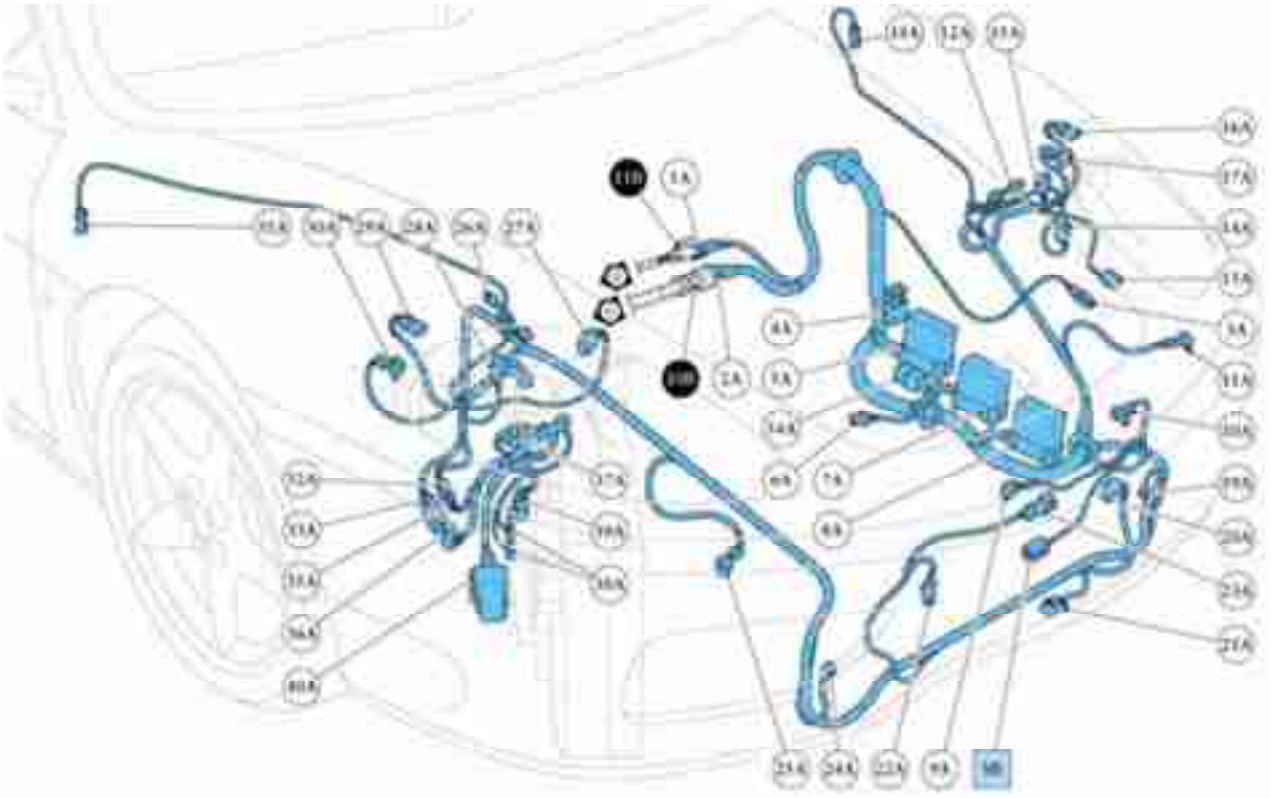
Up to a speed of 5 km/h, pulling the small lever **(K)** will open the luggage compartment completely. When this speed is exceeded, the lid will only open up to the safety stop, thereby helping air inlet into luggage compartment. The lid can be fully opened from the outside, by pulling the retaining lever **(E)**.



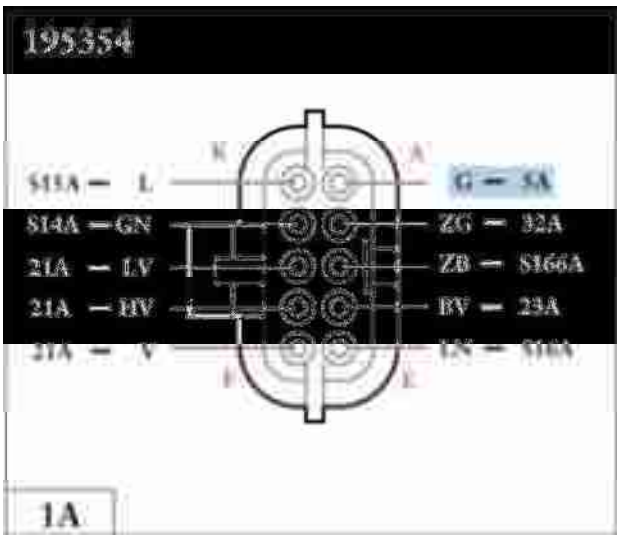
The installation of this device involved the modification of the front side connection cable (**195354**) and of the dashboard connection cable (cod. **195353**) as well as the use of a micro-relay in the fuse and relay box, inside the luggage compartment (L 2.10).

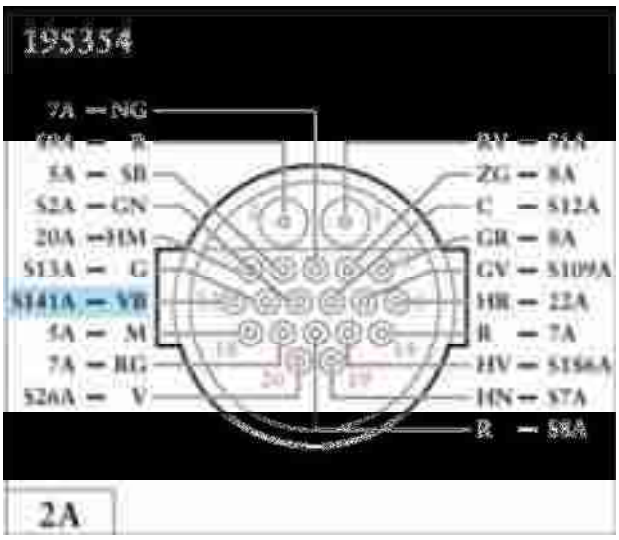
The instrument panel fuse also protects the children safety system: this way, in the event that a fuse burns out due to a failure in the children safety system, the driver will be immediately warned.

The following drawings show the modifications of the cable and the pinout for the connectors concerned with the children safety system. These are not included in the “ELECTRIC SYSTEM” section, as they are valid only starting from the **USA-CDN M.Y. 2003** version.

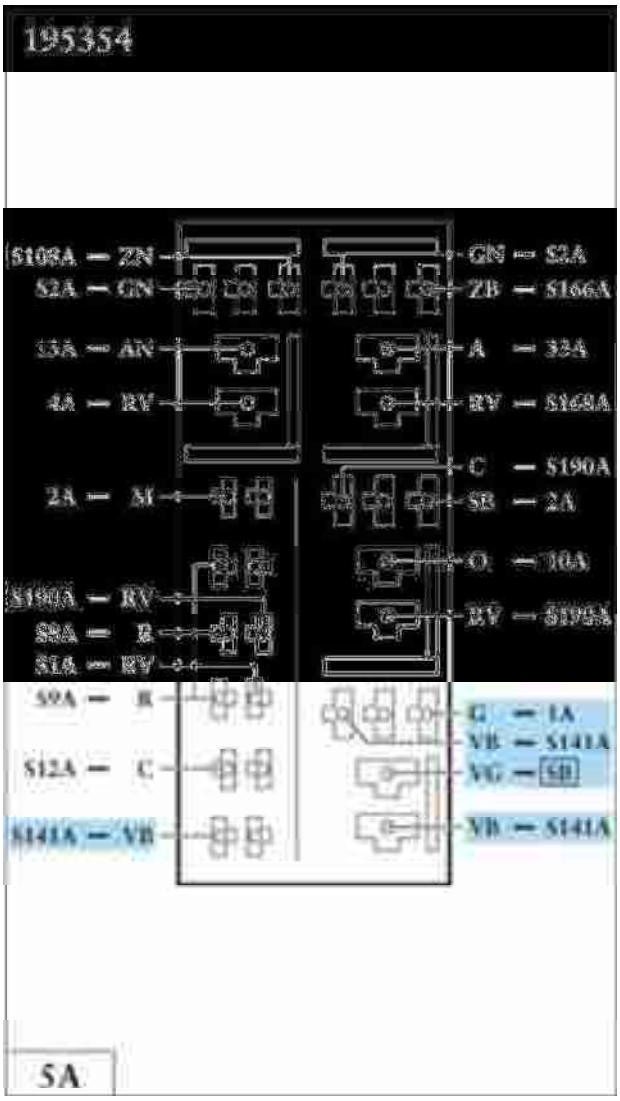


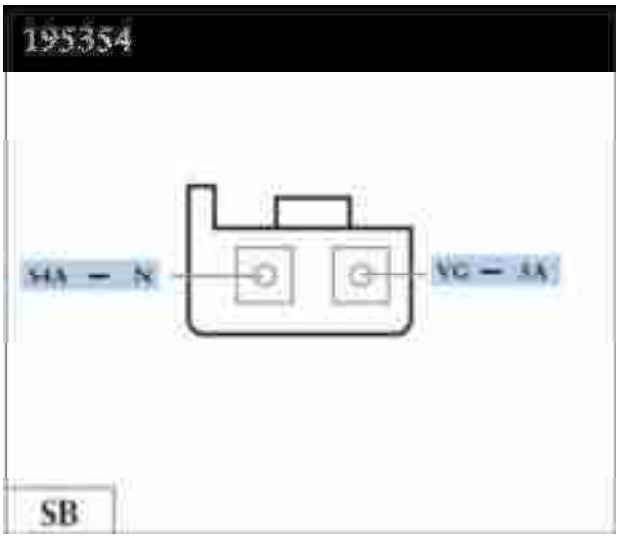
195354 - Front side connection cable (Valid for USA-CDN M.Y. 2003)
1A - Joint connecting dashboard cables to front cables
2A - Joint connecting dashboard cables to front cables

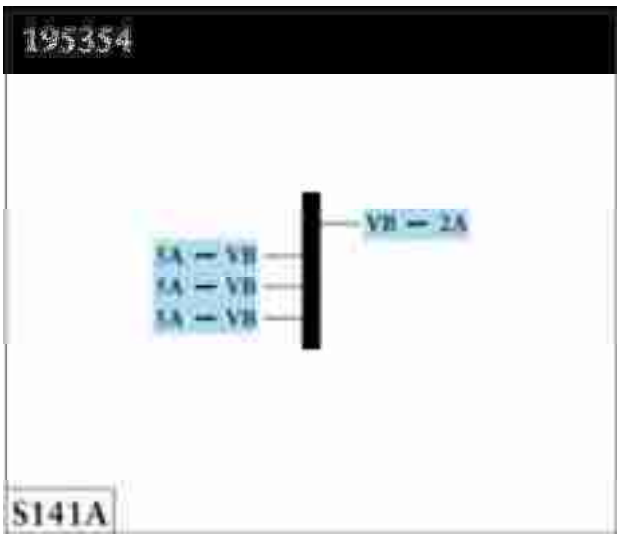


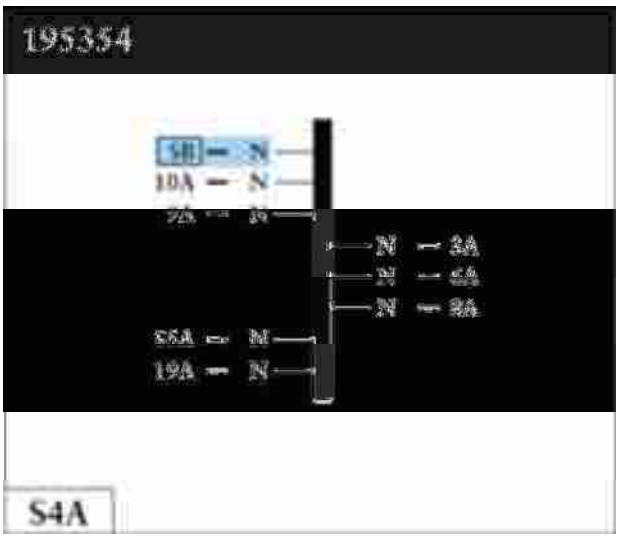


5A - Front ECU A
SB - Child safety

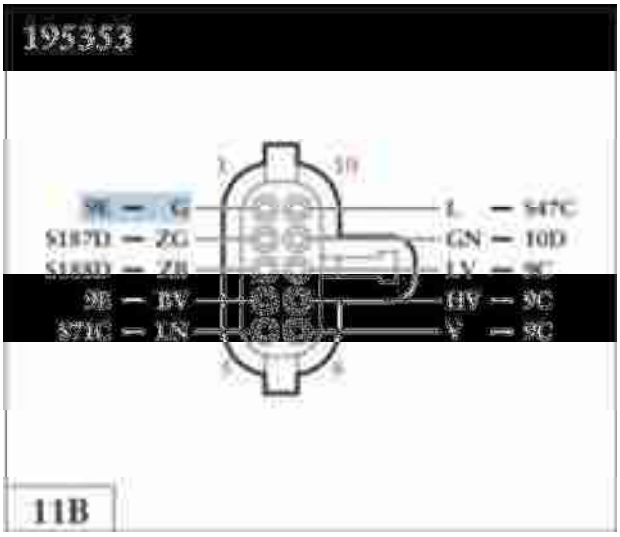


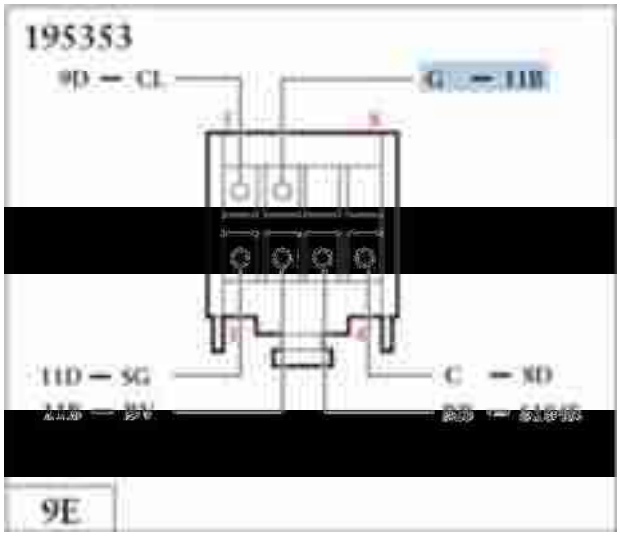






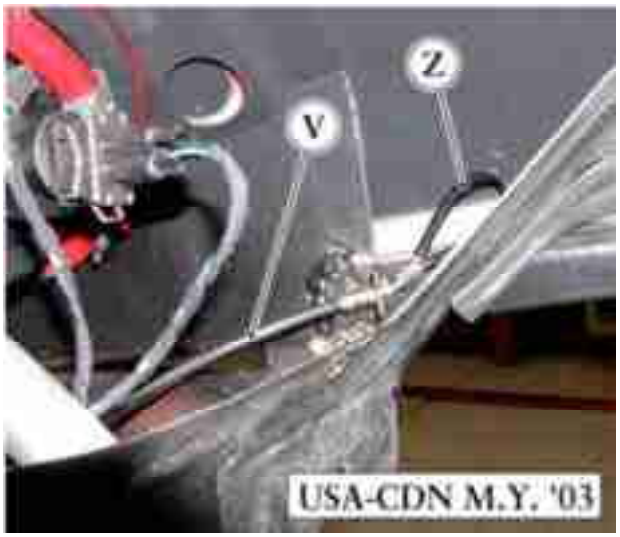
195353 - Dashboard connection cable (Valid for USA-CDN M.Y. 2003)
11B - Joint connecting dashboard cables to front cables
9E - Complete instrument





*Manual release of the safety hook actuator (valid for **USA-CDN M.Y.'03** version)*

In case of electric problems, the small actuator shaft can be manually released by pulling the end **(Z)** of the cable **(V)** positioned inside the front right-hand mudguard, after having removed the lid for accessing the headlamp.



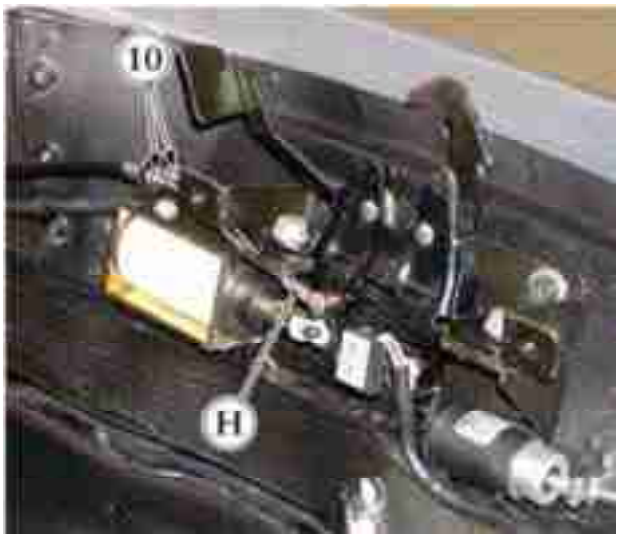
Replacing the cable for emergency opening from inside the luggage compartment
*(valid for **USA-CDN M.Y.'03** version)*

The cable for emergency opening from inside the luggage compartment is supplied together with that for emergency opening from inside the passenger compartment, since their terminals are fitted inside a single terminal eyelet.

- To remove the small lever **(G)** from the passenger compartment, follow the above instructions.
- Remove the ECU covering shield and the left-hand lining of the luggage compartment (M 3.06).
- Extract the Seeger ring **(9)** and detach the cable for opening from inside the luggage compartment from the support bracket on the chassis.

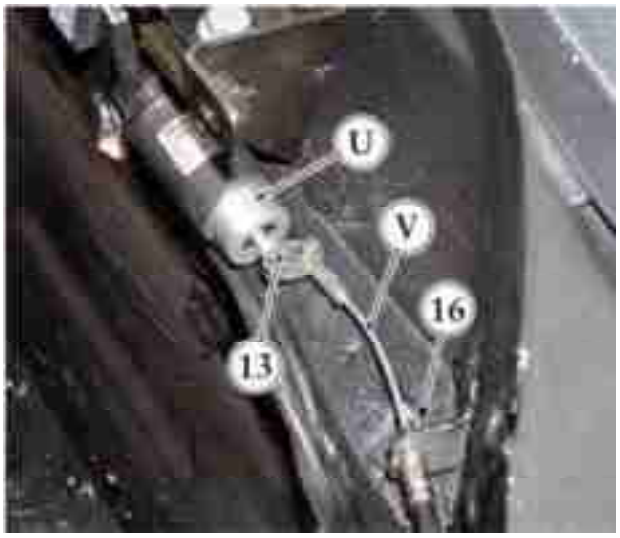
- Extract the cables together with their sheath from the luggage, freeing them from their support clips.

- Release the cable terminal eyelet **(H)** from the retainer on the lock lever.
- Detach the cables from the support bracket, extracting the Seeger rings **(10)**, and replace the entire cable.

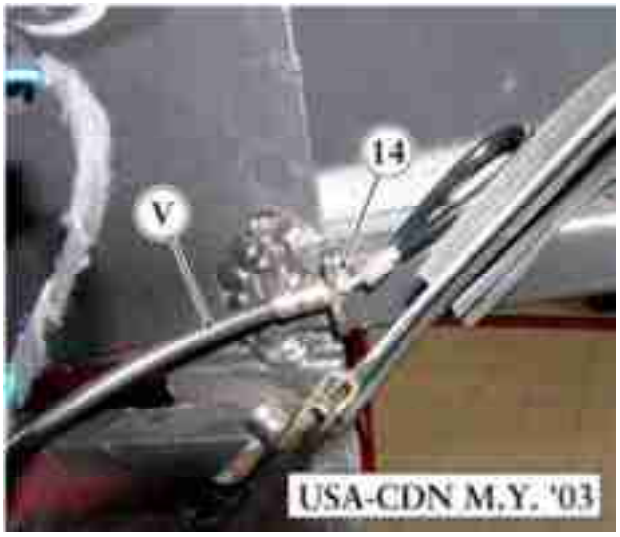


*Replacing the cable for manual release of the safety hook block actuator (valid for **USA-CDN M.Y.'03** version)*

- Remove the right-hand lining of the luggage compartment (M 3.06).
- Unhook the return spring, then remove the Seeger ring **(13)** and slide out the pin fastening the small anchoring unit for the cable on the actuator **(U)**.
- Detach the cable end **(V)** from the anchoring meshes.
- Extract the Seeger ring **(16)** and release the cable from the chassis support bracket.



- Free the cable end **(V)** from the retainer inside the left-hand mudguard, removing the Seeger ring **(14)**.

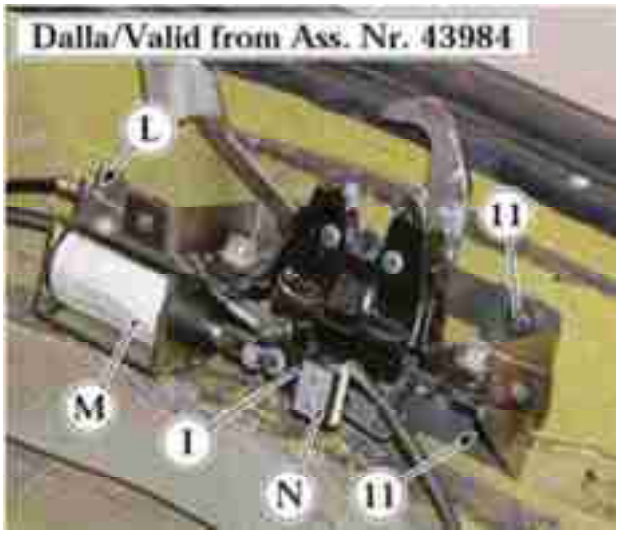


- Release the cable **(V)** together with its sheath from the support clip **(15)**.
- Pull the cable from inside the mudguard, passing it through the cable guide within the luggage compartment.

Replacing the lock

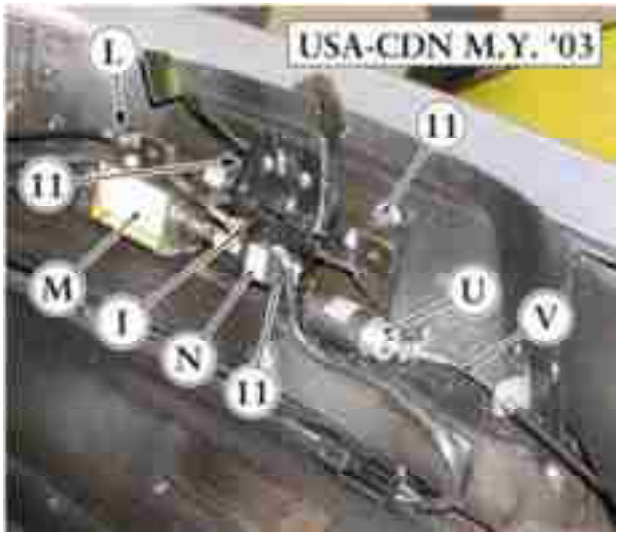
Remove the shield covering the ECUs and the left-hand upholstery of the luggage compartment (M 3.06).

- Detach the emergency opening wire from the lever **(I)** and from its bracket **(L)**, as previously described.
- Disconnect the electrical connections of the actuator **(M)** and of the micro-switch **(N)**.
- Unscrew the fastening screws **(11)** and remove the lock block from the chassis.



NOTES for USA-CDN M.Y. '03 version

- Detach the emergency opening cables from the lever **(I)** and from the bracket **(L)**, as previously described.
- Detach the electric connections for the actuator **(M)**, for the micro-switch **(N)**and for the actuator **(U)** that blocks the safety hook of the luggage compartment lid lock.
- Detach the cable **(V)** for manual release from the small actuator shaft **(U)**.



- When re-assembling, tighten the screws **(11)** to the prescribed tightening torque and check that the bonnet profiling perfectly suits the bodywork and lies exactly in mid position with the latter (M 2.02).

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.

NOTES

Only the new type locks are supplied as spare parts.

To mount a new type lock on vehicles UP TO **Ass. No. 43983** it is necessary to carry out an easy operation on the luggage compartment lid, after having removed the lock striker plate (M 2.02).

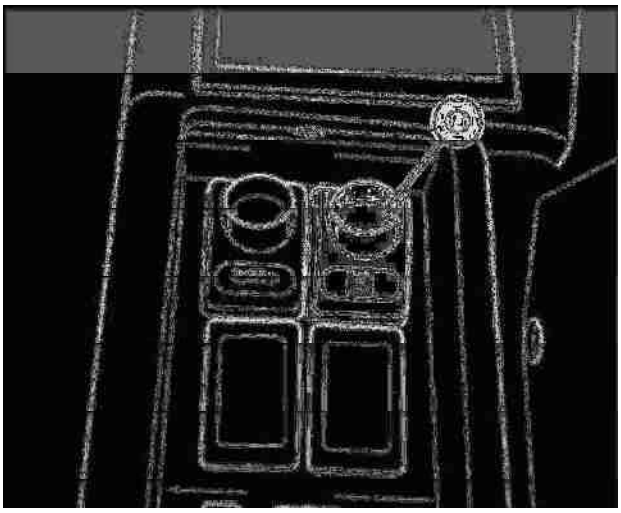
- Round off the straight edge of the central slot, found in the luggage compartment area underneath the lock striker plate (see dotted area in the figure).

- Furthermore, it is necessary to make a sufficiently long cut on the LH covering of the luggage compartment, in position with the lever outlet **(E)**.

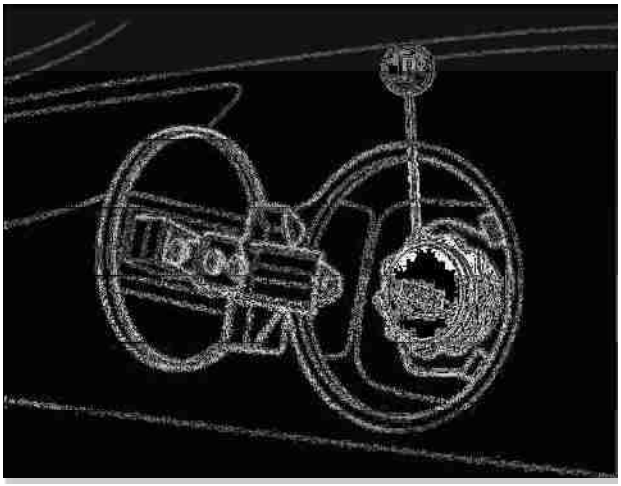
Fuel tank flap

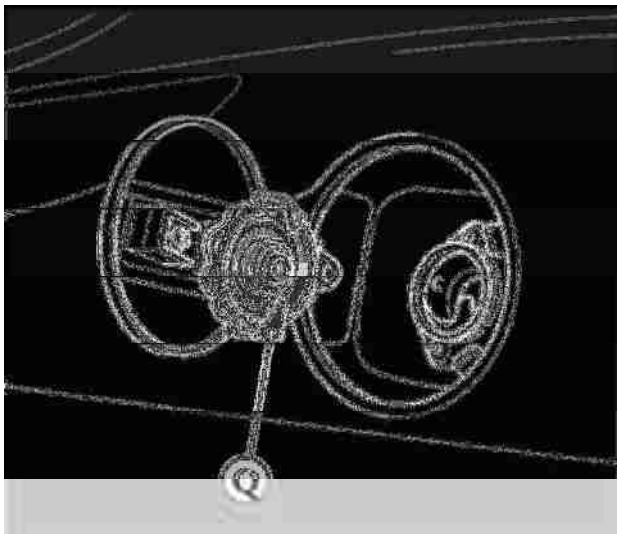
Opening

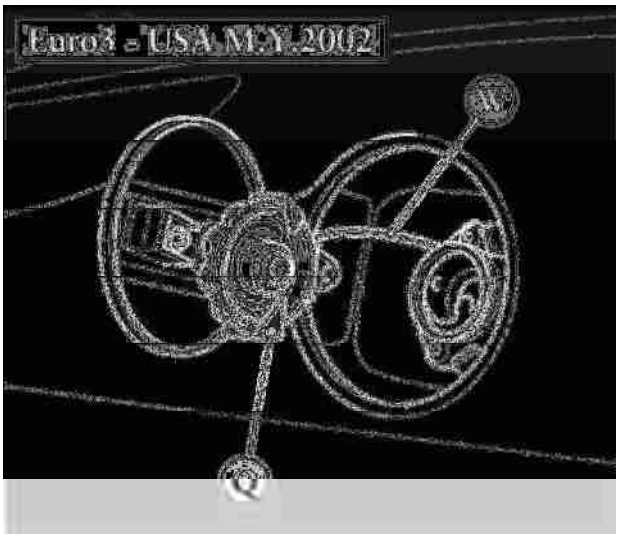
- Press the releasing push-button **(O)** to lift the cover.



- Unscrew the cap **(P)** turning it anti-clockwise and place it in its special seat **(Q)**.







CAUTION

Always stop the engine while refuelling. Remove the tap with extreme caution.

Keep any naked flames and lit cigarettes away from the vehicle while refuelling. Inhaling the fuel vapours can be noxious.

Closing

- Tighten down the cap **(P)** and close the flap by pressing it.

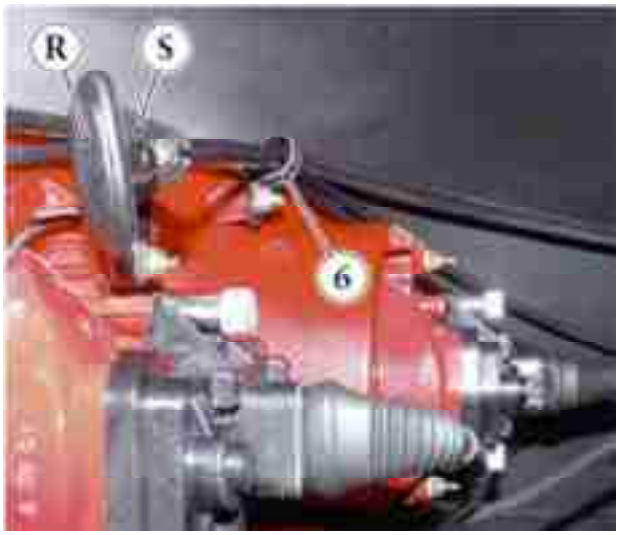
Note for the Euro 3 - US M.Y. 2002 cars

These cars are equipped with a restraining string (**W**) which keeps the cap (**P**) attached to the bodywork, thereby making it impossible to leave it behind it when re-fuelling.

Before closing the flap, make sure the string is not protruding from the filler neck compartment.

Emergency opening

If push-button **(O)** fails to work**,** pull the lever **(R)** located on the left-hand side of the engine compartment.



NOTES

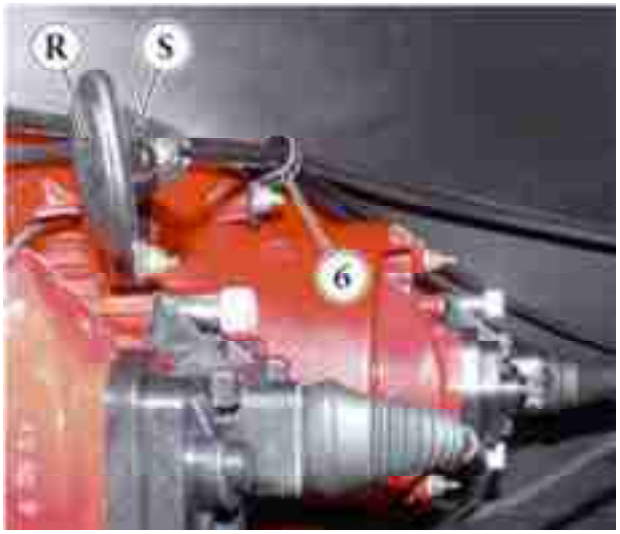
To replace the fuel tank flap and the actuator, (M 2.17).

To replace the tank filler neck, (M 2.16).

To replace the release button, (H 2.03).

Replacing the emergency opening wire

- Remove the LH side protection from the engine compartment (M 2.13).
- Remove the small lever **(R)** from the wire and extract it from the mounting bracket **(S)** (a similar procedure was described in the section concerning the emergency opening wire for the luggage compartment lid) and from the clamp **(6)**.



- Unscrew the two nuts **(12)** inside the fuel cap compartment, and slide out the flap opening control unit from inside the mud guard.

- Unhook the wire screw from the mounting bracket **(T)** and replace the entire wire.

NOTES

The emergency wire is supplied together with its sheath and does not need to be adjusted.

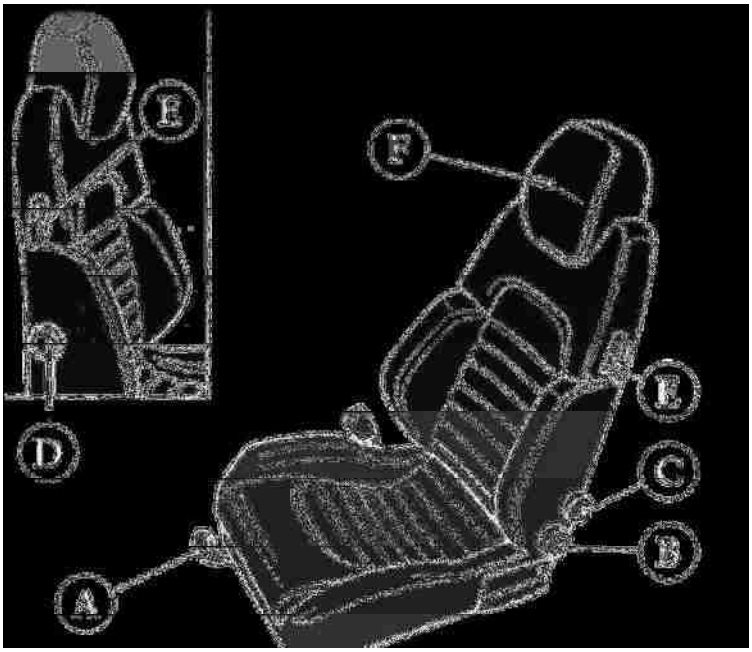
H2.14 SEAT CONTROL

It is essential to adjust the seats properly to guarantee comfortable driving and maximum efficiency of the passive safety systems.

CAUTION
The driver must never adjust the seat while driving, as this may cause him/her to lose control of the vehicle.

NOTE
For seat removal and re-fitting (M 3.03)

Mechanically adjustable seats



Lengthways adjustment
- Pull the lever **(A)** upwards and slide the seat forwards or backwards until reaching the desired position.
- Release the lever and gently move the seat to make sure it has locked into position.

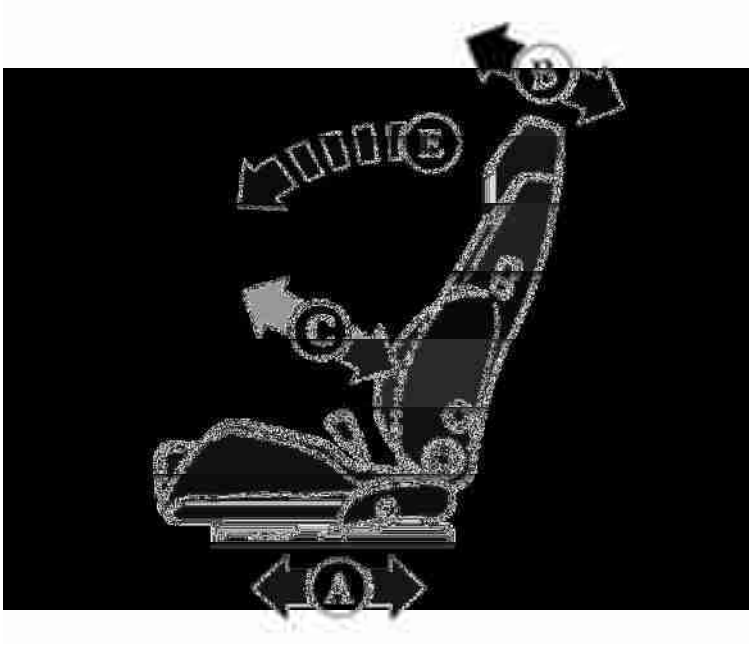
Seatback adjustment
- Rotate the knob **(B)** until the seat is sloping at the angle desired.

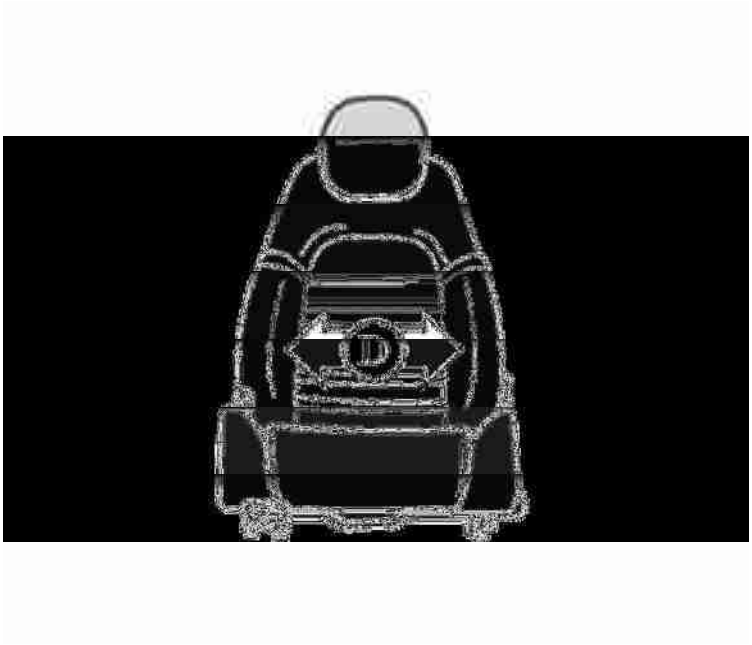
Lumbar support
- Rotate the knob **(C)** until the lumbar zone has curved to the degree desired.

Side supports
- Rotate the knob **(D)** until the desired width of the side supports has been reached.

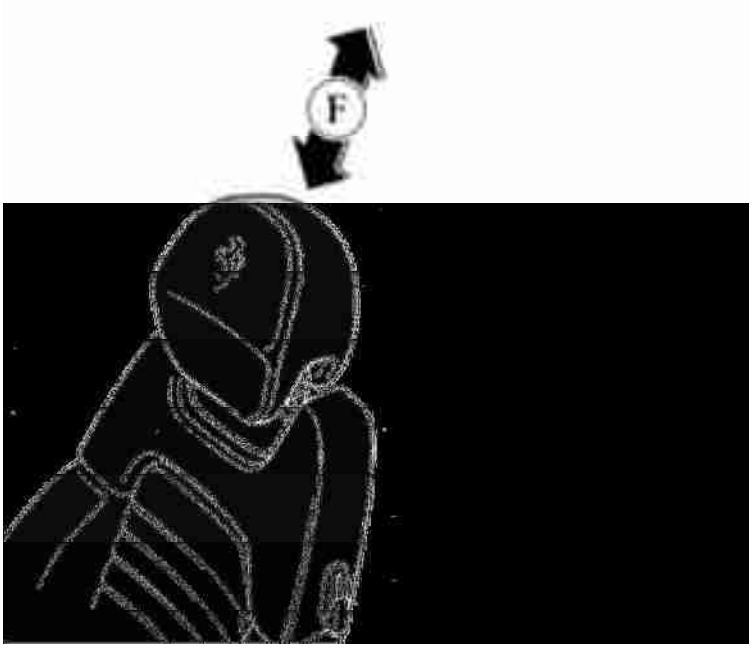
Seatback tilt

- Operate lever **(E)** to tilt the seatback forward.



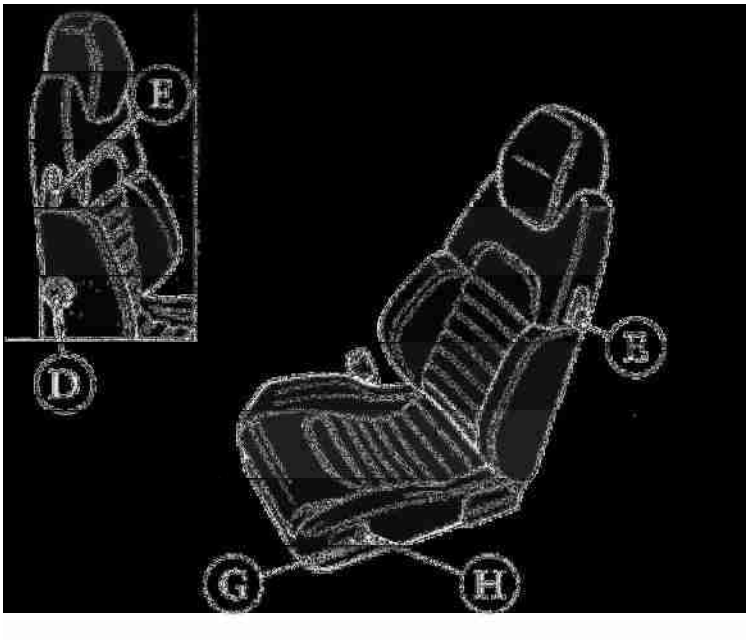


Head rest
Move the headrests **(F)** directly to adjust them to the desired height.



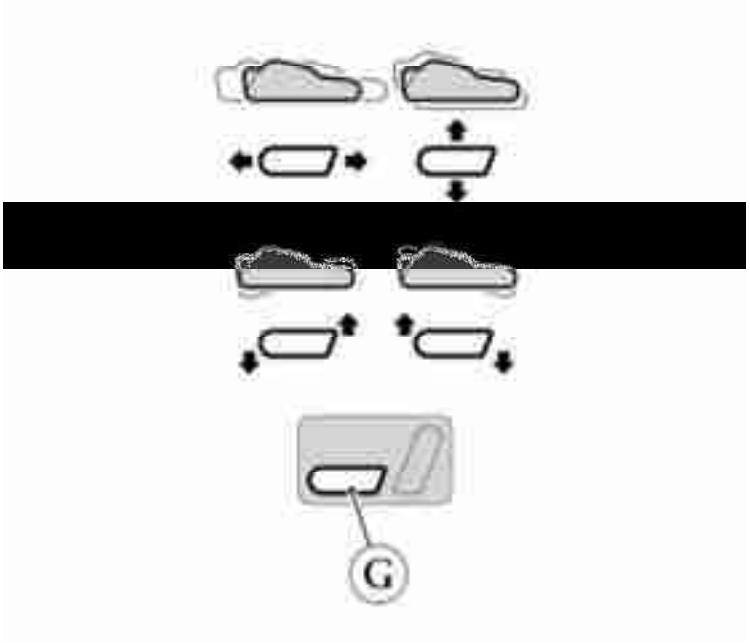
CAUTION
Adjust the headrests according to your height: the centre of the head rest must be level with the nape, not the neck.

Electrical seats



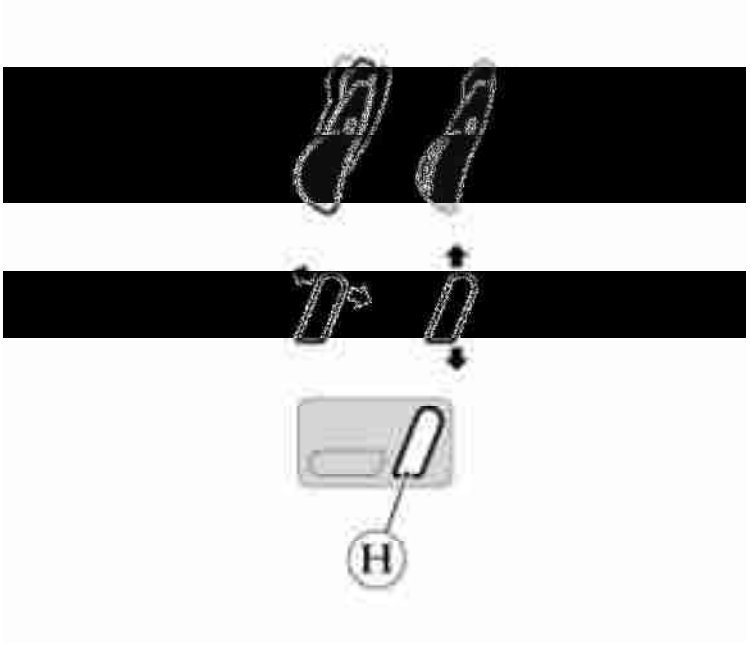
Lengthways and height adjustment

- Using control **(G)** it is possible:
  - to make the seat slide forwards and backwards, in a longitudinal direction,
  - to move the seat upwards and downwards, in a vertical direction,
  - to adjust the inclination of the seat cushion, in a clockwise and anti-clockwise direction.



Seatback inclination and lumbar support

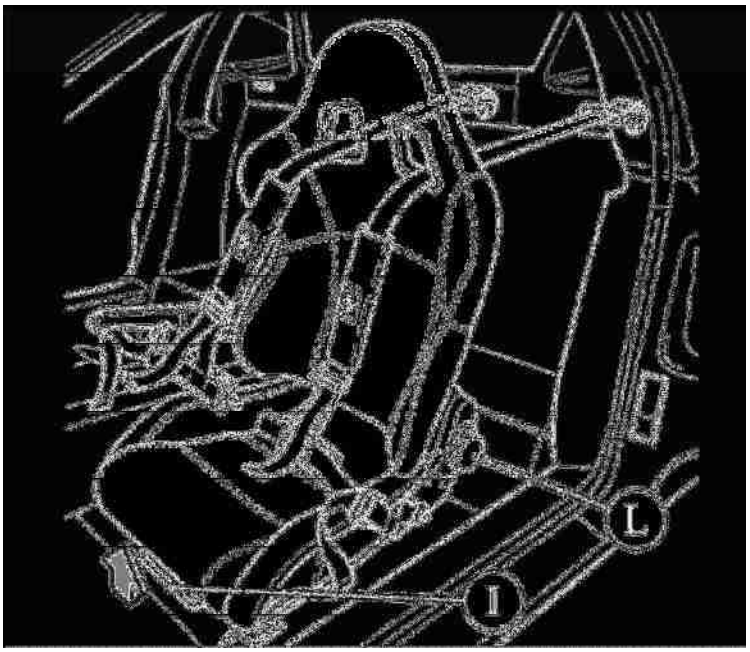
- Use control **(H)** to obtain the desired inclination of the seatback or the desired curvature of the lumbar zone.



Side supports – Seatback tilt - Headrest

See "Mechanical seats".

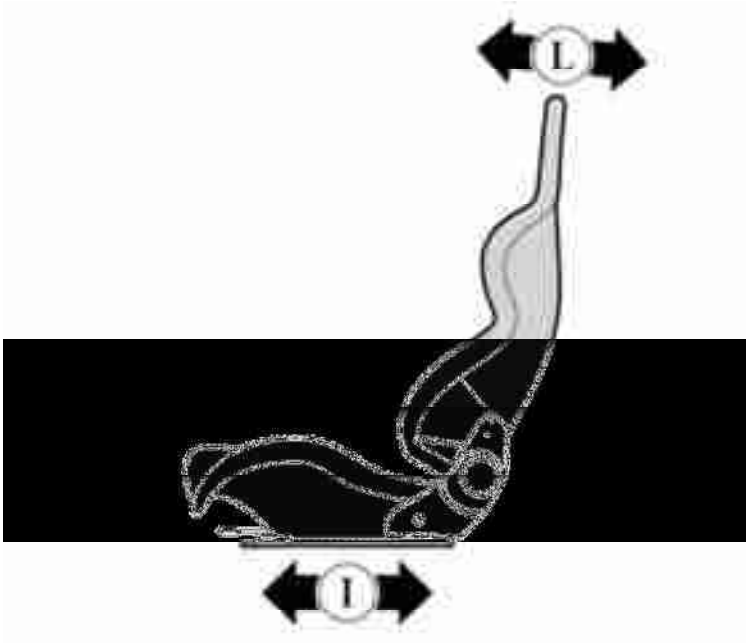
Sport seats



Supplied in three sizes: small, medium and large.

Longitudinal adjustment
- Pull the lever upwards **(I)** slide the seat forwards or backwards until obtaining the desired position.
- Release the lever and move the seat slightly to make sure it is locked.

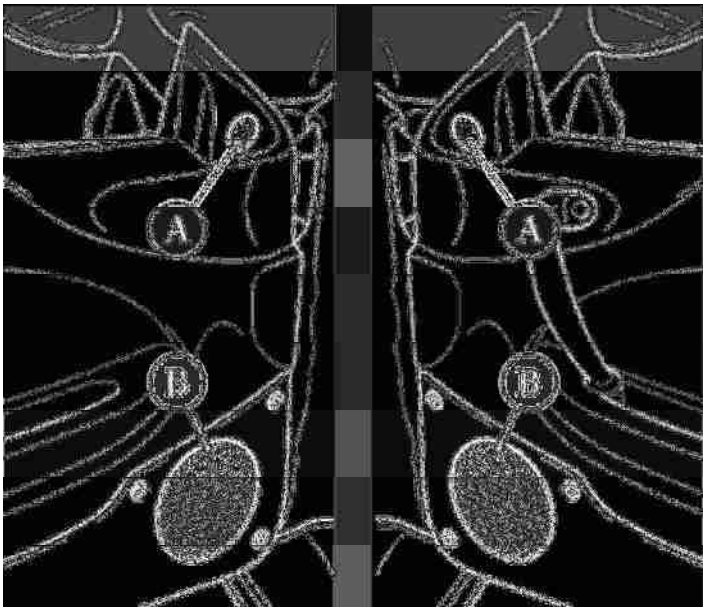
Seatback inclination
- Turn the knob **(L)** until obtaining the desired inclination.



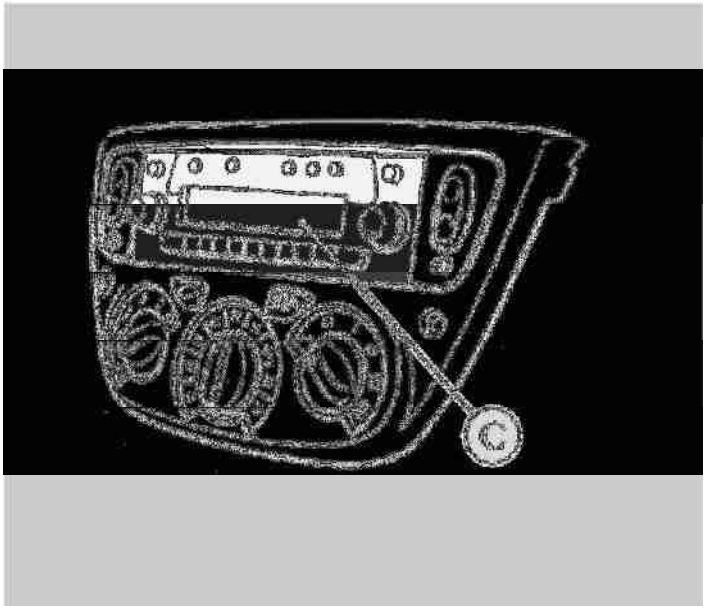
H2.15 STEREO SYSTEM

System's components:

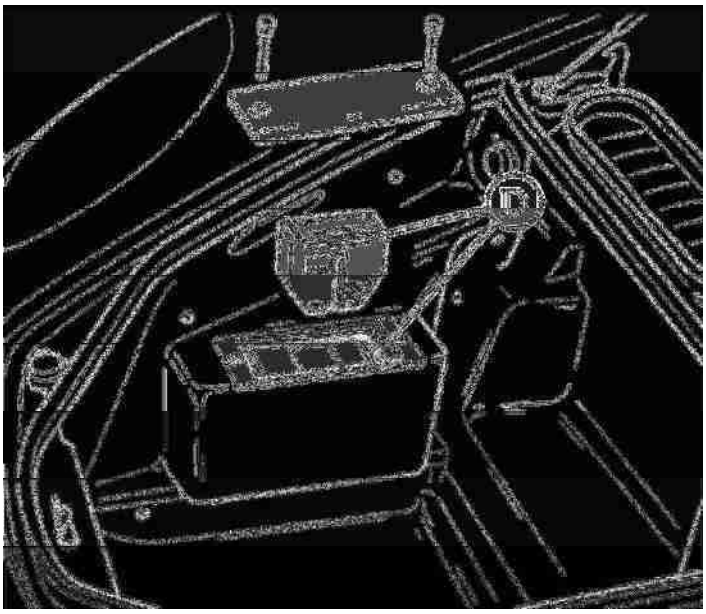
- 2 tweeter loudspeakers **(A)**.
- 2 woofer loudspeakers **(B)**.



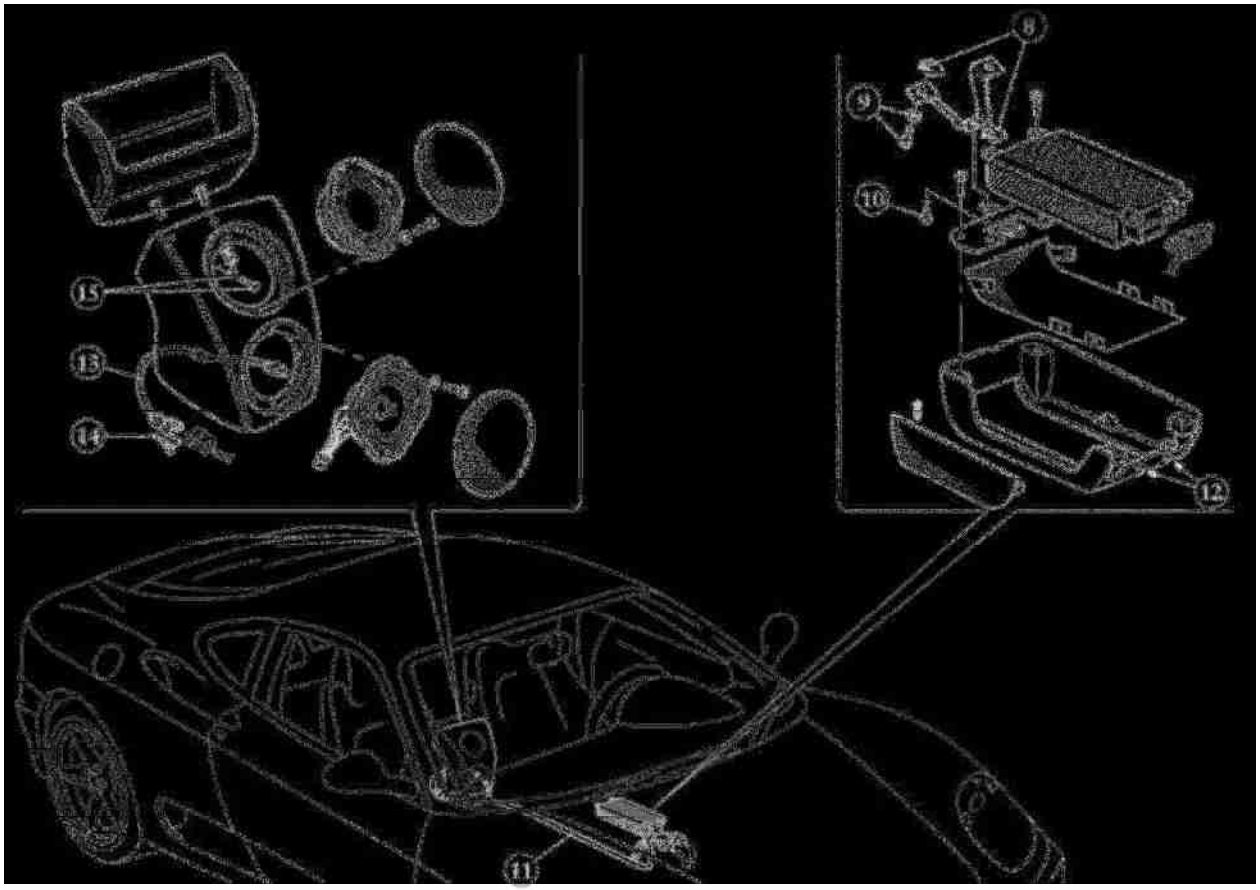
- Aerial mounted in the windscreen, complete with preamplifier.
- Car radio **(C)** with removable front panel.



- CD changer **(D)** (on request).



- Hi-Fi Sound System (optional) consisting of the following:
  - 200 Wrms high-power amplifier- found underneath the dashboard - with four 50 Wrms channels, analogue processing of the ASP sound signal;
  - Subwoofer – found in the mid area of the rear shelf - with active-passive double loudspeaker technology.



- Two special 50 Wrms tweeter loudspeakers, 19 mm diameter, with neodymium magnet. These replace the standard tweeters mounted on the support plate inside the rear view mirrors;
- Two special 50 Wrms midwoofer loudspeakers, 165 mm diameter, which replace the standard ones mounted on the doors;

Replacing the loudspeakers

Tweeter

- Remove the small internal panel (**L**) of the rear view mirror.
- Detach the loudspeaker connector from the door cable.
- Remove the loudspeaker **(A)** from within the small panel.

Woofer

- To remove it, (_____).

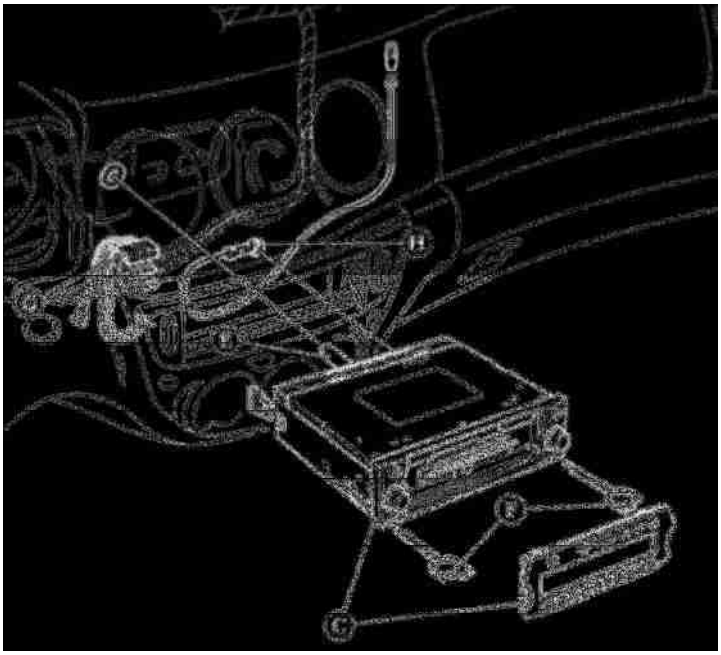
Preamplifier

The preamplifier **(F)** is installed under the windscreen's lower cross member, on the right-hand side.

- To remove the preamplifier: first remove the lower covering (M 3.01), then operate from under the dashboard.
- Detach the radio's aerial cable connection **(1)** and the dashboard power supply connection **(2)**.
- Detach the aerial cable connector **(3)** from the windscreen glass (M 2.06).
- Remove the preamplifier by unscrewing the screw **(4)**.

Car radio

The radio **(C)** is fitted on the small instrument panel, in the dashboard lower covering. In order to permit its correct centring onto the chassis, the back side of the radio is equipped with a special pin (**E**) (M 3.01).
To remove the radio from its seat on the instrument panel, use the special wrenches **(F)** supplied.
The connections for the instrument panel cable **(G)** and aerial cable **(H)** are attached on the back side of the housing: if the radio fails to work, before carrying out any intervention, first check for proper connections.

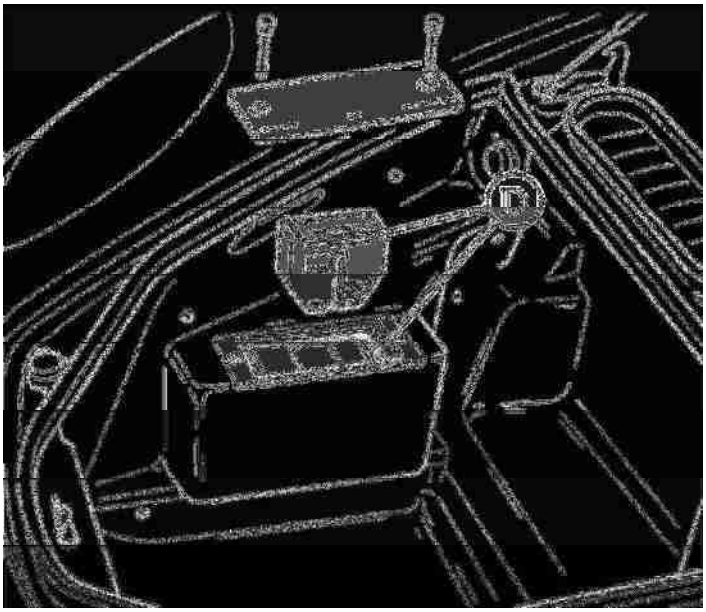


NOTES
For detailed instructions on the use of the car stereo, see the "Hi-Fi System" booklet.

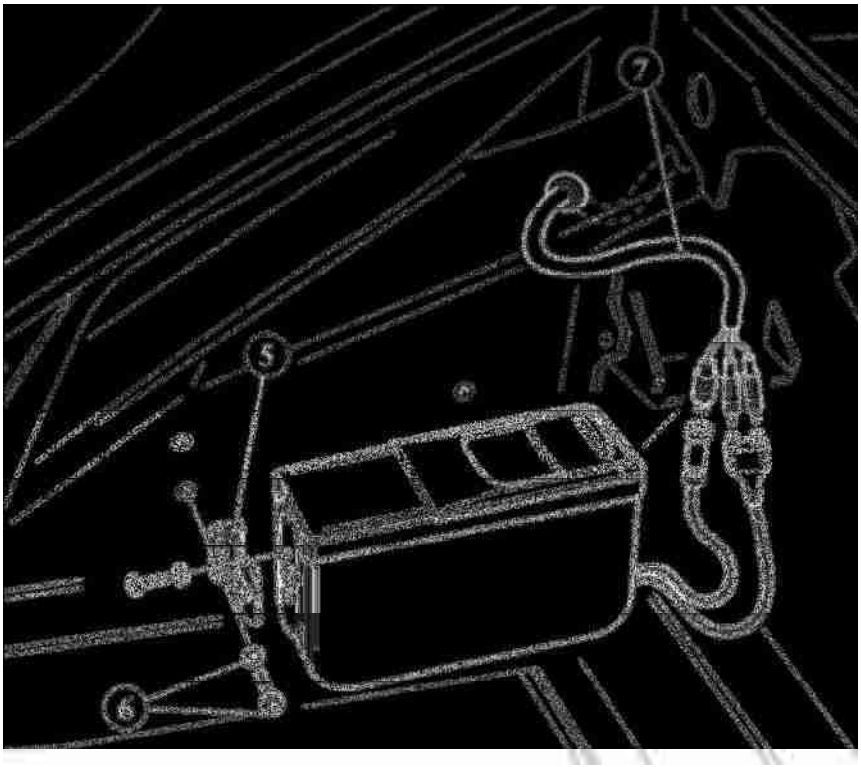
CD changer

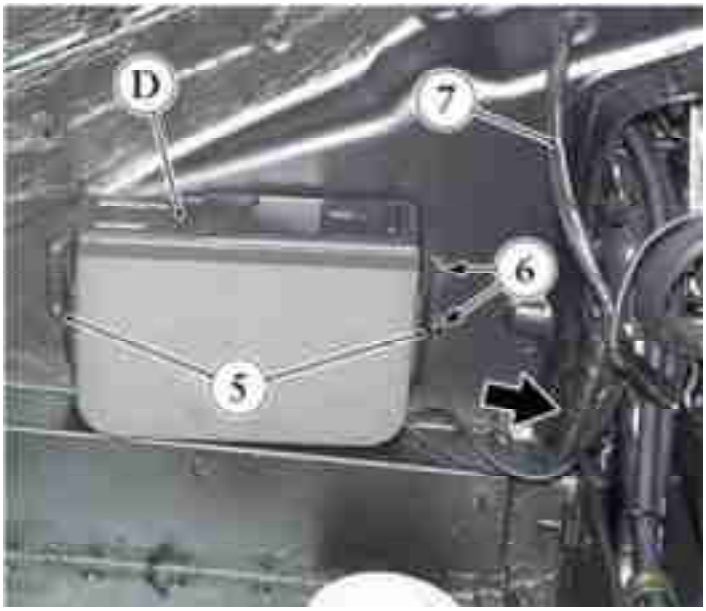
Installation

To install the CD changer **(D)** it is necessary to replace the right-hand side upholstery of the luggage compartment (M 3.06) with the specially designed upholstery provided with an opening for the CD changer.



- Fasten the special brackets **(5)** supplied in the CD kit on the CD changer sides.
- Install the device in the luggage compartment, and position it so that the cable outputs face the rear.
- Fasten it to the chassis with the screws **(6)** and connect it to the harness **(7**), applying protective tape to the connections.



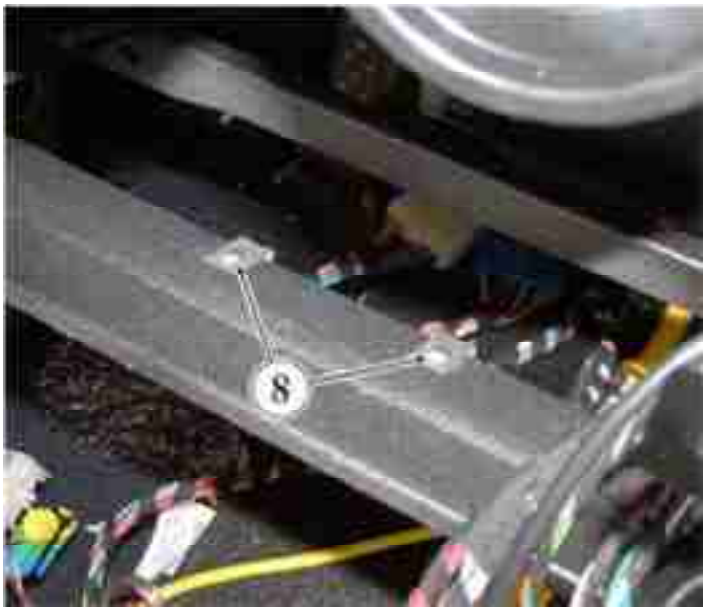


- Mount the new upholstery, using the original tightening points.

Mount the CD player flap using the special pins.

The Hi-Fi Sound System can be installed as an optional on vehicles with double map pocket on the partition panel between the passenger compartment and the engine compartment. These vehicles are equipped with the latest version of the chassis-dashboard assembly and with the dashboard connection cable, namely:
- 188897 – Valid **FROM Ass. No. 41814** - **NOT** for **RH Drive**;
- 189234 – Valid **FROM Ass. No. 41710** - **Valid** for **RH Drive**.

- To replace the original tweeter and woofer loudspeakers with the special ones, follow the above reported instructions.
- Remove the AC control dashboard (I 1.03).
- Fit the clips **(8)** into the two holes on small cross member of the dashboard frame.

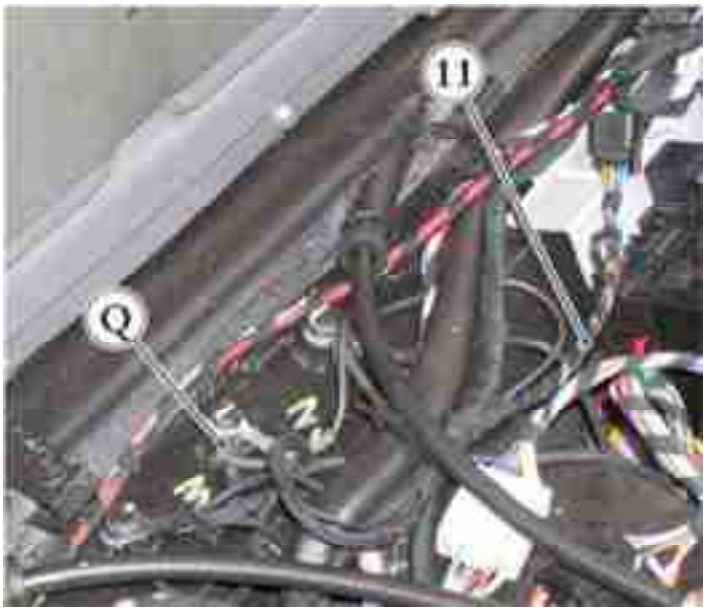


- Mount the fastening bracket for the amplifier box onto the small cross member, securing the box with screws and washer **(9)**.
- Fit a clip **(8)** onto the bracket hole

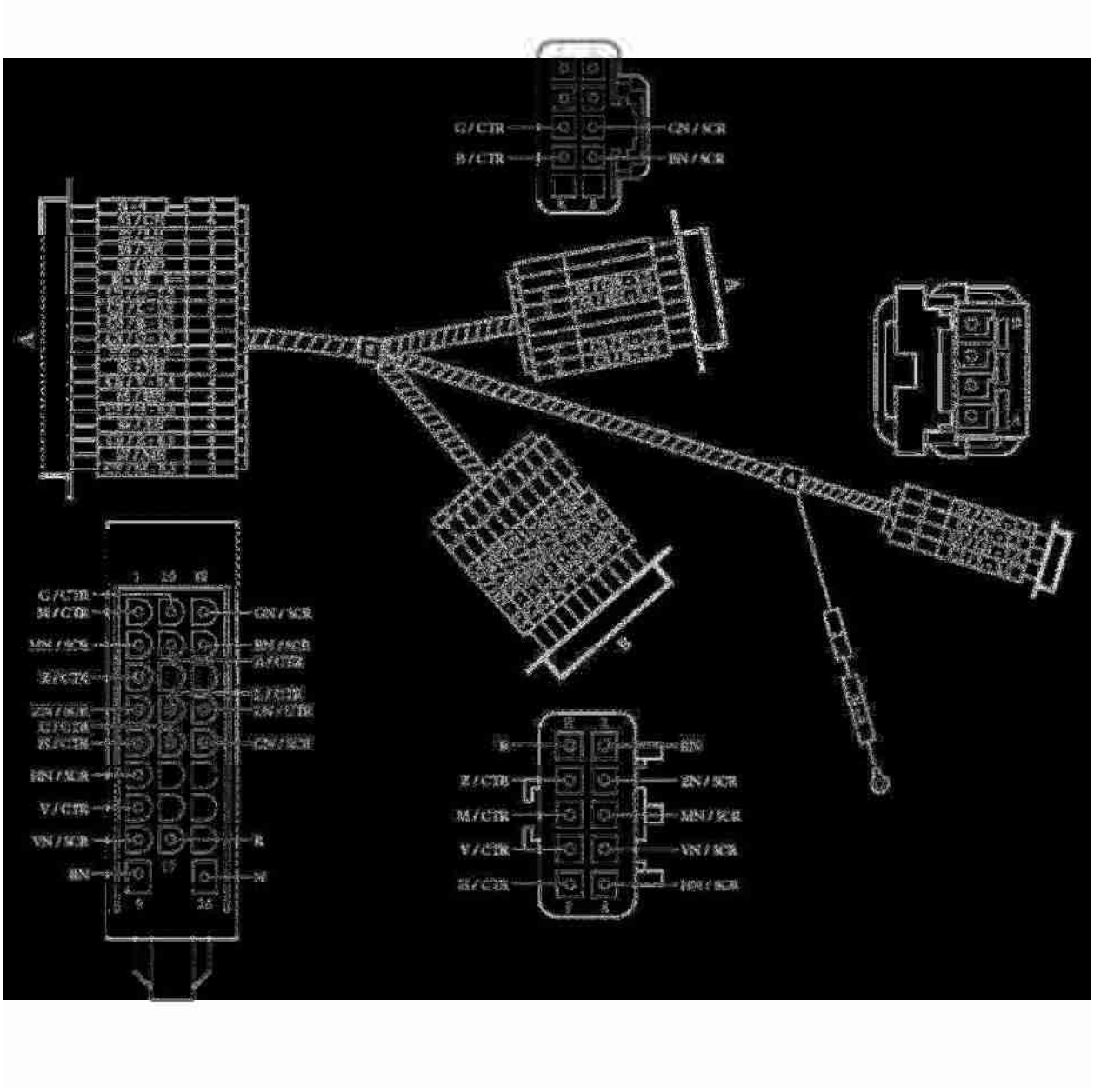
- Using a punch, make a hole underneath the under-dashboard, in position with the clip **(8)**.

- Use the screw **(10)** fastening the amplifier box to enlarge the hole.

- Remove the upper console, the central body and the front and lower covering for the tunnel (M 3.02) to lay the amplifier-subwoofer connection cable bundle **(11)**.
- Secure the earth terminal **(Q)** for the amplifier cable bundle **(11)** underneath the earth screw (the central one) on the rear shelf.

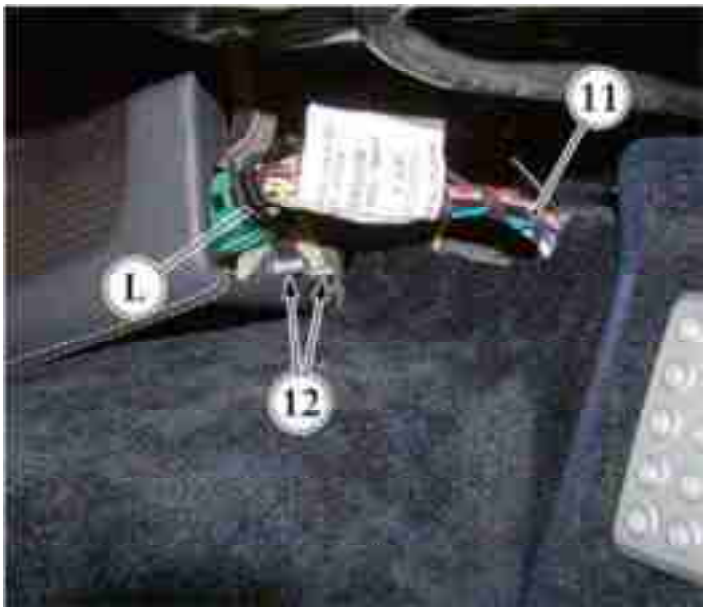


- Detach the connectors for the connection joint of the amplifier-radio system cable bundle (see **ELECTRIC SYSTEM** – **Table D** - connectors **42D**/**43D**) and connect them to the corresponding **(M)** and **(N)** terminals of the cable bundle.



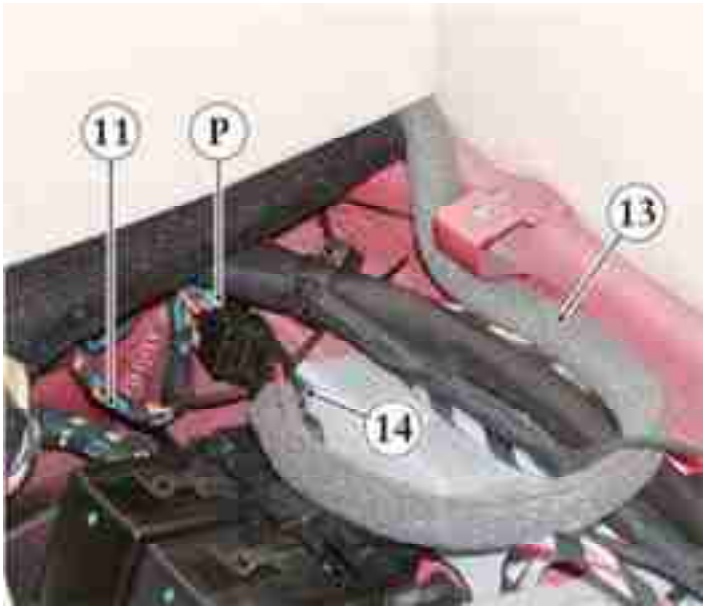
- Assemble the amplifier box components following the exploded view previously shown.

- Mount the special lower and front covering for the tunnel, equipped with an eyelet for passing the amplifier connector and with holes in position with the pins **(12)** fastening the rear side of the amplifier box.
- Extract the amplifier connector **(L)** for the cable bundle **(11)** and connect it onto the amplifier.



- Mount the amplifier box onto the lower tunnel covering and secure it onto the dashboard using the screw **(10)**.

- Rest the subwoofer box on the rear shelf and, using a punch, make holes in position with the box framework holes, to find the threaded holes on the engine compartment inspection lid.
- Assemble the upper casing onto the subwoofer box, following the exploded view previously shown.
- Rest the complete subwoofer box on the rear shelf taking out the cable **(13)** between the subwoofer box and the lower tunnel covering, on the left-hand side.
- Secure the complete subwoofer box onto the lid with screws and washer **(14)**.
- Attach the cable bundle **(11)** connector **(P)** to the corresponding terminal on the cable **(13)** connecting the subwoofer box, then secure the support clip **(14)** on the upper side of the fastening bracket for the control unit, right-hand side.



- Rest the complete subwoofer box on the rear shelf and secure it onto the lid with screws and washer **(14)**.
- Attach the cable connector **(13)** onto the subwoofer loudspeaker, and assemble the loudspeakers onto the box, following the exploded view previously shown.

- Refit the original components removed for the operation.

H2.16 ACCELERATOR CONTROL

The accelerator control pedal is pivoted on a frame fitted in the floor panel. This frame also contains the sensor that supplies the ignition/injection system **"ECU"** with the date relating to the pedal's position.

NOTES
For information on the functioning and replacement of the accelerator pedal sensor, (C 2.08).

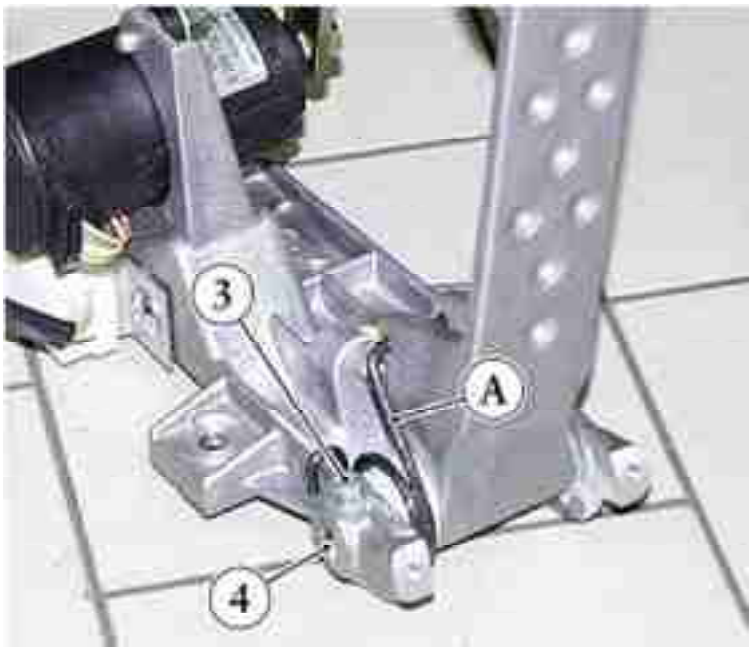
Removing the entire control

- Remove the pedal's protection and the covering of the pedal board.

- Detach the sensor connection **(1)**.
- Loosen the screws **(2)** and remove the entire control set from the passenger compartment.

Removing the pedal

- Detach the rod terminal from the ball joint on the pedal.
- Unscrew the screw **(3)** fastening the pin **(4)** to the bracket.
- Rivet the pin and remove the pedal together with its check spring **(A)**.



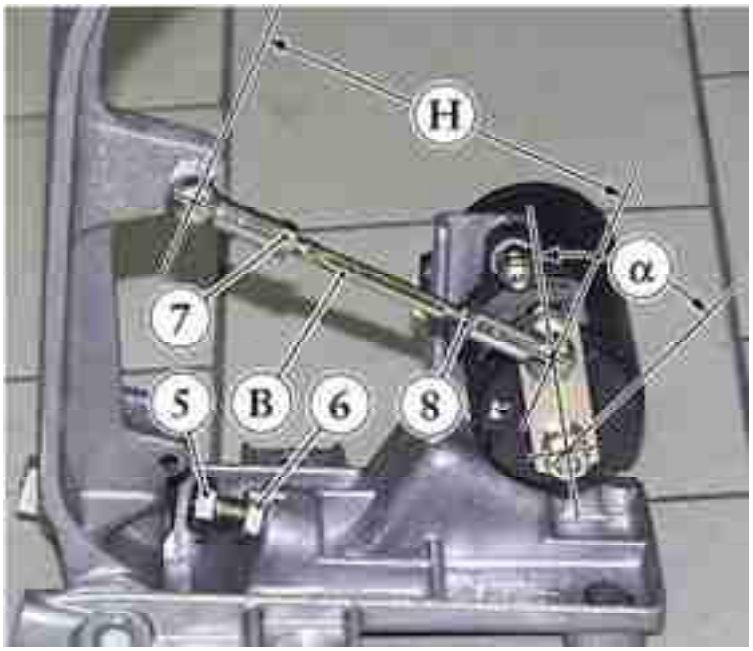
- Keep the pedal's lateral shims.
  It is possible to replace the pedal bushings in case the pedal shows an excessive backslash on the bracket's pin.
- When refitting, lubricate the pin **(4)** with **KLUBER ISOFLEX TOPAS NB 52** grease and insert the end of the spring **(A)** in the holes found on the pedal.

Adjusting the pedal position

The pedal's rest position is determined by the sensor and it depends on the centreline distance of the rod joints **(B)**.
If the centerline distance has been modified during maintenance interventions, the original setting must be restored as follows:

- loosen the lock nuts **(7** and **8)** and rotate the rod **(B)** until reaching a centerline distance **(H)** of about **101,3 mm** (**84,3 mm**, for the right-hand drive version) between the end joints;
- tighten the lock nuts.

The pedal end stroke is determined by the lever's **(C)** angular travel **(α)** of **68° 32'**.



Should the pedal travel need adjusting due to replacement or maintenance interventions, follow the instructions below:

- make sure the centreline distance **(H)** between the rod joints **(B)** complies with the prescribed values and position the pedal so that it features the prescribed travel;
- screw down the screw **(5)** until its head hits the pedal board;
- lock the nut **(6)** in this position.

H3.01 ALARM SYSTEM

General Information

The car alarm system, activated through a radio-frequency remote control, immobilises the engine and sends an acoustic alarm in case of theft attempt.
The system can carry out a self-diagnosis both on the sensors/actuators and on the theft attempts; a generic failure code is signalled through the flicking of the direction lights (L 2.08).
Connecting the SD-2 tester through the diagnosis plug-in (L 2.12) a guided passive diagnosis can be carried out in order to identify a possible system failure and therefore to proceed with the replacement/repair of the faulty part.

S stem Components (Fig

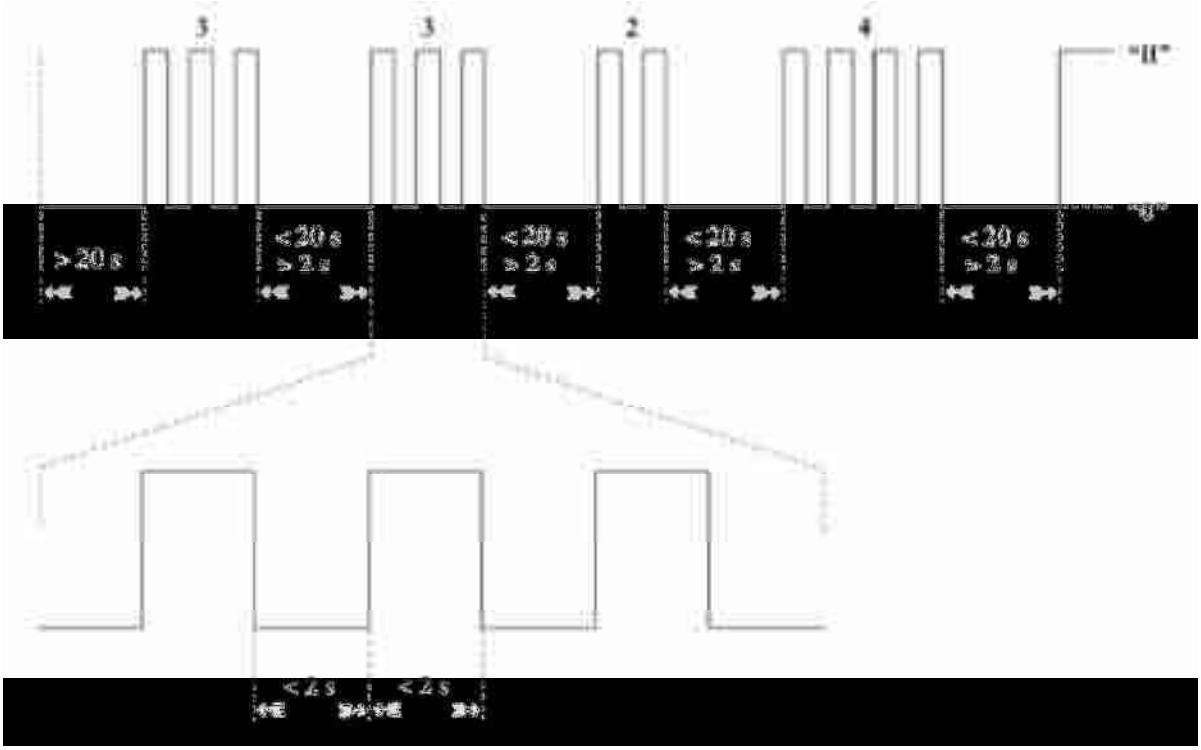
1 - Alarm system ECU.
2 - Motronic system interface ECU.

NOTES
The ECUs are placed under a lined metal shield fixed to the floor panel behind the driver's seat. This conforms to the minimum access time requested by insurance companies.

3 - Anti-lifting sensor; **12V** mercury switch
4 - Alarm; **12V**, with internal electronics and self-supply battery for intervention in case of deactivation while system is **"armed"**
5 - Door switches
6 - Luggage compartment switch
7 - Engine compartment switch
8 - LED
9 - Passenger compartment dome lights
10 - Hazard light intermittence switch
- Remote control Kit
- Motronic ECU
- Starting up Relay (only for version with standard gearbox)
- Diagnosis plug

PIN Code

Example with PIN CODE N° 3324



Each system is provided with a secret code, called **PIN code** (PIN = Personal Identification Number), which is supplied to the Client, discretely, on withdrawal of the car.
The Client has the responsibility of keeping the code in a safe place.
The **PIN code** allows to disarm the alarm system without the radio-control, simply by using the car key as described below:
a. make sure that the key was kept in position **0** for longer than **20 sec**.
b. To insert the first digit of the **PIN code**, turn the key to positions **II** - **0** as many times as the number involved;
Please Note
*During this operation, the key must not be kept in position **II** - **0** for longer than **2 sec**.*
c. Keep the key in position **0** for a period of **2÷20 sec**.
d. Repeat operations **b**. and **c**. for the remaining three digits.

NOTES
*If the resulting code is incorrect, wait at least **20 sec.** with the key turned to **0** before repeating the whole procedure.*

Operation

The system can be in one of the following conditions:
1. Disarmed and mobilised
2. Immobilised
3. Armed and immobilised

In this status, the alarm is *off* (not active), the doors are *unlocked* and the car can be started up.
You can obtain this status by deactivating the system with the remote control or, in case of an emergency, through the **PIN code.**
The system confirms this status by sending two short signals with the direction indicators.

2. Immobilised

This status is obtained when:
- **60 sec.** after having withdrawn the ignition key and having opened one of the doors (the 60 sec. are calculated from the moment the door is opened).
- **120 sec.** after the disarming of the system through the remote control, if the engine is still off.

When in this status, the car engine cannot be started up, the starter motor and the ignition/injection systems are inhibited and the LED flashes.
In order to start up the engine, the remote control must be pressed before turning the key to **"II"**.

NOTES
*On vehicles bound for Belgium the **"Immobilizer"** system is activated between **10** and **60 seconds** after the engine has been switched off (key turned to **0**) or immediately after opening the door.*

3. Armed and immobilised (alarmed on and vehicle immobilised)

When the system is **"armed"** the car status is as follows:
- engine immobilised;
- doors locked (the alarm system prevents the opening of doors, bonnet and boot and does not allow the car to be lifted in case it is being stolen with a truck trailer), LED flashing.

This status can be reached by:
a. operating the remote control after having turned off the engine and after having closed the doors, bonnet and boot.
The system needs **5 seconds** to be activated through the remote control (stabilising time).
b. **"Auto arming"** activation.

NOTES
The system confirms its activation by sending a short light signal with the direction indicators (in the countries where this is allowed).

If the alarm system ***IS NOT*** armed correctly, in case the doors / boot/ bonnet are not securely shut, the system will highlight this condition through five short light signals from the direction lights and activates nevertheless the alarm system.

Auto arming

To avoid conditions of open/disarmed car, the system activates its **"auto-arming"** protection in two separate phases:

- Immobilisation after **120 sec.**,
- Arming after another **180 sec.**.

The Auto Arming takes place only after the vehicle has been **"disarmed"** but the doors/boots have not been touched.

- The **"auto arming"** does not operate on the central door locking.

NOTES

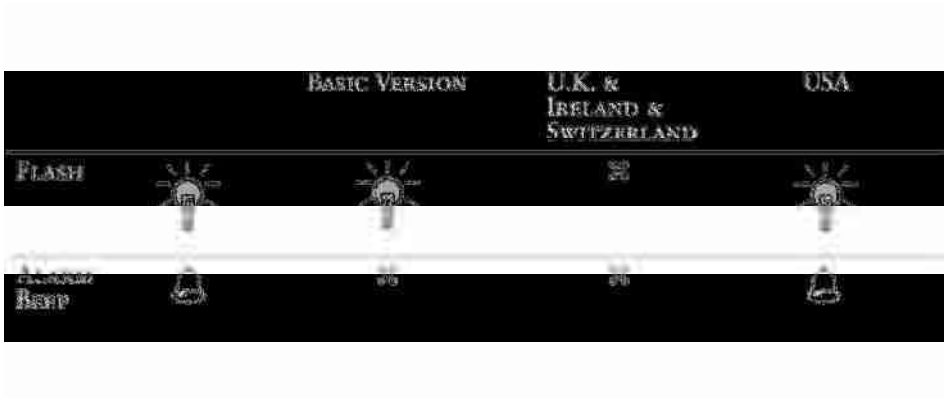
*On vehicles bound for Belgium, **"auto arming"** takes place 30 seconds after the last open peripheral unit has been closed (doors, engine compartment, luggage compartment).*

Alarm System Signals

Indicator table

a. system correctly **"armed"**	**1 flashes**
b. system correctly **"disarmed"**	**2 lampeggi**
c. system not correctly **"armed"** due to an incorrect entrance condition (open doors/boot/ bonnet or faulty switches)	**1 + 4 flashes**
d. disarming after a theft attempt (the system signals that one of the entrances has been forced and that the siren started)	**3 flashes**
e. alarm in case of theft	**5 cycles of 30",** direction indicators + siren with 5 sec. pauses, then only the direction lights for max 5 min. (In Switzerland, only one cycle is allowed)

f. **"0"** - **"II"** alarm **1 cycle of 30"** flashing + siren (attempt to force an entrance)



Indicator table

Basic version = Italy, France, Sweden, Norway, Portugal, Spain, Austria, Denmark, Finland, The Netherlands, Belgium, Germany, Middle East, South Africa, Hong Kong

Auxiliary Functions

Panic Function

An important characteristic of the system is its use in case of help or of danger.
By pressing the remote control for **3 sec.,** the car activates the siren and the flashing of the direction indicators so as to signal that the car owner is in danger.
The sequence is interrupted by pressing the remote control button for a further **3 sec**..

NOTES
On cars bound for Belgium, this option in not active.

Led

- Each time the key is turned to **"II",** the LED stays on for **6 sec.** and turns off in case no failure has been detected (self-diagnosis).
- If a malfunction has been detected (open boot/bonnet/doors), after 6 sec. the LED switches off and then on again to remain lit continuously.
- If the system is immobilised or armed, the LED flashes quickly the first **20 sec.** and then it flashes slowly and constantly.
- When the system is being **"disarmed"**, the LED flashes quickly while the remote control is being operated and then it switches off.

Dome light

It switches on for **10 sec.** when the system is **"disarmed"**.

Important notes

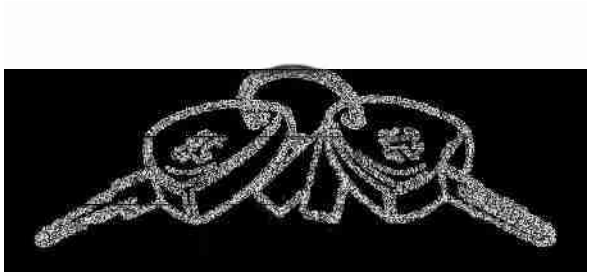
The remote control works within an area of ca. **5 m**. Should the system not respond to the control, move closer to the car and proceed as follows:
1. press the button of the remote control watching the LED: if it flashes quickly while the button is being pressed, the remote control is **OK**; if it does not flash quickly, check the battery and replace it if necessary. The remote control batteries must be replaced regularly, at least every six months.
2. if the remote control is **OK** and the system still does not respond, you must follow the **"re-synchronisation"** procedure by pressing the remote control button 3 consecutive times within **10 sec.**.

Vehicle transportation in case of accident or of failure

The car must never be transported with the alarm system in **"Armed"** status.
If, however, the alarm is **"armed"**, **"disarm"** it using the remote control and then open and close one of the doors: this procedure **"immobilises"** the alarm system.

Keys

When the car is delivered to the Client, 2 keys and 3 remote controls (**1** colour master: **"red" + 2** colour slave: **"black"**) are supplied.



The Client must keep in a safe place the remote controls (**1 "red" + 1 "black"**), the unused key, and the card with the **PIN code.**

In case of loss of the key

The Client must turn to the Concessionaire/Importer, communicating the number found on the plastic card supplied with the key.

In case of loss of one or more remote controls

The Client must request a new remote control kit (**1** master + **2** slave) and the card with the new **"PIN code"** to the Concessionaire/Importer.
The new remote controls must then be memorised as follows:

- Set the ECU for self-learning procedures; this status can be obtained entering the **PIN code** as previously described; after the last digit, wait for a lapse of time ranging between **> 2 sec.** and **< 20 sec.,** then carry out a sequence of 10 **ON** - **OFF**.
  Every sequence consists of:
  - turning the key to **ON**, so lighting-up the luminous LED;
  - then waiting for the LED to turn-off and turning the key to **OFF**.
- Once these operations have been completed, turn the key back to **ON** for the eleventh time: the LED will start flashing.
- Press the button of the new **"master"** remote control (this procedure will allow the ECU to store the new **PIN code** which was delivered to the Client crypted, together with the new remote controls).
- Press the two **"slaves"** (first one, then the other) and check that the 3 new remote controls are functioning correctly.
- Return the old remote controls to the FERRARI Technical Service Department.

Technical Informatio

- Siren absorption: **3.5 mA** (the siren is self-supplied with a 7.2 V N C battery). If the vehicle battery is disconnected, with the system active, the siren carries out a whole alarm cycle and is immediately recharged when the vehicle battery is reconnected. The siren ("dipped" type siren) communicates every **2÷3** seconds with the alarm system ECU on a serial line through a 4-digit code and it cannot be activated or deactivated in any other way.
- Anti-lifting sensor absorption: **6.0 mA**. The sensor is reset with the car in any position and communicates its activation when, with the system on, the position stored is changed.
- Total absorption with system deactivated: **10.0 mA**.
- Total absorption with system activated: **15.0 mA**.
- Total absorption with car at rest: **35 - 40 mA**. The battery loses **50%** of its charge in **30÷40** days. If the car is not going to be used for long periods of time, it is best to wait for the alarm system to be in the immobilised status and disconnect the battery.

Replacing Parts

Siren

The siren is placed on the left-hand side of the luggage compartment, behind the movable rear panel.
To remove it from its seat, you must:
- remove the luggage compartment movable panel; (M 3.06);
- unscrew the fastening screws **(11)**;
- pull out the siren **(4)** together with its bracket and detach the connection from the front harness.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.
During re-assembly, place the siren with its cone **(A)** turned downwards and with an angle of **30°** for water drainage.

Anti-lifting sensor

It is placed in left-hand side of the dashboard holding frame.
To remove it from its seat, you must:

- remove the lower covering of the dashboard; (M 3.01);
- disconnect the dashboard cable connector **(12)** from the sensor **(3)**;

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

- unscrew the two bolts near the pins **(13)** fastening the sensor support bracket on the dashboard holding frame.

- remove the sensor and its support bracket.

ECUs

They are fixed to the ECUs' covering, behind the driver seat.
To remove them from their seat, you must:

- remove the ECU covering (M 3.04);
- unscrew the fastening screws **(14)** and lift the holding bracket of the ECUs from the floor;

- detach the two connectors for the tunnel cable from the alarm system ECU **(1)**(**13H - 14H**, see Table **H** - ELECTRICAL SYSTEM);
- disconnect the connector **(C)** (**16H**, see Table **H** - ELECTRICAL SYSTEM) for the jumper connecting cable from the interface ECU **(2)**;

- remove the ECUs from the bracket.

During re-assembly, make sure the alarm system aerial **(D)** is correctly placed on the bracket and check that all connectors are properly fitted.
For connection to the system, see Table **H** - ELECTRICAL SYSTEM.

IMPORTANT
After replacing the alarm system ECUs, the Motronic ECU must be replaced as well.

Bonnet/boot switches

The switches (**6** and **7**, **Fig.1**), that indicate the open/close status of the engine and luggage compartment are secured to the respective devices and cannot be replaced individually.

- To disassemble the lids' opening devices (H 2.13).

Led

The LEDs **(8)** are located on the switch-holding panel, on the left-hand side of the dashboard and on the movable panel for the car stereo.

- To replace the first, you must remove the switch panel(_____) and pull out the LED box

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.

Door switch

The switch **(5)** that controls the door opening is fitted by pressing it into the front bodywork panel.

- To remove it from its seat, lever it with a small screwdriver and, once it's out, disconnect it form the dashboard cable.

Dome light

- To remove and replace the light bulb, (H 2.09).

Hazard light intermittence switch

The intermittence switch **(10)** is fitted on the right-hand side of the under-dashboard, next to the shock-absorber control EUC.
For connection to the system, see Table **C** - ELECTRICAL SYSTEM.

Diagnosis

The errors stored by the ECU are the following:

- ECU CIRCUIT OVERHEATING
- ERROR IN LOCKING CIRCUIT
- ERROR IN EEPROM CHECK
- ECU INTERFACE DOES NOT RESPOND
- INTERNAL ERROR INTERFACE ECU
- ALARM SYSTEM ECU AND INTERFACE ECU DO NOT DIALOG
- MOTRONIC ECU DOES NOT RESPOND
- ERROR IN SIREN COMMUNICATION
- LOW VOLTAGE IN SIREN BATTERY
- SIREN CIRCUIT DISCONNECTED

The parameters that can be detected with the car at a standstill and the key turned to **II**, are the following:

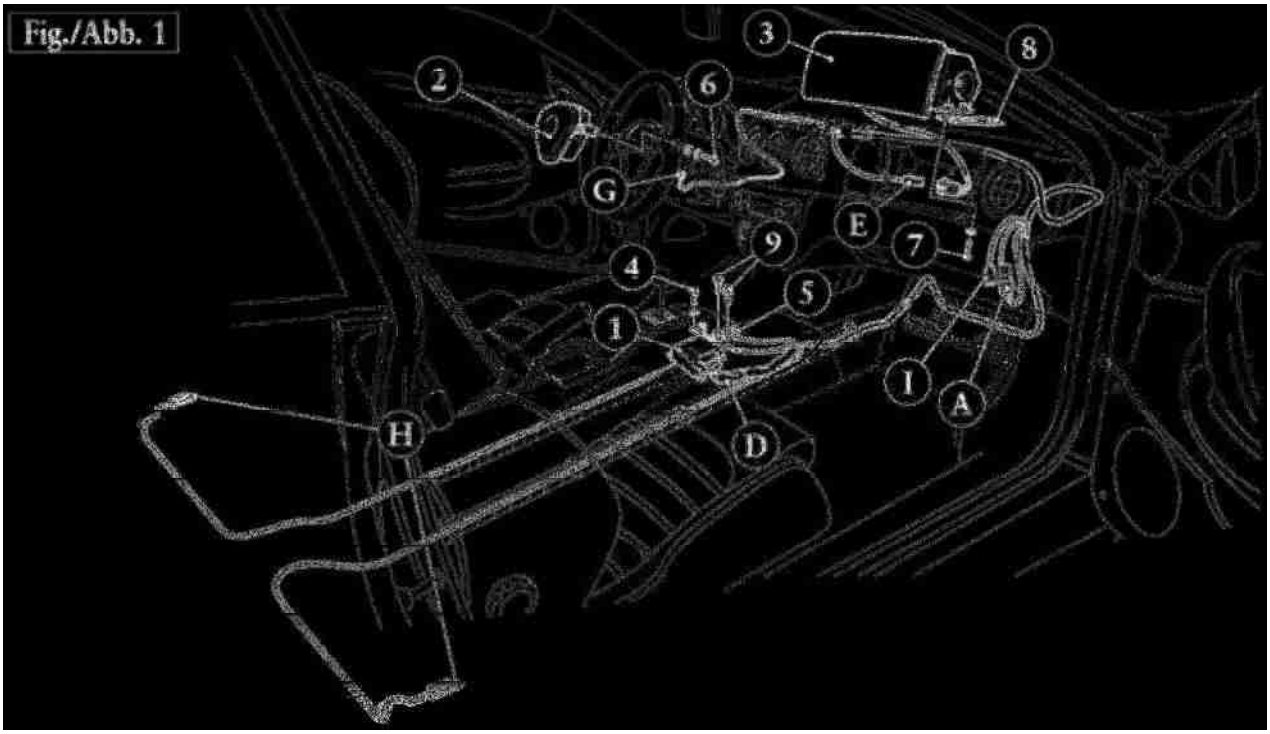
Alarm system status	DISARMED	The system was activated by the user.
	IMMOBILIZED	The system started automatically and immobilised the engine.
	ARMED	The system was activated by the user or the auto-arming mode set off.
	ALARM	The system is activating the alarm.
	PANIC	The panic function was activated.
	NOT WORKING	The ECU was not activated.
Doors status	OPEN/CLOSED	
Luggage compart. status	OPEN/CLOSED	
Engine compart. status	OPEN/CLOSED	
Inclination sensor status	ACTIVE/NOT ACTIVE	
Injection status	ON/OFF	

The statistical parameters detected by the ECU are used to check if and when the alarm system went on, storing the last eight activations and their cause.

ALARM ACTIVATION COUNTER This value cannot be deleted.	A max of 255 activations will be stored after which the counter will be reset.
ACTIVATION CAUSED BY DOORS	Theft attempt on one of the doors.
ACTIVATION CAUSED BY LUGGAGE COMPART	Theft attempt on the front bonnet
ACTIVATION CAUSED BY ENGINE COMPART.	Theft attempt on the rear engine compartment.
ACTIVATION CAUSED BY THE ANTI-LIFT. SENSOR	Theft attempt through car lifting.
ACTIVATION CAUSED BY IGNITION	Theft attempt through tampering of the ignition switch.

H3.02 AIRBAG

Description



*Keys to **Fig. 1***
1 - Electronic Control Unit
2 - Driver's side front Airbag
3 - Passenger's side front Airbag
4 - ECU fastening screw
5 - ECU stranded earth wire
6 - Fastening screw for driver's side Airbag
7 - Fastening screw for passenger's side Airbag
8 - Shim for passenger's side Airbag
9 - Screws fastening the earth wires onto the bodywork
A - Diagnosis socket
D - ECU connector
E - Connector for passenger side Airbag module
G - Connector for driver's side Airbag module

The car is fitted with an Airbag system and safety seatbelts with electronically controlled**, "four-charge"** pre-tensioners. In the event of a frontal collision, this system activates the pre-tensioners of the front seatbelts and the front Airbags.
The system consists of the following components:

1 Electronic Control Unit.
2 Driver's side front Airbag
3 Passenger's side front Airbag
- pre-tensioners for front seatbelts, driver's and passenger's side (H 3.03).

The system can be connected by means of:
- diagnosis plug-in **(A)** to perform a check cycle with the SD-2 tester
- instrument panel warning light to display failures.

All the system components are interconnected and connected with the car's electrical system by means of a specially designed wiring harness, fitted with a yellow sheath.

Operation

An electronic, longitudinal, accelerometric sensor is fitted inside the ECU. Its signal, which is suitably processed by a microprocessor, enables the ECU to detect the crash impact and consequently activate the pre-tensioners and

the Airbags.
A second longitudinal, electromechanical sensor, which features safety functions, enables the operation.
The ECU can intervene in two different ways:
- activating the pre-tensioners only;
- activating the pre-tensioners and the Airbags.

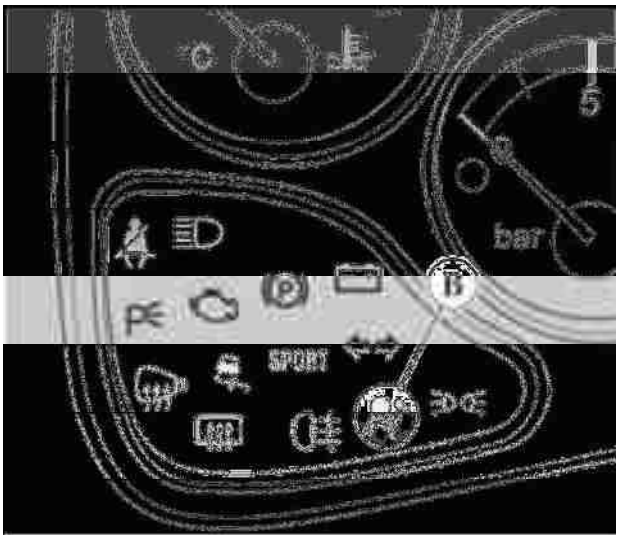
IMPORTANT
The ECU detects front collisions only. No operation is carried out in the event of side collisions, rear bumps or car roll-overs.

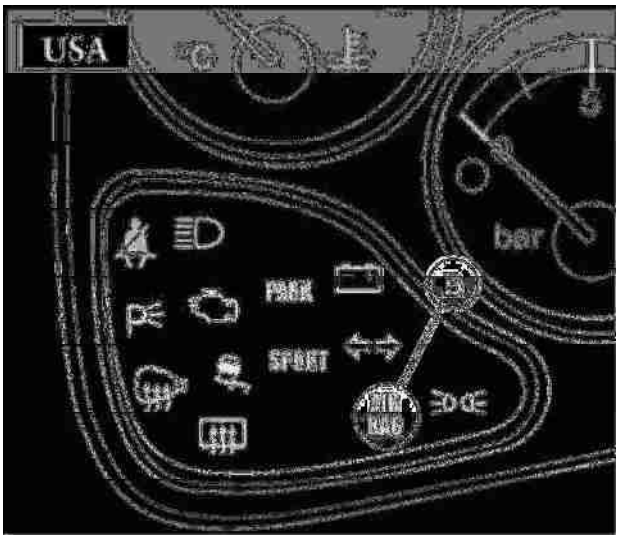
1- Electronic control unit

The ECU is installed in the passenger compartment, under the central console, and it is stiffly fastened onto the bodywork. This enables the deceleration sensors, fitted inside the ECU itself, to be located next to the car's centre of gravity, thus being able to detect the car internal decelerations with utmost precision.

NOTES
The ECU has an arrow printed on it. When installing the ECU, this arrow must always point towards the car's front.

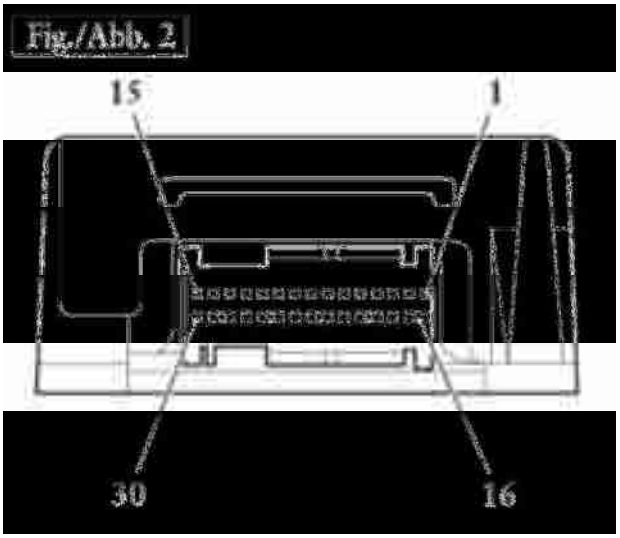
Power is supplied to the ECU when the ignition key is in running position. The ECU remains activated for **220 ms** after the power supply has been cut off, in order to ensure the system operation even in case of collisions which may cause a voltage drop in the system.
When driving the car, the ECU constantly monitors the system: if a failure is detected, the warning light **"Airbag failure" (B)** on the instrument panel (see "Airbag warning light") switches on and this condition is stored.





The ECU microprocessor checks the signal coming from the accelerometric sensor and determines the impact magnitude. On the basis of the latter level and after having been enabled by the safety sensor, the microprocessor sends a signal for the Airbags' activation. Also this signal is stored together with all the related information.

The ECU interfaces with the system through a 30-way connector (**Fig. 2**) (**29D**, see Table **D** - ELECTRICAL SYSTEM).



For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

2- Front Airbag, driver's side

The driver's side Airbag module is secured onto the steering wheel and houses the metal casing containing the folded bag – the total capacity of the latter amounts to **55 litres**. The module also contains the gas-generator device, which is electrically activated by the ECU.
Soon after the Airbags have been activated, the bag immediately deflates thanks to the permeability of its material.
The module's plastic cover opens upwards, following the pre-set breaking lines and thereby allowing the bag to burst out thoroughly.
A

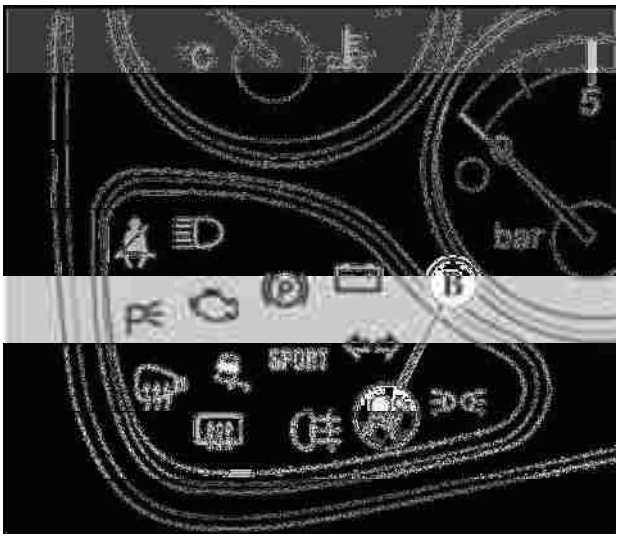
NOTES
If, for any reason, the two caps would even partially rotate and this would make it impossible to find out the original, proper position, the spiral contact must be replaced.
*For connection to the system, see Table **E** - ELECTRICAL SYSTEM.*

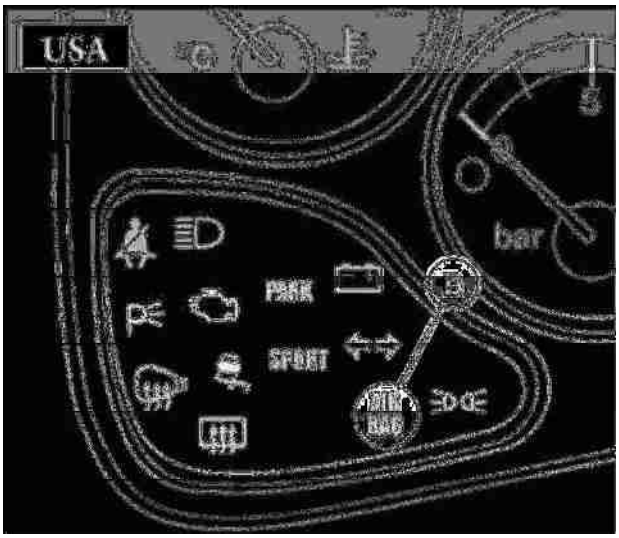
3- Front Airbag, passenger's side

It is located on the dashboard, over the glove compartment. Its operation is the same as for the driver's side module, the only difference lies in that the bag is bigger (ca. **140 litre** capacity).
The module is mounted directly onto the dashboard support structures, without using any support brackets.

CAUTION
We recommend the driver and the passenger to avoid travelling with objects (cans or drink bottles, pipes etc.) which may cause injuries in the event of the Airbag opening.

Airbag Failure Warning Light (B)





The red colour Airbag warning light switches on upon starting-up the car and remains lit for ca. **4 seconds** (self-test phase); it then switches off if no failures are found.

The warning light remains constantly lit or comes on when the car is running in the event that the ECU detects one of the following malfunctions:

- Airbag system failure;
- collision with consequent, even partial activation of the system, i.e. pre-tensioners activation only;
- failure in the connection circuit of the warning light.

Once the failure has been signalled, the warning light remains on as long as the malfunction is not eliminated and deleted from the error storage by means of the SD-2 system.

NOTES

If the ECU detects a failure it may, in some cases, disable the system. In this event, immediately check for the problem causes (see "System diagnosis") and have the malfunction repaired.

Important notes

When the system is activated, it produces gases which inflate the bag. These gases are not harmful, as they are suitably cooled and filtered.
However, some residual combustion products may, if they come in contact with liquids or halogen substances (such as humidity, petrol etc.) generate toxic substances.
To guarantee safe working conditions, follow the below instructions:

- always use goggles when handling closed Airbag modules;
- always lean the Airbag module with the opening cover upwards;
- never lay anything on the opening cover of an Airbag module;
- always carry the Airbag module with the opening cover opposite your body;
- never adapt, install or re-use the Airbag system or its components on a car other than that for which they have been designed and manufactured;
- store the Airbag modules keeping them closed and intact, in a fresh, dry and protected room;
- always use rubber gloves and protection goggles when handling open Airbag modules after explosion. The Airbag surface may contain sodium hydroxide or hydrazoic acid (produced when the combustion residual products come in contact with liquids, humidity, petrol etc.). These substances may even have a lethal effect;
- if an Airbag module is activated, let it cool down for ca. **20 minutes** before carrying out any intervention on the inflation system;
- store the units which did not open or which proved to be defective (e.g. failure in the inflation system) clear from acids, halogens, heavy metals and salts;
- do not carry out any intervention on the Airbag electrical system. If the latter shows a malfunction, it must be replaced as a whole;
- when repairing cars which have been involved in fires or accidents, check the electrical system for efficiency through the SD-2 tester system, always using the trial resistances before connecting the Airbag modules;
- do not apply adhesive products or materials and do not treat anyway the module upholstery on the driver's and passenger's side;
- after a collision which caused the Airbag activation, **all of the system components must be replaced (see "System diagnosis").**

CAUTION

***NEVER** expose the Airbag modules to temperatures over **150 °C (300 °F)**, since the high temperature, and not the current, is the factor which triggers bursting.*

Tightening torques		Category
ECU fastening screws	**7,5**	**B**
Driver's side module fastening screws	**10**	**B**
Passenger's side module fastening screws	**11**	**B**

Component replacement

CAUTION

Before carrying out any intervention or replacing a system component, check that the ignition key is turned to the STOP position and disconnect the battery (_____).

When welding operations have to be performed on the car, the ECU must be disconnected as well.

ECU

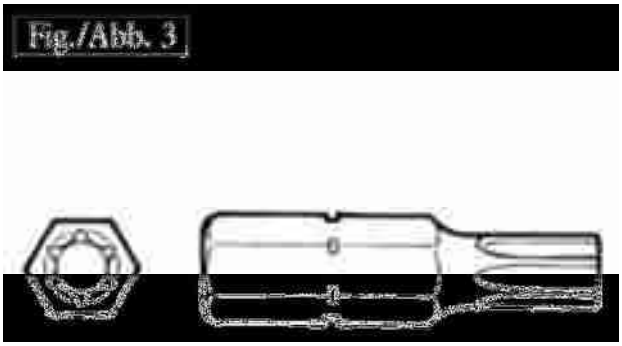
- To gain access to the ECU, it is necessary to remove the central console (M 3.02).
- Unscrew the screws **(4)** fastening the console to the tunnel; the front left-hand screw also secures the stranded earth wire **(5)**.
- Remove the ECU and detach the connector **(D)**.

- Mount the new ECU in the same position where the previous one was located and attach the connector **(D)**.
- Position the stranded earth wire terminal **(5)** and tighten the screws **(4)** to the prescribed tightening torque.

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

Driver's side Airbag module

- From the back of the steering wheel, remove the protection caps plugging the access holes to the module fastening screws.
- Use a wrench type **TORX T30** e **T40 (Fig. 3)**, available on the market and unscrew the two side screws **(6)**.



- Slide off the module from the steering wheel and detach the connection **(E)** for the spiral contact.

- When re-assembling, tighten the screws **(6)** to the prescribed torque.

Passenger's side Airbag module

- Remove the glove compartment from the dashboard (M 3.01).
- Detach the connector **(F)** from the Airbag system cable.
- Unscrew the screws **(7)** fastening the module to the dashboard frame.

- Remove the module from the dashboard and keep the spacers, if any (**8**, **Fig. 1**).
- When mounting a new module, carefully adjust its profile and align the outer covering with the dashboard, using spacers **(8)** if needed.
- Tighten the screws **(7)** to the prescribed torque.

Airbag cable

The Airbag system cable can be easily identified thanks to its yellow coloured outer sheath. The cable route is shown in **Fig. 1**.

To replace the cable, some components within the passenger compartment must be removed:

- the battery; (_____);
- the lower (M 3.02) and front (M 3.04) tunnel coverings;
- the dashboard (M 3.01).

- Detach the ground cable terminals by unscrewing the screws **(9)** fastening them to the bodywork.

- Detach the connector **(D)** from the ECU, from the passenger's side Airbag module **(E)** and the connector **(G)** from the spiral contact.
- Detach the connections **(H)** from the pre-tensioners (H 3.03).
- Detach the connection **(I)** from the dashboard cable and remove the Airbag cable releasing the fastening clamps.
- Fit the new cable in the same position where the former one was located.

Once the new components are installed, carry out a system testing cycle through the SD-2 tester system, which has to be connected using the special plug-in (L 2.12); Then print out the test results.
To ensure that the ECUs and/or the modules are identified correctly, put the components' **"bar codes"** on the printouts and send them to Ferrari.

CAUTION
The driver's and passenger's side Airbag modules must be replaced every ten years after their installation (see C/E plate), even if the car has never been involved in collisions.
No restraining systems for children can be installed on the passenger seat.
Where the legislation in force provides it, children under twelve cannot travel on the front seats.
In the event of a crash with consequent activation of Airbag modules, dispose of the exploded modules as harmful waste, in accordance with the legislation in force in the related country.

System diagnosis

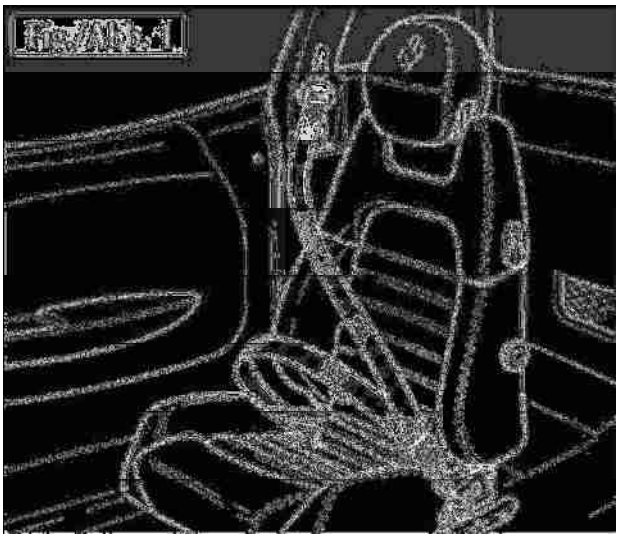
By means of the Ferrari SD-2 tester system, it is possible to be connected to the system ECU in order to delete the errors and to identify the possible failure highlighted through the switching on of the warning light.
In the event of a crash causing the activation of the entire system (i.e. Airbags and pre-tensioners) it will no longer be possible to delete the ECU storage memory. The ECU therefore, must be replaced together with the modules.
In the event that only the pre-tensioners are activated, the ECU memory can be deleted twice: only if the pre-tensioners are activated a third time will it be necessary to replace the ECU.
The Airbag ECU can detect two types of errors: errors due to the electric wiring harness or to a system component, or errors generated inside the ECU which cannot be debugged anyway. In the latter case, the ECU must be replaced and a new automatic cycle must be carried out.

Every time a collision causes the Airbags to open or the pre-tensioners to explode, following the below instructions is mandatory:
- replace all of the Airbag system components;
- carry out the diagnosis cycle;
- print out the cycle result;
- attach the identification sticker found on the new ECU, on the printout;
- send a copy to the Ferrari Technical Service Department and keep the original.
- for your own files, it is important to attach also the resistors – possibly sent with the new harness - to the cycle printout.

By plugging-in the SD-2 tester, it is possible to display the errors stored by the ECU:
- ECU error
- ECU power supply
- Failure Light
- Driver's Airbag
- Passenger's Airbag
- Driver's pre-tensioner
- Passenger's pre-tensioner

H3.03 SEATBELTS

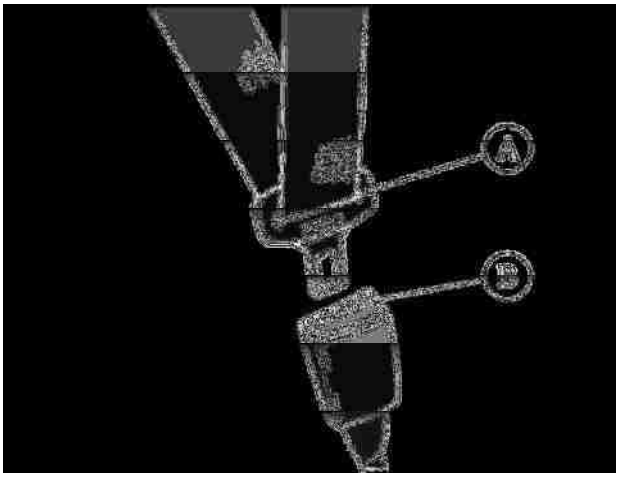
The seatbelts, fitted as standard, are automatic, with three anchor points (see **Fig. 1**) and an emergency stop inertia winding unit, fitted with pre-tensioners.



Using the seatbelts

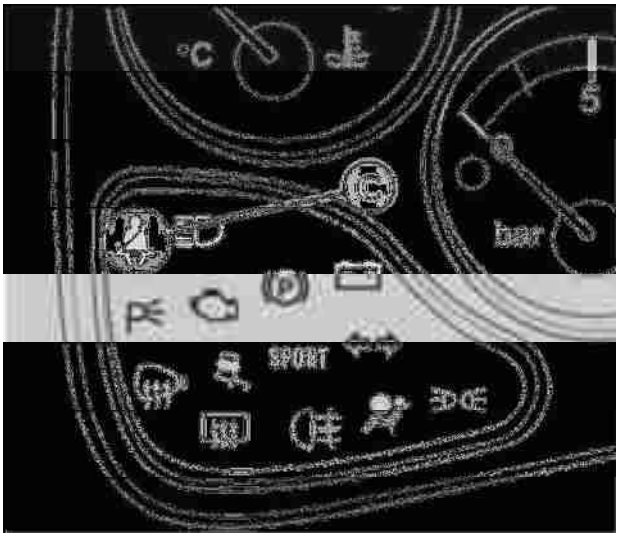
Fastening the seatbelt

- Position the seat and head rest correctly.
- Grip the fastener terminal **(A)**, pull the seatbelt downwards slowly and insert the tang in the seating **(B)** if the seatbelt jams while being pulled down, let it wind back a little and then start to pull it down again, avoiding sharp movements.



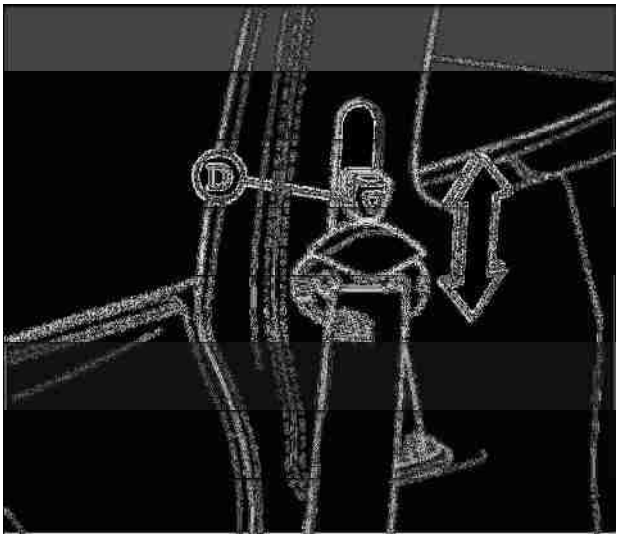
- Check that it has clicked into the locked position.
- Position the seatbelt correctly.

If the driver's seatbelt is not fastened, when the ignition key is turned to the ON position, the light **(C)** will go on and a signal will sound for **10 seconds**.



Adjusting the seatbelt position

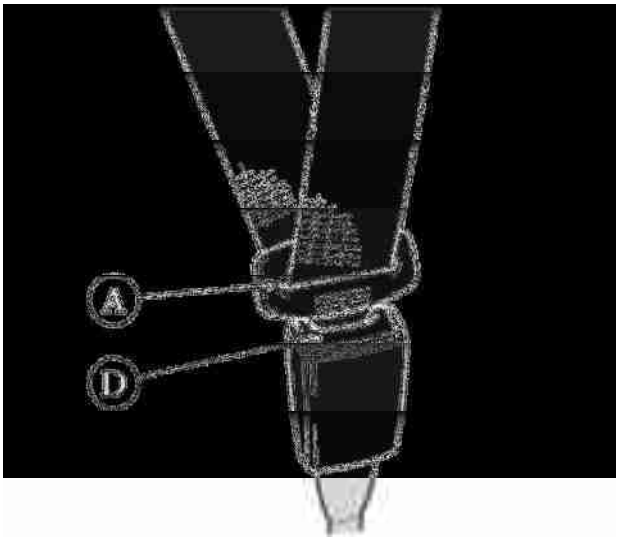
- Push the locking knob **(D)** upwards to release the adjusting device then move the seatbelt into the desired position.



- Always check that it locks correctly. The seatbelt is positioned correctly when it passes about halfway between the neck and the end of the shoulder. The lower part must fit against the pelvis, not the stomach.

Unfastening the seatbelt

- Press the release button **(D)**.
- Keep hold of the fastening tang **(A)** as it returns to the resting position.

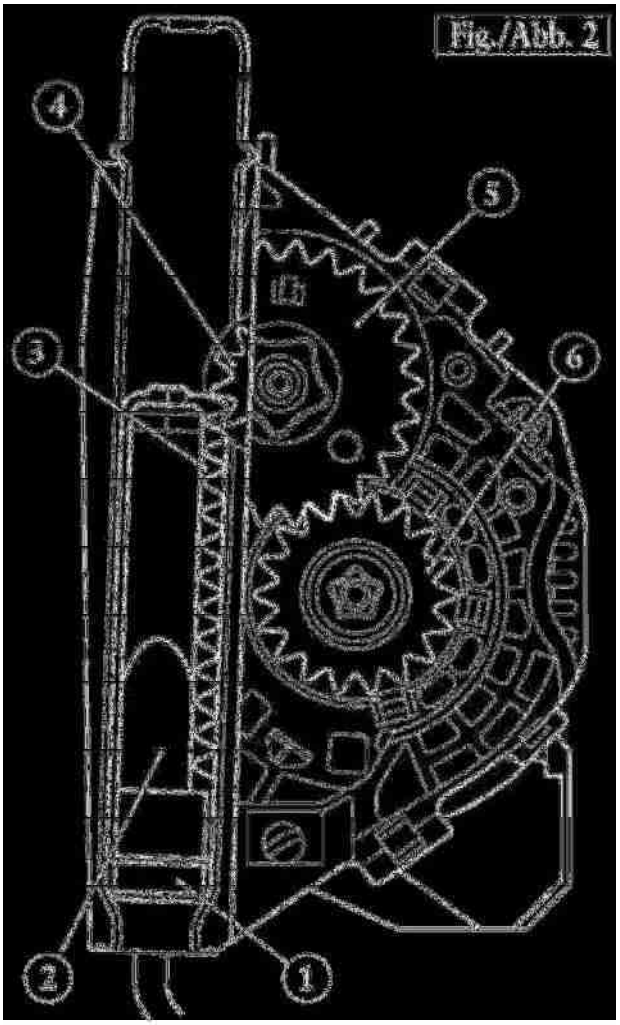


Pre-tensioner

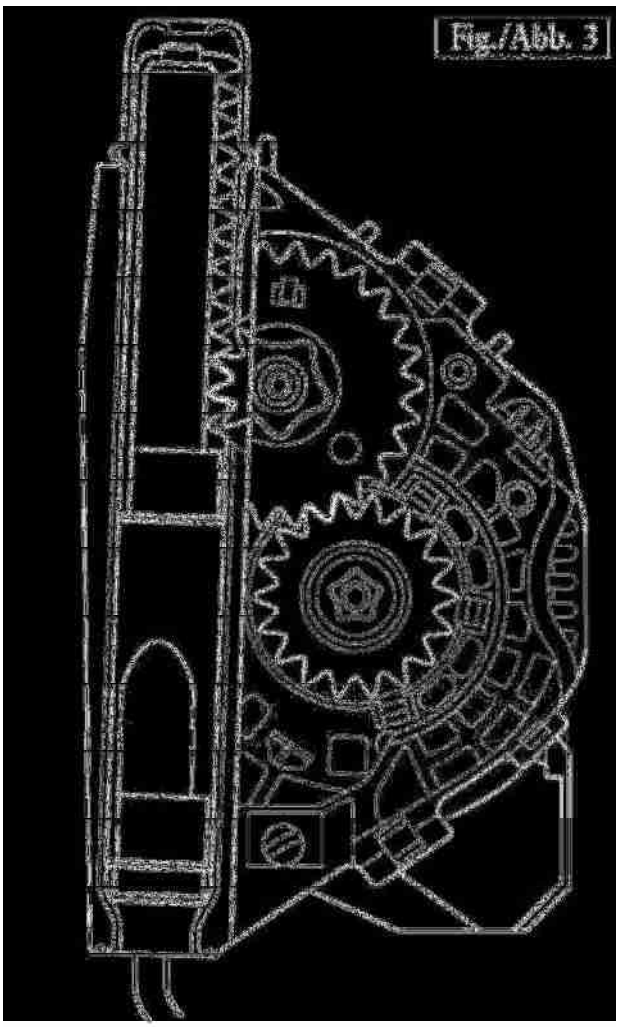
This device is made up of a winder and a pyrotechnically-activated pre-tensioner. The pyrotechnic activation is an integral part of the winder and together they form a single component which is fastened to the vehicle's door panel framework.

The aim of this device is to make the protective action of the seat belt more efficient.

Operation
Before activation, the device is as shown in **Fig. 2**.
For connection to the system (H3.02).

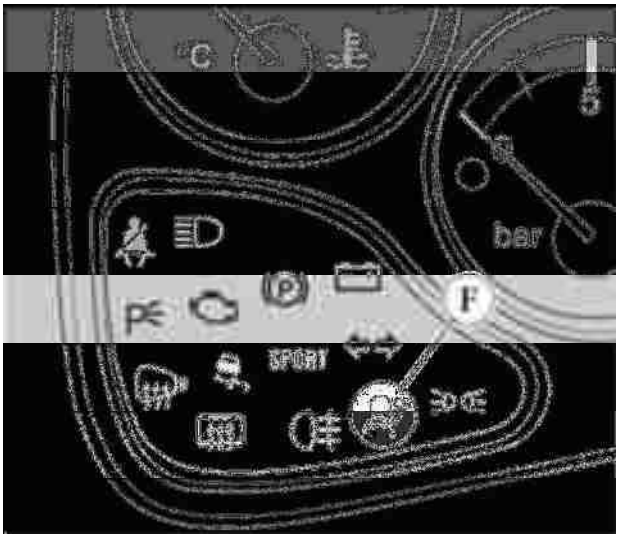


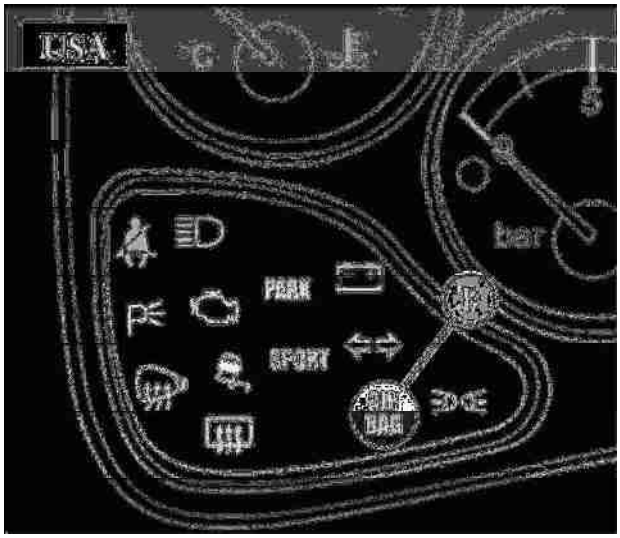
When the control ECU that controls it (H 3.02) detects an impact which is greater than the set threshold, it transmits a signal to the pre-tensioners which set off the pyrotechnic charge **(1)** of the gas generator: the combustion of the propellant **(2)** develops a gas whose pressure generates a force which pushes the rack piston **(3)** upwards. This movement is transmitted by the toothed wheels **(4)** and **(5)** to the toothed bushing **(6)** which rewinds the belt by a few centimetres (as shown in **Fig. 3**). In this way the seatbelt is guaranteed to fit the occupant's body perfectly, before the restraining action begins.



IMPORTANT
After activation, the pre-tensioners cannot be re-used and must be replaced.

The activation of the pre-tensioners is a signalled by the light **(F)** on the instrument panel going on and the seatbelts locking.





On activation, the pre-tensioners produce a small amount of powder. This powder is not toxic and does not indicate the beginning of a fire.

Taking Care of the Seatbelts and the Pre-tensioners

- Following a collision with a certain degree of impact, replace the seatbelt, even if it does not appear to be damaged in any way.
- Check regularly that the fastening screws are fully tightened and that the belt is intact and runs without jamming.
- The belt must be kept clean: the presence of any dirt could reduce the winding efficiency.
- To clean the seatbelt, wash it by hand with a neutral soap and water, rinsing it and leaving it to dry. Do not use strong detergents, bleach or aggressive solvents which could weaken the fibres.
- Do not let the winding units get wet: they can only be guaranteed to work properly if they are never soaked in water.
- The pre-tensioner does not require any maintenance or lubrication. If it is immersed in water or mud, it must be replaced without fail.
- The pre-tensioner must be replaced every **15 years**.
- The disassembly or modification of the seatbelts, winding units or pre-tensioners is strictly forbidden.
- Any special maintenance which involves blows, vibrations or overheating in the pre-tensioner area, may cause these to activate; normal vibrations from the road will not have this effect.

Safety Devices

- The pre-tensioners must never be exposed to temperatures exceeding **100 °C** for more than 6 hours and they must be kept clear of sparks and naked flames.
- Temperatures of over **150 °C**, may cause the automatic activation of the pre-tensioner.
- Any pre-tensioners which have experienced impacts or have been dropped are no longer useable and must be returned with the irregularity experienced indicated.
- The gas generators must never come into contact with acids, water, grease and heavy metals as this could cause the production of poisonous or noxious gases or explosive compounds.
- It is forbidden to store the pre-tensioners with flammable and/or combustible materials.
- It is strictly forbidden to disassemble the components of the restraining system.
- When transporting the pre-tensioners, never hold them by the belt as this could damage them.
- Dismount the pre-tensioner before carrying out any repair work which involves heavy blows (for example, on the frame or bodywork) and/or high temperatures (for example, painting at temperatures of over **100 °C**).
- Activate the pre-tensioners which are to be scrapped.
- Avoid contact with the skin and do not ingest the propellant: use protective gloves when handling the pre-tensioners which have been activated. In the event of contact with the propellant, rinse the affected area thoroughly with water and seek for medical assistance.

Child safety

Because of their size and shape, children are at greater risk than adults. It is necessary, therefore, to use suitable safety or restraining systems.

All children whose physical characteristics (height, weight) fall within the limits/values fixed by the laws in force in each individual country, must be protected by the relative restraining or safety system (child seat, cots, cushions) approved by the **ece/onu** regulation **44**.

For countries which do not adhere to the ece/onu regulation 44, reference should be made to the specific national regulations.

In any case, we recommend that you always use approved child restraining systems, labeled with the quality control mark.

In the event of an accident, an incorrectly fitted child restraining system may increase the risk of harm to the child.

The seatbelts in the car have been designed and tested to protect people of at least 36 Kg in weight and over 1,50 m in height.

For this reason, for persons who do not meet these requirements it is necessary to install specific restraining systems, equipped with special safety belts or with accessories which can adjust the child position with respect to the car's safety belts.

When installing and using child-restraining systems, follow the instructions which the Manufacturer is obligated by law to supply with the system itself.

Since the car is equipped with Airbags, no child restraining system may be installed on the passenger seat. The child restraining systems and seatbelts must not be modified in any way. Where stipulated by law, children under 12 may not travel in the front seats.

Tightening torques		Category
Height adjusting fastening screws	**20**	**B**
Winder fastening screw	**38÷42**	**B**
Winder slot fastening nut	**38÷42**	**B**
Screw to fasten belt to seat	**38÷42**	**B**

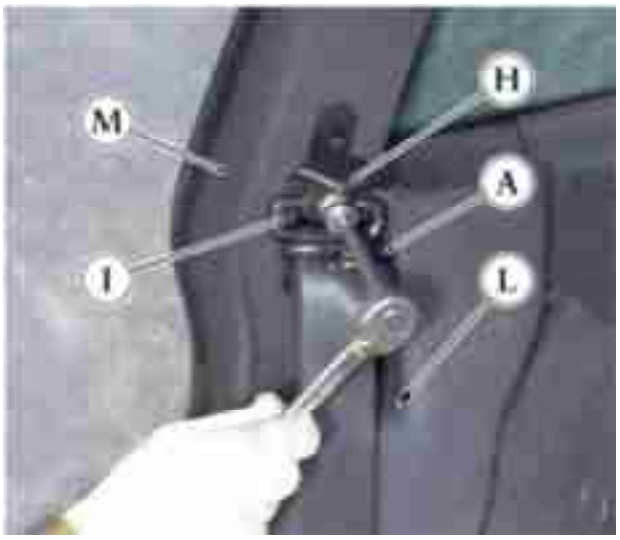
Replacing the seatbelt

- Check that the ignition key is in the Stop position and always disconnect the battery (L 2.02).

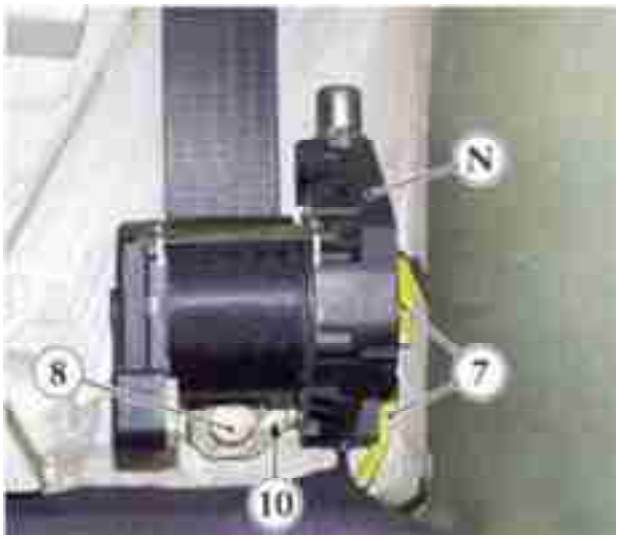
CAUTION
After disconnecting the battery, wait at least one minute before disconnecting the pre-tensioners.

- Remove the closing cap and loosen the screw which fastens the end **(G)** of the seatbelt to the seat. In the case of the driver's seat, it is necessary to detach the connection for the fastened seatbelt indicator.

- Raise the guard **(H)** and remove the winder slot fastening nut from the height adjuster.
- Lift the pass-through piece **(L)** off the upholstery **(M)** and detach the latter from the door panel frame (M 3.04).
- Pass the fastening terminal **(A)**, the winder slot **(I)** and the seatbelt tang **(L)** through the gap in the upholstery **(M)**.



- Remove the Airbag cable connection **(7)** from the winder **(N)**.
- Remove the winder fastening screw **(8)** and then the whole seatbelt.



- If necessary, the height adjuster **(O)** can be removed, by extracting the screws **(9)** which fasten it to the bodywork panel.

R -assembly

- If the height adjuster **(O)** has been disconnected, re-mount it, tightening the screws **(9)** to the prescribed torque.
- Connect the Airbag ECU power supply connector **(7)**, to the pre-tensioner gas generator.
- Fix the winder **(N)** to the bodywork, inserting the positioning tooth **(10)** at the base of the door panel frame into the winder support slot.
- Tighten the fastening screw **(8)** to the prescribed torque.

CAUTION

Do not use a percussion screwer.

- Pass the seatbelt fastening terminal **(A)**, winder slot **(I)** and the belt pass-through piece **(L)** behind the pin **(11)** and fit them into the upholstery **(M)**.
- Mount the upholstery onto the door panel (M 3.04) and position the pass-through piece **(L)**.
- Fasten the winder **(I)** onto the height adjuster **(O)**, tightening the nuts to the prescribed torque and then position the guard **(H)**.

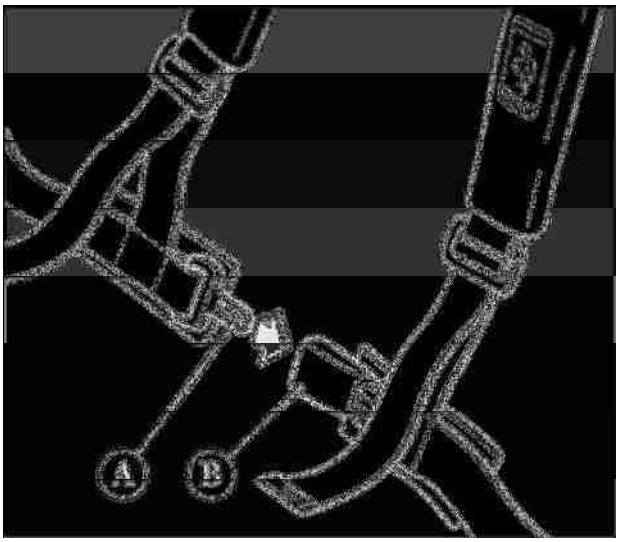
- Fix the seatbelt fastening terminal **(G)** onto the seat, tightening the fastening screw to the prescribed torque. Attach the connection for the driver's fastened seat-belt indicator.

- Install the closing plug and reconnect the battery.
- Use the SD-2 tester to check the system's efficiency.

Four point seat-belts (for sports seats)

There are four fastening points with buckles for adjusting the length.
For maximum protection, keep the seat-back in an upright position, make sure you back is well supported and adjust the seat-belt correctly, so that it fits snugly around your chest and pelvis.

Fastening the seat-belt:
After having adjusted the seat correctly;
- Insert the hooking tongue **(A)** into the seat **(B)** and make sure clicks into place.

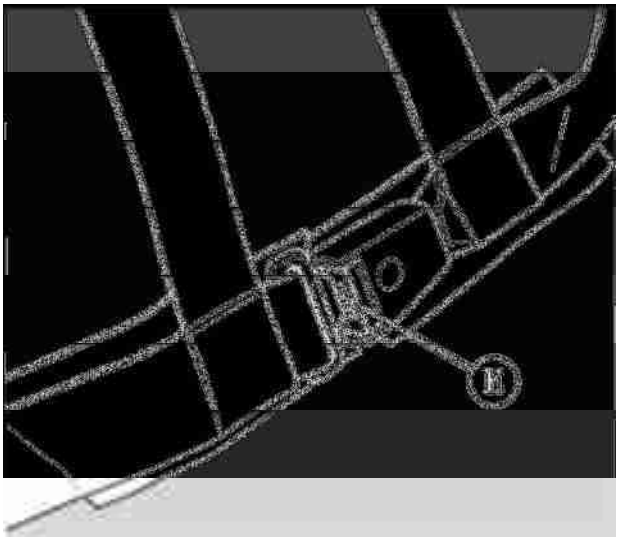


Adjustment

- Position the protective devices **(P)** on the upper part of the shoulder.
- Pull the end **(Q)** of the belts so that they fit snugly to the body.

Release

- Press the release button to un-hook the belt **(E)**.



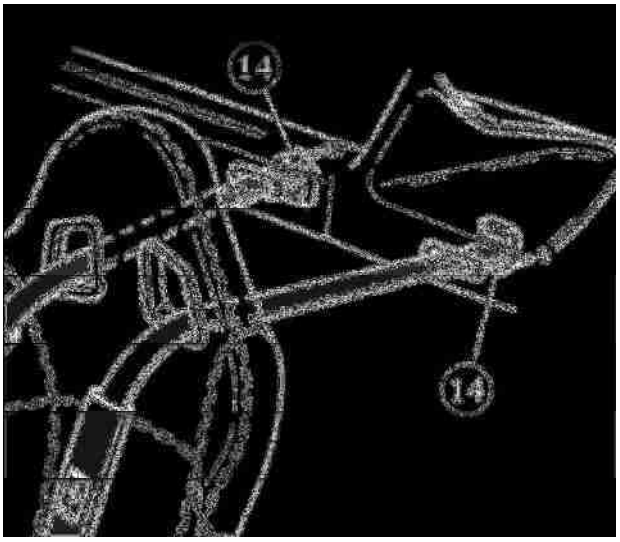
Replacement

- On the external side, unscrew the screw **(12)** which fastens the end of the belt to the seat.

- On the inner side, **u**nscrew the screw **(13)** which fastens the seat-belt's hooking part to the seat and remove it.

- Remove the rear cross member positioned under the rear window and the side coverings (M 3.04).

- Detach the belt-feeder plastic plates from the coverings.
- Unscrew the screws **(14)** fastening the seat-belt to the passenger/engine compartment partition panel and detach the end support from the coverings.



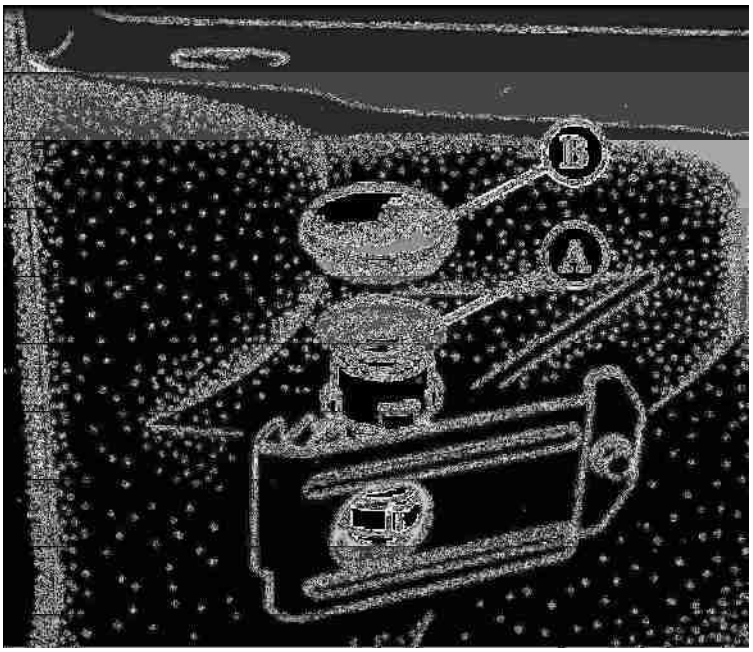
- When re-assembling, lock the fastening screws to the prescribed tightening torque.

H3.04 INERTIA SWITCH

The inertia switch is located on the left-hand side of the passenger compartment, in the lower part of the front door panel frame, and it is protected by a metal bracket.

Operation

In the event of a violent collision, the inertia switch cuts off the power supply to the fuel pump. This prevents more fuel escaping from the tanks.
Inside the switch, there is a steel sphere which can move into a conical seating and which is kept in position by the attraction force generated by a permanent magnet.
In the event of a violent collision, the inertia of the sphere is stronger than the magnet's attraction force and so this pushes it upwards, out of the conical seating, to hit a rapid triggering mechanism that forms a circuit which is normally closed.
When the mechanism is hit by the sphere, it changes position, opening the circuit and stopping the power supply to the pumps.
Once the mechanism has been triggered, the switch can be reset by pushing the upper button **(A)**, after removing the protective cap **(B)**.



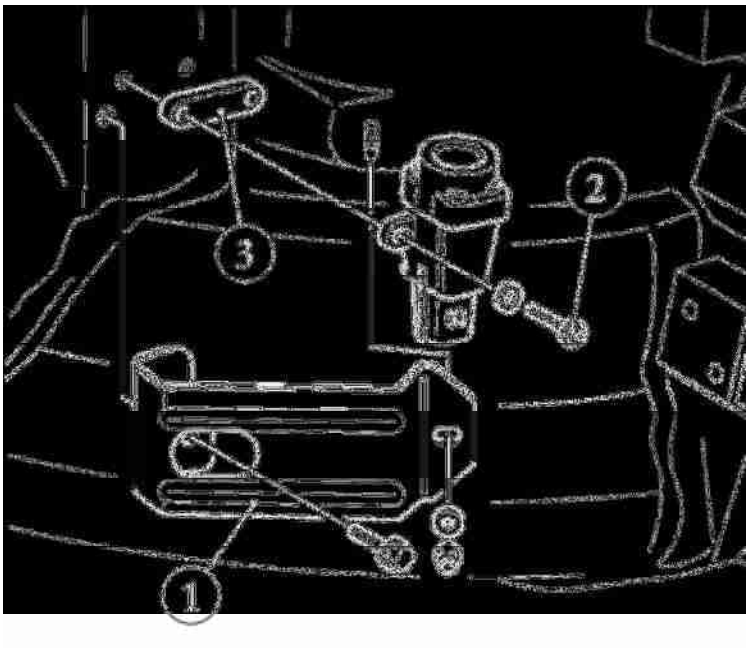
CAUTION
If, in the event of a slight collision, you notice petrol fumes or leakages from the fuel supply system, avoid resetting the switch as this may result in a fire, and look for the problem cause.

Replacing the inertia switch

- Turn the battery master switch to the OFF position (L 2.02).
- To gain access to the switch, first move the left-hand shaped foot mat away from the door panel frame.
- Remove the shield **(1)** and disconnect the dashboard cable from the switch.

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

- Remove the fastening screws **(2)** and then the switch, making sure you keep the spacer plate **(3)**.



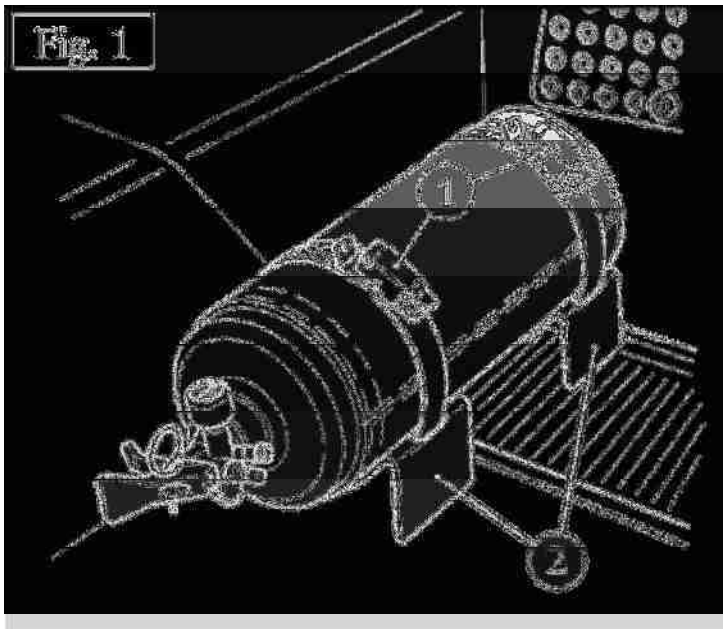
- After remounting the new switch, reactivate the battery connection and wait for at least one minute before starting up the engine again.

H3.05 EXTINGUISHER (Optional)

Upon request it is possible to install an extinguisher, including the fastening brackets, on the passenger side of the car's floor.

Notes
To use the extinguisher, follow the specific instructions illustrated on it.

When the car is running, the extinguisher must always be fastened to the support bracket with the specific retaining clamps **(1,** Fig. **1)**..



Fitting uisher

- Position the brackets **(2)** on the car floor and align them with the raised part of the passenger foot rest **(A)** (see figure).
- Make four through-holes in correspondence with those on the bracket.

- Using 4 rivets, fasten the bracket to the car floor **(3)** and fit the clamps **(1)**.
- Install the extinguisher **(4)**, with its casing **(5)**, on the brackets and turn the charge indicator **(A)** so that it faces upwards.
- Lock the retaining hooks onto the clamps **(1)**.

H4.01 BREAKING-IN

The most modern manufacturing methods permit top precision in the production and assembly of components. However, in spite of this, the moving parts undergo a settling process, basically during the first hundreds of kilometres of travel.

During this stage, follow carefully the instructions below.

- Do not exceed **5000 rpm** during the first **1000 Km** of travel.
- After starting up, do not exceed **4000 rpm** until the engine is sufficiently warm (water temperature **65÷70 ° C**).
- Avoid continuous, high running speed of the engine for prolonged periods of time.
- Before using the vehicle for a long trip, check the level of fluids and lubricants (A1.02) and the tyre pressure (F 1.01).

H4.02 ENGINE IGNITION AND GEAR SHIFTING (mechanical gearbox)

Starting the engine

Before starting up the engine, ensure that the alarm system and that all electrical devices with high electrical energy input are deactivated.

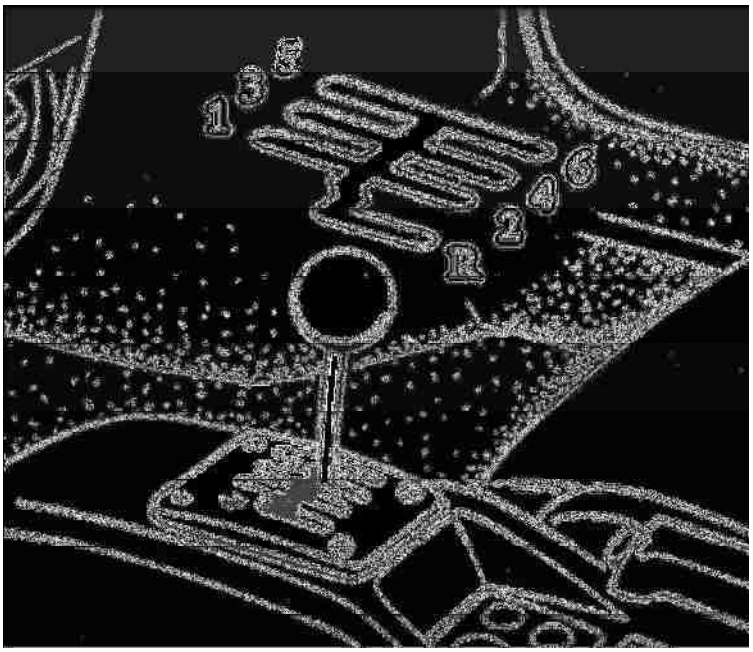
- Ensure that the parking brake is engaged.
- Put the gearshift lever in neutral.
- Press the clutch pedal all the way down without pressing on the accelerator.
- Turn the ignition key to the running position and wait for the **"check OK"** ideogram to appear on the multifunction display.
- Turn the ignition key to the starting up position and release it as soon as the engine starts up.

IMPORTANT
Do not keep the key turned to the starting up position once the engine has been started up.
In case the engine fails to start, turn the key back to the stop position before repeating the procedure.

Warming up the engine after ignition

Do not run the engine at high engine speeds until the coolant has reached an approximate temperature of at least **65÷70 °C**.

Departure



With engine started:

- Press the clutch all the way down and put the gearshift in **"1st"** gear.

NOTES
Use the 1st speed for parking and for departures on uphill stretches.

- Release the hand brake completely.
- Slowly release the clutch pedal while gradually accelerating.
- Then proceed by engaging the other gears, pressing the clutch all the way and shifting the gearshift to the next position. When shifting to a lower gear, be careful about not exceeding peak engine speed (red zone) allowed for the engine.
- Engage the reverse gear only when the car is stopped. Press the gearshift downward and then shift it to the left and rear.

While driving

Never drive (not even downhill) with the revolution counter pointer near the peak engine speed.
When the revolution pointer approaches peak speed (red zone), the driver must be very careful not to exceed that limit.
Under normal conditions, all of the red lights on the instrument panel multi-function display should be off. When these lights turn on, they are signalling a malfunctioning of the respective system.
Ensure that all parts are functioning properly, by checking the respective control instruments.

IMPORTANT
Continuing to drive with a red warning light that is lit, can cause serious damage to car parts and affect their operation and performance.

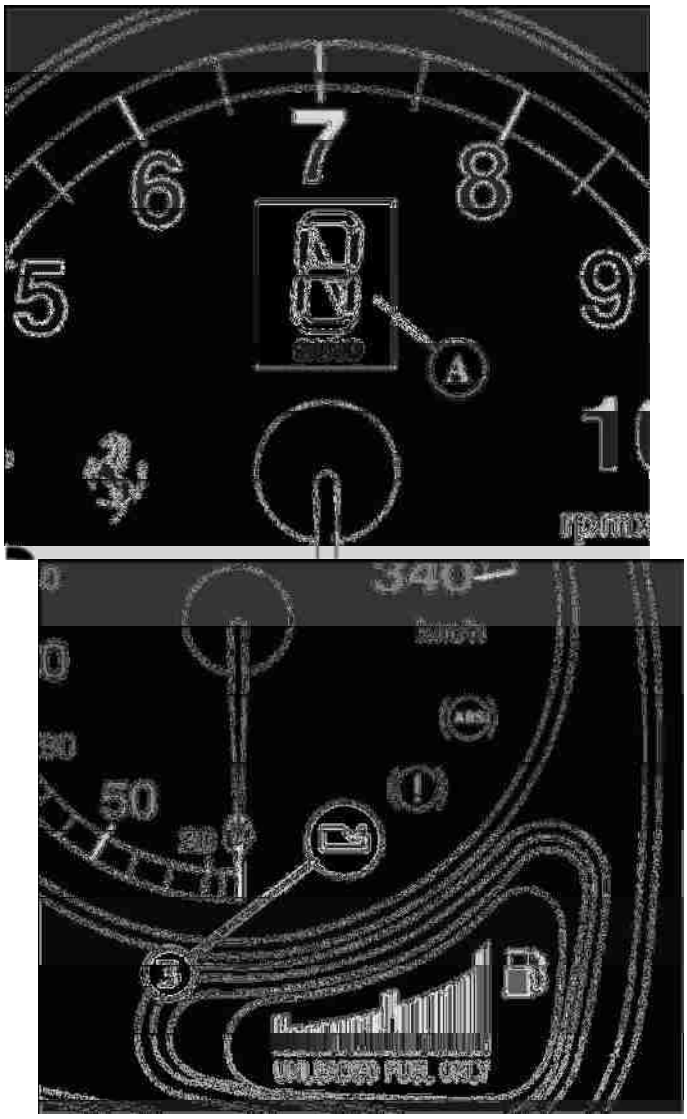
After heavy-duty use, let the engine idle for several minutes before stopping it.

CAUTION
Never turn off the engine when driving downhill, as the servo brake looses its braking action due to the vacuum decrease and therefore, after a few braking attempts, the system becomes almost totally inefficient.

H4.03 ENGINE IGNITION AND GEAR SHIFTING (electrically-controlled gearbox)

System start-up

When the ignition key is turned to position **"II"**, all of the gearbox display segments **(A)** and the respective failure warning light **(B)** will light up. The latter will switch off within a few seconds if no defects are detected.



The display will highlight the gear engaged.

The following may also occur:

- when the door on the driver's side is opened, the pump starts up for several seconds. This function makes it possible to have the system ready when the ignition key is inserted.
- the failure warning light **(B)** flashes for a brief amount of time **(10 sec)** and then switches off: the system is completing the **"start-up"** phase and will then start up correctly.

NOTES

Do not use system controls during this phase.

If the warning light **(B)** continues to flash without switching off, repeat the starting up procedure after switching off the engine. If the problem persists, carry out the necessary checks to eliminate the cause of the malfunction.

If warning light **(B)** remains lit, it means there is a breakdown in the system. This condition will also have been signalled by an acoustic alarm when the ignition key was turned to position **"II"**. Carry out all necessary checks to eliminate the cause of the malfunction.

Operation with the engine off

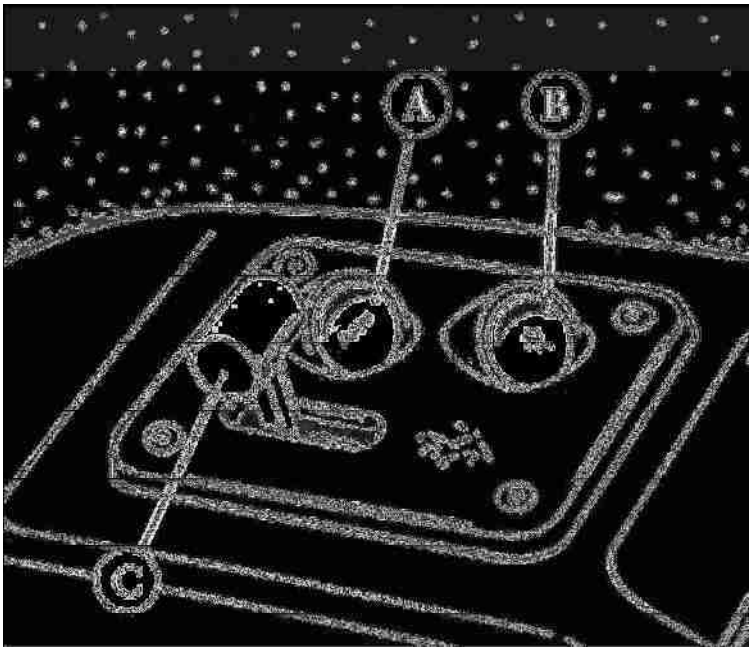
Once the "System Start-up" phase is over, the display will show the gear engaged:
- **"N"** (Neutral)
- **"R"** (Reverse gear)
- **"1"** (1st gear)
- **"2"** (2nd gear), etc.

If the indication on the display is flashing (which can also happen with **"N"**), it means that the gear has not been engaged or disengaged correctly: request **"N"** again and then the desired gear.

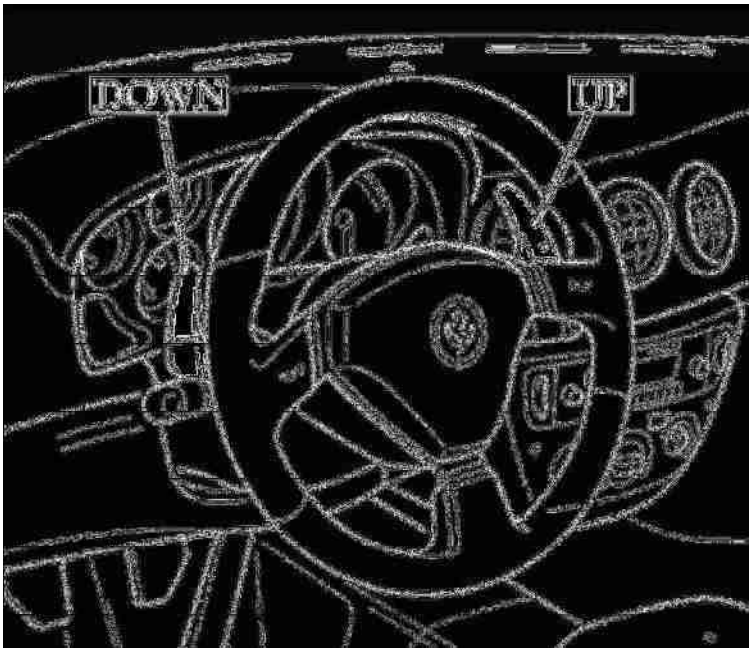
NOTES

If a horizontal dash appears on the display, there is a breakdown of the system.

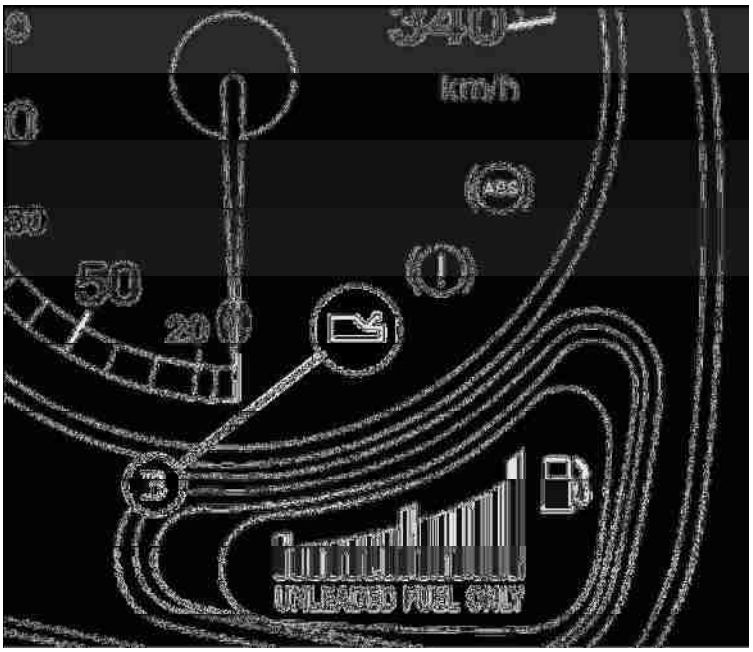
With the engine turned off, it is possible to engage all gears and to request **"N"**. To do this, proceed as follows while keeping the brake pedal pressed down during the request:
- **"N":** pull both levers found under the steering wheel.
- **"R":** lift and pull lever **(C)** in the direction of the rear of the car.



- **Up-shifting gears:** pull the lever **"UP** towards the steering wheel.
- **Downshifting gears:** pull the lever **"DOWN"** towards the steering wheel.



Keep pulling the lever **(C)**, towards the rear part, until symbol **"R"** appears on the display.
Immediately release the **"UP"**, **"DOWN"** and **"R"** levers after the gearshift change request. A long manoeuvre would activate the failure warning light **(B)** and the acoustic alarm.



To prevent the battery from running flat, do not operate the system with the engine off.
To prevent the pump from overheating, avoid useless sequences of gear-shifting with the engine off.

Starting up the engine

- Make sure the parking brake is engaged and that the doors are closed.
- During engine starting up, keep the brake pedal pressed down.
- Do not press the accelerator pedal.
- Shift the gearshift to neutral, pulling both **"UP"** and **"DOWN"** levers towards the steering wheel. Check to ensure that the engaged gear display indicates **"N"** and that the latter is not flashing.
- Turn the ignition key to position **"II"**. Wait for the multi-function display to show the **check ok** ideogram.
- Turn the ignition key to position **"III"** and release it as soon as the engine starts up.

Do not keep the key turned to position **"III"** for a long period of time.
If the engine fails to start, turn the key back to position **"0"** and wait for the gear display to turn off before repeating the procedure.

IMPORTANT
When starting up of engine, keep the brake pedal pressed down

The engine can be started up also with a gear engaged. To do this, turn the ignition key to position **"III"** keeping the brake pedal pressed. The system allows the clutch to open so that the gearshift can engage the neutral. The starter motor will then receive clearance to start up the engine. This procedure usually requires a time lapse of one second. In case of extremely low temperatures however, this procedure can take slightly longer.
If, instead, the gear is engaged in position **"N"**, the engine starts up immediately.
Once the engine is running, release the key, which will automatically return to position **"II"**.
If the engine fails to start up, after having turned the key back to position **"0"**, wait for the gearshift display to switch off and repeat the entire procedure.

Warming up the engine after ignition

Do not run the engine at high engine speeds until the oil temperature has reached at least **65÷70 °C**, approximately.

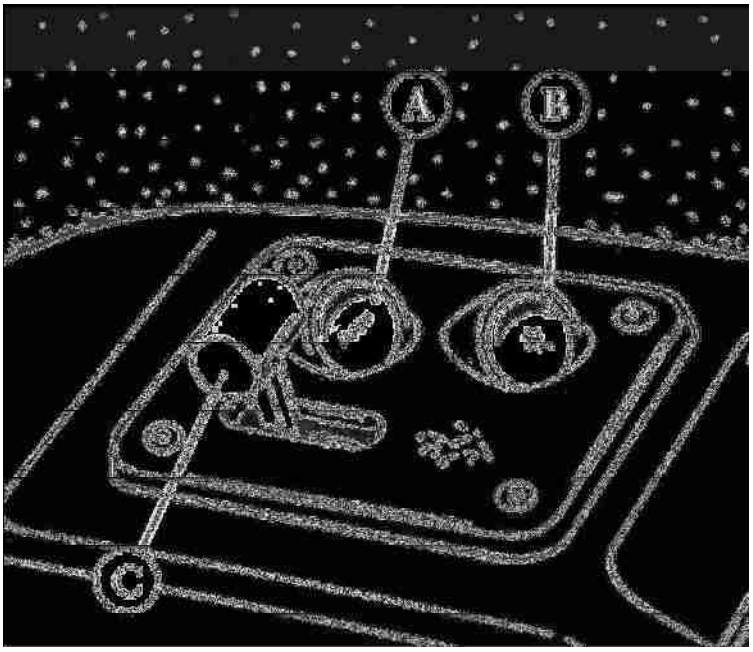
Departure

With the engine running, the car at a full stop and the brake pedal pressed down, pull the right-hand **"UP"** lever towards the steering wheel, in order to engage the **"1st"** gear.

NOTES
Use the 1st speed for parking and for departures on uphill stretches.

Release the brake pedal and press the accelerator to depart.
If you opt for a more **"modulated"** depart, keep the brake pedal pressed down, from **"N"** pull the **"UP"** lever twice in order to allow the car to depart in **"2nd"** gear.
For a more rapid departure (only possible in **"1st"** gear), simply press the accelerator pedal more rapidly.

With the engine started and the car stopped, it is possible to shift directly from **"1st"** to **"2nd"** gear to **"R"** (reverse gear), by using the lever **(C)**. It is also possible to shift from reverse gear to **"1st"** gear by pulling the **"UP"** lever towards the steering wheel.



When the reverse gear is engaged, a safety acoustic signal beeps intermittently as long as the **"R"** gear remains engaged.

If the system automatically engages the **"2nd"** gear while shifting from **"R"** to the **"1st"** gear, this indicates that an interference has occurred in the **"1st"** gear. Therefore, this is not a malfunction as it falls within the system operation. For the same reason, in shifting from **"1st"** gear to **"R"**, the system automatically engages **"N"** in the event of an interference.

During prolonged stops with the engine running, it is advisable to keep the gearshift in **"N"**.

As may happen on downhill stretches, if the vehicle is allowed to progress in **"N"**, when **"UP"** is requested, the system will engage a gear on the basis of the speed of the vehicle.

For safety reasons, when the vehicle is stationary, the engine running and a gear engaged, the system activates an acoustic alarm and automatically shifts to **"N"** when:

- the brake or accelerator pedal is not pressed within a time period exceeding **4 seconds**;
- the brake pedal is kept pressed for a time period exceeding **10 minutes**;
- the car door is opened without using the brake or accelerator pedal;
- the engine compartment lid is opened.

The acoustic signal will be activated even if overheating of the clutch occurs during the **"pickup"** manoeuvre.

In this case, the departure manoeuvre must be **"forcedly"** concluded avoiding hesitation or remaining still by using the brake pedal after having released the accelerator pedal.

IMPORTANT

- *If the car is stopped with a gear engaged, always keep the brake pedal pressed until ready to depart.*
- *Do not **"modulate"** the accelerator pedal during departure.*
- *Use the second gear when greater control is needed during manoeuvres at very slow speed.*
- *Request reverse gear only when the car is at a complete stop and with the brake pedal pressed.*
- *In the event that the car is stopped on uphill stretches, do not use the **"departure manoeuvre"** to keep the car from moving. Use the brake and then the accelerator pedal only when ready to re-depart.*
- *If the accelerator pedal is pressed very rapidly and all the way down, with **ASR** deactivated or with **"SPORT"** mode active, you will obtain a **"performance"** departure, which will involve marked skidding of the driving wheels even under good grip conditions.*

"UP", up-shifting of gears

Use the right-hand **"UP"** lever even without releasing the accelerator pedal.

The **"UP"** shift request is not accepted if engaging of the desired gear forces the engine to a too low speed rate. It will not be accepted also in case an **"UP"** shift request is already in progress for runaway speed rates.

Gear-shifting will be faster if requested with the accelerator pedal pressed all the way down and if the engine is running at over **5.500 rpm.**

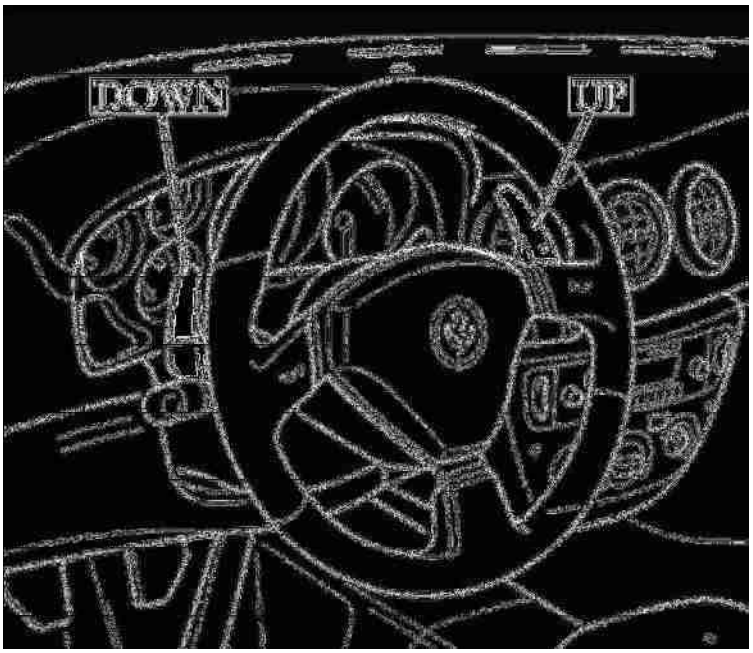
In any case, a good rule is:
- To shift gears without releasing the accelerator pedal if it is already pressed.
- To wait for the gear shifting to finish before requesting the next gear, thereby avoiding multiple requests in rapid sequence.

"UP" for runaway speed rates

The system engages a higher gear **"automatically"** if, with the accelerator pedal pressed down, the engine approaches the **"runaway speed rate"**. This does not occur with the car set to **"SPORT"** mode.

"DOWN", downshifting of gears

Use the left-hand **"DOWN"** lever even without releasing the accelerator pedal.
The **"DOWN"** shift request is not accepted if the engagement of the desired gear forces the engine beyond a certain engine speed in relation to the gear requested. It is not accepted also if a **"DOWN"** shift is already in progress due to low speed rates.



In any case, a good rule is:
- To shift gears without releasing the accelerator pedal if it is already pressed.
- In the event of a **"DOWN"** shift request in order to start passing a vehicle when rapid acceleration is desired, press the accelerator pedal just before using the lever.
- To wait for the gear shifting to finish before requesting the next gear, thereby avoiding multiple requests in rapid sequence.

"DOWN" for low engine speed rates

- The system **"automatically"** downshifts gears if the engine speed drops below the **1.300** minimum **rpm** speed rate.
- The **"DOWN"** command from the lever is ignored if a gear shifting is already in progress due to low engine speed rates.

Double clutching in Sport mode

The downshifting double clutching is performed automatically only with the **"SPORT"** mode active**,** under conditions of sports driving (engine over **5,000 rpm**), and also more markedly upon the increase in the engine speed.

Request for "N" (Neutral)

If necessary, it is possible to request **"N"** at any speed.
If **"UP"** is requested subsequently, the system will engage the gear most suited to the speed of the car.

Stopping the car

When the car is at a full stop, the system automatically engages the **"1st"** gear (unless previously requested **"N"**).
With the car stopped and the engine running, always keep the brake pedal pressed until ready to re-depart.

Turning off the engine and the system

The engine can be switched off by turning the key to the **"0"** position, both with the gearshift in **"N"** or with a gear engaged (the gear can only be the **"1st"**, **"2nd"** or **"R"**).
After turning the key, the engine switches off and the display will remain lit for a few seconds. If the gearshift is in **"N"**, the acoustic alarm will be heard.

CAUTION

- *Never leave the car unattended with the gearshift in "N". Engage the gear (1st or "R"), ensure that the display is not flashing and always engage the parking brake.*
- *Never leave the car unattended with the engine running.*
- *Do not remove the ignition key while the car is moving! The system (and thus the display) will remain active but it will operate irregularly until the car is stopped. Moreover, the steering wheel will lock automatically with the first steering manoeuvre.*

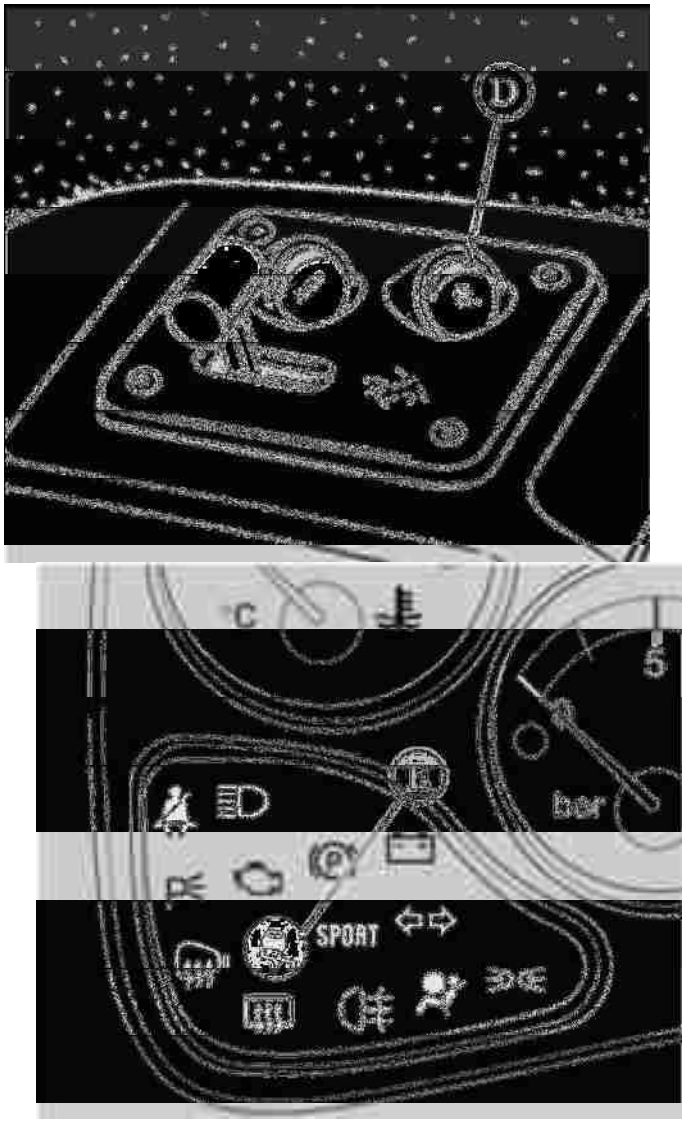
In this case, the failure warning light **(B)** will light up and before re-departure, the system (and therefore the display) will have to be switched off and the **"System Start-up"** procedure repeated.
In any case, it is good practice to:

- Turn off the engine and the system while keeping the brake pedal pressed.
- Do not request a gear engagement while the system is switching off.

Other system functions

"Low Grip" mode

This function can be used when the road surface is particularly slippery (due to snow, ice…). To activate/deactivate it, use the switch **(D)**. This will switch on the corresponding warning light **(E)** on the instrument panel.With the car in the **"LOW GRIP"** mode, the system will use the **"2nd"** gear instead of the **"1st"**.

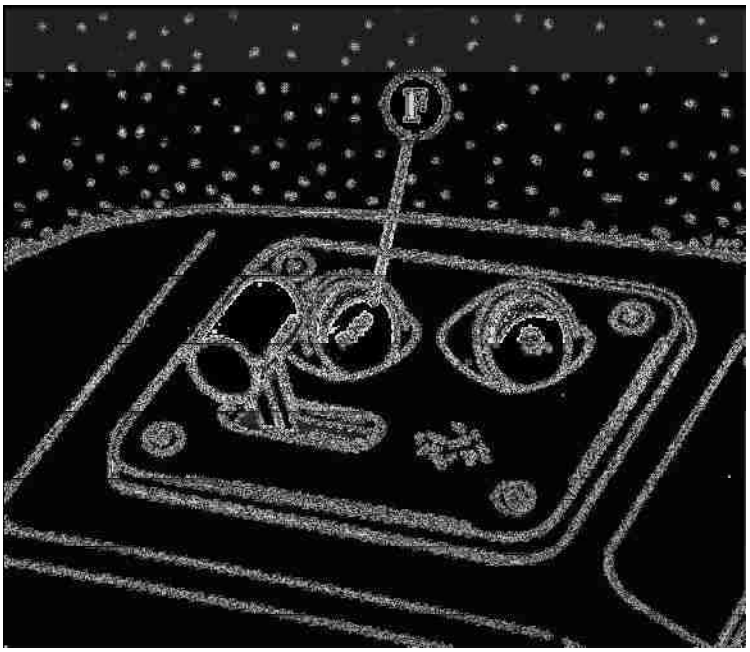


Therefore, when the car is stopped and the engine running, whether from neutral or reverse gear, the **"2nd"** speed will be automatically set when you request an **"UP"** shift or when the vehicle stops.
With the second gear engaged, the **"DOWN"** shift request from the lever will be ignored.
While driving, the system automatically engages the next gear up as soon as the engine speed approaches the pre-established speed of **3.200 rpm.**
The **"LOW GRIP"** mode has priority over the other functions (**"Automatic"** and **"SPORT"**) and it assists the ASR system.
The **"DOWN"** shift request from the **"6th"** to the **"5th"** gear will only be accepted if the **"5th"** gear engine's rpm is lower than **3.200 rpm.** Since it is possible to activate **"LOW GRIP"** function at any time and since the system limits engine speed to **3.200 rpm** for all gears except the **"6th"**, **"UP"** gear shifts might occur even when not requested.
In any case, it is good practice to deactivate other operating modes (**"AUTOMATIC"** and **"SPORT"**) before setting the car to the **"LOW GRIP"** mode.

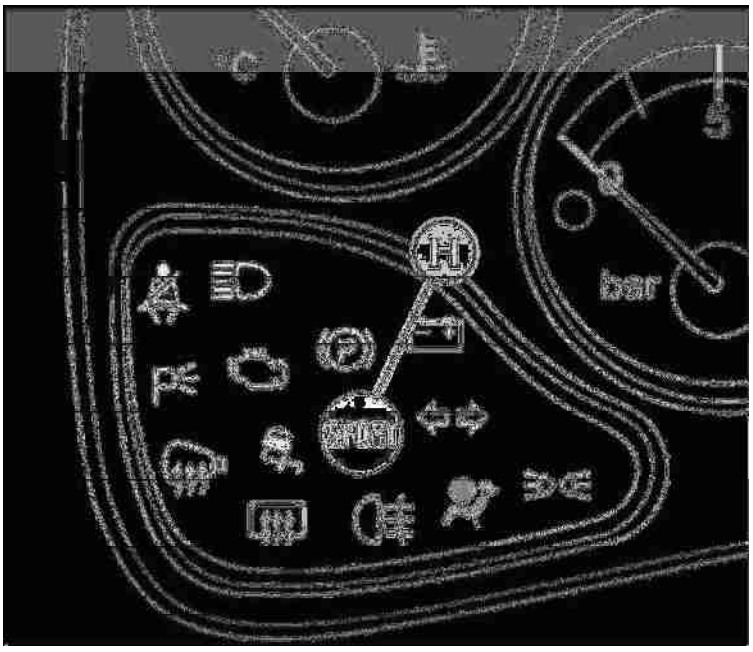
"Automatic transmission" mode

This mode is activated (or deactivated) by using the **(F)** switch. The message **"AUTO"** will light up on the dashboard inside the engaged gear display. The system will automatically shift gears **"UP"** and **"DOWN"** in accordance with the car speed, the engine's speed and the driver's torque/power request.

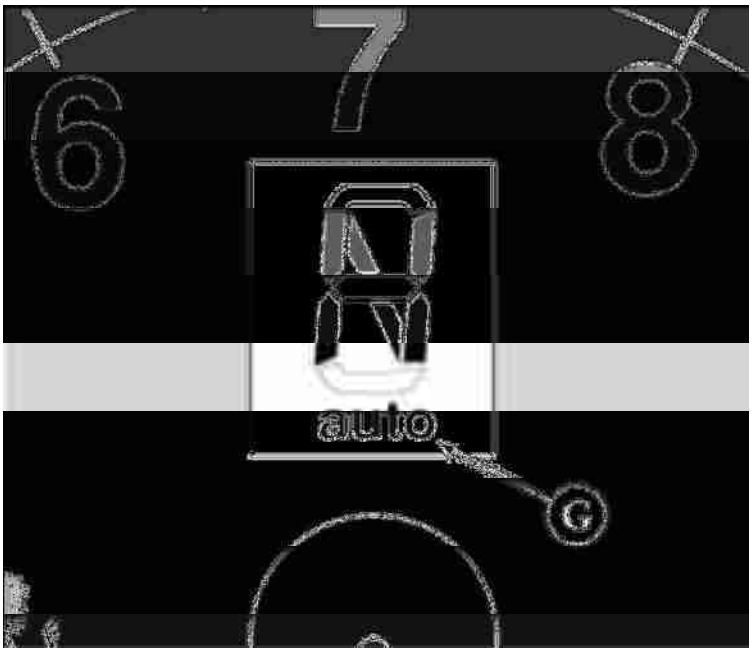
The **"Automatic transmission"** mode has priority over the **"SPORT"** mode. Therefore, if the **"AUTOMATIC" (F)**



switch is activated when you in the **"SPORT"** mode, even if the **"SPORT" (H)** warning light remains lit,

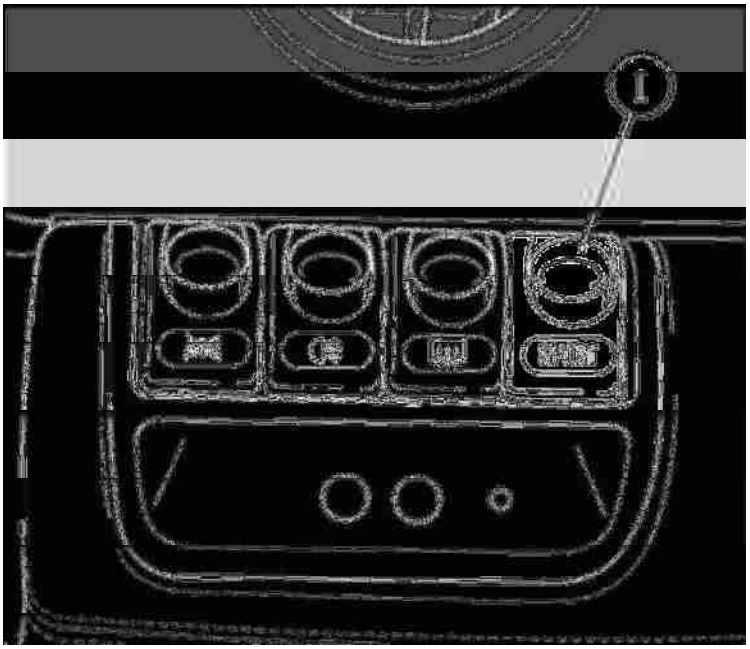


the message **"AUTO" (G)** will light up



and the Selespeed system will function in the **"Automatic transmission"** mode. The suspensions position, however, will remain set to **"SPORT"**.

You can reset the car to **"NORMAL"** mode (or to **"SPORT"** mode, if that was the active function) either requesting a gearshift, or keeping the switch **(I)** pressed until the warning light **"AUTOMATIC"** switches off.

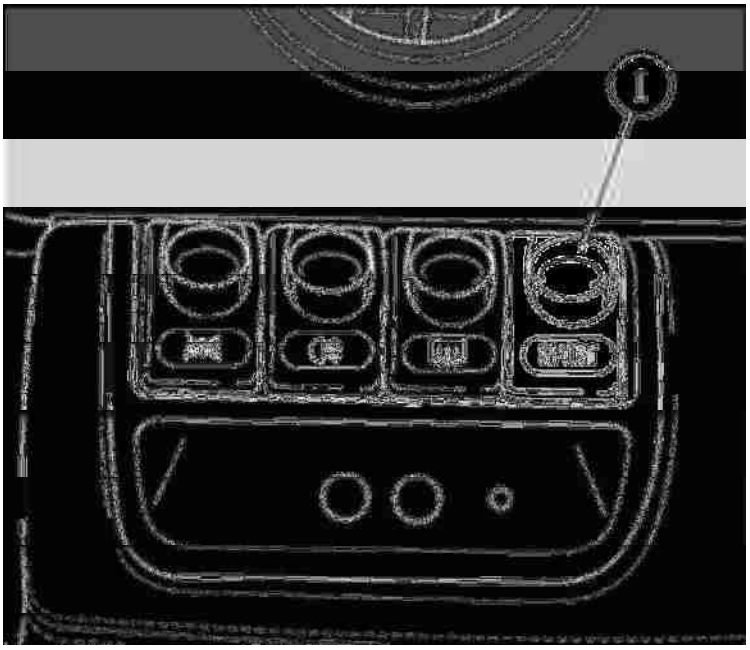


Requesting **"N"**, **"1st"** or **"R"** gearshift position when stopping the car, does not involve a change of mode from **"AUTOMATIC"** to **"NORMAL"**.

It is good practice to deactivate other operating modes before selecting the **"AUTOMATIC"** mode.

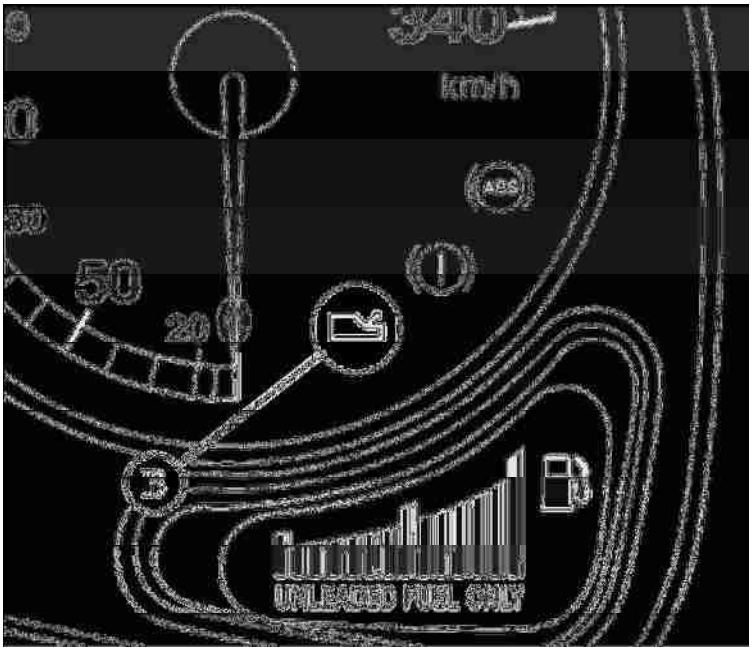
"SPORT" mode

This mode is activated by using the **(I)** switch on the dashboard.



The corresponding warning light **"SPORT" (H)** on the dashboard will light up.
To switch from **"SPORT"** mode back to **"NORMAL"** mode, press the same switch again.
Since the **" SPORT"** mode has a lower priority with respect to the **"LOW GRIP"** and the **"AUTOMATIC"** modes, in case these modes are already set before you activate the **"SPORT"** mode, the system will ignore the command even if the corresponding warning light switches on.
The **"SPORT"**mode is characterised by a stiffening of the suspensions and faster gear-shifting compared to the gear-shifting in the **"NORMAL"** mode
Gear shifting will be **"faster"** if requested while pressing the accelerator pedal all the way down and over ca. **7.000 rpm.** Under these conditions, the driving wheels may start skidding even on dry road surfaces (particularly in the lower gears).
"DOWN" gearshifting with accelerator pedal released will have a braking effect bordering on skidding of the driving wheels on a dry asphalt.
During sports driving, with gear-shifting at very high rpm, double clutching will take place automatically when downshifting gears.
We advise you not to use the **"SPORT"** mode on roads with low to medium grip conditions (e.g. presence ice, snow, or with wet asphalt), as such conditions can cause skidding of the driving wheels during gear-shifting. As a consequence, we suggest a heavy-duty use of **"SPORT"** mode only on tracks.
It is a good rule to deactivate the other specific modes (**"LOW GRIP"**, **"AUTOMATIC"** modes) before selecting the **"SPORT"** mode.

In case of malfunctioning of the system control levers, the system will activate the acoustic alarm and the failure warning light **(B)**, it will reselect the **"AUTOMATIC"** mode and ignore any gear shifting command, including requests for **"N"** and **"R"**.



If the problem persists, carry out all necessary checks to have the cause of the malfunction eliminated

Push departure

In the event of malfunctioning of the starting system, a **"push departure"** is possible, proceeding as follows:

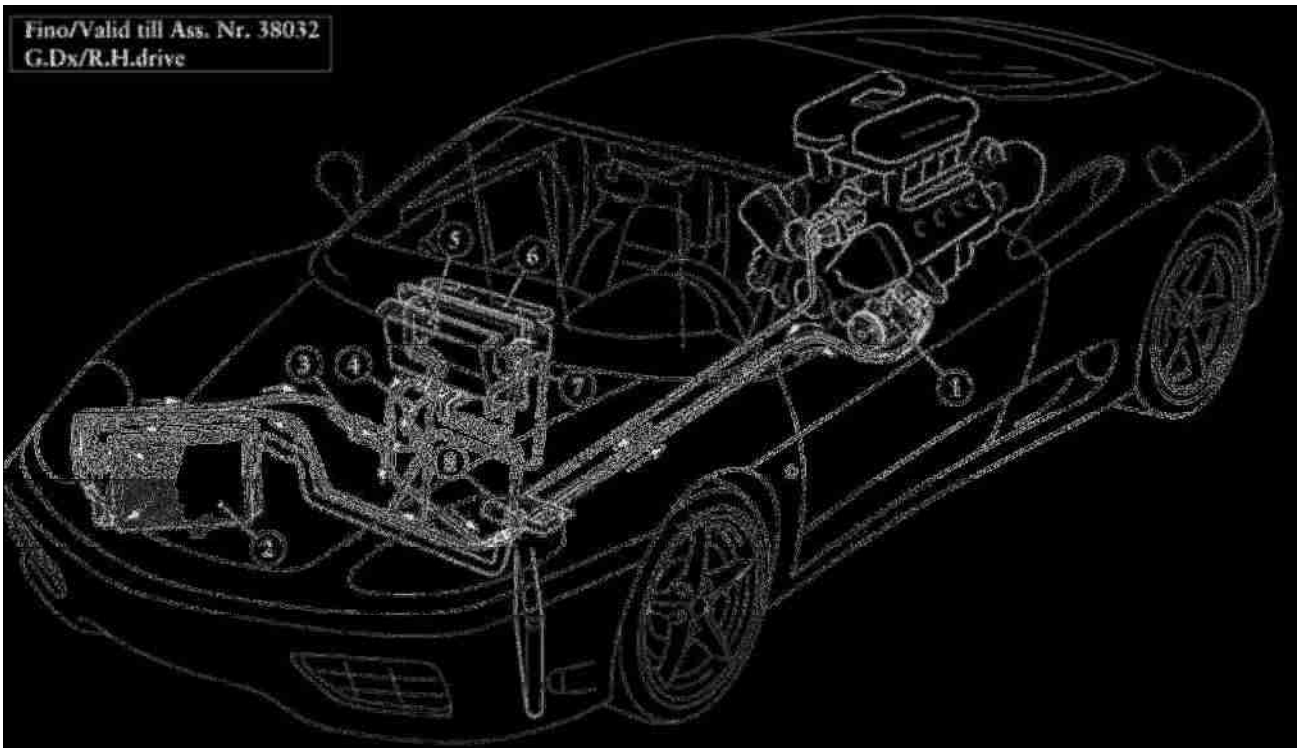
- perform the **"System Start-Up"** phase;
- request **"UP"** while the vehicle is gaining speed with the gearshift in **"N**;

In any case, avoid this procedure except in the event of an emergency!

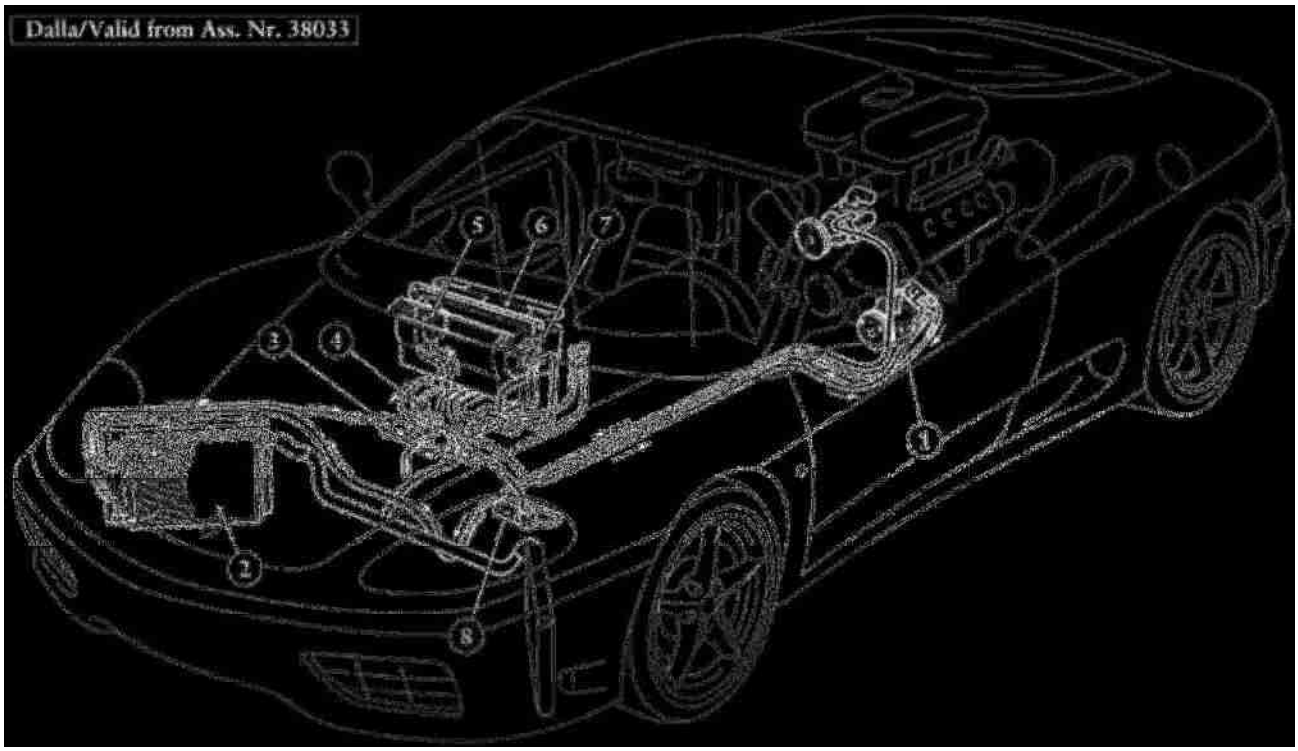
I1.01 SYSTEM OUTLINE

The air temperature control system consists of a heater/evaporator unit controlled by a microprocessor ECU which, during both automatic and manual operation, keeps the temperature within the passenger compartment steady, regardless of the climatic conditions, by controlling the air temperature, distribution and flow. The system also automatically draws air from outside or recycles air inside the car, independently of the outside climate conditions.

The hydraulic system is made up of the following parts:



1 - Compressor
2 - Condenser
3 - Dehydrator filter
4 - Pressure switch
5 - Expansion valve
6 - Heater/evaporator
7 - Proportional valve
8 - Water recirculation pump



1 - Compressor
2 - Condenser
3 - Dehydrator filter
4 - Pressure switch
5 - Expansion valve
6 - Heater/evaporator
7 - Proportional valve
8 - Water recirculation pump

The gaseous coolant (**R134 A**) is drawn in by the compressor **(1)** which sends it to the condenser **(2)** at a pressure which varies according to the outside temperature.

Once in the condenser, the coolant condenses and turns fluid.

The dehydrator filter **(3)** removes anyl traces of humidity due to the presence of vapor in the system and also serves as a tank for the coolant.

In this area of the system, a pressure switch **(4)** detects the pressure and disconnects the electromagnetic clutch when this reaches the peak values.

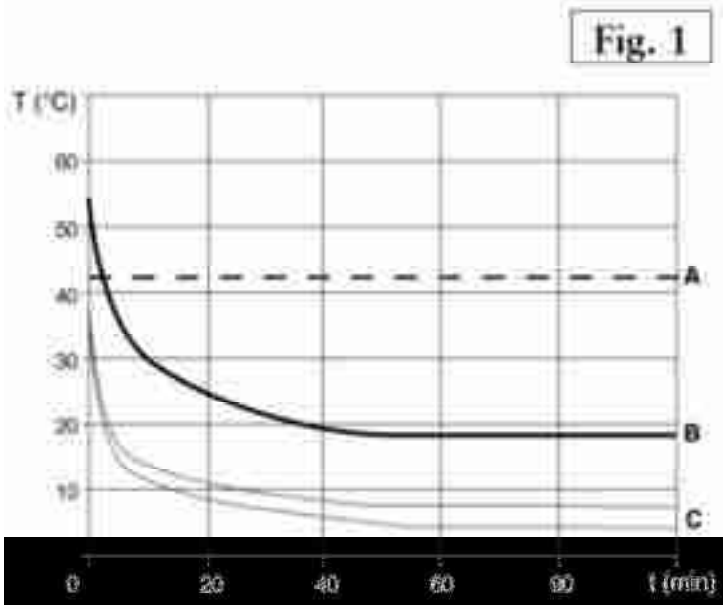
From the dehydrator filter, the coolant flows through the expansion valve **(5)**, which controls the flow to the evaporator **(6)** and causes a pressure falling.

Within the evaporator, the coolant changes from the liquid to the gaseous state at low pressure **1,5÷2 bar**) and low temperature **(–5 ÷ +5 °C)** by absorbing the heat from the air which passes through the air conditioning unit.

When exiting the evaporator, the coolant is once again drawn in by the compressor and put into the cycle.

The graphic representations refer to the following conditions:

Cooling system graph (**Fig. 1**)
- Maximum ventilation
- Maximum cold required
- Ventilation distribution
- Recirculation.



Plates key (**Fig. 1**)
T - Temperature
t - time
A - Room temperature = 43 °C - Sun radiation
B - Average temperature at head level
C - Average outlet temperature

Heating **stem graph** (**Fig**

I1.02 OPERATION

Control Logic

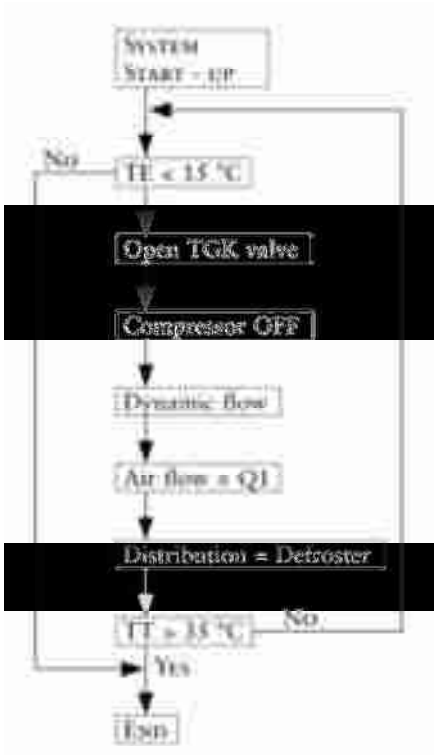
The E.C.C. (**E**lectronic **C**limate **C**ontrol) system controls the temperature inside the car, regulating the following functions:

- proportional water valve which regulates the flow of hot water in the heat exchanger;
- the fan speed, by means of an electronic control device (PWR);
- the insertion of the electromagnetic joint of the compressor;
- the air distribution system;
- the air recirculation flap.

Obviously, the selections made directly by the user shall prevail on the optimum conditions selected by the system.

Temporary Start-up

To improve the car comfort and to prevent the user from being hit by cool air in winter, a start-up procedure has been implemented.
This procedure is illustrated in the flow chart; in particular, the temporary start-up is not carried out, only if **TE > 15 °C**.



Plates key

TE - **O**utside **T**emperature
TT - **T**reated **T**emperature
TA - **C**ompartment **T**emperature
TR - **R**equested temperature
TO - **R**eference temperature

The system is kept at the maximum heat level until the treated air temperature reaches at least **35 °C**, after which the system starts its control phase.

Mathematical Model

The abbreviation **TTV** (**D**esired **T**reated **T**emperature) indicates the temperature of the air from the ventilation outlets needed to maintain the desired temperature in the car.
This value is calculated according to the following energy balance equation:

$$TTV=TA + K1\ (8/Q)\ (TR-TE-6) + K2\ (8/Q)\ (TR-TA) + K3\ (8/Q)\ (TO-TA)$$

- where **K1 (8/Q) (TR - TE - 6)** represents the car's heat loss;
- **K2 (8/Q) (TR - TA)** is an increase factor which is annulled when the temporary procedure stops;
- **K3** is a function of **(TO - TA)**, where the theoretic increase of the room temperature is taken into account.

Check of the Heater Evaporator Sub-System

The **TTV** value calculated using the thermodynamical model is reached by checking a proportional water valve in a closed-circuit.
A suitable algorithm calculates the value to be applied for the valve so that the procedure is carried out precisely as provided by the the mathematical model.

Fan Check

The fan rotation speed is calculated differently, depending on whether the heating **(TE < TR)** or cooling **(TE >TR)** phase is in progress.
When the user decides to change the fan speed manually, the **TTV** calculation is updated.
If the user decides to turn the fan off, the compressor is forcedly turned off, in order to avoid freezing of the evaporator.

Compressor Check

The activation of the compressor electromagnetic joint is carried out by the microcomputer through a hysteresis, when the outside temperature is over **4 °C** setting an amperage increase, and setting an amperage decrease when it is **2 °C**.
To avoid freezing of the evaporator, the E.C.C. system checks for two conditions: the fan is running and the evaporator temperature is higher than **3 °C,** setting an amperage increase, and setting an amperage decrease if it is **1 °C**.

NOTES
A control procedure ensures the activation of the joint for at least 3 seconds every 30 minutes the engine operates, thereby avoiding compressor lubrication problems in winter.

Distribution

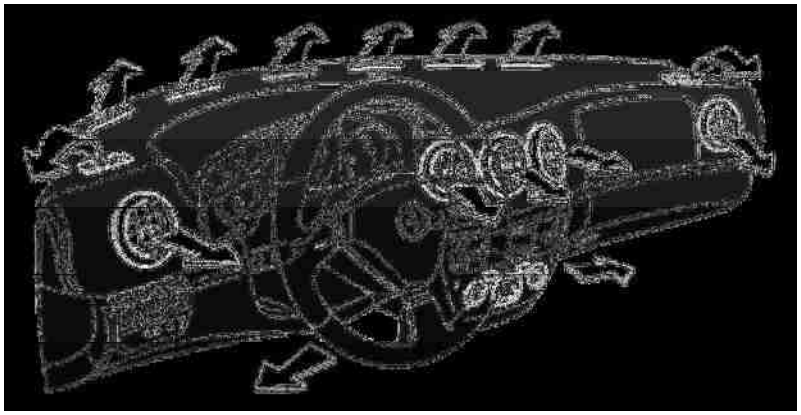
The automatic distribution function is linked to the desired treated temperature **(TTV)**.

Recirculation

The automatic recirculation function depends on the **TE** and **on the desired passenger compartment conditions**. The system recirculates the air solely under these conditions.

I1.03 CONTROLS

The air conditioning system controls the temperature and the humidity within the passenger compartment.



Operation Modes

Automatic: this mode automatically adjusts the humidity and ventilation according to the selected temperature.
Manual: this mode makes it possible to set the controls as desired.

Function and Controls

Ventilation system

1 - Air-flow distribution control
2 - Fan speed control
3 - Air recirculation switch

Heating/cooling system

4 - A/C control switch
5 - Temperature selection control
The dehumidification function is integrated into the air conditioning system and decreases the air humidity present within the passenger compartment.

1 - Air flow control

It carries out the following functions:

Automatic: the air flow is controlled by the electronic system depending on the climate conditions and the selected temperature.
Manual: possibility of directing the air flow to four different areas.
Quick Demisting/Defrosting: activates the demisting and/or defrosting functions of the windscreen and the side windows.

2 - Fan speed control

It carries out two functions:

Automatic: the air flow is controlled by the electronic system according to the selected temperature to be attained.

Manual: the position only draws in the outside air, with the car in motion. The **"I"**, **"II"**, **"III"** and **"IIII"** positions select the air flow rate.

3 - Air recirculation switch

Released: the air flow comes from the outside. With temperatures over **35 °C**, the recirculation function is always operative, with two-minute pauses every twenty minutes in order to change the air.
Pressed (recirculation push button lit): the air flow comes from inside the passenger compartment. The recirculation function speeds up the heating and cooling of the air. *Extensive use is unadvisable*

4 - A/C control switch

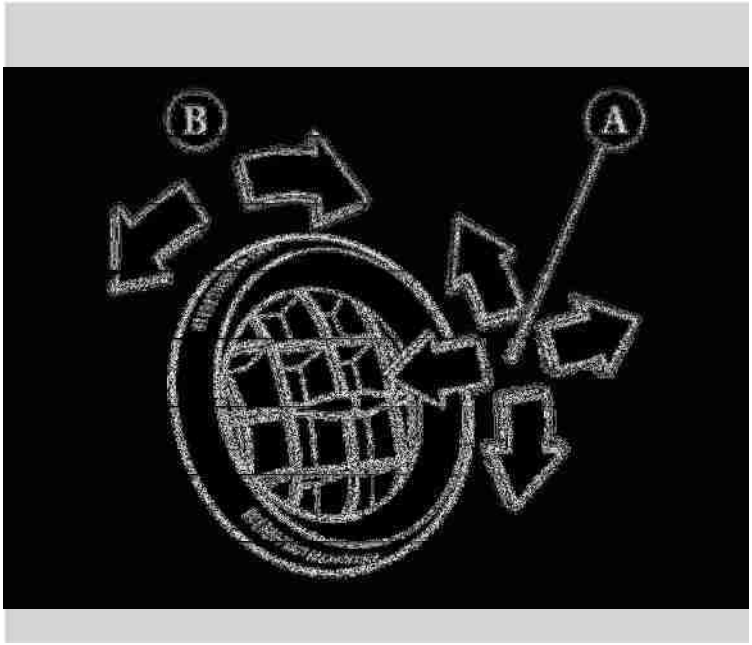
Released: the air conditioner is on. The air is cooled and/or is only dehumidified depending on the selected temperature.
Pressed (recirculation push button lit): the air conditioner is off. The heating is on in any case, according to the selected temperature.

5 - Temperature selection control

Sets the desired temperature within the passenger compartment. The outer positions **LO** and **HI** indicate the minimum and maximum air temperature selections respectively.

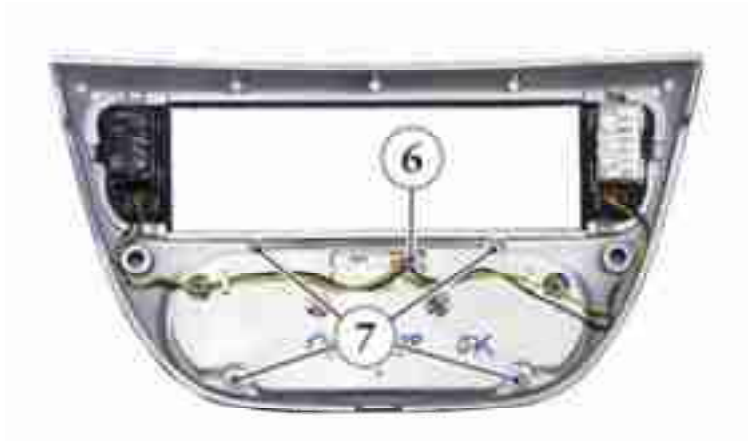
Adjusting the Air Vents

A - Air flow adjustment
B - Air flow rate
Rotation: counter-clockwise = **on**
clockwise = **off**.



Replacing the A/C Control Unit

To replace the A/C control unit it is necessary to remove the support instrument panel (M 3.01).
Detach the connector **(6)** from the control unit.
Unscrew the screws **(7)** and remove the A/C control unit from the left-hand side instrument panel.
For connection to the system (L 4.15).



I1.04 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category
Fastening screws on heater/evaporator	**15**	**B**
Screw fastening compressor to bracket	**25**	**B**
Screw locking expansion valve	**9**	
Screws for compressor fastening	**25**	**B**
Condenser input/output p e unions (	**16,**	
Underfloor rig e unions (	**16,**	
Unions on filter output pipe to heater/evaporator unit and condenser rigid output pipe to filter (5/8”)	**16,2 (output)** **9 (input)**	**A**
Unions on pipe from heater/evaporator unit to compressor return (7/8”)	**25,7 (input)** **9 (output)**	**A**

I2.01 COMPRESSOR

Technical Features		
Brand		**DIAVIA**
T		**V**
No. cylinders		**5**
Min. displacement	cm^3	**9**
Max. displacement	cm^3	**151**
Continuous speed	rp	**0**
Peak Max.	rp	**0**
Pneumatic control valve	p	
Oil quantity	cm^3	**265**
Type of coolant		**R134 A**
Type of oil		**HD ISO 135 RL 150**

Tightening torques	Nm	Category
Screws fastening compressor to crankcase	**25**	**B**
Nut fastening bracket and support	**53**	**A**
Condenser delivery union (3/4”)	**16,2**	**A**
Evaporator backflow union (7/8”)	**25,7**	**A**

The A/C compressor is fastened to a stand, in front of the left support of the engine.
The compressor is the Diavia type, has five cylinders and is driven by a belt controlled by the crankshaft pulley through an electromagnetic clutch.

NOTES
To replace or check the tension of the belt for compressor control, (A 3.04).

When the clutch is engaged, the electromagnet which drives the disk against the pulley is activated. Due to the friction between the two surfaces, the pulley drags the disk, thereby rotating the compressor shaft.

Disassembl

NOTES

The A/C compressor may be replaced even if the engine is installed in the car, by removing the rear part of the underfloor (M 2.12).

- Drain the system (I 3.01).
- Remove the transmission belt (A 3.04).
- Remove the connection **(A)** from the cable connecting the engine auxiliary devices.
- Unscrew the two screws **(1)** fastening the upper support plate.

- Detach the evaporator backflow pipe from the union (**B**, greater diameter) and the condenser delivery pipe to the from the union **(C)**.

- Unscrew the two front fastening screws **(2)** and the rear screw **(3)**.
- Unscrew the nut **(4)** fastening the bracket **(D)** to the stud bolt of the engine support

- Remove the compressor together with the support.

Checks

In case of slipping of the electromagnetic joint pulley, it is necessary to check the supply voltage of the joint winding, by connecting a voltmeter to the terminals of the compressor winding.
If it is below the normal values, check the battery voltage, the integrity of the harness and earth contact.
If it is within the normal values, connect in series an amperometer to the joint winding and check the voltage. In case of out-of-tolerance values, replace the compressor.

Suppl voltage:	**12 V**
Current:	**3,6 A**
Resistance:	**2,8÷3,3 Ω**

In case of oil loss from the pipe unions or from the compressor, it is necessary to check the oil level (I 4.02).

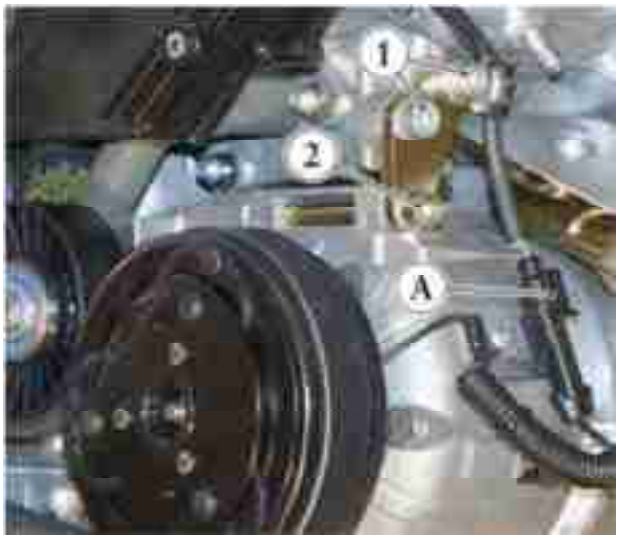
R -assembly

- Install the compressor with bracket onto the crankcase, fastening it with its original screws **(1)**, **(2)** and **(3)**, tightened to the prescribed torque.

- Fasten the rear bracket to the stud bolt of the crankcase, locking the nut **(4)** to the prescribed torque.
- Tighten the delivery and backflow pipes on the unions **(C)** and **(B)** to the prescribed torque.

- Attach the connection **(A)** to the cable connecting the engine devices.

For connection to the system, see Table **T** - ELECTRICAL SYSTEM.



- Fill the system (I 3.02).
- Re-assemble the components removed during the procedure.

I2.02 CONDENSER

The A/C condenser is assembled together with the right radiator of the cooling system.

Periodically check the state of the condenser's radiator core. Clean the fins, removing any leaves, insects or mud that may obstruct the air flow and cause overheating of the liquid.
Fix any deformations carefully, while avoiding possible breakage.
If the radiator core is excessively damaged, replace the radiator.
Periodically check, as per the PROGRAMMED MAINTENANCE PLAN, the condition of the connecting pipes.

NOTES
To replace the condenser, carry out all the disassembly and re-assembly procedures described in (B5.04), for the right-hand radiator.

I2.03 DEHYDRATOR FILTER

Tightening torques		Category
Condenser-filter	**16,2**	**A**
Filter-evaporator p e union	**16,2**	**A**

It is located in the luggage compartment, under the evaporator.
At the intervals prescribed in the PROGRAMMED MAINTENANCE PLAN, it is necessary to replace it.

Disassembl

- Remove the movable shield from the luggage compartment (M 3.06).
- Drain the A/C system (____).
- Undo the screws **(1)** which fasten the pipe unions for the filling/draining system (in the RH Drive version it is sufficient to undo only the filling system union screw).
- Detach the clamp **(2)** and remove the pipe union **(3)** connecting the compressor; keep the Oring (not for RHD).
- Unscrew the screw **(4)** and remove the bracket fastening the filter to the chassis.
- Remove the connection **(A)** from the pressure switch.
- Remove the filter from the pipe **(6)** connecting the condenser.
- Detach the pipe union **(5)** from the evaporator and remove it together with the filter.
- Remove the filter from the pipe **(5)**.

- Plug the pipes in order to prevent foreign bodies from entering into the system.
- Replace the filter.

R -assembly

- Fit the pipe union **(5)** on the filter and position it on the vehicle body, fastening it with its special bracket.
- Fit the pipe union **(6)** on the filter.
- Lubricate the ORings on the filling/draining unions with A/C system oil and fasten them with the screws **(1)**.
- Definitely lock the pipe unions **(5)** and **(6)** to the prescribed tightening torque.
- Fasten the clamp **(2)** on the filter bracket and re-assemble the connector **(A)** on the pressure switch.

- Fill the system (I3.02).

I2.04 PRESSURE SWITCH

It is mounted on the pipe connecting the dehydrator filter to the evaporator.
The MIN/MAX pressure switch disengages the electromagnetic clutch when the pressure **exceeds 28 bar**, avoiding overpressure in the system, and when the coolant pressure is **under 2 bar**, thereby avoiding functioning of the system when it is empty. When the coolant pressure **exceeds 15 bar**, the pressure switch controls the activation of the electric cooling fan for the compressor, at the first speed. At **20 pressure bars**, the electric fan passes to second speed.

Replacement

- Remove the movable shield from the luggage compartment (M 3.06).
- Detach the connector **(A)** from the pressure switch.

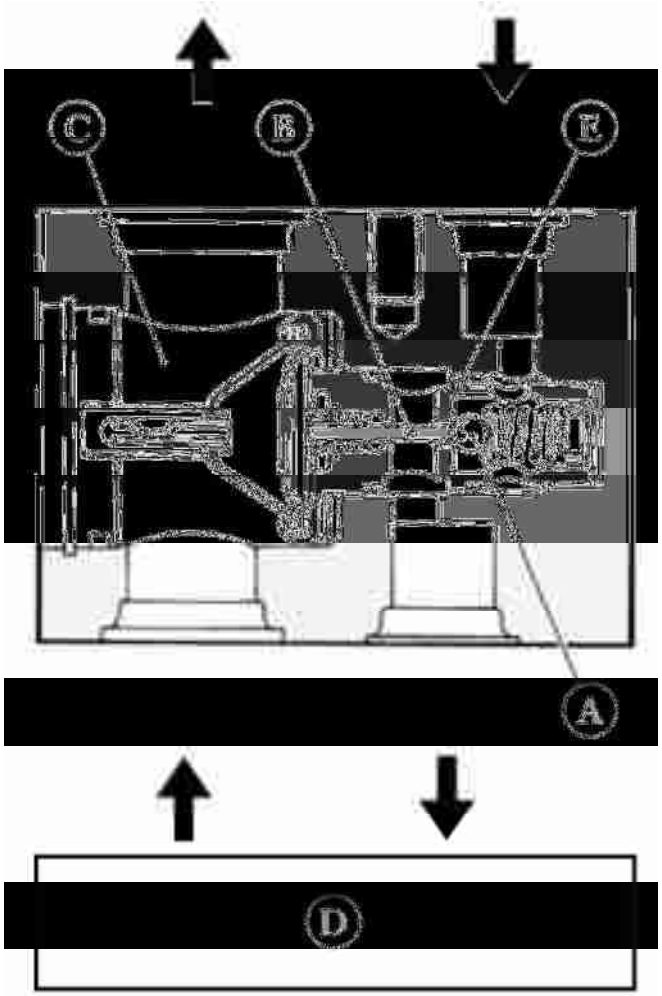
- Unscrew the pressure switch from the filter-evaporator pipe and replace it..
- When re-assembling, lubricate the O-Ring with A/C system oil and lock the pressure switch.
- Attach the connector **(A)**.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

- Proceed with the system filling I3.02).

I2.05 EXPANSION VALVE

It is located on the right-hand side of the evaporator, behind a plastic protection shield.
The expansion valve reduces the coolant pressure and controls its flow to the evaporator.
The opening of the valve is controlled by the ball **(A)**. This is activated, through the pivot **(B)**, by the expansion or the contraction of the fluid which flows through the duct **(C)**, and which is sensitive to the evaporator **(D)** output coolant temperature.



In case the evaporator output temperature increases, the ball **(A)** is pushed by the expansion of the fluid, thus opening the valve **(E)** and allowing a greater flow of coolant into the evaporator **(D)**.

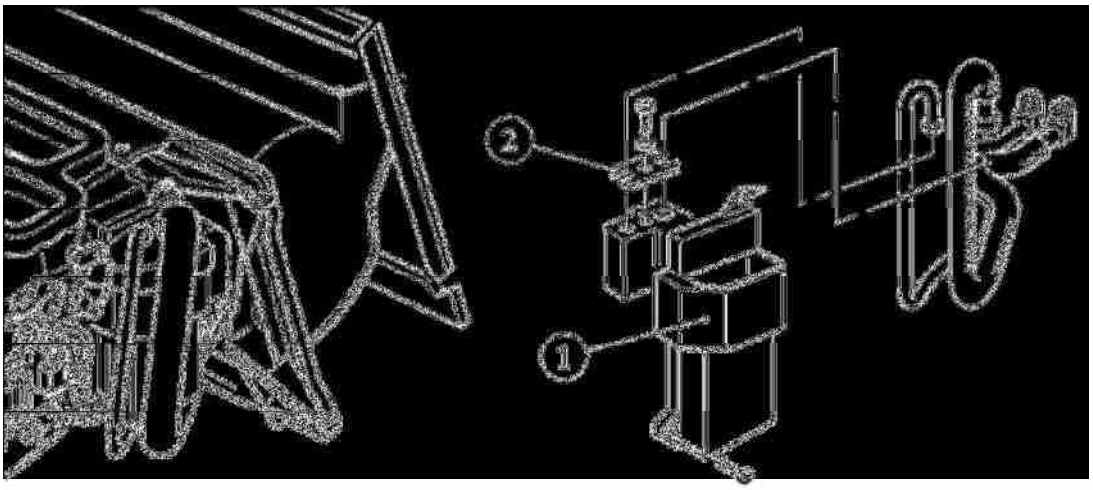
Replacement

The expansion valve is supplied with the complete evaporator unit but, in case of malfunction (I 4.03), può essere richiesta anche singolarmente.

NOTES
It is advisable to replace the expansion valve after the evaporator has been removed from the car (I 2.06).

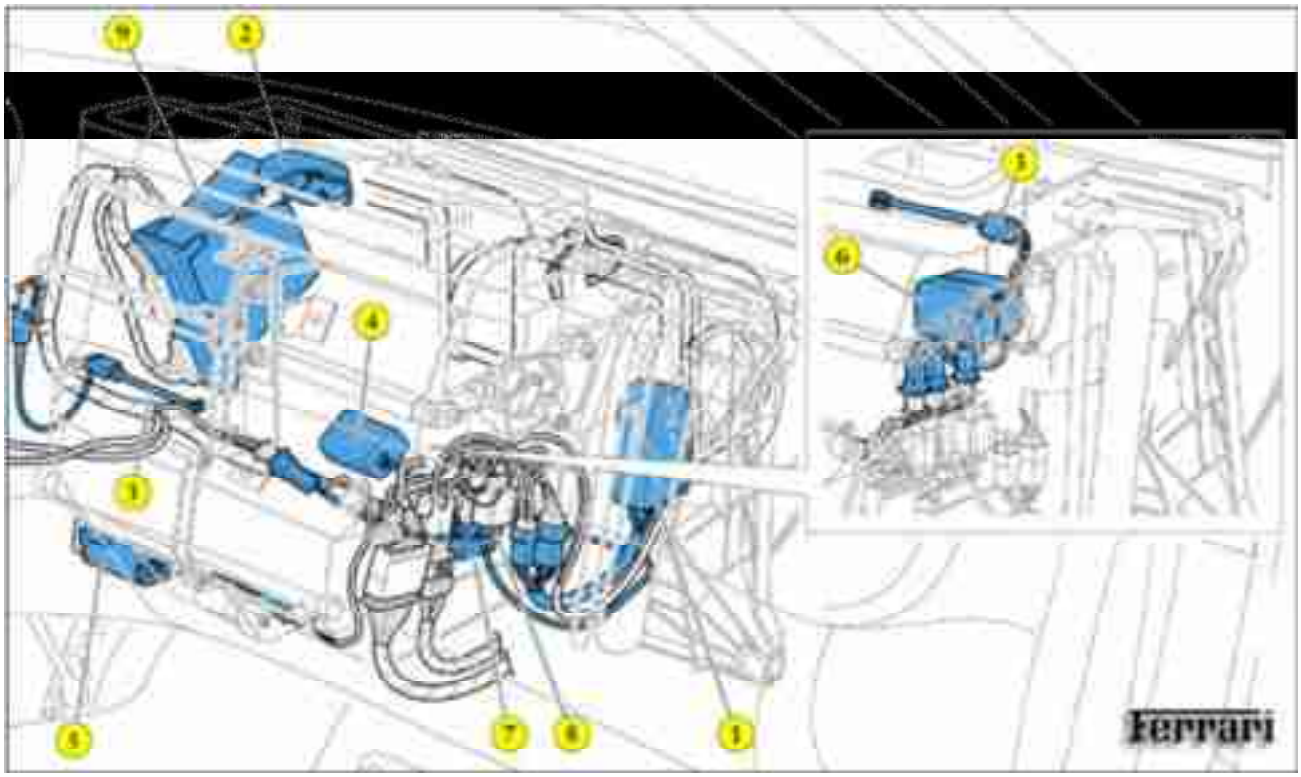
- Remove the protection **(1)** and take off the insulating material from the pipes.

- Detach the two pipes on the upper part of the valve, removing the fastening plate nut **(2)**.
- Remove the valve from the pipes on the evaporator and replace it.



- When re-assembling, position the valve correctly and fix it to the pipes with the fastening plate nuts **(2)**.
- Re-assemble the protection **(1)** and apply the special insulating material on the upper part.
- Re-assemble the evaporator unit (I 2.06).

I2.06 HEATER / EVAPORATOR



The unit is fastened to the panel dividing the passenger compartment from the luggage compartment and contains, in a single block, the heater and the evaporator. This solution permits to obtain:

- heated outside or inside air;
- cooled outside or inside air;
- dehumidified, and if desired heated, outside or inside air;
- defrosting of the glass surfaces.

The air drawn in from outside enters the heater/evaporator unit through an antipollen filter.

NOTES

Replace the antipollen filter of the A/C system at the intervals prescribed in the PROGRAMMED MAINTENANCE PLAN, following the procedure described in (A 3.14).

The air exiting the evaporator flows to a diffuser which distributes it to the ventilation outlets in the passenger compartment.

Inside the unit is a motor equipped with two fans which cannot be replaced.

The following parts are located externally:

1- electric fan speed control;
2- air flow motor;
3- treated air temperature sensors (I 2.09);
4- outside air/inside recirculation motor;
5- motor for air flow distribution to foot-area;
6- hot/cool air mix motors;
7- electric fan protection cap fuse;
8- ECU protection fuse;
9- ECC unit (I 2.10);

To detect malfunction, the SD-2 actuators can be activated (I 4.01).

Replacing the External Parts

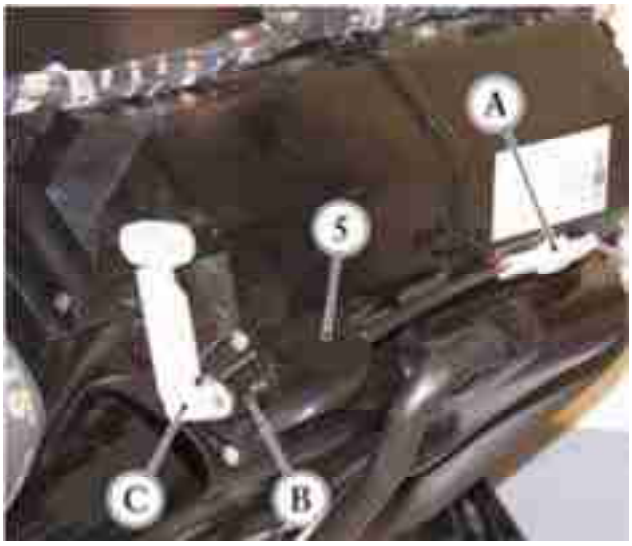
The replacement of external parts may be carried out even with the unit installed in the car, through the lower part of the dashboard.

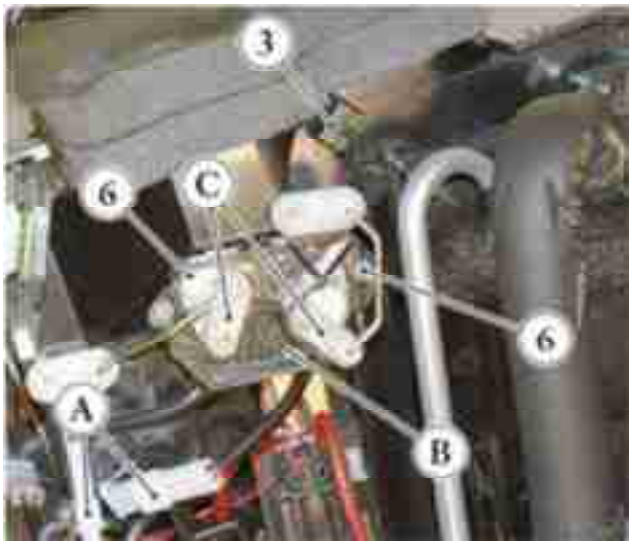
- To remove the motors **(2)**, **(4)**, **(5)** and **(6)**, after disconnecting the connector **(A)** from the unit harness, it is necessary to detach the support bracket **(B)** and to disengage the control lever **(C)** from the connecting levers

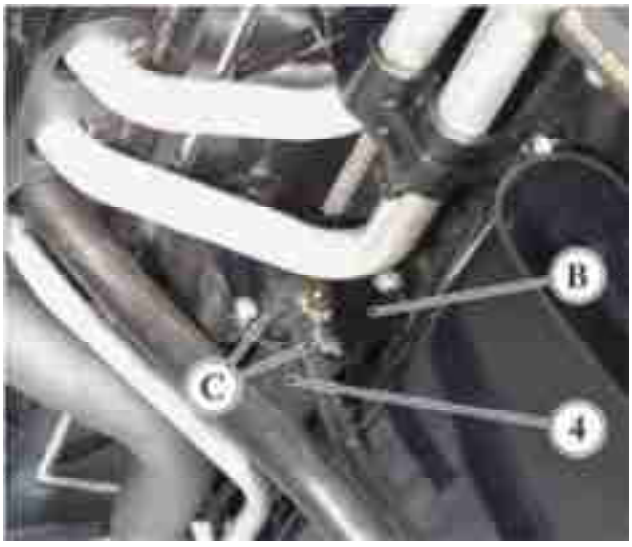
to the flap.

- To remove the sensors **(3)**, slide them out of the evaporator after having detached the connector.

For connection to the system, see Table **R** - ELECTRICAL SYSTEM.







Replacing

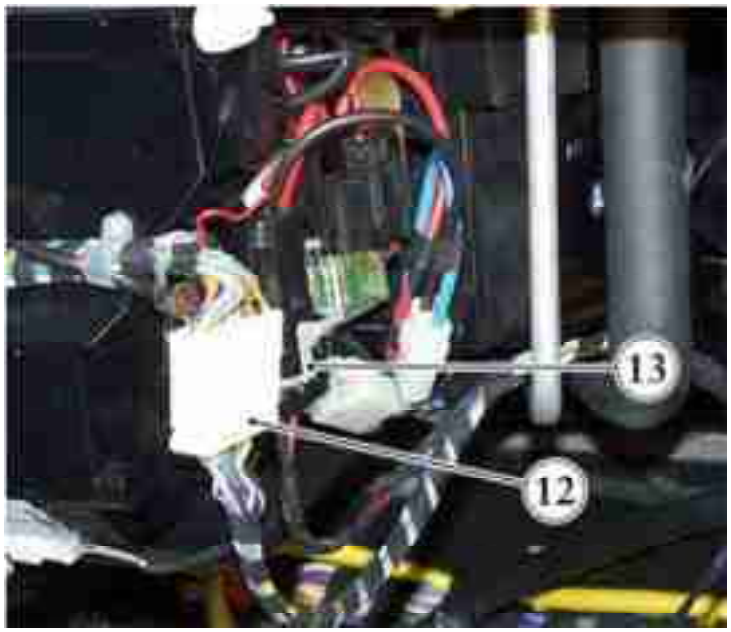
In case of damage to the unit's internal parts, it is necessary to replace the entire unit.

Disassembly

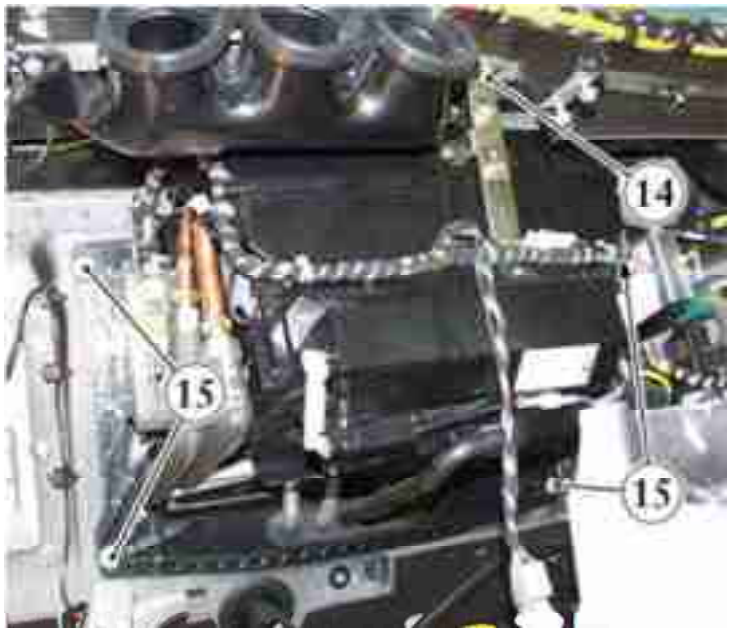
- Remove the movable shield of the luggage compartment (M 3.06).
- Drain the A/C system (I 3.01).
- Remove the filling/draining pipe unions from the evaporator by unscrewing the screws **(9)** and remember to keep the O-Rings.
- Set a container beforehand under the heating circuit pipes **(10)** and **(11)** and water recirculation pipes and detach these pipes from the evaporator.

- Remove the support with the antipollen filter.
- Detach the dashboard cable connections **(12)** and the supply connection **(13)** from the evaporator unit harness.

For connection to the system, see Table **R** - ELECTRICAL SYSTEM.



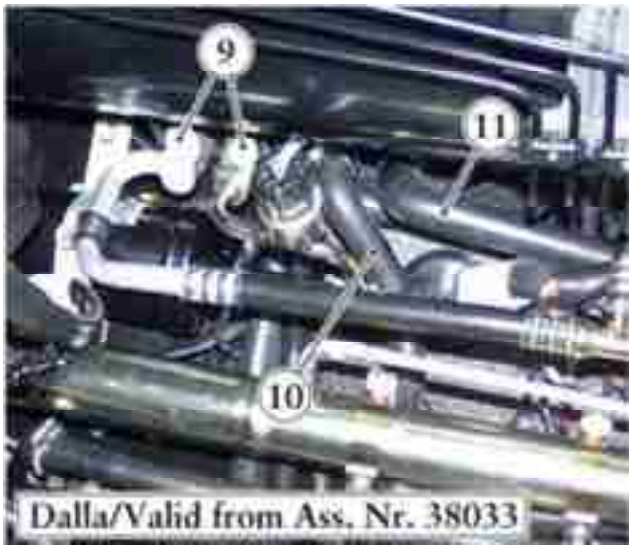
- Remove the dashboard and the support frame (M 3.01).
- Unscrew the screw **(14)** fastening the front bracket of the evaporator unit.
- Unscrew the four nuts **(15)** that fasten the unit to the panel dividing the passenger compartment from the luggage compartment.



- Remove the complete heater/evaporator unit, sliding it out from the passenger compartment.

Re-assembly notes

- Before assembling, make sure that the adhesive gaskets are placed onto the flange fastening the dividing panel and the upper part.
- Install the unit checking it is positioned with the air flow ducts.
- Lock the four nuts to **15 Nm** torque.
- Install the pipes **(10)** and **(11)** in their respective unions and lock them with the special clamps.



- Position the draining pipe, drawing it under the steering box.
- Re-assemble the A/C filling/draining pipe unions, lubricating the ORings with A/C system oil and fastening them with the screws **(9)**.
- After re-assembling all the parts removed during the procedure, fill the A/C system (I 3.02) and top-up the coolant level (B 5.07).

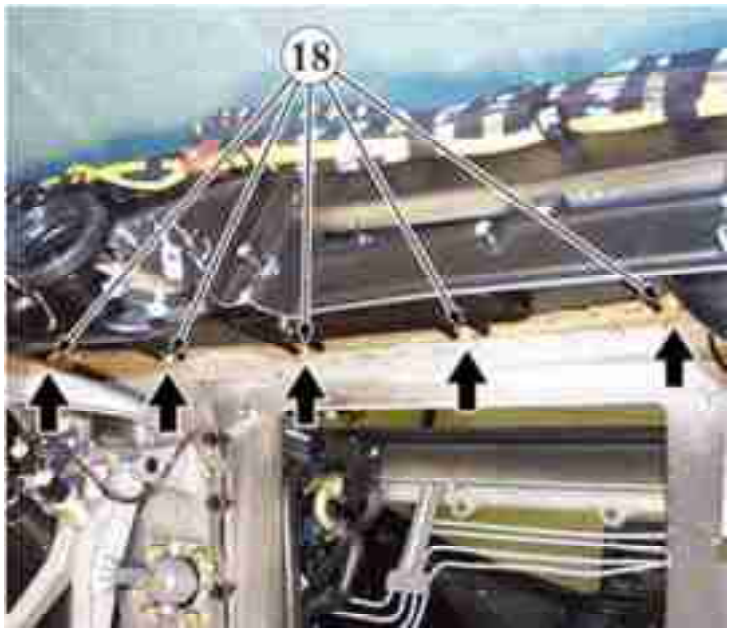
Air Diffuser Replacement

After disassembly the heater/evaporator unit, the air diffuser may be removed.

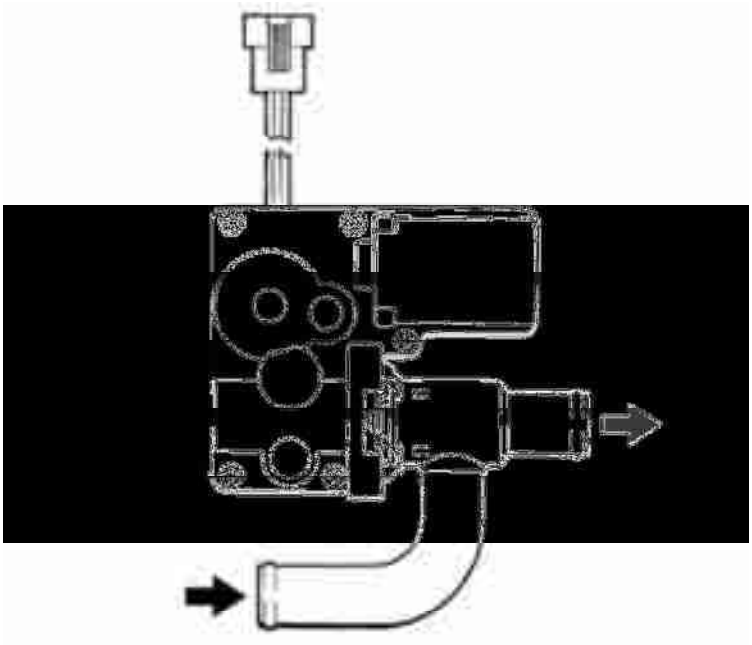
- Unscrew the two screws **(16)** fastening the central part of the diffuser to the chassis.

- Unscrew the screws **(17)** fastening the side of the diffuser

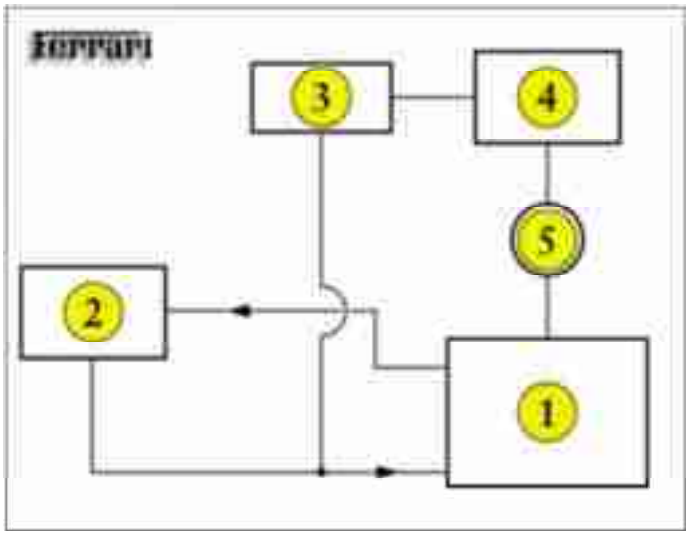
- Unscrew the five lower nuts **(18)** and remove the diffuser from the passenger compartment.



I2.07 PROPORTIONAL VALVE (TGK)



It is located on the left side of the heater/evaporator unit and it is connected to the water backflow pipe from the radiator to the engine (see drawing).



1 - Engine
2 - Radiator engine coolant
3 - TGK valve
4 - Heater
5 - Recirculation pump

The proportional solenoid valve intersects the hot water flow coming from the motor by means of a shutter controlled by a proportional control electric motor.
The water flow which enters the heater is therefore regulated by the control unit.

Replacement

- Remove the rear movable panel of the luggage compartment (M 3.06).
- Remove the windscreen wipers (M 2.07).

- Remove the support with the air conditioning filter.
- Remove the shield under the windscreen (G 2.07).

Valid up to Ass. No. 38032 and RHD

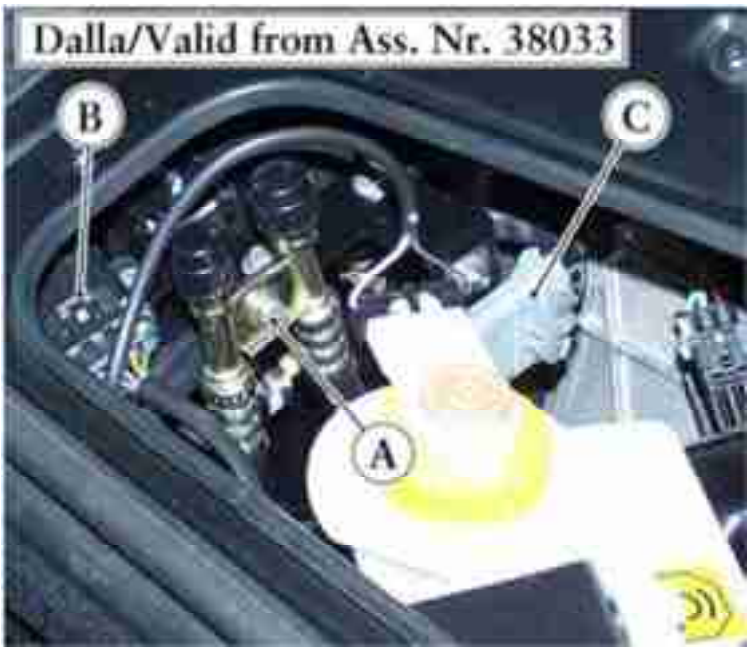
- Remove the connection support bracket and detach it from the dashboard cable.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

- Place a pan under the valve and loosen the clamps **(1)**.
- Detach the pipes from the valve.
- Unscrew the two screws **(2)** and remove the proportional valve together with the bracket.

Valid from Ass. No. 38033 - Not for RHD

- Detach the two filling-draining system pipes from the support bracket by unscrewing the screw **(A)**.
- Position them so that they do not interfere with the following operations.



- Detach the support bracket for the connections of the valve (**B**) and of the battery charge plug (**C**), if available, then disconnect them from the dashboard cable.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

- Place a pan under the valve and loosen the clamps **(1)**.
- Detach the pipes from the valve.
- Unscrew the two screws **(2)** and remove the proportional valve together with the bracket.

- After re-assembling all the components removed during the procedure, top-up the coolant level (B 5.07).

I2.08 RECIRCULATION PUMP

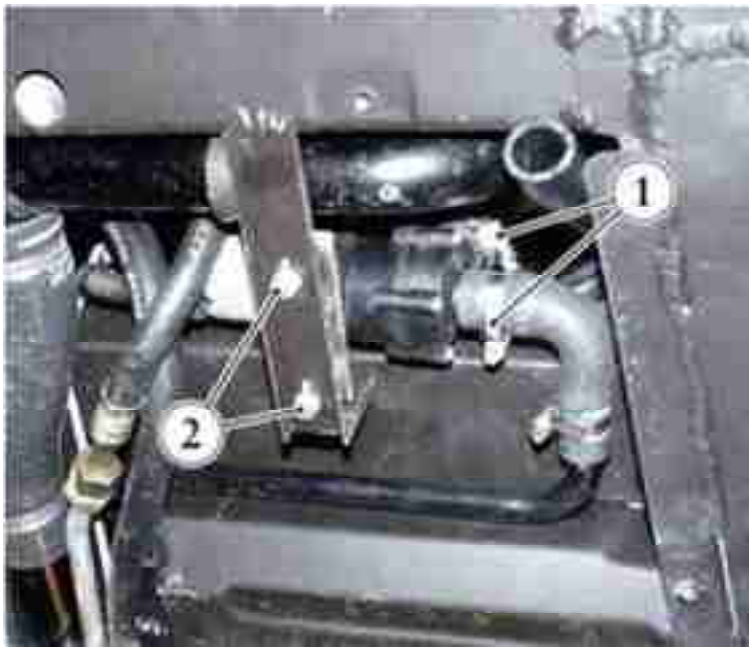
The recirculation pump is located on the left side of the underfloor, at the beginning of the tunnel containing the rigid pipelines.
It is connected to the water pump and to the heater/evaporator unit (I 1.01) and is controlled by the air temperature control system ECU, connected through a branch of the dashboard cable.

Replacement

- Remove the front part of the underfloor (M 2.12).
- Drain the coolant (B 5.04).
- Remove the dashboard cable connector from the pump.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

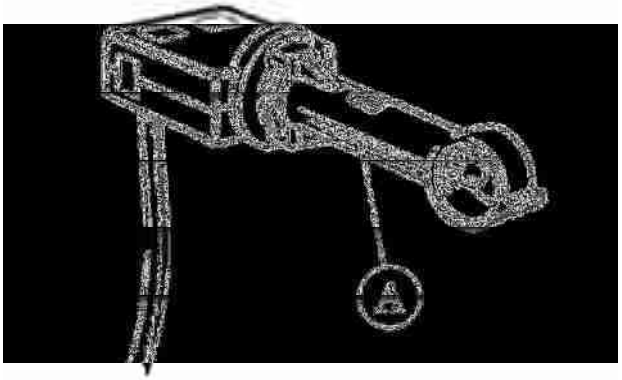
- Loosen the clamps **(1)** and detach the pipes connecting the evaporator and the rigid underfloor pipe from the recirculation pump.
- Unscrew the two nuts **(2)** and remove the recirculation pump together with the bracket.

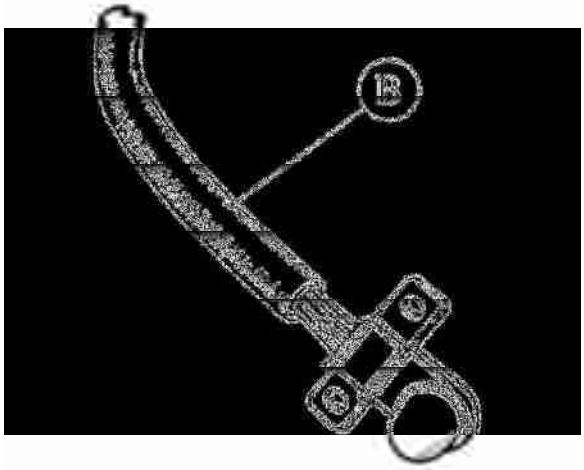


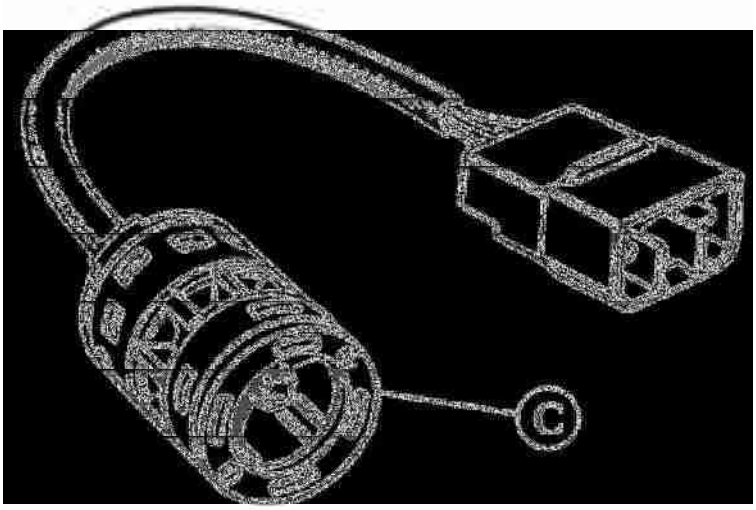
- After re-assembling the pump, it is necessary to fill the system with coolant (B 5.07).

I2.09 NTC SENSORS

The sensors **(A)**, **(B)** and **(C)** are the NTC type and their resistances vary depending on the temperature.



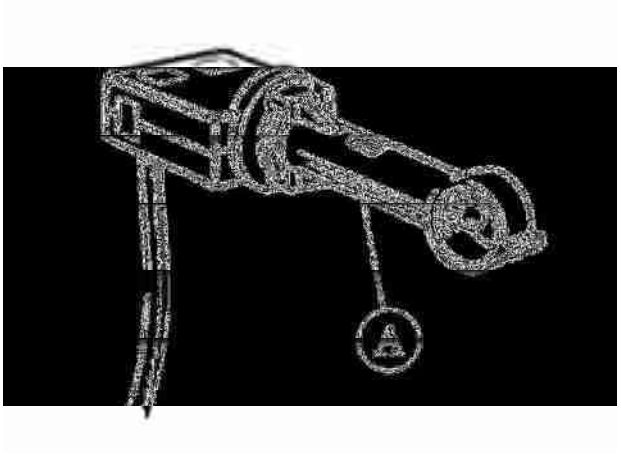




They detect the temperature in different car areas and send the detected data to the control unit in order to optimize the air conditioning.

To check the proper functioning of the sensors, it is necessary to connect the SD-2 diagnosis system (I 4.01).

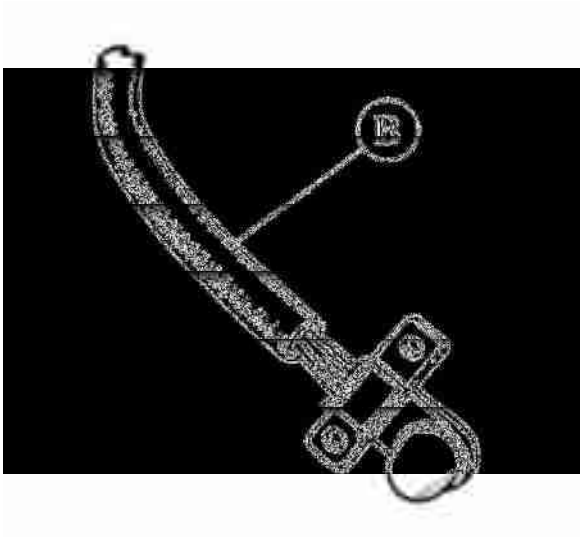
A - FLOOR and VENT treated air temperature sensors



They are located on the heater/evaporator unit and they send a signal to the control unit in order to optimize the operation cycle of the compressor and of the proportional valve which controls the water flow.

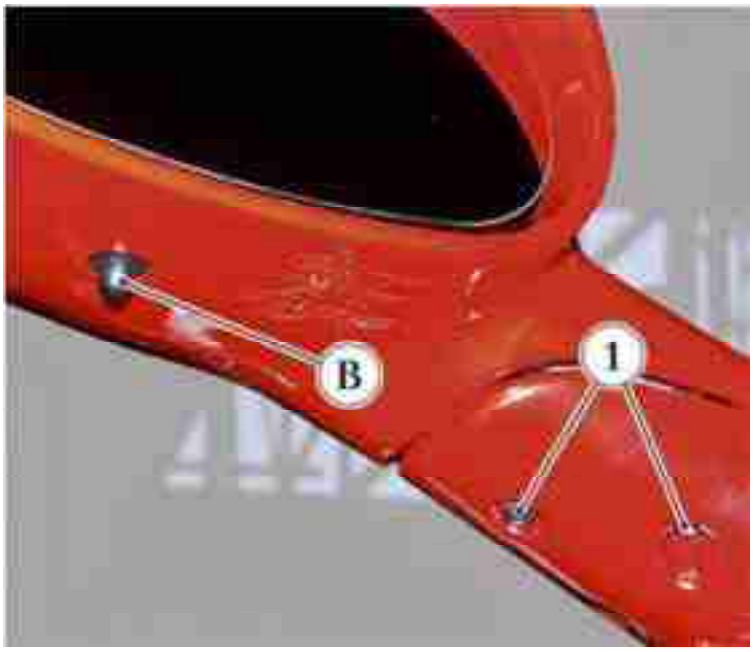
- For their removal (I 2.06).

B - Outside air temperature sensor



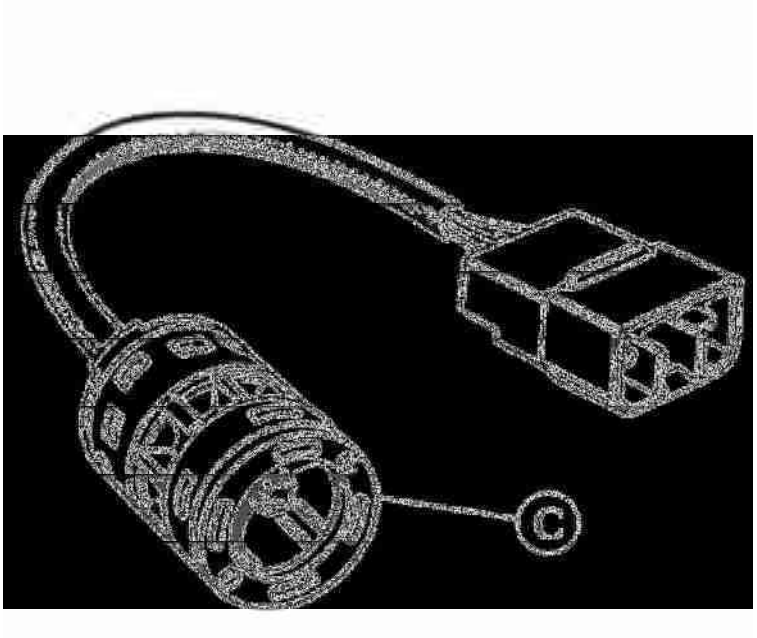
It is located inside the left wing mirror and provides information on the outside air temperature.

- To remove it, it is necessary to detach the left wing mirror (M 2.11).
- Separate the two parts of the mirror by unscrewing the screws **(1)**.



- Remove the sensor from inside the movable part of the mirror.

C - Passenger compartment temperature sensor



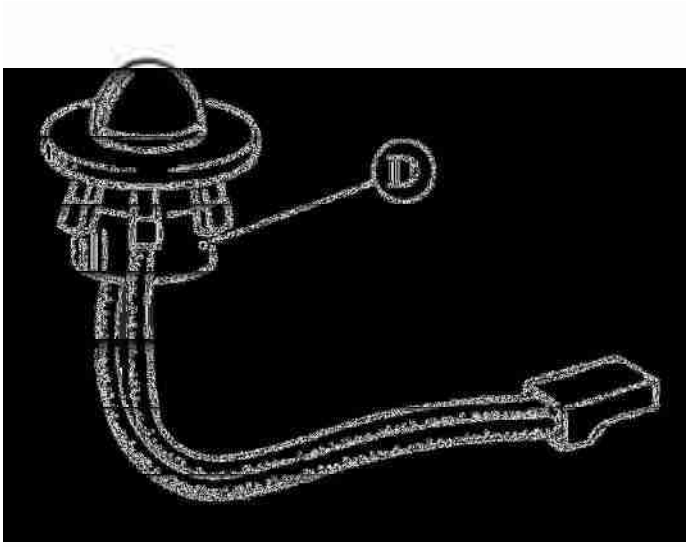
It is fastened to the dashboard, on the right side of the steering column. By means of a small fan, it makes air continuously circulate within the passenger compartment over the sensitive part of the sensor.
This way a continuously updated signal on the temperature within the passenger compartment is sent to the control unit.

- To remove it, detach the connection from the dashboard cable.

For connection to the system, see Table **R** - ELECTRICAL SYSTEM.

- Remove the external protection grid and unscrew the screws fastening the dashboard structure.
- Slide out the sensor from inside.

D - Sun radiaton sensor



Located in the upper part of the instrument dashboard, the sensor optimizes the desired ventilation and temperature within the passenger compartment depending on the sunray incidence angle.

- To remove it, it is necessary to dismantle the dashboard (M 3.01).
- Remove the clasp on the inside of the dashboard and slide off the sensor from outside.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

I2.10 ELECTRONIC CLIMATE CONTROL UNIT

It is fastened with a bracket to the left side of the heater/evaporator unit.
The main control unit inlet signal is the passenger compartment temperature, set by means of the A/C control dashboard switch.
The control unit compares this value to the one detected by the passenger compartment temperature sensor and activates the proportional valve or the compressor joint, depending on the conditions selected on the fan and distribution switches of the A/C dashboard.
The operation cycle of these two components has variable duration and frequency depending on the difference between the detected temperature, the selected and the outside temperature.
By means of the SD-2diagnosis system, it is possible to activate the actuators operated by the electronic control unit (_____).

Replacement

- Detach the two connectors (**1R - 2R**, see Table **R** - ELECTRICAL SYSTEM) of the A/C system from under the dashboard.
- Unscrew the screw **(1)** and remove the support bracket.

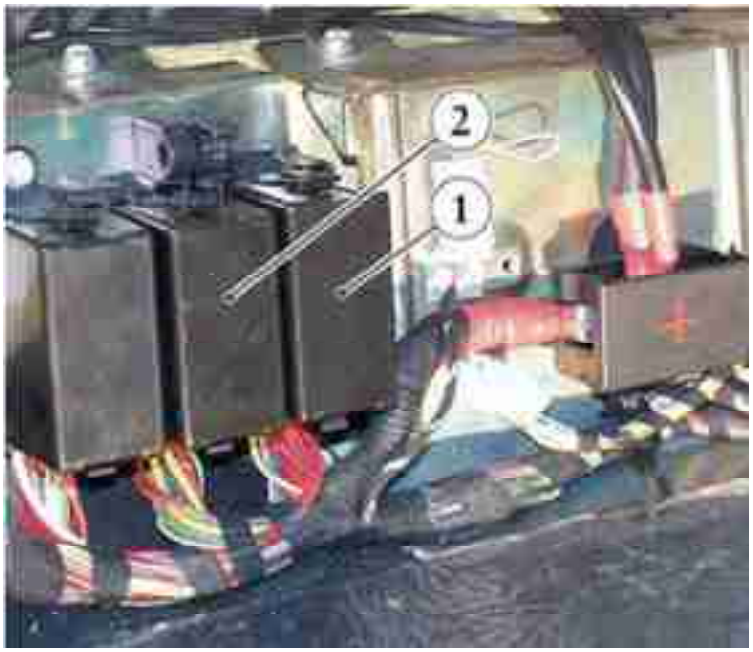
- Remove the control unit, sliding it out of the rear housings.

I2.11 RELAYS AND FUSES

The fuses protecting the control unit and the electric fan are located on the heater/evaporator unit (I 2.06).
The relays and fuses protecting the air temperature control system and the compressor are located inside the relay and fuse box, behind the driver's seat.
The relay used is the normal car type and controls the compressor. It can be tested by the SD-2 diagnosis system (I 4.01).

Replacement

- To gain access to the fuse boxes, it is necessary to remove the lower covering of the electronic control units, behind the driver's seat.
- Remove the covers **(1)** and **(2)** and replace the faulty part.



To follow the cable path and to locate the position of connectors attached to the system devices, see Section - ELECTRICAL SYSTEM.

I3.01 SYSTEM DRAINING

The system must be drained using the special equipment for the recovery/recycling of coolant gases.

If the equipment allows for it, measure the quantity of oil coming out of the system to be able to top-up the oil level afterwards.

CAUTION

Do not drain the coolant near fire as this could produce a toxic gas (phosgene).

Valid up to Ass. No. 38032 and RHD

- Remove the movable rear panel of the luggage compartment (M 3.06).
- Remove the protection caps (**A**) and screw the filling pipe union (RED) onto the union (**1,** greater diameter), and the intake pipe union (BLUE) onto the union (**2**, smaller diameter).

Valid from Ass. No. 38033 - Not for RHD

- To gain access to to the system filling/draining unions, it is necessary to remove the inspection lid (A3.18).
- Remove the protection caps (**A**) and screw the filling pipe union (RED) onto the union (**1,** greater diameter), and the intake pipe union (BLUE) onto the union (**2**, smaller diameter).

- Recover the coolant gas and then carry out the **system draining cycle**.

IMPORTANT
This procedure is extremely important for the efficiency of the system.

When emptying the system, it is important to make sure that the vacuum values are reached, as per the following table.

Time	***Vacuum***	
(minuti)	*(mbar)*	*(mmHg)*
5	**811**	**609**
15	**879**	**660**
30	**982**	**736**

- Make sure that the pressure does not exceed **33 mbar (25mmHg)** in **5 minutes**. If these values are not respected, it means the system has a leak.
- IInsert **500 g** of prescribed coolant (A 1.02) and search for the leak with an electronic leakfinder.

CAUTION

Do not use fire to locate coolant leaks as this produces a toxic gas.

- In case of disassembly of the system components, it is necessary to repeat the "system draining" cycle and to make sure there are no leaks.

I3.02 SYSTEM FILLING

With the equipment connected to the filling/draining unions of the car (I 3.01) and after the "system draining", proceed with the filling.

- If during the emptying of the system the car retained the oil present in the compressor, it is necessary to top-up the same quantity of oil prescribed (A 1.02).
- Carry out the **system filling** cycle.
- The quantity of coolant necessary for the complete filling (including the draining and filling system pipes) is **750 gr** net (A 1.02).
- During the system filling phase, in case the balance of pressures is reached prior to completion of the filling, it is necessary to:

- start-up the engine at **2000 rpm**;
- turn on the A/C system regulating it on max. cold and set the fan at max. speed;
- close the doors.

This way the compressor will draw in even the remaining coolant.

- When the filling is completed, let the system run for about **10 minutes**.

Make sure that in the above-mentioned conditions the high and the low pressure lye within the following values.

Values after 10 minutes operation, at Max. cooling:

- Room temperature: **20÷22 °C**
- Low gauge pressure: **2,0 bar**
- High gauge pressure: **13,5 bar**
- Outlet air temperature (average measured at the vents): **8÷13 °C**

In general, using the graphs outlined in (I 1.01), it is possible to check the efficiency of the system, both during heating and cooling phases, taking into account the passenger compartment and the outlets temperature during operation.

- Remove the unions of the filling/draining pipes and re-assemble the caps (A).

A
Dalla/Valid from Ass. Nr. 38033

I4.01 SD-2 OPERATION CHECK

Through the SD-2 diagnosis system it is possible to display the errors stored by the electronic control unit during the system operation.
It is possible to select the type of error and/or the system component to obtain information (parameters) pertaining to its operation. A Help environment can be thereby accessed, where information, electric diagrams, connectors and guided diagnosis to solve the detected faults are displayed.

NOTES
Before proceeding with a diagnosis, it is necessary to print out the errors.

Error selection menu

- FLOOR treated air temperature sensor
- VENT treated air temperature sensor
- Speed control
- Outside temperature
- Passenger compartment temperature

Parameters

- Temperature selection control
- Distribution control
- Ventilation control
- Potentiometer mix signal
- Recirculation control
- On/off control
- Passenger compartment temperature
- Outside temperature
- FLOOR treated temperature
- VENT treated temperature
- Distribution actuation
- Sun sensor signal
- Motronic signal
- Recirculation
- Compressor
- Battery voltage
- Fan control temperature
- Car type
- Hardware code
- Software code.

Through the SD-2 diagnosis system, it is possible to activate the **actuators** controlled by the electronic control unit:
- FLOOR distribution motor
- DEF/FLOOR distribution motor
- FRONT distribution motor
- MIX motor
- recirculation motor
- max. fan speed relay
- compressor relay
- ECU Motronic signal
- fan speed control.

IMPORTANT
After replacing an actuator or the control unit itself, it is necessary to carry out a check cycle of the air temperature control system with SD-2 system.

To make sure the system is working properly, carry out the following procedures:
• Let the car settle at room temperature.

- Connect the Ferrari SD-2 tester to the connection under the dashboard.
- Start the diagnosis program of the air temperature control system.
- Set the A/C control unit as follows:
  - air flow to **aut**;
  - air ventilation to **aut**;
  - **max. cold** selected temperature;
  - **released** recirculation push button
  - **released** stop push button
- Start the engine at minimum speed and close the doors and side windows suitably, thus allowing the initial **max. cold** test to start and to be carried out for **5 minutes**.
- Turn the knob of the selected temperature to **max. hot** for **2 minutes**, leaving all the other controls unvaried.

Once these procedures are properly carried out, the system will function correctly if the temperature exceeds the values indicated in the following table:

Outside Temperature

Test Type		**TE ≥ 30 °C (TE ≥ 86 °F)**	**24 °C ≤ TE ≤ 29 °C (75.2°F ≤ TE ≤ 84.2 °F)**	**TE ≤ 23 °C (TE ≤ 73.4 °F)**
Cold test after 5 minutes	**TA**	**≤ 25 °C (77 °F)**	**≤ 22 °C (71.6 °F)**	**≤ 19 °C (66.2 °F)**
	TT	**≤ 13 °C (55.4 °F)**	**≤ 12 °C (53.6 °F)**	**≤ 11 °C (51.8 °F)**
Hot test after 2 minutes	**TA**	**≥ 31 °C (87.8 °F)**	**≥ 27 °C (80.6 °F)**	**≥ 25 °C (77 °F)**
	TT	**≥ 61 °C (141.8 °F)**	**≥ 56 °C (132.8 °F)**	**≥ 55 °C (131 °F)**

TA = Compartment temperature
TT = Treated temperature

System Check Cycle

After replacing one of the actuators or in any case after an overhaul of the system, it is necessary to carry out a check cycle.
The cycle includes the following procedures:
- programming of the test and identification;
- ECU error reading;
- air distribution check;
- selected temperatures;
- pressure switch and fan cycle check;
- MAX hot position check;
- error check;
- printing.

I4.02 COMPRESSOR OIL LEVEL CHECK AND FILLING

The oil present in the compressor may be checked only at the work-bench since there is no level detection system.

IMPORTANT
It is not necessary to check the quantity of oil in the compressor if an equipment is used which is able to top-up the quantity of oil drawn during the draining of the system.

Check the quantity of oil in the compressor each time there is a leak in the system and even before refilling with coolant during periodic maintenance.

Filling

- Remove the A/C compressor (I 2.01).
- Unscrew the cap **(1)** and drain the oil.

- Through the cap hole **(1)**, pour **265 g** of prescribed oil (_____).

IMPORTANT
Only use the prescribed coolant. Avoid products that may damage the hoses.

- Replace the the cap **(1)** with the gasket and screw it tightly.
- Re-install the compressor and carry out the filling cycle.

It is recommended to check the oil level in the compressor each time there is a leak in the system and even before refilling with coolant during periodic maintenance.

I4.03 EXPANSION VALVES CHECK

- After having filled the system with coolant gas using the special equipment (I 3.02), start the engine and turn on the system.
- Gaining access from under the dashboard, remove the expansion valve insulation **(A)**.

- Using a small quantity of coolant, cool the sensor bulb of the expansion valve until the low pressure gauge on the filling machine reaches the vacuum level.
- Keeping the bulb cool, turn off the A/C system and make sure the pressure gauge value remains steady for about **3 minutes**, which means that the system seals are tight.
- Turn off the engine and cover the bulb with insulation material.

- With the filling equipment connected, let the engine run at **2000 rpm**.
- Release the **STOP** push button **(1)** on the A/C instrument dashboard, to programme the system for operation.
- Turn the control **(2)** counter-clockwise, until reaching the **LO** minimum temperature position.
- Put the fan control **(3)** to **"I"** minimum speed.

- Remove the insulation **(A)** from the expansion valve.

- Using a little amount of coolant, cool the valve area containing the temperature-sensitive fluid.
- Make sure that on the equipment the low pressure gauge starts to drop. The expansion valve works correctly if the pressure drops progressively.
- Heat the area in the valve which contains the temperature-sensitive fluid.
- Check that the low pressure gauge increases. The expansion valve functions properly when the pressure does not exceed the normal value.
- Switch off the engine and insulate the expansion valve.

I4.04 PRESSURE SWITCH CONTROL

MIN contact

- With the filling equipment connected (I 3.02), turn off the engine, leaving the key contact turned on (position **"II"**).
- Release the **STOP** push button **(1)**, programming the system for operation.
- Turn the control **(2)** counter-clockwise until reaching the **LO** minimum temperature position.

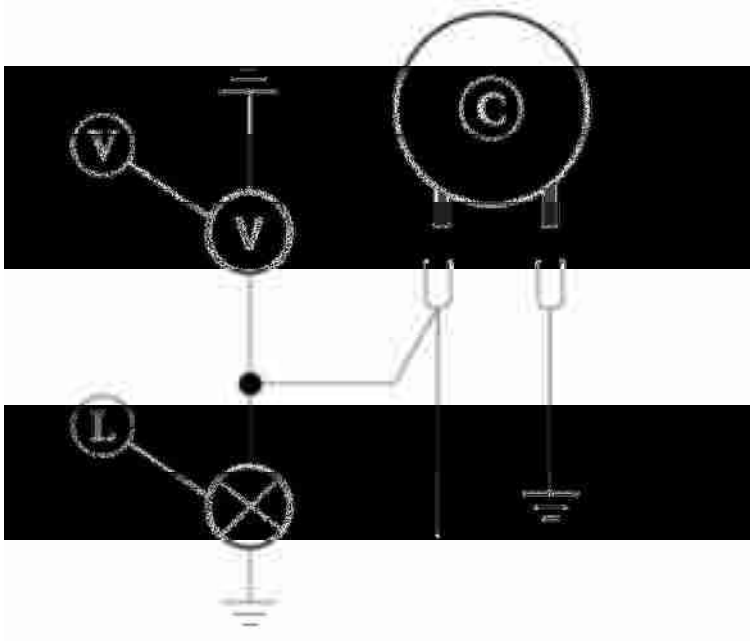
- Make sure the compressor electromagnetic clutch is engaged.
- Remove the pressure switch **(3)** from the dehydrator-evaporator filter pipe and make sure the electromagnetic clutch is disengaged.

NOTES

When disassembling the pressure switch, there is no coolant leakage since the dehydrator filter union is fitted

with a check valve.

- Check whether the electromagnetic clutch is disengaged. To show the electromagnetic clutch of the compressor **(C)** is engaged, fit a warning light **(L)** or a voltmeter **(V)** parallel on the winding contacts that engage the clutch itself.



MAX contact

- Let the engine run at **2000 rpm**.
- Release the **STOP** push button **(1)**, programming the system for operation.
- Turn the control **(2)** counter-clockwise until the **LO** minimum temperature position is reached.

- Remove the remote control switch **(4)** of the condenser electric fan (B 5.04).

- Make sure the electromagnetic clutch is **disengaged** when the high pressure gauge reaches **28 bar**, and that it is **engaged** when the high pressure gauge indicates about **23 bar**.
- Re-install the remote control switch.

I4.05 ELECTRIC FAN ACTIVATION CONTROL

- With the filling equipment connected (I 3.02), run the engine at **2000 rpm**.
- Release the **STOP** push button **(1)**, programming the system for operation.
- Turn the control **(2)** counter-clockwise until the **LO** minimum temperature position is reached.
- Check whether the electric fan of the condenser is activated on the pressure switch control when the high pressure gauge exceeds **15 bar** (first speed of electric fan) and **20 bar** (second speed of electric fan).

L1.01 SPECIFICATIONS

Power supply voltage: **12 Volt**

Battery

Brand: **FIAMM**
Type: **ECOFORCE VR760 (valve regulated lead acid battery)**
Features: **12V-760A EN -450A IEC-115RC**

Electric generator

Brand: **NIPPONDENSO**
Type: **101211/0020**
Current: **150 A**

Starter motor

Brand: **NIPPONDENSO**
Type **5-128000-10**

L1.02 KEY-OPERATED CIRCUITS

- Start-up
- Windscreen wipers and washers
- Stop lights
- Indicators
- Flash lights
- Rear fog lights
- Reverse lights
- Glove compartment light
- Ignition
- Injection
- Electric fuel pumps
- Air conditioning system
- Instruments (except clock)
- Motors for water radiators cooling ventilators
- Rear window heater and wing mirror defroster
- Wing mirror adjustment
- Shock absorber setting system
- ABS/ASR system
- Exhaust temperature control circuit.

L1.03 LIGHTS

Lamp use	*Type*	*Power (12V) (except Xenon lamps)*
High beam lights	halogen	**HB3 60W**
Low beam lights	halogen	**HB3 60W**
	Gas exhaust (Xeno)	
Front dipped lights	Incandescent	**W5W**
Front direction indicator lights	Incandescent	**PY21W**
(Side Marker Lights	Incandescent	**2CP**
Side direction indicator lights	Incandescent	**T4W**
Rear dipped and stop lights	Incandescent	**P21/5W (2**
Rear direction indicator and dipped lights	Incandescent	**P21/5W**
Rear direction indicator lights	Incandescent	**P21W**
(Stop lights	Incandescent	**P21/5W**
Rear fog lights	Incandescent	**P21/5W (3**
Reversing lights	Incandescent	**P21W**
License plate lights	Incandescent	**R5W**
Auxiliary stop lights	Incandescent	**T5 2,3W**
Central ceiling light	Incandescent	**10W**
Spot lights	Incandescent	**6W**
Glove compartment light	Incandescent	**C5W**
Door open lights	Incandescent	**3W**
Luggage compartment light	Incandescent	**C5W**

(Only for **US** and **CDN** versions.
( ) Only a **5W** filament is used for the dipped lights.
(Only a **21W** filament is used.

L1.04 TIGHTENING TORQUES

NOTES
To check the tolerances in relation to the tightening category (02.05).

Description	Nm	Category
Earth protection screw (M6)	**8**	**B**
Earth protection screw (M8)	**15**	**B**
Nut fastening wires to terminal board	**20**	**B**
Screws fastening headlamp to body	**11**	**B**
Screw fastening alternator	**5**	
Nut fastening cable to starter motor	**1**	
Screws and nuts fastening starter motor	**25**	**A**
Nut fastening cable to starter motor	**14**	**C**
Screw fastening starter motor bracket to gearbox	**30**	**A**
Nut fastening bracket to starter motor	**6**	**A**

L2.01 BATTERY

The battery is located in the passenger compartment, underneath the passenger side footrest mat. This position guarantees the battery excellent operating conditions and therefore a maximum performance and working life.

This battery is endowed with (L 1.01) a sealed energy circuit and therefore does not require any maintenance. Moreover, it features a low electrolyte consumption rate, an extremely low self-discharge rate and a reduced quantity of gas produced during charging.

The battery output is far greater than necessary to respond to the absorption of the electrical apparatus installed in the car.

In addition to the original electrical equipment, mounting other apparatus (telephones etc.) increases the power absorption and requires special maintenance besides recharging the battery at regular intervals (L 3.01).

A special master battery switch located in the luggage compartment (L 2.02), permits to disconnect the battery from the electrical system when work has to be carried out on its parts or when the car remains unused for long periods of time.

IMPORTANT

Each time the battery is disconnected, all the self-learning in the ignition/injection ECU are deleted. In this case, it is necessary to reset the parameters before using the car again (A 3.28).

Remember that the battery has a self-discharging current of approximately **7 mA**, which makes it necessary, in the event of particularly long periods of inactivity, to recharge the battery at least once a month (L 3.03).

NOTES

To remove the battery (A 3.28).

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

L2.02 MASTER BATTERY SWITCH

It is located on the right-hand side of the luggage compartment and it enables the user to disconnect the battery's power supply to work on the devices or to disconnect the battery from the system if the vehicle is not going to be used for long periods of time.

IMPORTANT

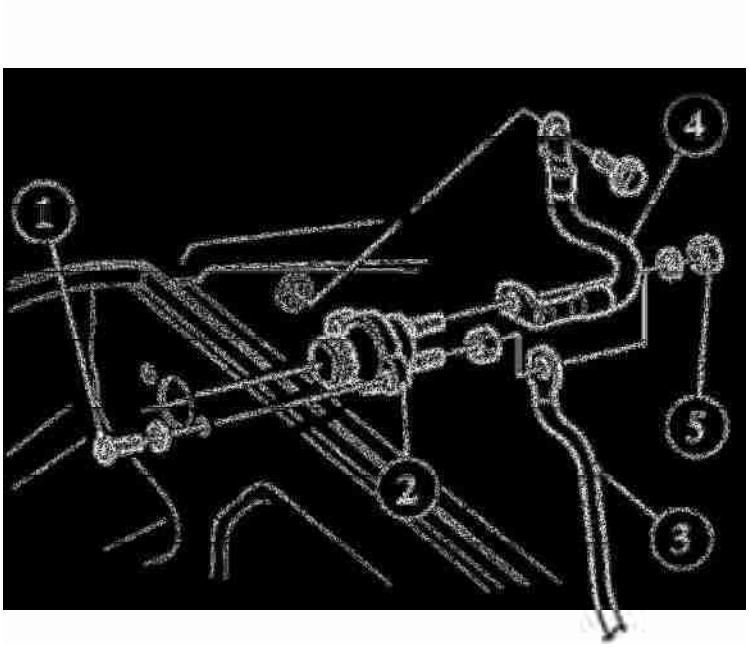
*Having turned the battery master switch to "**ON**", wait at least **10** seconds, with the ignition key in position **"II"**, before starting the engine. This time allows the electronic system, controlling the motor-driven valves, to self-learn the parameters.*

Replacing the battery

- Put the master battery switch in the **OFF** position.

- Remove the detachable rear panel of the luggage compartment (M 3.06).
- Remove the windscreen wiper arms (M 2.07).
- Remove the windscreen shield (G 2.07).
- Disconnect the positive terminal from the battery (A 3.28).
- Unscrew the two screws **(1)** and the relevant internal lock nut **(2)**.
- Remove the master battery switch and disconnect the cable **(3)** which connects it to the battery and the ground plait **(4)**.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.



- When reassembling, apply protective grease for electrical contacts to both the cable terminals and the fastening pins.
- Tighten the nuts **(5)** to a **15 Nm** torque.
- After reconnecting the battery, carry out a self-learning cycle (A 3.28).

L2.03 GENERATOR

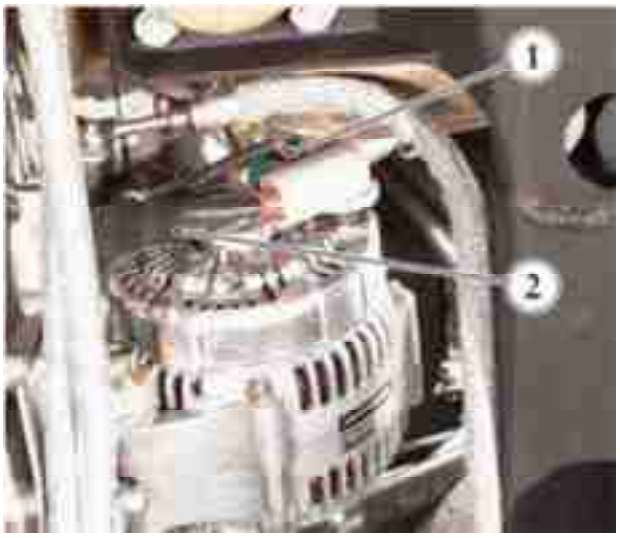
The current generator (alternator) is mounted on the right-hand side of the engine crankcase and it is controlled by the crankshaft pulley, driven by a belt which also operates the water pump.
In the generator is fitted a voltage regulator.
Check the car's electrical system absorption and the alternator recharging rates at regular intervals (see Programmed Maintenance Plan), or in the event that the recharging system shows malfunctions (A 3. 29) and (L 3.01).

NOTES
To replace the belt and check the voltage, (A 3. 04).

Tightening torques	Nm	Category
Tightening of alternator screws	**59**	**B**
Tightening of nut on alternator cable	**14**	**C**

Disassembly
- Put the master battery switch in the **OFF** position (L 2.02).

It is also possible to replace the alternator when the engine is already installed in the car, after removing the rear panel of the underfloor (M 2.12).
- Remove the controlling belt (A 3. 04).
- Remove the connector **(1, green)** from the alternator and detach the terminal of the engine services wiring loom **(2)**, which is connected to the battery.



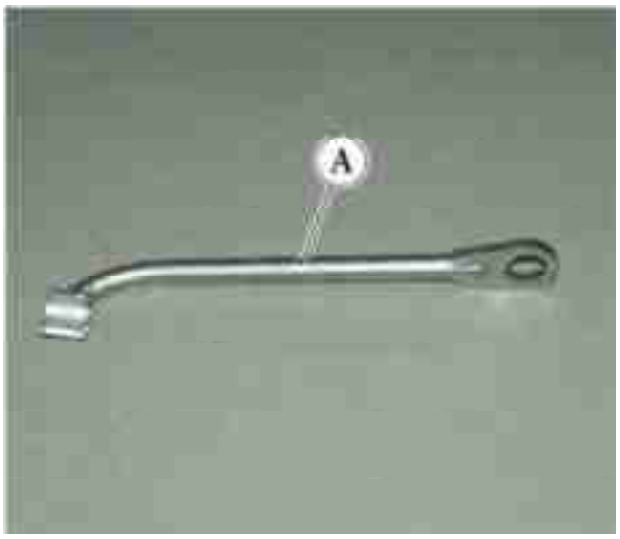
NOTES
For the sake of clarity, the drawings show an engine on the test bench.

- Remove the screw **(3)** and the related lower nut **(4)** fastening the alternator to the belt tensioner.
- Remove the upper fastening screw **(5)**.
- Remove the alternator and remember to keep the spacers **(6)**.

Re-assembly

NOTES

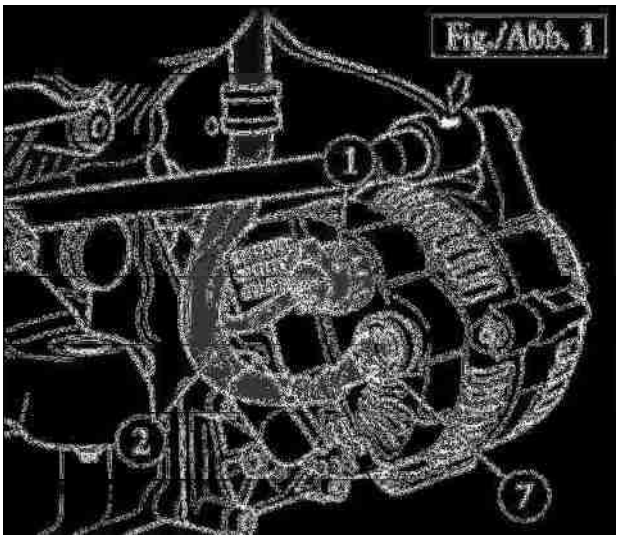
*When replacing the alternator, to improve its fastening on the engine, we recommend you proceed by fitting the rear bracket **(A)**, already used on the Challenge Stradale, as described at the end of this chapter.*

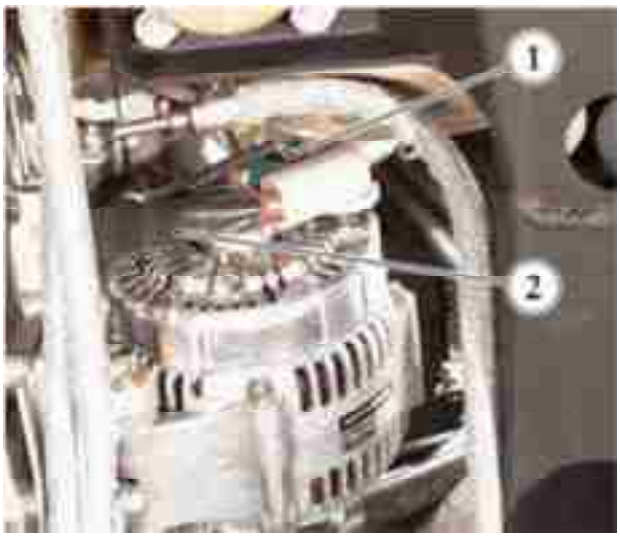


- Place the alternator on the engine and fasten it with the original screws, fitting the spacers where marked **(6)**.
- Tighten the screws **(3)** and **(5)** to the prescribed torque.

- Apply protective grease for electrical contacts to the terminals of the cable **(2)** and to the relative fastening brackets.
- Fasten the cable **(2)** onto the alternator, positioning it as shown in **Fig.1**, and tightening the nut **(7)** to the prescribed torque.
- Attach the connector **(1)** to the alternator.

For connection to the system, see Table **S** - ELECTRICAL SYSTEM.

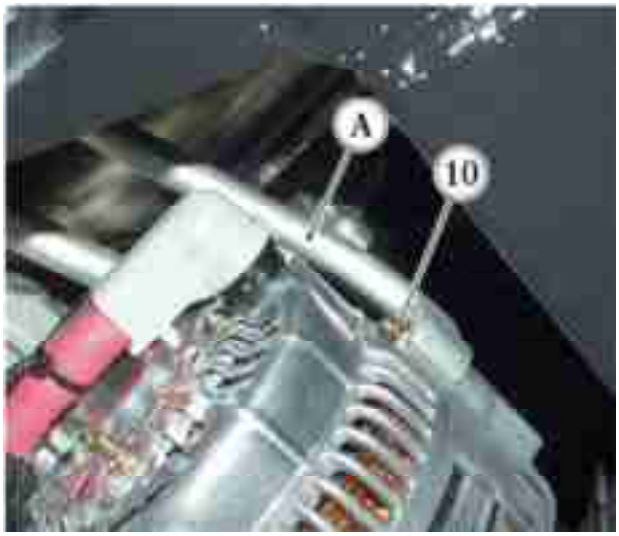




- Mount the belt and check voltage (A 3. 04).
- Reconnect the battery and re-assemble the parts removed for the operation.

Fitting rear alternator supporting bracket

- Remove the nut **(8)** with the washer **(9)** on the fastening screw for the engine mounting rubber bushing.
- Slide the screw out from underneath, until it is on the engine mounting bracket's upper resting surface.
- Remove the nut **(10)** on the outer right-hand stud bolt, which fastens the parts together on the alternator body.
- Position one end of the bracket **(A)** on the alternator stud bolt and rest the other end on the engine mounting bracket.
- Push the rubber bushing fastening screw and lock it with the washer **(9)** and nut **(8)** to a torque of **98 Nm**.
- Using the original nut, lock the bracket **(A)** on the alternator stud bolt to a torque of **0.9 Nm**.



L2.04 STARTER MOTOR

It is mounted on the left-hand side of the gear box and it is electrically connected to the battery by means of the engine services wiring loom.
Despite its light weight, it features a considerable power.
The starter motor is supplied as one spare part, and if any problems are due to the starter motor alone it must be replaced, not repaired.
Should the motor be noisy when in use or when started, check that the teeth of the pinion, on the starter motor itself, and those on the ring gear, on the clutch pressure plate, (D 3.01), are in good condition. It is possible to check the latter, by removing the inspection hatch cover **(A)** located under the gear box.

Before replacing the starter motor, check that the cause of the malfunction is not related to its connection to the system, or to the battery's charging condition (L 3. 02).

Tightening torques	Nm	Category
Tightening of starter motor screws and nuts	**2**	
Tightening of starter motor cable nut	**1**	
Screw fastening starter motor bracket to gearbox	**3**	
Nut fastening bracket to starter motor	**6**	

Replacing

- Put the master battery switch in the **OFF** position (L 2.02).

It is also possible to replace the starter motor when the engine is already installed in the car after removing the rear panel of the underfloor (M 2.12).

- Remove the engine services wiring loom connector **(1)** from the starter motor and detach the terminal of the power supply cable **(2)**, which is connected to the battery.
- Remove the two nuts **(3)** and the front screws **(4)** fastening the starter motor to the gearbox.

- Remove the two screws **(5)** which fasten the supporting bracket of the starter motor to the differential cover.

- Remove the starter motor from the gearbox.

R -assembly

- Check that the contact surfaces on the starter motor and the gearbox are clean and perfectly flat.
- Mount the starter motor with the rod onto the gearbox stud bolt.
- Put all the fastening elements into place.
- Tighten first the nuts **(3)**, then the screws **(5)** and finally the screw **(4)** to the prescribed tightening torque.

- Apply protective grease for electrical contacts on the cable terminal **(2)** and on the relative fastening bracket.
- Fasten the cable **(2)** onto the starter motor, tightening the nut to the prescribed tightening torque.
- Attach the connector **(1)** to the starter motor.
- Reconnect the battery and reassemble the parts removed for the operation.

For connection to the system, see Table **T** - ELECTRICAL SYSTEM.

L2.05 WINDSCREEN WIPER MOTOR

It is mounted on the pedal board support by means of a bracket, and remains covered by windscreen shield.
To keep it in best working condition, the motor is fitted inside a protective, waterproof casing, which must never be removed.
If the motor is noisy or other problems are encountered when it is in use, it is necessary to replace it.
The motor is connected to the windscreen wiper arm with spherical jointed leverages. This mechanism does not need particular maintenance, except for the lubrication of the joints during the regular checks.
If the joints show excessive clearance, it is necessary to replace the entire leverage.
The impulse is transmitted to the motor by a timer control **(A)**, in accordance with the position of the control lever.

This element is located on the right-hand side of the passenger compartment. It is accessible from under the dashboard and it is fastened to a bracket which also supports the suspension regulation ECU.
For connection to the system, see Table **C** - ELECTRICAL SYSTEM.

To protect the windscreen wiper system and the motor, there is a set of fuses located, with the remote control switch, in the boxes behind driver's seat (L 2.10).

Tightening torques		Category
Nut fastening arm and starter motor to levers (M8)	**23÷25 (*)**	**B**
Tightening of arm nut (M5)	**3,5÷4,5**	

(*) Tighten twice with an interval of 30 minutes.

Replacing the Windscreen Wiper Motor

- Remove the brake/clutch fluid tank (_____), leaving it connected to the system.
- Put the master battery switch in the **OFF** position (L 2.02).
- Detach the connector **(1)** from the front harness.

For connection to the system, see Table **B** - ELECTRICAL SYSTEM.

- Remove the nut **(2)** and extract the windscreen wiper arm control lever **(3)** from the motor.

NOTES

*To remount the lever **(3)** on the motor bracket in the correct position, mark the positioning of the two elements.*

- Remove the nuts **(4)** which fasten the motor bracket to the pedal board support.

- Slide off the motor and rod.
- When reassembling, tighten the nut **(2)** to the prescribed tightening torque.

Replacing the Leverage

- Remove the windscreen wiper arm (M 2.07).
- Remove the windscreen shield as described (_____).
- Detach the leverage control lever **(3)** from the motor, as described above.
- Remove the fastening screws **(5)** from the left and right-hand windscreen wiper supports **(6)**.

- Remove the entire leverage from the car.
- When reassembling, take care to place the leverage in the right position: to work correctly, the joint **(B)** must be placed in advanced position with respect to the arm support.
- Place the special conical centring washers in position with the front fastening screws of the windscreen wiper arm supports.

Replacing the Arms

- Remove the luggage compartment lid (M 2.02).

NOTES
When reassembling, it is advised to memorize the position of the rubber blades on the windscreen in order to be able to position the arm on the leverage bracket correctly.

- Remove the cap and the arm fastening nut **(7)**. The left-hand arm is fitted with a transmission lever which must be detached by unscrewing the nut **(8)**.

- Slide off the arm and the windscreen wiper blade.

NOTES
To replace the blade only, (M 2.07).

- When reassembling, mount the arm onto the control bracket, maintaining the original position of the blade in relation the windscreen.
- Tighten the nuts **(7)** and **(8)** to the prescribed tightening torque.
- Replace the cap

L2.06 HEAD LIGHTS

NOTE

For the characteristics of the light bulbs (L 1.03).

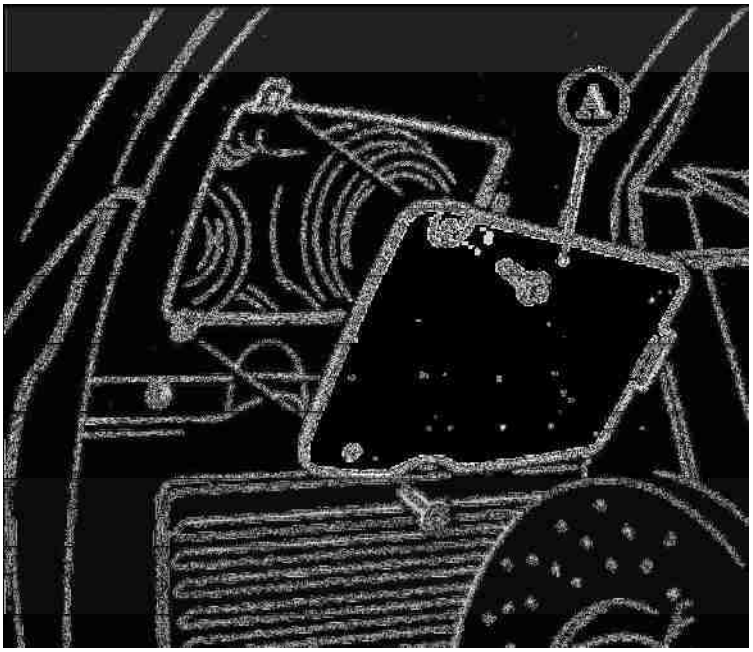
It is possible to gain access to the headlights through an opening in the external part of the wheelhouse.

IMPORTANT

Before replacing a light bulb, make sure that the corresponding fuse is intact. The headlight fuses are located in the box containing the fuses and the relays, in the luggage compartment (L 2.10).

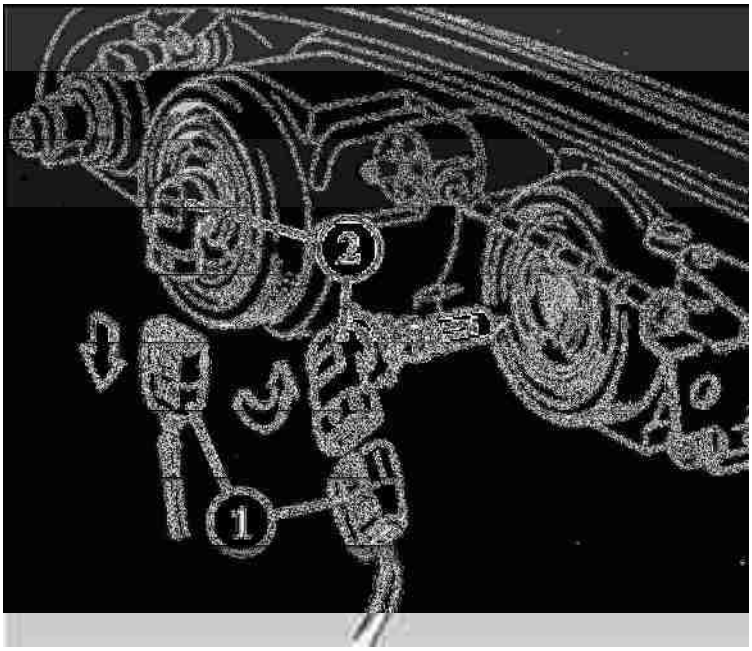
To replace a headlight bulb, proceed as follows.

- Put the battery master switch in the **OFF** position (L 2.02).
- Turn the wheel towards the inside or remove it.
- Remove the flap **(A)** of the light inspection hatch.



Low (halogen) and high beam light bulbs

- Detach the harness **(1)** from the bulb-holder **(2)**.



- Rotate the bulb-socket anticlockwise and slide it out from the headlight unit.
- Replace the light bulb, supplied with the bulb-holder, with an identical new one and mount it in the headlight unit.
- Make sure that the bulb-holder is locked firmly in place.

IMPORTANT

The high an low beams have halogen light bulbs: avoid touching the bulbs with bare hands. If this should occur, clean the bulbs with alcohol.

Xenon low beam light bulbs

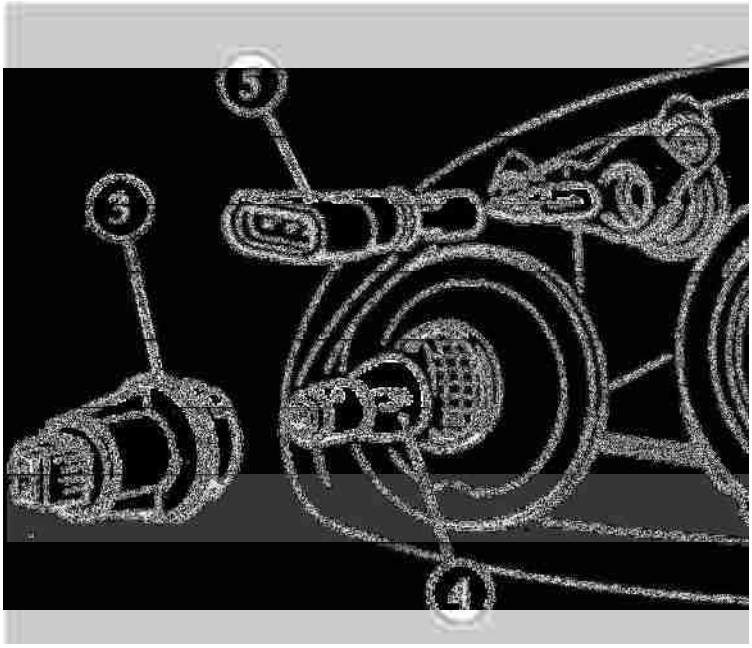
WARNING

*The power supply for these light bulbs is at high voltage; never carry out any procedures with the ignition key turned to position **"II"**.*

- Remove the protective casing and detach the connector **(B)** of the ECU connecting wire from the light bulb.
- Rotate the ring-nut **(C)** in a clock-wise direction and remove the light bulb from the headlight unit.
- Replace with a new, identical light bulb.
- Re-fit it, making sure it is locked perfectly.

Indicator light bulbs

- Detach the harness from the bulb-holder **(3)**.
- Detach the bulb-holder from the headlight unit.
- Remove the light bulb **(4)** and mount the new one, which must be identical to the one replaced.



Dipped Light Bulbs

- Detach the harness from the bulb-holder.
- Rotate the bulb-socket **(5)** in the headlight unit support and slide it out.
- Slide the bulb out of the bulb-holder and replace it.
- Remount the inspection hatch flap and reconnect the battery.

Replacing the entire headlight

In the event of damage to the glass surface, or if water has leaked into the lights, it is necessary to replace the entire headlight, proceeding in the following way.

- Put the master battery switch in the **OFF** position (L 2.02).
- Remove the wheel (F 3.06).
- Remove the external parts of the wheelhouse (M 2.05).
- Remove the front bumper (M 2.03).
- Remove the radiator air flow duct (B 5.04).
- Within the side upholstery of the luggage compartment, remove the plug from the hole for the headlight adjusting screws.
- Remove the horn (L 2.11).
- Unscrew the headlight's rear fastening screws **(6)**.

- Unscrew the two front fastening screws **(7)**.

- Remove the screw **(8)** from the internal side of the luggage compartment.

- Detach the front harness connectors from all the bulb-holders, as described above.

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.

- Remove the entire headlight, extracting it from the lower part of the mud guard.

REASSEMBLY NOTES

- Tighten the fastening screws **(6)** and **(7)** to the prescribed torque of **11 Nm**.

- After mounting the new headlight, the beam aiming must be adjusted as described (L 3.04).

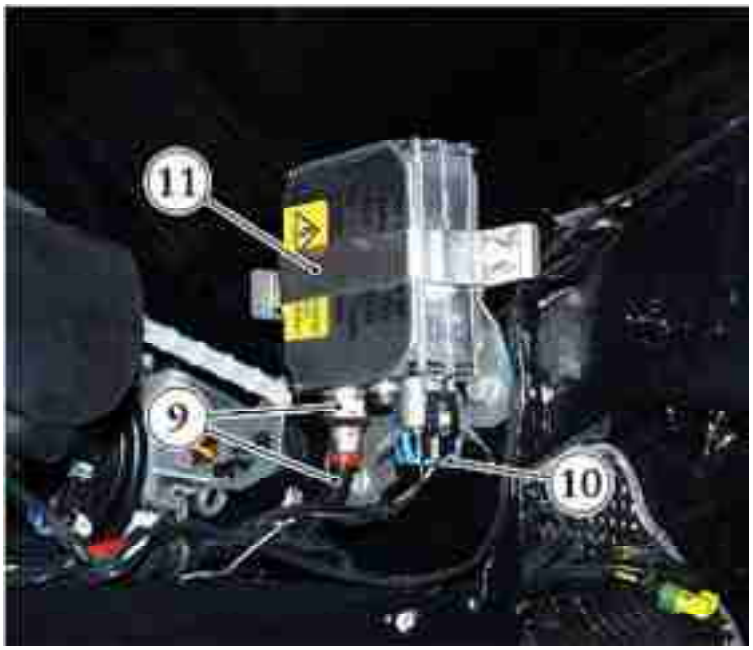
Replacing the ECU for Xenon light bulbs

WARNING

*Always work with the ignition key in position **"0"**.*

- When replacing the ECU, it is necessary to disconnect it from the light bulb, by detaching the high voltage wire connector **(9),** and connector **(10)** from the front harness.
- Unscrew the fastening screw and remove the support bracket **(11)**.

When reassembling, check that connector **(9)** and the high voltage wire are fastened correctly and positioned as illustrated in the figure.



L2.07 REAR LIGHTS

NOTE

For the characteristics of the light bulbs (L 1.03).

The rear light bulbs can be accessed from the luggage compartment, with the boot open.

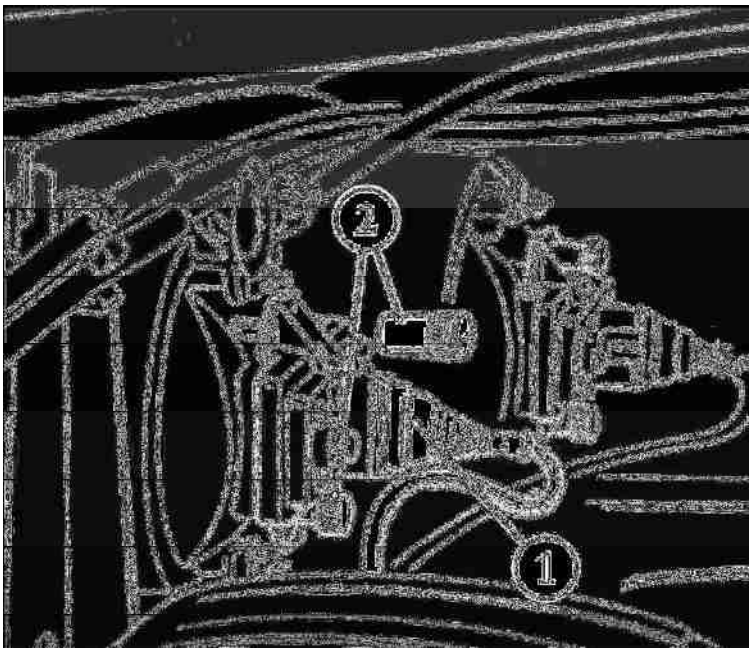
IMPORTANT

Before replacing a light bulb, make sure that the corresponding fuse is intact. The rear light fuses are located in the boxes containing the fuses and the relays in the engine compartment (L 2.10).

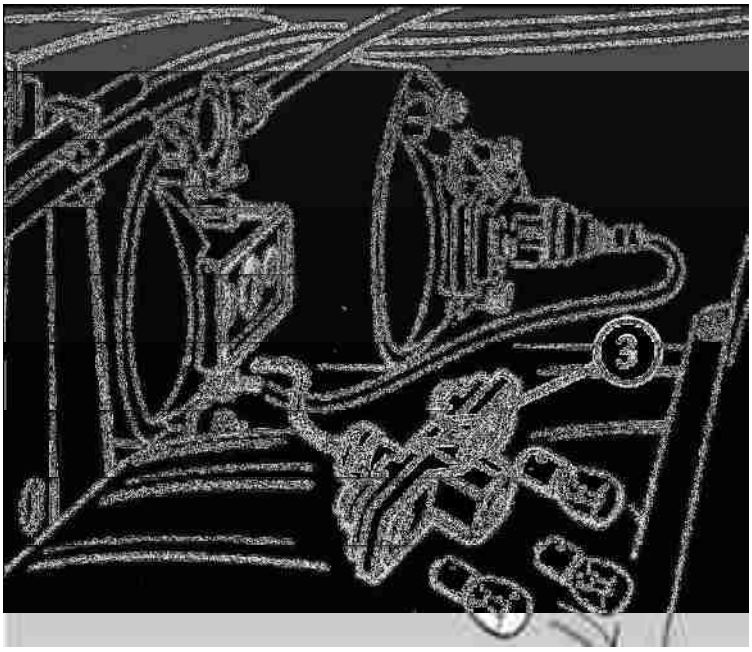
Replacing the Light Bulbs

To replace a rear light bulb, proceed in the following way.

- Put the master battery switch in the **OFF** position (L 2.02).
- Detach the harness **(1)** from the bulb-holder cover.
- Unscrew the screws **(2)** and remove the bulb-holder cover.



- Rotate the light bulb in its housing and then replace it with an identical new one.
- Remount the bulb-holder cover, making sure that the surrounding gasket **(3)** is in good condition and correctly installed in its seat.

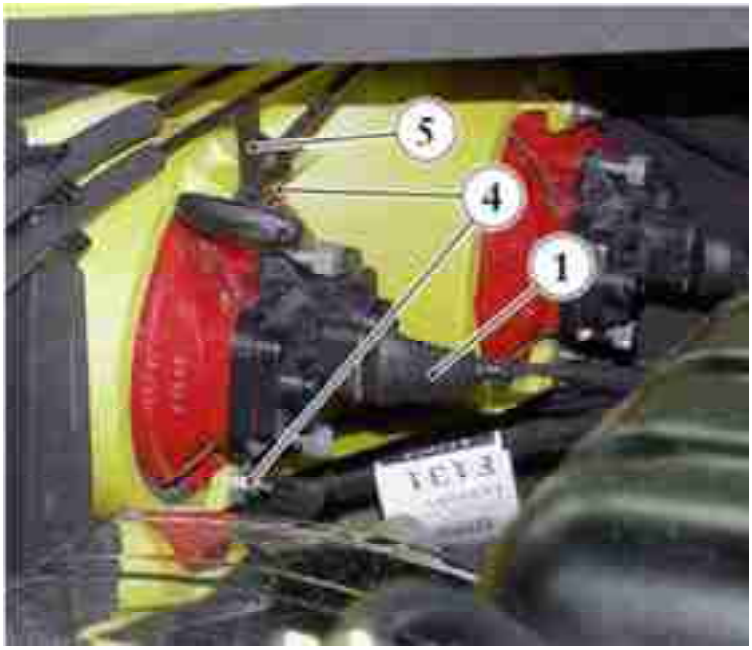


- Reconnect the harness and the battery.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

Replacing the Rear Light Bulbs

- Put the master battery switch in the **OFF** position (L 2.02).
- Detach the harness **(1)** from the bulb-holder cover.
- Unscrew the nuts **(4)** which fasten the light to the rear panel.



- Remove the entire light from the outside.
- When remounting the light, take care to position the small bracket **(5)** for the emergency fuel flap opening cable under the upper nut **(4)**.

Replacing the Auxiliary Stop Light Bulbs

The auxiliary stop light consists of LEDs connected in series. If one of these should burn out, it is necessary to

replace the entire stop light, which is located in the rear part of the engine compartment

- Put the battery master switch in the **OFF** position (L 2.02).
- Unscrew the two nuts **(6)** which fasten the light to the boot supporting brackets.

- Slide off the entire light from the outside of the engine compartment and detach the connector **(7)**.

- When reassembling, take care in adjusting the light: it must be in position with the left-hand connector seat.

For connection to the system, see Table **L** - ELECTRICAL SYSTEM.

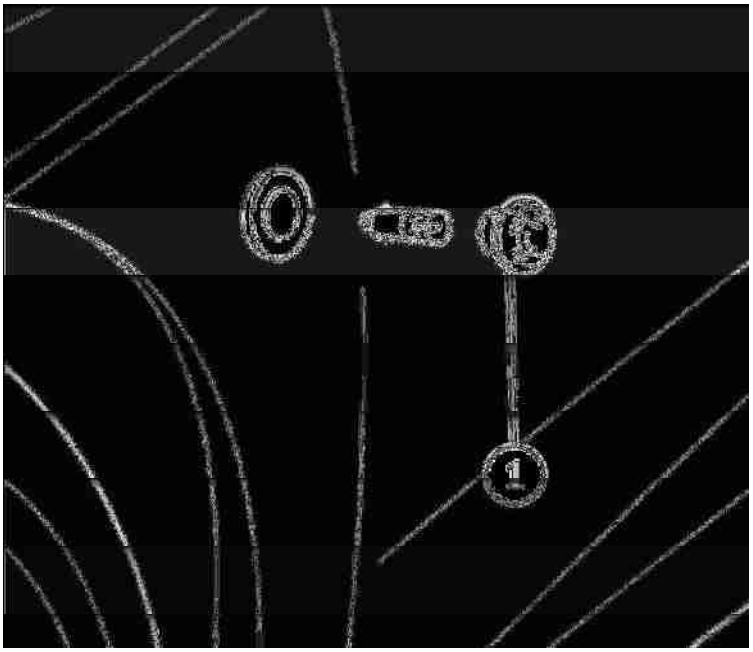
L2.08 SIDE INDICATORS

NOTE

For the characteristics of the light bulbs (L 1.03).

Replacing the Light Bulb

- Extract the outside plastic shield **(1)** taking care not to damage the bodywork.



- Remove the burnt out light bulb by pushing it down in the housing and turning it anticlockwise.
- Insert the new light bulb in the indicator body and remount the outside shield.

Replacing the Entire Indicator

- Remove the wheel (F 3.06).
- Remove the upper external part of the wheelhouse (M 2.05).
- Working on the inside of the mud guard, detach the indicator connector from the front harness.
- Slide the entire indicator out and replace it.
- When reassembling, after fitting and connecting the new indicator to the system, it is necessary to fasten the connector to the frame with plastic adhesive material.

For connection to the system, see Table **A** and **L** - ELECTRICAL SYSTEM.

Replacing the Side Marker light bulb (Only US and CDN versions)

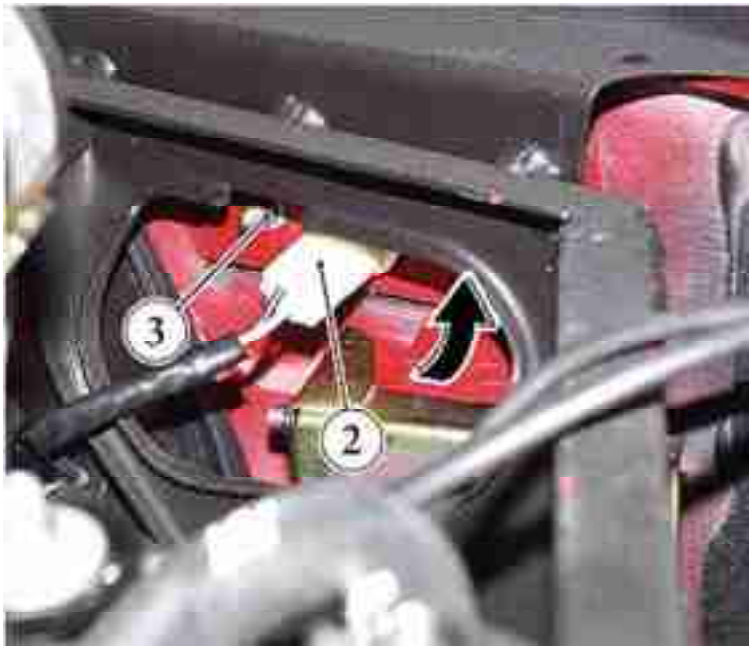
In order to gain access to the front light bulb, it is necessary to remove the inspection flap machined on the external edge of the wheelhouse (L 2.06).

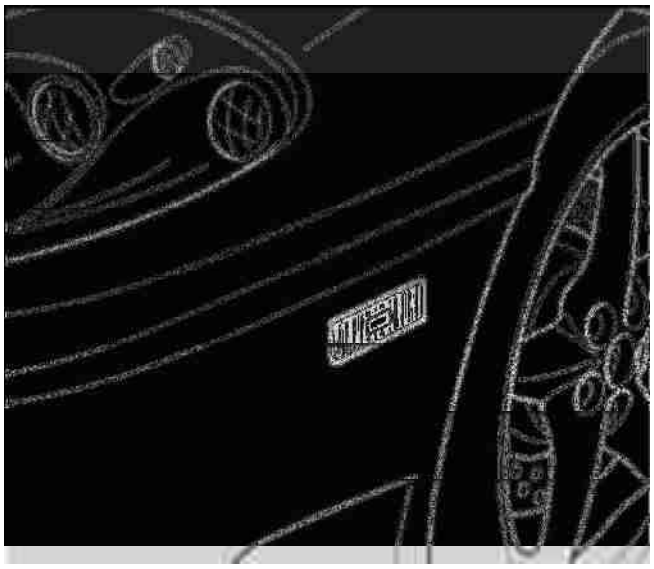
To gain access to the rear light bulb it is necessary to use the opening machined on the chassis, in the position of the side fastening for the bumpers.

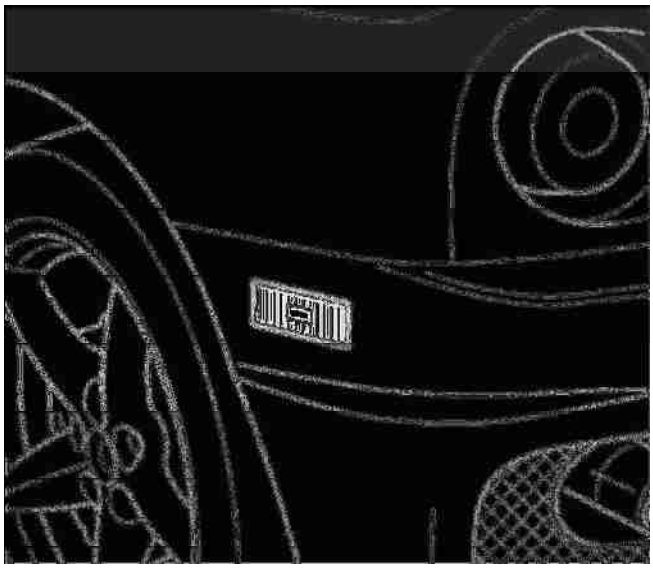
- Rotate and detach the light bulb holder **(2)** from its seat in the Side Marker.
- Extract the light bulb holder and replace the light bulb.

When replacing the entire Side Marker it is necessary, after having disconnected the harness from the system, to unscrew the two nuts **(3)** and remove the Side Marker from the outside.

For connection to the system, see Table **A** and **L** - ELECTRICAL SYSTEM.

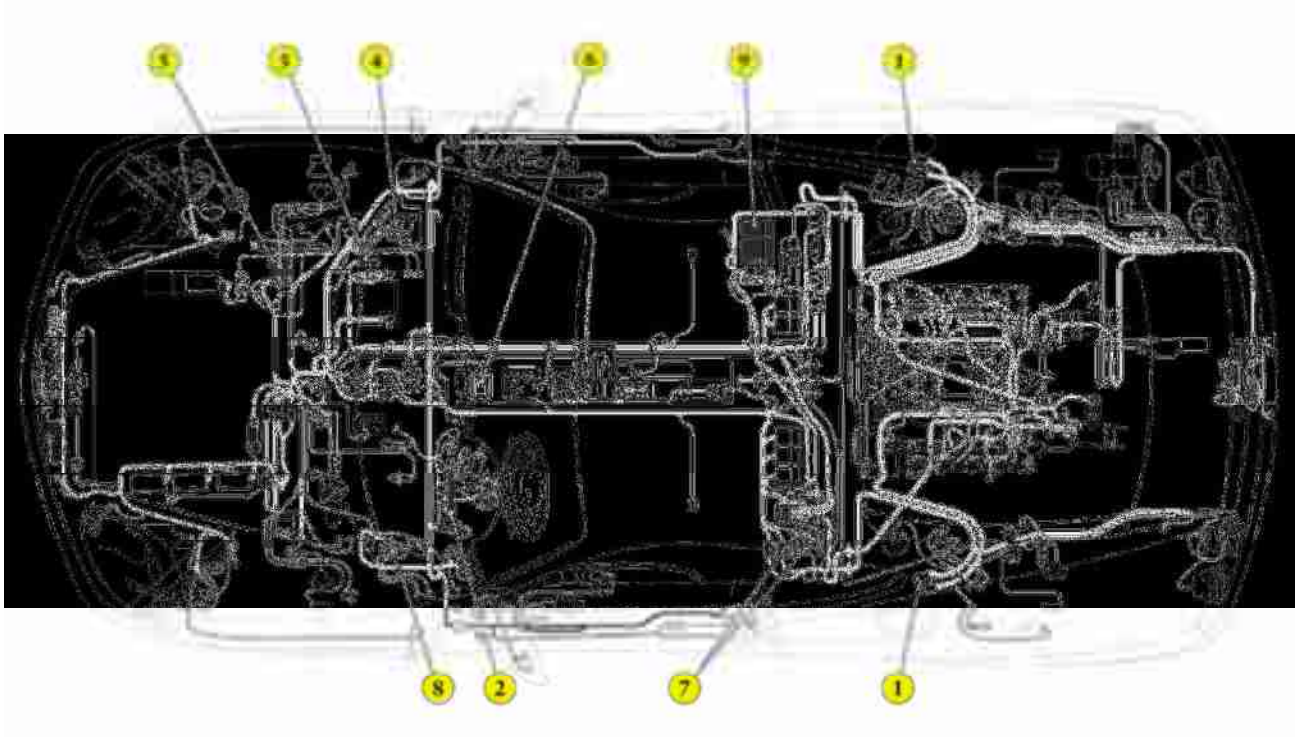






L2.09 ECUS

Each system in the car is controlled by an Electronic Control Unit **(ECU)**. These are located at various points around the car.
Their operation and replacement are described in the sections dealing with the systems of which the ECU is an integral part.
To make it easier to identify these systems, the locations of all the car's ECU's are laid out in this paragraph.



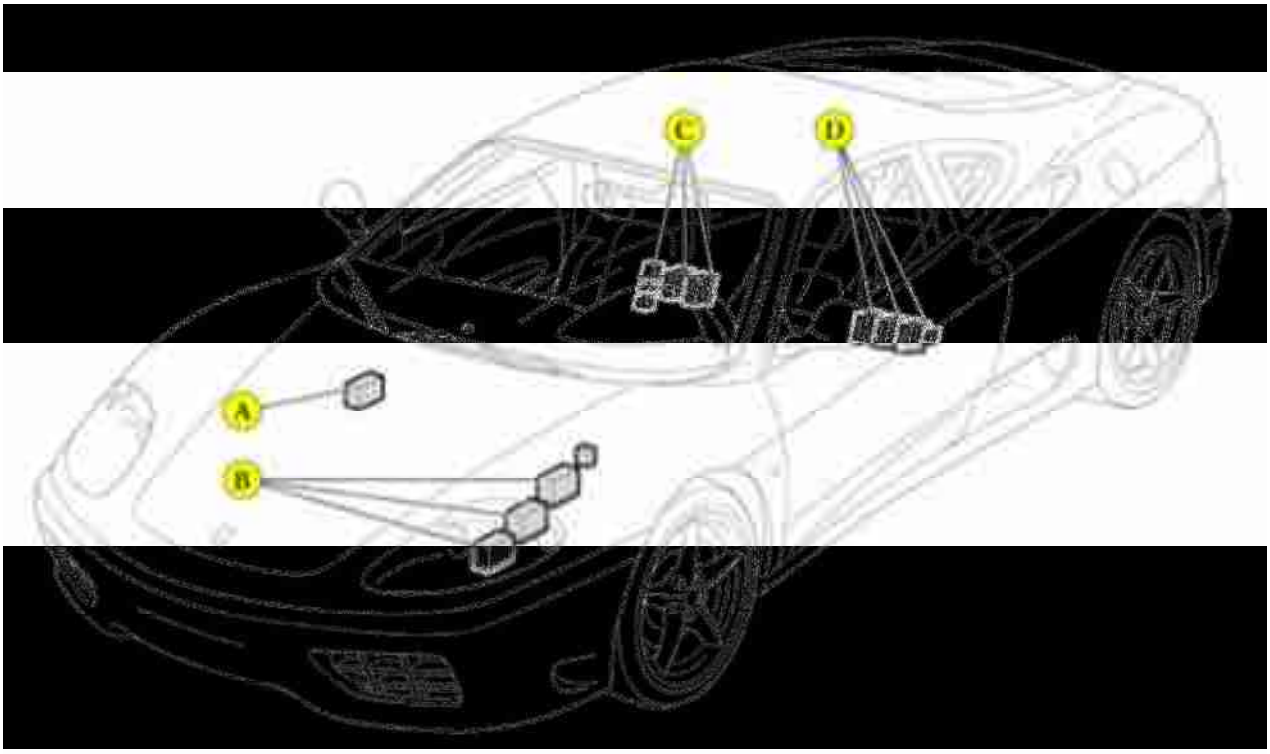
NOTES
To follow the cable connections, in order to identify the connectors and the connected devices.
*Furthermore, for every ECU, it is possible to consult the **HELP** files, used in the SD2 diagnosis system.*

Plates key

1 - Motronic (see Section **C**)
2 - Instrument panel (see Section **H**)
3 - Air conditioning (see Section **I**)
4 - Shock absorber calibration (see Section **F**)
5 - ABS-ASR (see Section **G**)
6 - Airbag (see Section **H**)
7 - Car alarm (see Section **H**)
8 - Power windows (see Section **M**)
9 - Electrically-controlled gearbox (see Section **D**)

L2.10 FUSES AND RELAYS BOXES

Location of Fuse Boxes



Plates key
A - Power fuses
B - Luggage compartment fuses and relays
C - Right-hand side passenger compartment fuses and relays
D - Left-hand side passenger compartment fuses and relays

Fuse colour

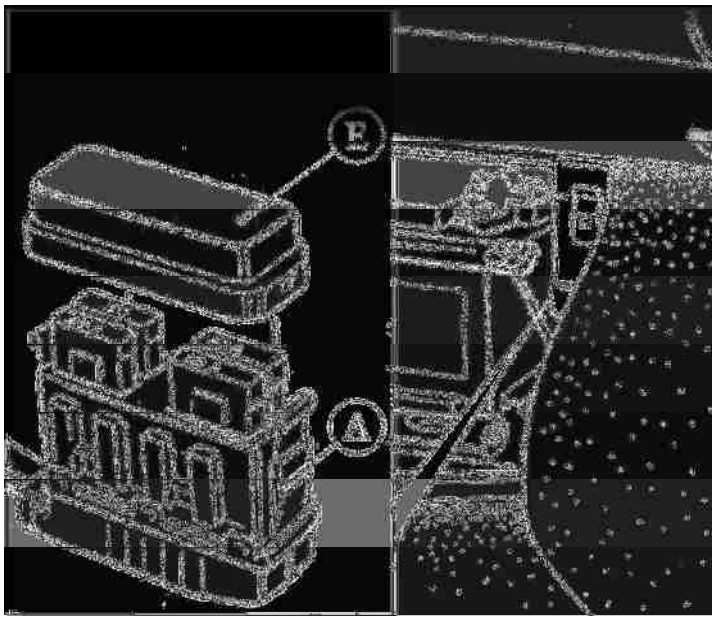
Amps	*Colour*
A5	Yellow ocher
A7,5	Brown
A10	Red
A15	Light blue
A20	Yellow
A25	White
A30	Green
A20	Yellow
A30	Green
A40	Orange
A50	Red
A60	Blue

Relay characteristics

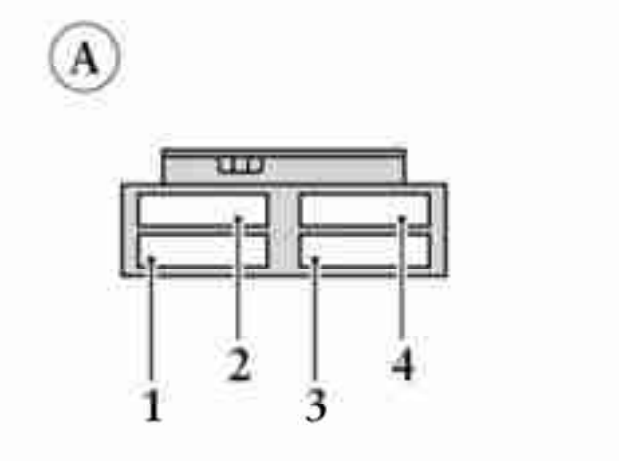
Code	*A*	*Description*	*Model*
161590	**20**	Switch micro-relay	**BOSCH 0332 017 300**
161591	**20/10**	Switch micro-relay	**BOSCH 0332 207 300**
177761	**50**	Switch relay	**ITALAMEC 516 20**
172882	**30**	Switch micro-relay	**BITRON 232003**
155437	**—**	"F1" pump relay (rif. 49)	**SIEMENS V23124-B57-X203**

A - Power Fuses

To gain access to these fuses, lower the battery protection shield (A 3.28) and remove the protection cover **(E).**



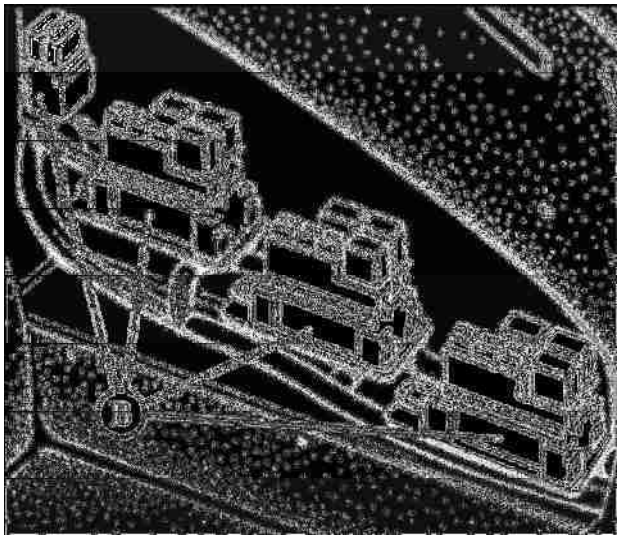
The box contains the following fuses:



Ref.	*Amps*	*Use*
1	60	Systems' protection fuses
2	50	A.C. unit
3	60	Systems' protection fuses
4	60	ABS/ASR

B- Luggage Compartment Fuses and Relays

To have access to the fuses and relays, it is necessary to remove the luggage compartment side panel (M 3.06) and the related protection covers **(E)**.



The boxes contain the following fuses:

Ref.	*Amps*	*Use*
5	**40**	RH radiator fan.
6	**30**	LH radiator fan.
7	**5**	+15 instruments
8	**—**	Not used
9	**15**	Luggage compartment light - Emergency
10	**30**	Luggage compartment lid opening actuator
11	**30**	Headlight washers
12	**—**	Not used
13	**15**	LH low beam
14	**5**	+30 Instruments
15	**15**	RH low beam
16	**15**	Horns
17	**7.5**	LH high beam
18	**7.5**	RH high beam
19	**25**	LH headlights
20	**15**	Dipped lights
21	**7.5**	License plate and switches' lights
22	**15**	High beam headlights
23	**5**	RH front and LH rear dipped lights
24	**5**	LH front and RH rear dipped lights

The boxes contain the following relays:

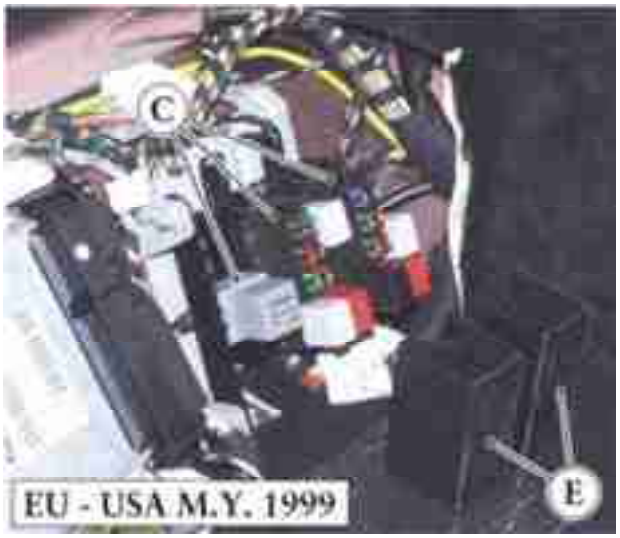
Ref.	*Amps*	*Use*
25	**—**	Not used
26	**30**	Luggage compartment lid opening actuator
27	**30**	RH radiator fan
28	**30**	LH radiator fan
29	**—**	Not used
3		Horns

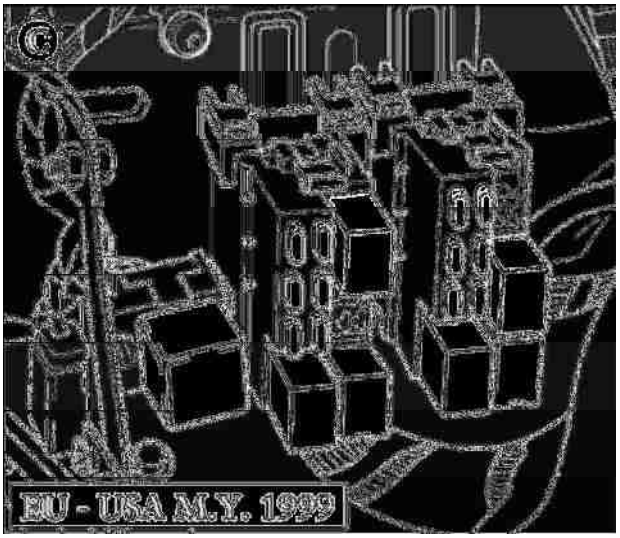
3		High beam headlights
32	**20**	Low beam headlights
33	**—**	Not used
34	**20**	License plate and switches' lights
35	**20**	Parking lights
36	**20**	Dipped lights

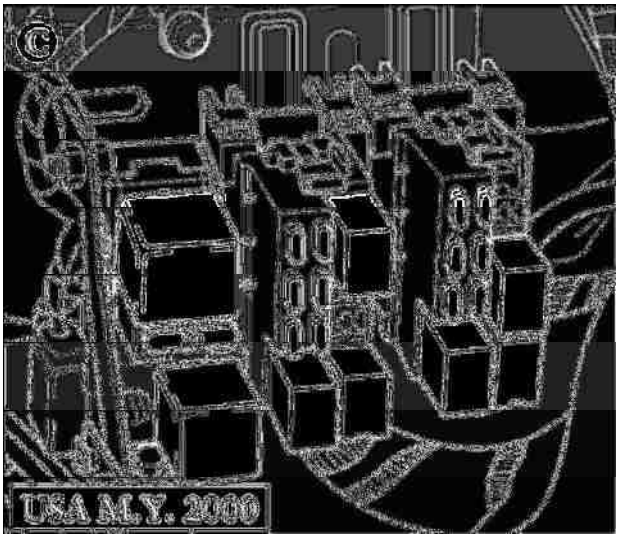
The luggage compartment light timer **(F)** is fitted under the rear housing.

C – Fuses and Relays in the Passenger Compartment, Right-Hand Side

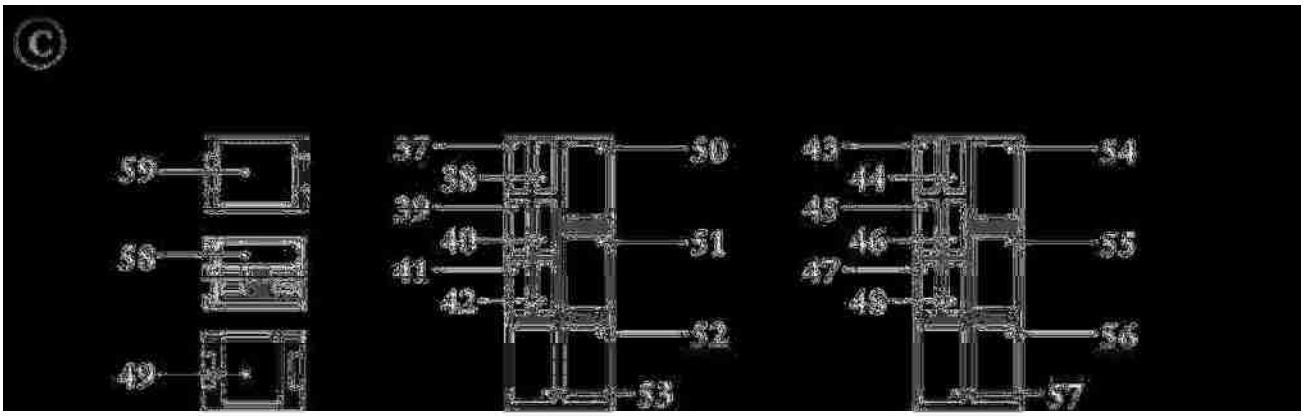
To have access to the fuses and relays, it is necessary to remove the panel covering the ECUs, behind the passenger's seat (M3.04) e i relativi coperchi di protezione.







The boxes contain the following fuses:



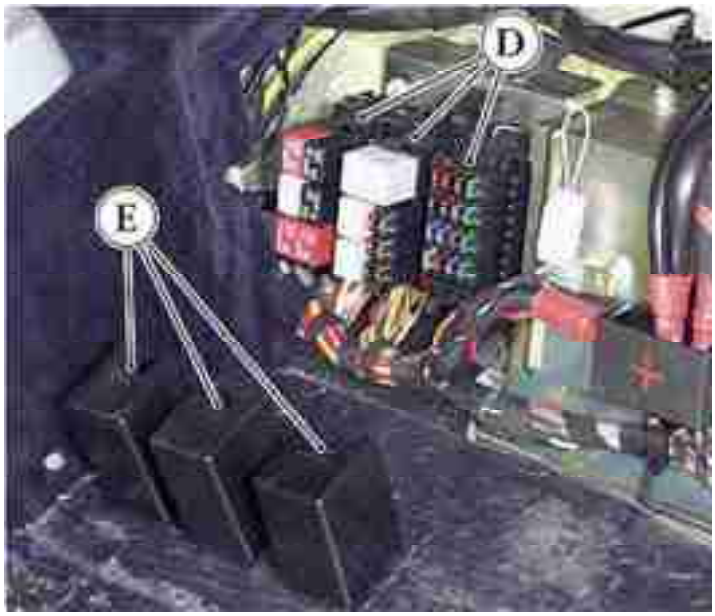
Ref.	*Amps*	*Use*
37	**5**	Phase transformer
38	**15**	Oxygen sensor
39	**10**	+RH Motronic master relay
40	**7.5**	Mirrors' defrosting
41	**30**	RH Motronic
42	**10**	+15 RH Motronic
43	**15**	+15 Radio-Clock-Wing mirrors-Light switch
44	**7.5**	+30 Motronic
45	**30**	Heated rear window
46	**10**	abs-asr
47	**30**	RH seat
48	**A10**	Stop lights
59	**50**	Air pump (US M.Y. 2000 version)

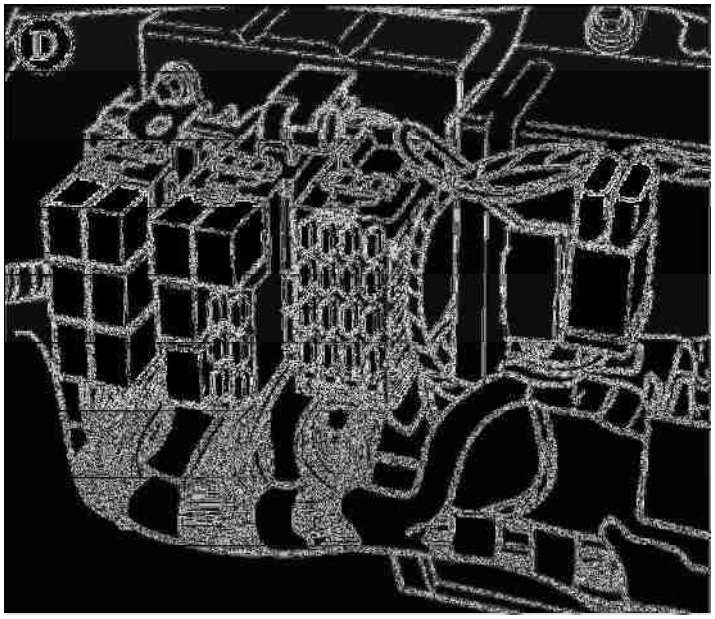
The boxes contain the following relays:

Ref.	*Amps*	*Use*
49	**—**	"F1" system pump (electrically-controlled gearbox)
50	**20**	RH fuel pump
51	**—**	Not used
52	**30**	Heated rear window
53	**20**	Phase transformer
54	**—**	Not used
55	**10**	RH Motronic master
56	**30**	Key-controlled devices
57	**30**	Windscreen wiper
58	**50**	Air pump (US M.Y. 2000 version)

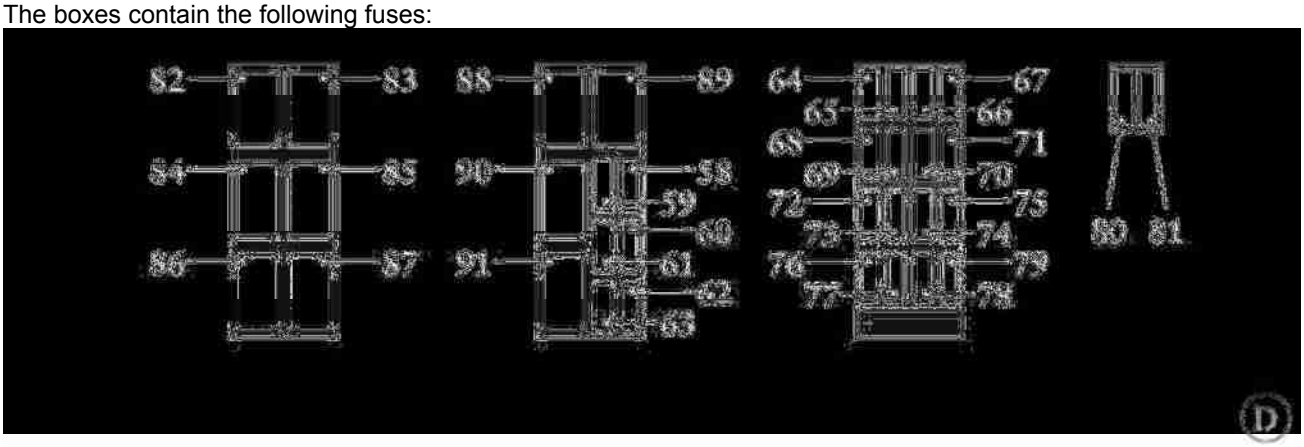
D – Fuses and Relays in the Passenger Compartment, Left-Hand Side

To have access to the fuses and relays, it is necessary to remove the panel covering the ECUs, behind the driver's seat (M3.04) and the respective protection covers **(E)**.





The boxes contain the following fuses:



Ref.	*Amps*	*Use*
58	**15**	Oxygen sensor
59	**10**	+ LH Motronic master Relay
60	**30**	LH Motronic
61	**10**	+15 LH Motronic
62	**5**	+15 devices
63	**7.5**	A.C. Compressor
62	**10**	Water recirculation pump
65	**7.5**	Rear fog lights
66	**7.5**	+30 Motronic
67	**30**	LH seat
68	**7.5**	Reverse gear
69	**10**	+30 Radio
70	**15**	Ceil. lights - Cigar lig. - Park.lights - Doors light - Glove comp. lights
71	**30**	Side powered window
72	**15**	Battery charger
73	**15**	+30 door lock
74	**5**	+30 anti-theft alarm
75	**30**	Driver's side powered window
76	**25**	Windscreen wiper
77	**10**	+15 Check Shock absorbers - AirbaG
78	**15**	+30 ignition switch
79	**30**	Starter motor
80	**30**	"F1" system pump (electrically-controlled gearbox)
81	**20**	"F1" gear box (electrically-controlled gearbox)

The boxes contain the following relays:

Ref.	*Amps*	*Use*
82	**30**	+30 windscreen wiper
83	**30**	Rear fog lights
84	**30**	Cut-out of start-up with battery charger
85	**30**	Devices
86	**30**	Start-up
87	**30**	Devices
88	**20**	LH Motronic master
89	**20**	LH fuel pump
90	**20**	A.C. Compressor
91	**20**	Reverse gear

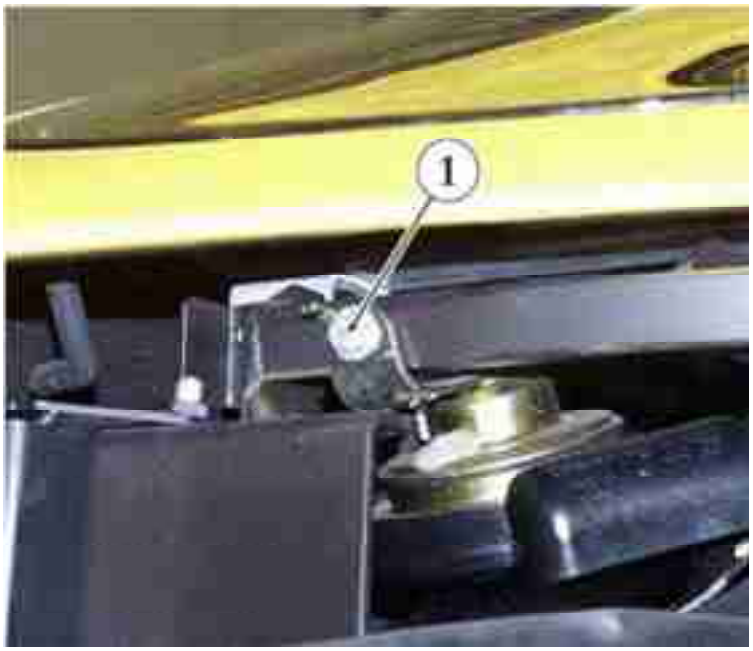
L2.11 HORN

This is made up of two elements, mounted on the frame, underneath the front bumper.
The two horns are identical, the only difference is the position of the supporting bracket.
In the event of the horn malfunctioning, before replacing it, check the system connections (see Table **A** - ELECTRICAL SYSTEM).

Replacing the Horn

- Remove the front bumper (M 2.03).
- Remove the fastening screw **(1)** on the front frame.

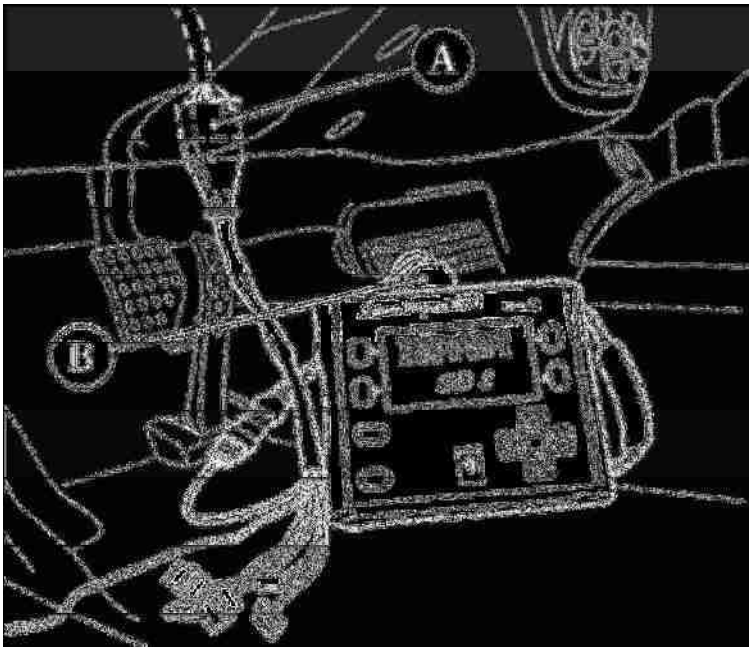
For connection to the system, see Table **A** - ELECTRICAL SYSTEM.



- Remove the horn together with the supporting bracket and detach it from the harness.

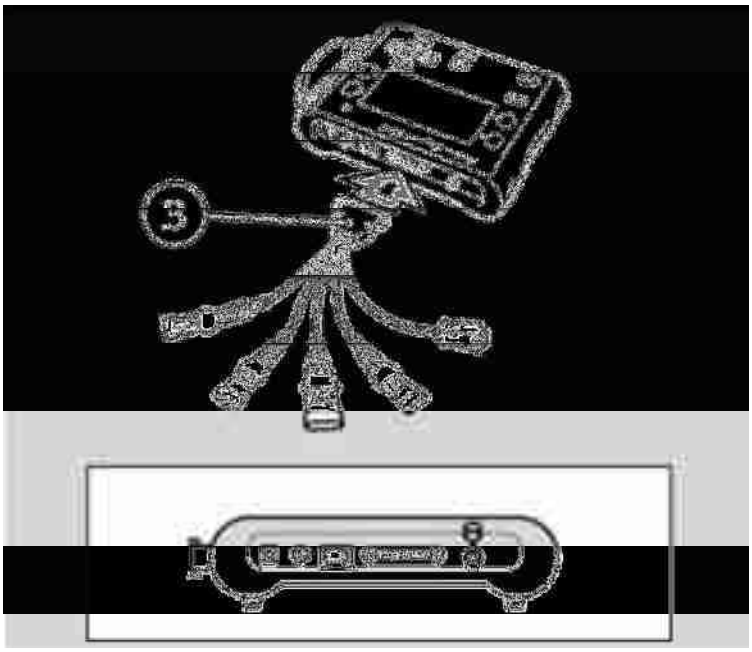
L2.12 DIAGNOSIS TESTER PLUG-IN

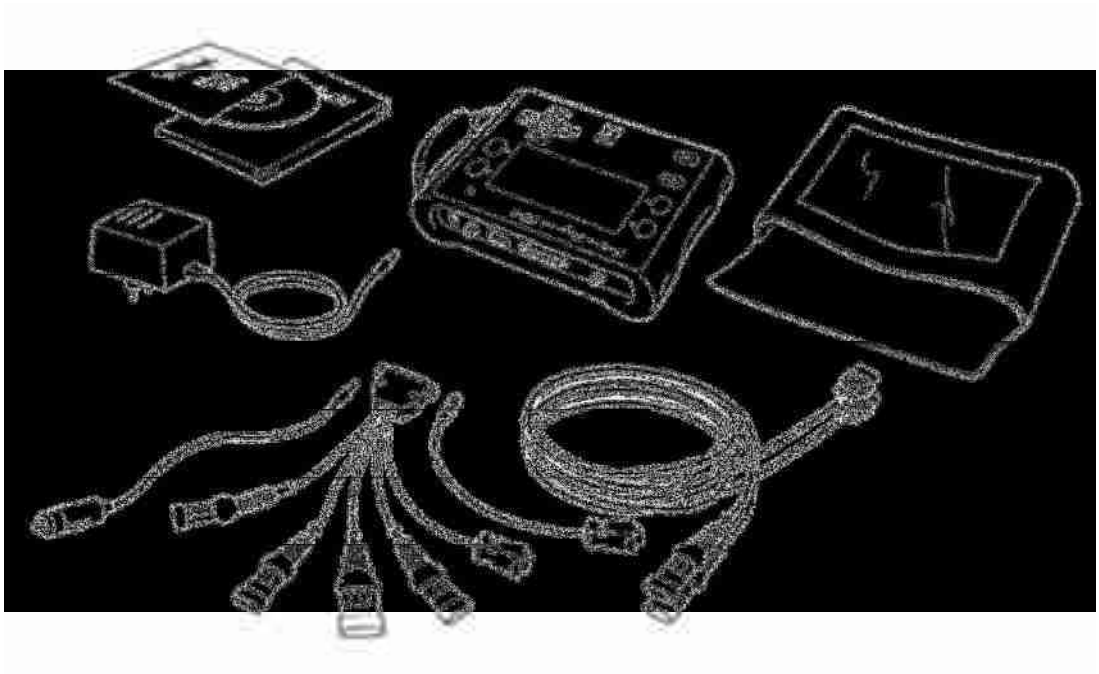
The car is fitted with a single connector **(A)** for the connection with the SD-2 diagnosis tester. Said connector is located under the lower covering of the dashboard, in position with the steering column.
By means of this connector, the tester can interface with all the car's systems and carry out the diagnosis.
The tester must be connected to the connector **(A)** by means of the cable bundle **(B)** supplied with the unit.



As well as the cable bundle **(B),** the SD-2 tester is also supplied with a set of connection cables, the feeder, a CD-ROM containing the diagnosis programme, an instruction manual and the storage case.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.





L3.01 CHECKING THE ELECTRICAL SYSTEM ABSORPTION

To check the background power absorption required by the devices connected directly to the positive pole of the battery, proceed as follows:

- Keep the ignition key in the **0** (stop) position.
- Remove the passenger-side footrest (A 3.28), to gain access to the battery.
- Use a **Beckman** digital multimeter, type **T11 OB**, set to measure currents of up to 200 milliamperes and suitably calibrated.
- Connect the tester between the negative and earth terminals and wait for 5 minutes.
- Disconnect the battery using the battery master switch (L 2.02).
- Close the doors, the luggage compartment and engine compartment (if the luggage and engine compartments must be kept open to access the connections, simulate closure with the lock/switch).
- At this point, check the no-load current with the tester.

No-load maximum current: 30 mA

If the no-load absorption exceeds the level indicated, you must perform the necessary checks to identify the cause of the dispersion, in order to bring the absorption back to the correct level range.
If there are supplementary systems fitted in the vehicle (satellite alarm system, etc.), the absorption will exceed the value shown.

NOTES
The power absorption rate is extremely important as it has a major influence on the battery maintenance programme (L 3.03).

If, following the installation of new devices, the battery tends to run down too quickly, check the electrical system and, if no faults are found, it is advisable to recharge the battery **at least every 15 days** (A 3.28).

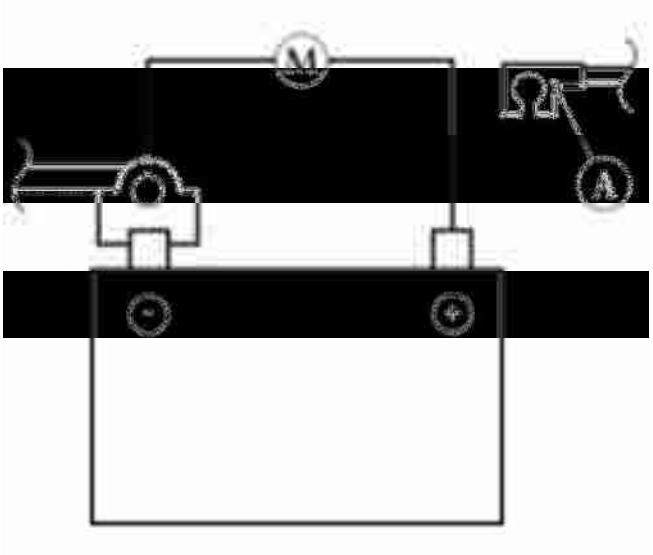
In the event of an emergency start-up (when the battery is flat) it is necessary to connect it to an external battery and/or a stabilised battery charger, using the battery's positive and negative poles.
If the car remains unused for prolonged periods, you are advised to disconnect the battery from the system, using the master battery switch. In any case, always follow the instructions contained in paragraph (L 3.03).
If you do not wish to disconnect the battery to keep certain devices functioning, such the radio station memorisation, the car alarm system etc., it is essential to recharge the battery **at least once a month** (A 3.28).

L3.02 CHECKING THE BATTERY CHARGE LEVEL

If you are in doubt about your battery or it if shows signs of inefficiency, check its charge level.
For the purposes of such a check, the battery must be at room temperature (between **15** and **25 °C**) and must have been resting for at least 6 hours, i.e. it must not have been connected to any devices, even if these absorb only a few milliamperes. To achieve these conditions, turn the battery master switch to the **OFF** position (L 2.02).
Then proceed as follows:

- Remove the passenger-side footrest (A 3.28), to gain access to the battery.

- Detach the positive terminal **(A)** from the battery.
- Using a **Beckman** digital multimeter type **T11 OB (M),** which must be suitably set, connect the instrument terminals to the battery poles.



- Read the voltage value on the multimeter display, taking into account the hundredths of a volt too and compare it with the values given underneath.

Battery voltage	Over 12.55 V	OK
	Under 12.55 V	Recharging is necessary

In the event that the display shows the battery is insufficiently charged, it is necessary to recharge it (L 3.03) or replace it.
Once the battery has been recharged, make sure it maintains the same charge over time by carrying out a test under full-load conditions.
For said test, use a battery testing instrument which can measure currents ranging from **200** to **300 ampères**.
Test the battery in the following way:

- connect the battery testing equipment to the battery terminals;
- measure the temperature of the latter;
- set the battery testing equipment to a discharge current equal to **75%** of the figure indicated on the battery plate (Closed Loop);
- use the battery under full load for **15 seconds** and read the voltage, always keeping the battery under full load;
- compare the voltage measured (with open circuit) with the limits indicated in the following table.

Charging level (Volt)	*Charging percentage (%)*
Higher than **12.70**	**100**
Between **12.45** and **12.70**	**75-00**
Between **12.36** and **12.45**	**50-75**
Lower than **12.36**	**0-50**

If the voltage measured under full-load conditions is lower than the voltage indicated in the table, the battery must be considered faulty and must be replaced.

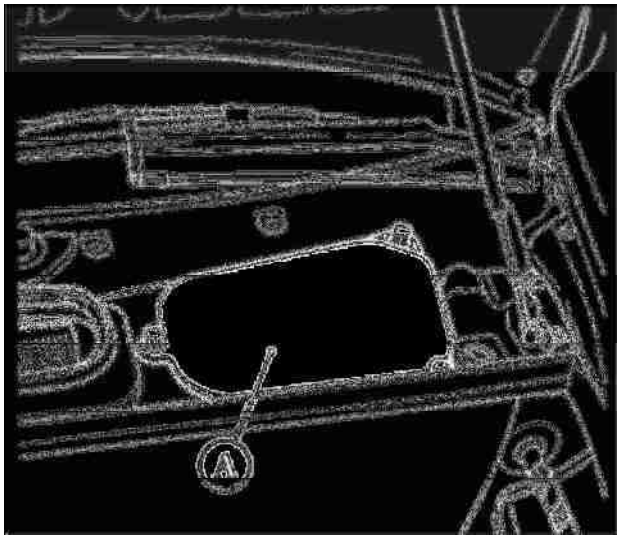
IMPORTANT
Check the tester setting regularly.

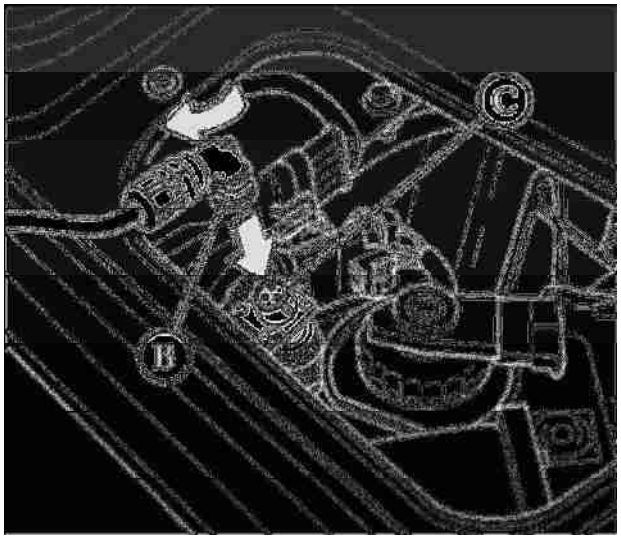
The battery charging level can be considered sufficient if it is higher than **75-80%**; the multimeter display must show voltage levels which are not lower than **12.50-12.55 Volts.**
If the voltage levels measured are lower, it is necessary to recharge the battery (L 3.03).
You are reminded that, once the battery has been recharged, the voltage of the poles is not a faithful indication of the charging levels because of the electrolyte stratification inside the battery. This phenomenon occurs when the electrolyte has not yet mixed evenly; however, this condition is obviously achieved when the battery is in use.

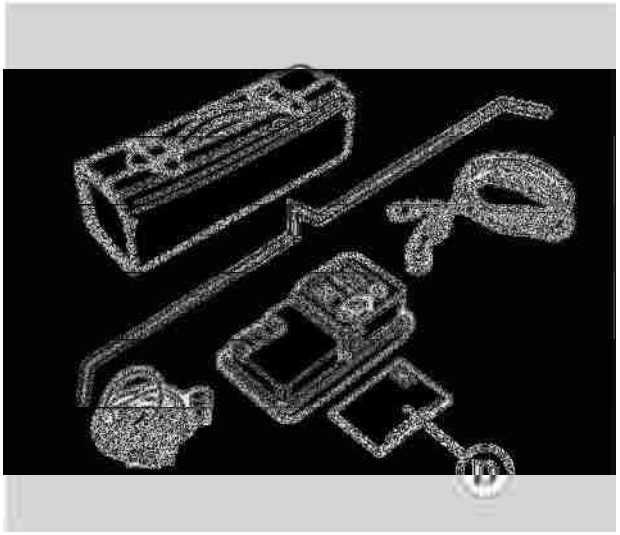
L3.03 RECHARGING THE BATTERY

Battery charger

Cars which are pre-set for the Ferrari battery charger, are equipped with a power socket. This can be accessed through the opening machined under the inspection cover **(A)** for the brake/clutch fluid reservoir.
Attach the connecting wire connector **(B)** to the power socket **(C)** and use the battery charger according to the instructions contained in the booklet **(D)** which is supplied with the device.







Follow the information here below, for cars which do not feature a battery charger socket:

- Remove the passenger-side footrest (A 3.28), to gain access to the battery.
- The battery must be kept at room temperature (**15-25 °C**). The charging time increases at lower temperatures.

IMPORTANT

To safeguard the electrical components fitted in the vehicle, always use a battery charger with a max. constant voltage of 14.4 ÷ 15V and a charge current limiting device before recharging it (A 3.28).

- Turn the battery charger to **12 V**, and connect it to the battery terminals.

CAUTION

Lead acid batteries do not produce gas during recharging, but the voltage values must be observed to prevent potential swellings and explosionsof the accumulator.

- Measure the voltage at the battery terminals with a multimeter (L 3.02).

Charge	*Voltage*	*Current*	*Time*
Standard	14.4 ÷ 15V max	max 6 ÷ 12 A (10 ÷ 20% battery capacity)	12 ÷ 24 hours
Quick	14.4 ÷ 15V max	18 ÷ 30 A (30 ÷ 50% battery capacity)	4 ÷ 6 hours
From completely flat, battery with voltage of 10 ÷ 9 V	14.4 ÷ 15V max	1 ÷ 2 A	12 ÷ 24 hours (then proceed with the “standard” charging)

Ensure the external temperature of the battery never exceeds **45°C** during recharging. If this does occur, stop recharging for a few hours, then resume and complete the procedure.

Checking the Charge Level

- Check the charge levels according to the procedure indicated in (L 3.02).

Recharging Intervals

- *Car inactive and battery connected*

It is necessary to recharge the battery, if the car is left unused for a long period of time.
The recharging intervals should correspond to those indicated in the table that follows, according to the system absorption as described in (L 3.01).

Absorption (mA)	*Interval (days*
< 40	
-60	
-80	
80-100	**10**

- *Car inactive and battery disconnected/battery in storage*

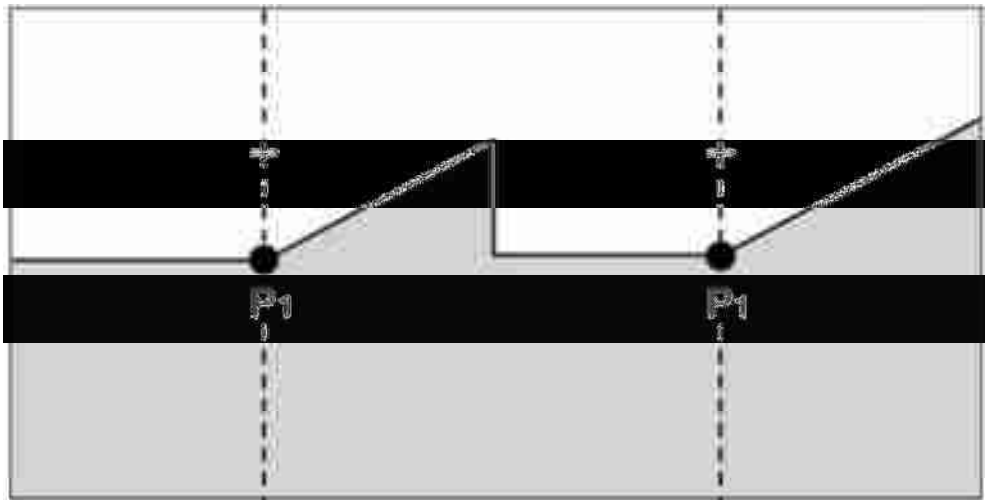
If the battery is put in storage, or the car is parked with the battery disconnected, recharging must be carried out **at least once every three months**.
It is also necessary for the parking area to be free of dampness and the temperature to be kept at approximately **25 °C**.
void temperatures of **over 30 °C** since this increase in the room temperature will cause the battery to run down.

Other warnings

- If the battery charge level is found to be less than **75%**, the battery must be recharged with a normal charger.
- If the instruments with cut-out functions are used, **make sure the voltage regulator starts recharging when the battery voltage is lower than 12.55-12.60 V**. If in doubt, contact the supplier of the device and have the regulator set.
- if the battery is left flat for a long period, this could cause permanent damage, to such an extent that the battery can no longer be used. The extent of the damage depends on the amount of time and the temperature at which the battery has been left in this condition.

L3.04 HEADLIGHT AIMING

- Place the car, without occupants or loads and with the tyres at the prescribed pressure, on flat ground facing a white screen situated in the shade.
- Mark two crosses on the screen which correspond with the centre of the low beams.
- Move the car backwards **10 metres** and turn on the low beams (external headlights). The light beam reference points **P1** (see **Fig. 1**) must appear underneath the crosses, which correspond with the centre of the headlights, at **1/10** of the distance between the ground and the crosses themselves.



NOTES

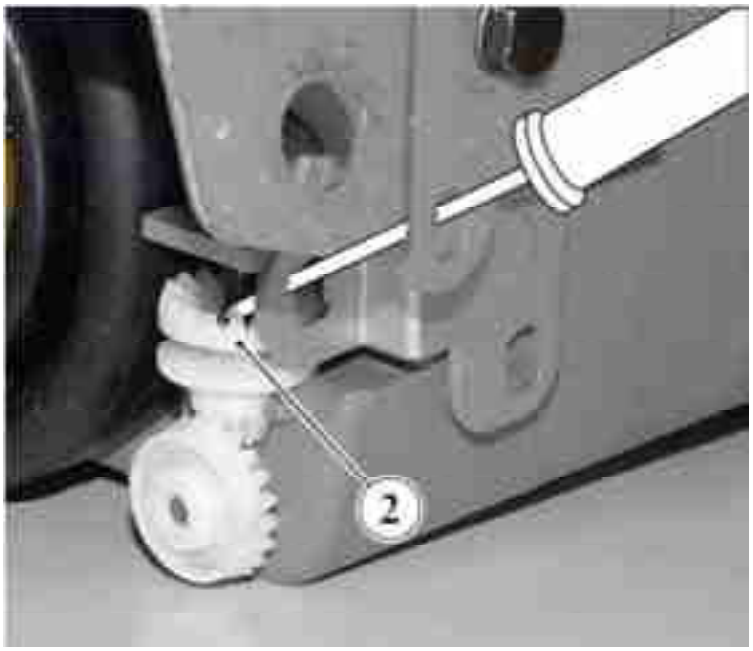
The values above refer to the laws currently in force in Italy. For other countries, comply with the local legislation.

To modify the vertical aiming of the headlights, proceed in the following way.

- Within the side upholstery of the luggage compartment, remove the plug for the headlight adjusting screw hole.
- Use the adjusting screw **(1)** to aim the light beam upwards or downwards.

To adjust the light beam horizontally, it is necessary to work through the hole mentioned above.

- Fit the head of a Philips screwdriver (medium-sized) in the conical gear **(2)**, located in the lower part of the headlight.


2

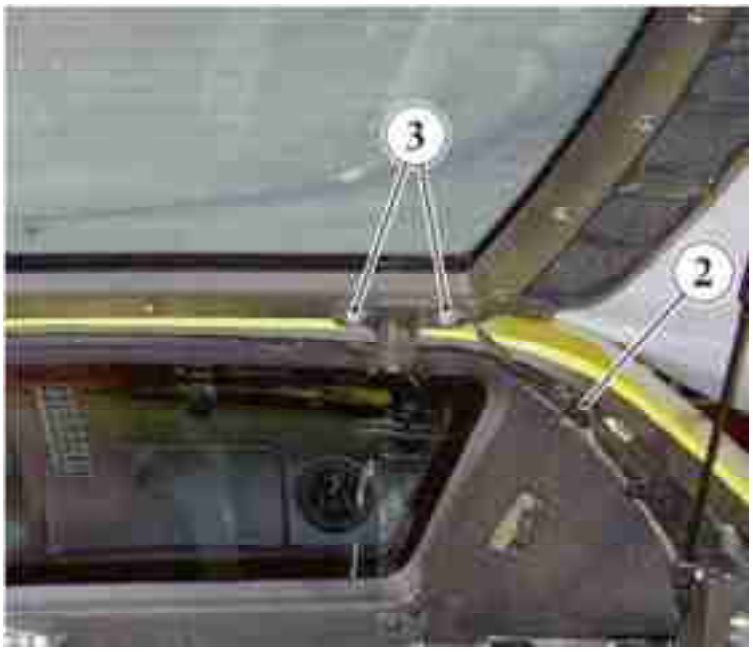
M2.01 ENGINE COMPARTMENT LID

To release the engine compartment lid lock, use the lever located on the left-hand door rear pillar or, if this fails to work, pull the ring on the emergency wire, which is placed in the fuel-filler compartment (H 2.13).
An alarm system micro-switch is fitted on the lock (H 3.01). This switch is activated upon closing the lid.
The auxiliary stop light is installed in the rear part of the engine compartment lid (L 2.07).
When carrying out maintenance works at the prescribed intervals (see PROGRAMMED MAINTENANCE PLAN) the lid hinges and lock must by lubricated with protective water-repellent grease.

Disassembly

- Remove the hinges' protections **(1)** by unscrewing the four fastening screws.

- Remove the lid supporting struts from the ball joints on the chassis.
- Remove the right-hand shield of the engine compartment (M 2.13).
- Detach the heated rear window connection **(2)** from the right-hand engine compartment harness.



- Unscrew the screws **(3)** fastening the hinges to the engine compartment.

- Remove the entire lid and keep any spacers under the hinges.

Products

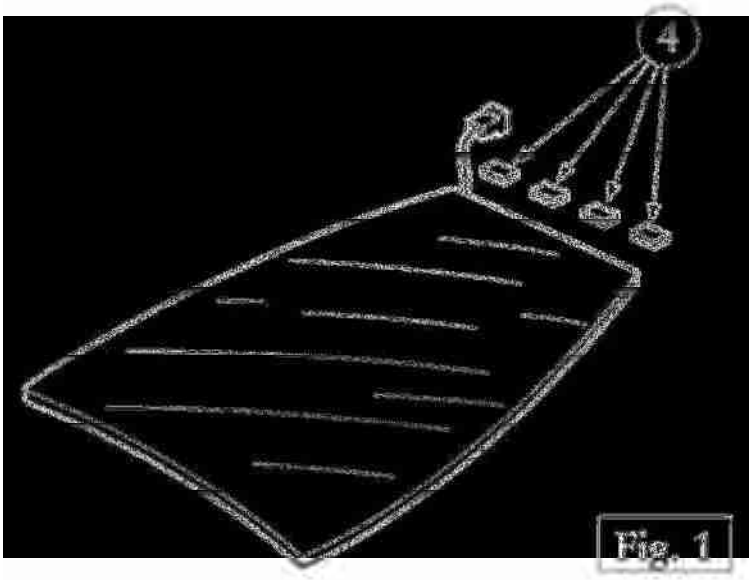
- Activator	**BETAWIPE VP 04604**	**cod. 63397600**
B - Primer for paint/plastic	**BETAPRIMER, RED cap**	**cod. 62864900**
C - Primer for glass	**BETAPRIMER, GREEN cap**	**cod. 62864800**
D - Adhesive primer	**BETASEAL 1703**	**cod. 64954900**

Tightening torques

Screws fastening the hinge to the frame	**26 Nm**
Screws fastening the lock striker plate to the lid	**7,4 Nm**

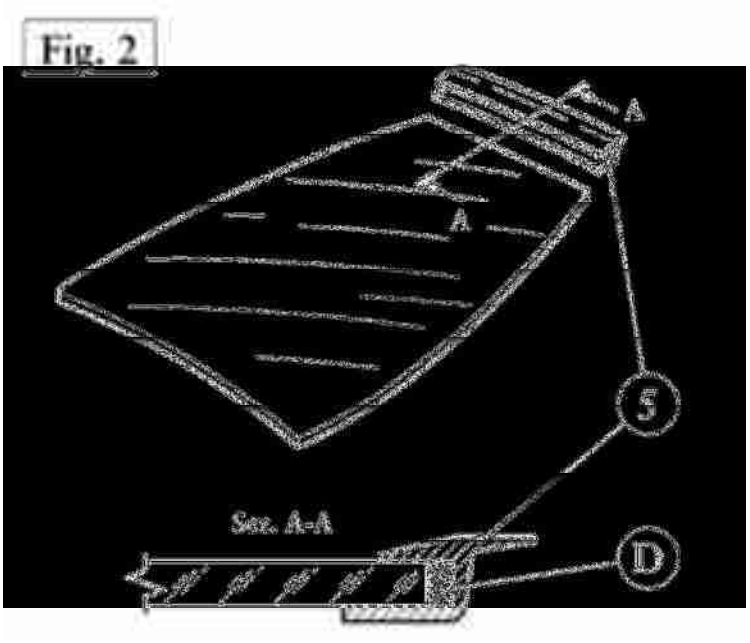
Rear Window Replacement

- Remove the damaged window from the lid, using a heated knife with a special blade.
- Remove all traces of primer from the lid surfaces.
- To avoid contact with the primer, protect the painted parts of the lid and the silk-screen printed parts of the window with adhesive tape.
- Rest the new glass flatwise on the external side, on a suction support.
- Degrease the perimeter using activator **(A)**.
- Take four spacers (**4**, Fig. **1**) and, after having removed the protective paper, fit them on the inner front side of the glass, spacing them suitably.

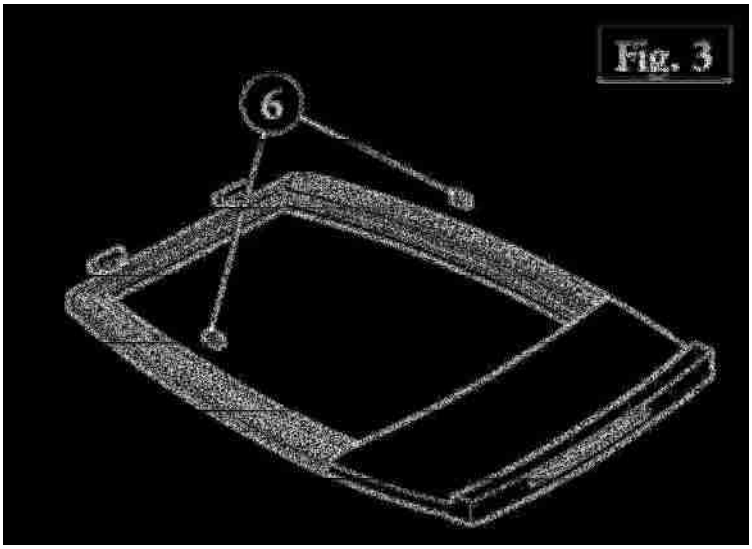


- Take a new strip (**5**, Fig. **2**) and degrease the internal seat using activator (**A**).
- Use a brush to apply primer (**C**, **GREEN** cap) onto the internal seat of the strip.
- Let the product dry for about ten minutes, then apply a uniform and continual line of adhesive primer (**D**) to the internal seat of the strip.
- Fit the strip (**5**) on the glass, keeping it pressed for some minutes.

IMPORTANT
The strip should, if possible, be fitted within ten minutes of applying the adhesive.

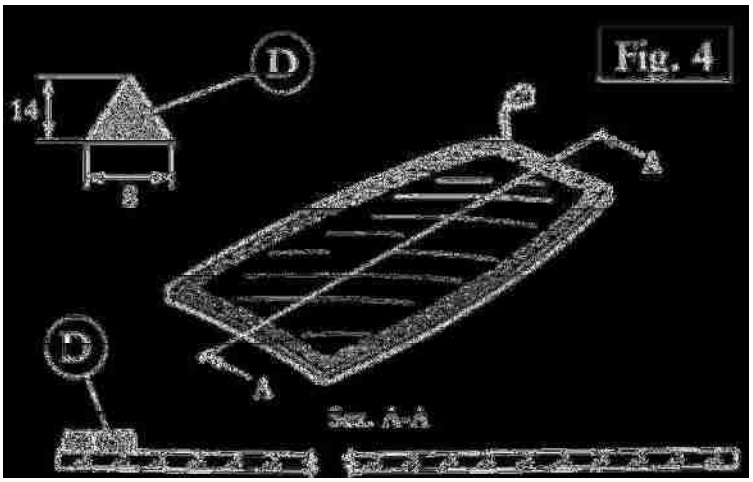


- Degrease the glass' resting surface on the lid, using activator **(A)**.
- Use a brush to apply primer (**B**, **RED** cap) to the degreased surface.
- Leave the product to dry for about ten minutes.
- Fit a spacer **(6**, Fig. **3)**, level with the centre line of each grille, onto the engine compartment lid.

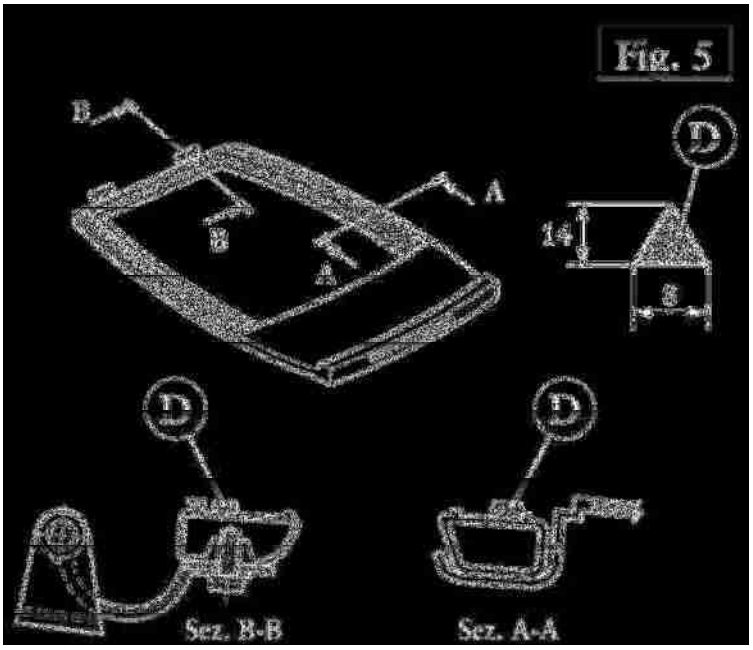


-

- Then apply adhesive primer (**D**) to the glass using a extrusion gun, equipped with a triangular section nozzle (Fig. **4**).
- Apply the product evenly to the inside of the glass.
- Even the strip of product using a spatula and check there are no interruptions: if necessary, reapply the product to the broken stretches

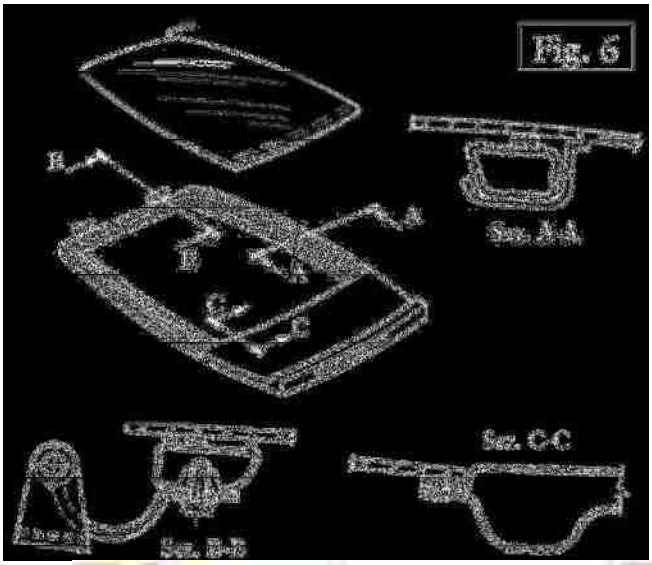


- Apply adhesive primer (**D**) to both sides and to the front part of the engine compartment lid, using the same procedure used for the glass (Fig. **5**).

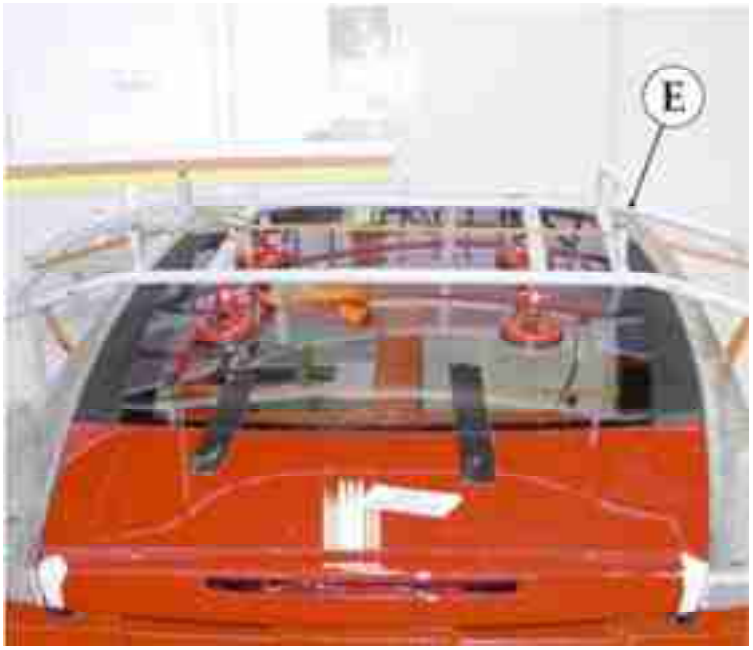


- Using the special suction handles, fit the glass onto the engine compartment lid (Fig. **6**), centering it in the opening available and aligning the upper end with the outer section of the grilles.

IMPORTANT
The glass should, if possible, be fitted onto the lid within ten minutes of applying the adhesive.



- Apply the holding frame **(E)** and let it rest for at least four hours.

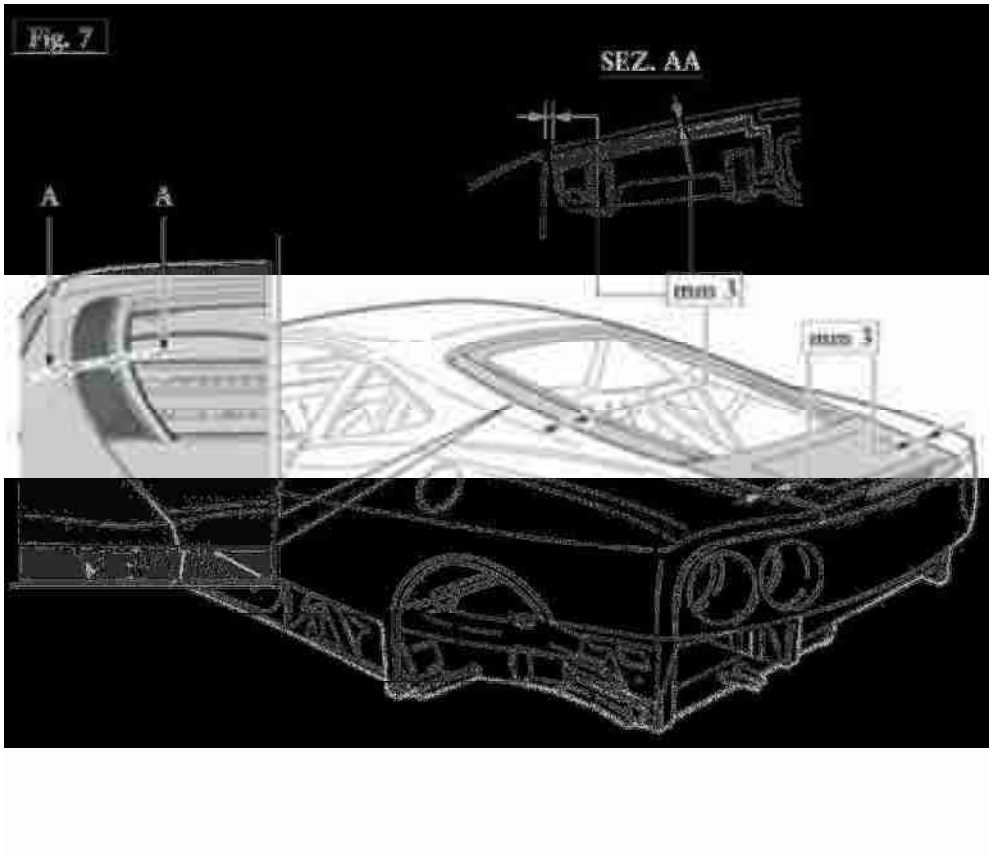


- Remove the masking tape and clean the rear window as well as the painted areas of the engine compartment lid.

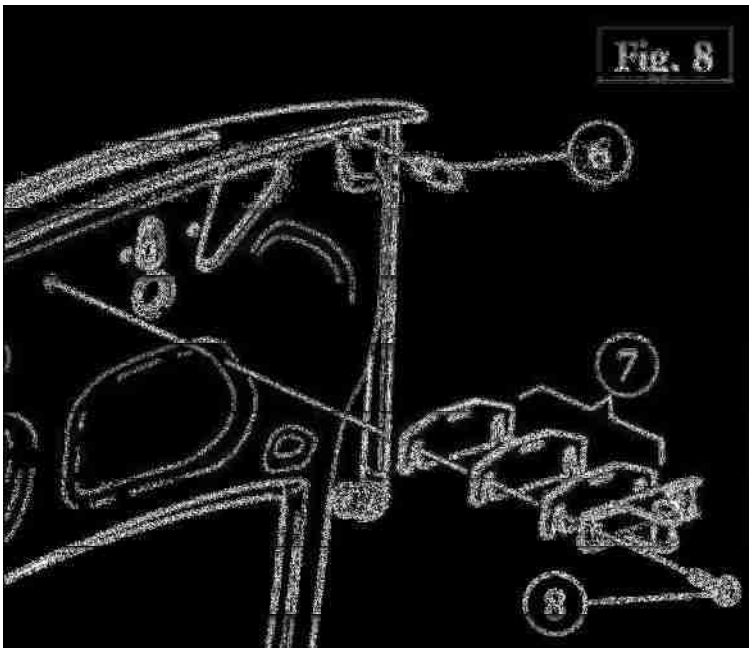
Re-assembly

- The entire engine compartment lid must be re-mounted on the bodywork by fastening the hinges with the screws **(3)** without locking them.

- Lower the engine compartment lid and check that the latch is working properly. Carefully check that the lid lies in central position on the bodywork and that it is not protruding (see Fig. **7**).



The lid position can be adjusted by means of the spacers, on the hinges, the dowels **(6,** Fig.**8)** and the plates **(7)** of the lock striker plate, on the engine compartment lid (H 2.13).



- After having correctly adjusted the lid position, lock the screws **(3)** and **(8)** tightly to the prescribed tightening torque.
- Connect the engine compartment harness and re-assemble the components which had been removed for the procedure.

M2.02 LUGGAGE COMPARTMENT LID

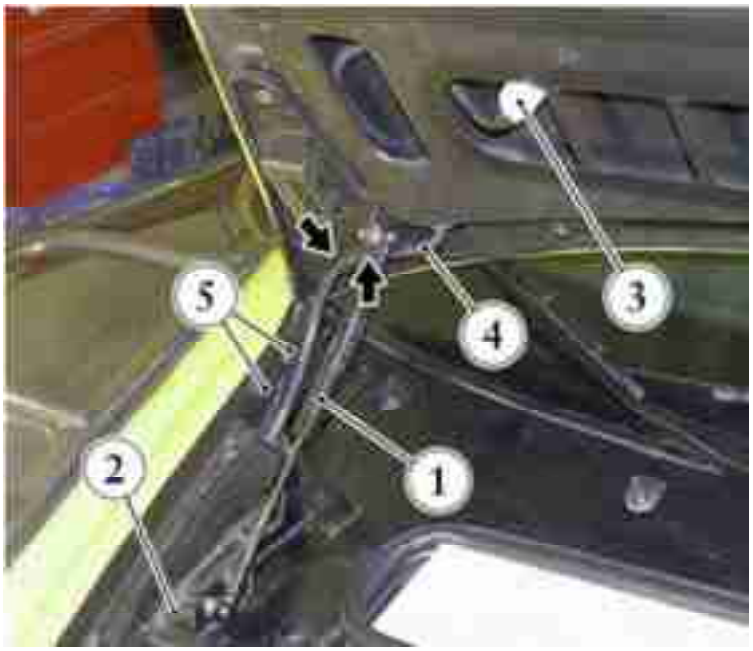
The switch for the luggage compartment lid opening is located on the central console. In the event that this device fails to work, an emergency opening wire is installed under the lower dashboard upholstery, on the left-hand side of the steering column (H 2.13).
An alarm system micro-switch is fitted on the lock (H 3.01). This switch is activated upon closing the lid.
When carrying out maintenance works at the prescribed intervals (see PROGRAMMED MAINTENANCE PLAN) the lid hinges and lock must by lubricated with protective water-repellent grease.

Tightening torques

Hinge fastening screws	**15 Nm**
Screws fastening the lock striker plate	**14 Nm**

Disassembly

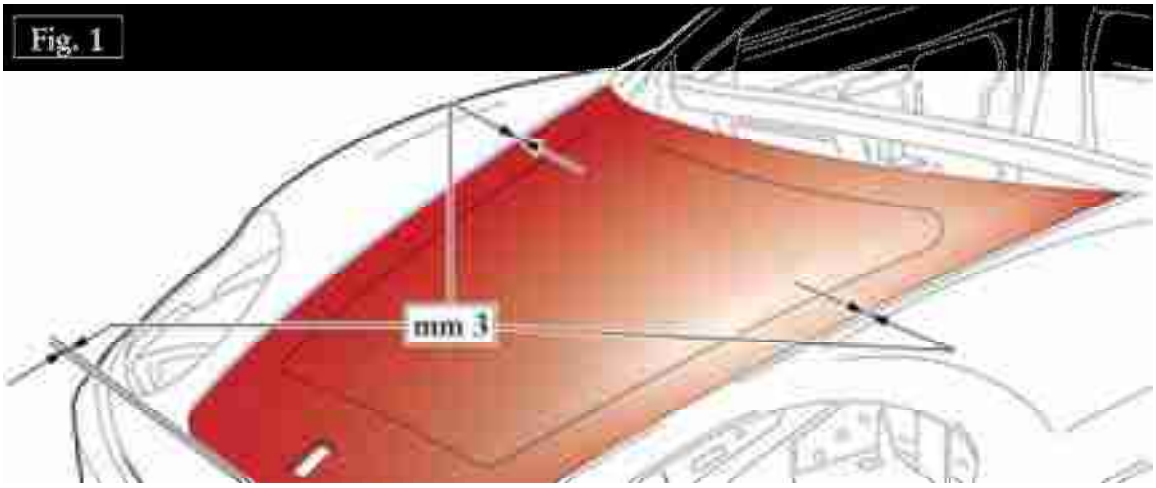
- Detach the gas struts **(1)** supporting the lid from the ball joints on the pawl support **(2)**.
- Remove the hinge supporting clamps and slide out the windscreen washer system pipe **(4)** from the check valve **(3)** located in the interspace within the bonnet.
- Unscrew the screws **(5)** fastening the lid hinges to the bodywork.



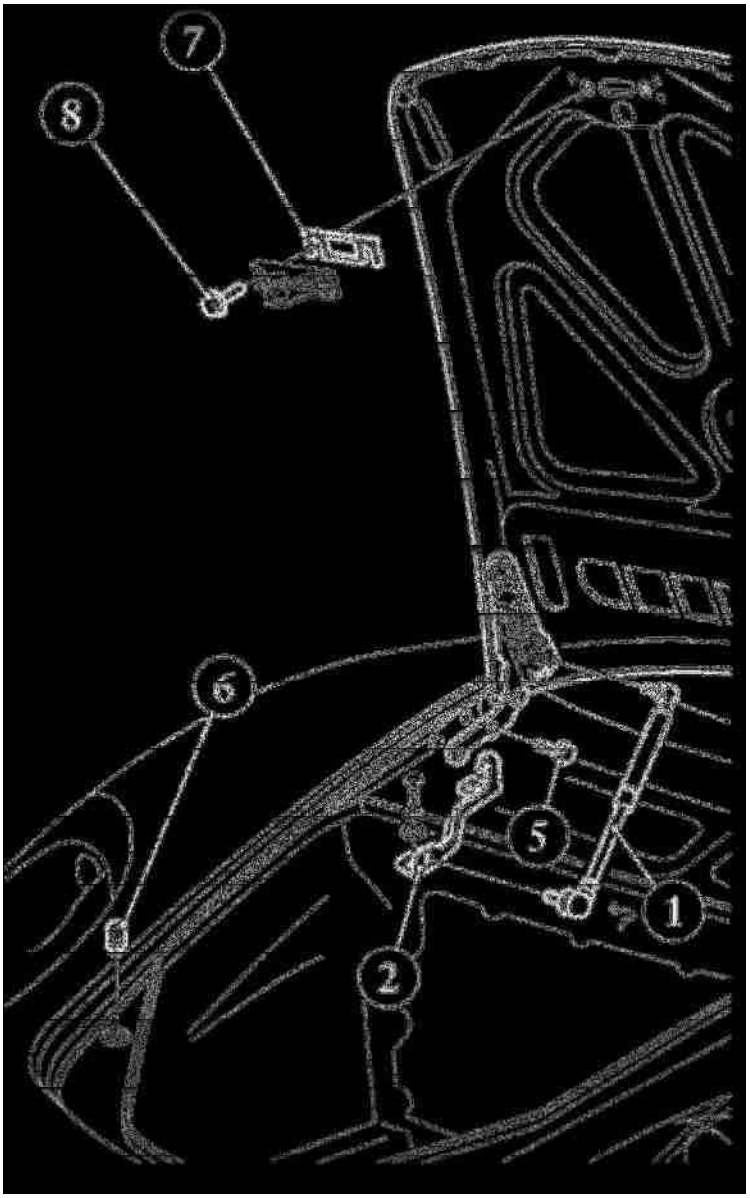
- Remove the entire lid.

Re-assembly

- The entire engine compartment lid must be re-mounted on the bodywork first by fastening the hinges with the screws **(5)** without locking them.
- Lower the engine compartment lid and check that the latch is working properly. Carefully check that the lid lies in central position on the bodywork and that it is not protruding (see Fig. **1**).



The lid position can be adjusted by means of the pads **(6)** and the shims **(7)** of the lock striker plate, on the engine compartment lid, after having loosened the screws **(8)** (H 2.13).



- After having correctly adjusted the lid position, lock the screws **(5)** and (**8**) finally to the prescribed tightening torque.
- Fit the pipe **(4)** into the check valve **(3)** and fasten it onto the hinge support by means of two tear clamps. Lower the lid to check that it does not squeeze the pipe.
- Re-assemble the components which had been removed for the procedure.

M2.03 FRONT BUMPER

Tightening Torques

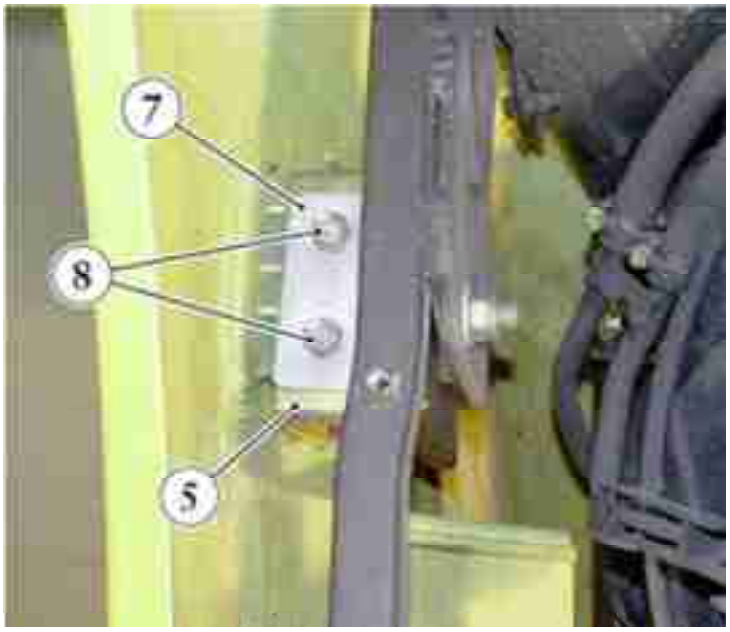
Tightening of bumper central nut	**40 Nm**
Tightening of bumper side nut	**20 Nm**

Components (Fig. 1)

- Bumper
2 - Strip
3 - Central shim
4 - Central fastener
5 - Side fastening bracket
6 - Adjustable fastener for bracket-chassis
7 - Side fastening plate
8 - Side fastening nut
9 - Right-hand grille
10 - Left-hand grille

Disassembly

- Remove the front wheels (F 3.06).
- Remove the lower parts of the wheelhouses (M 2.05).
- Remove the front part of the underfloor (M 2.12).
- Unscrew the nuts **(8)** fastening the bumper's side to the chassis brackets **(5)** and remember to keep the side plates **(7)**.



- Gaining access from the luggage compartment, remove the grommets against the bumper's fastening nuts.
- Unscrew the nuts **(4)** fastening the bumper central part to the chassis.

- Slide out the bumper **(** with strip **(** , and remember to keep the central shims **(** .

Note for US and CDN versions

In order to obtain approval for circulation in these countries, these cars are equipped with special bumpers (**A**, Fig. **1**) which contribute to dampening the impact generated in a head-on collision.

Re-Assembly

When re-fitting the bumper that had been previously removed, it is mandatory to re-use the original shims **(3)**. In the event that a new bumper is mounted, always use the original shims to start with.

- Temporarily install the bumper for the purpose of checking the clearance **(H)** and the alignment **(Q)** with the bodywork (see **Fig. 2**).

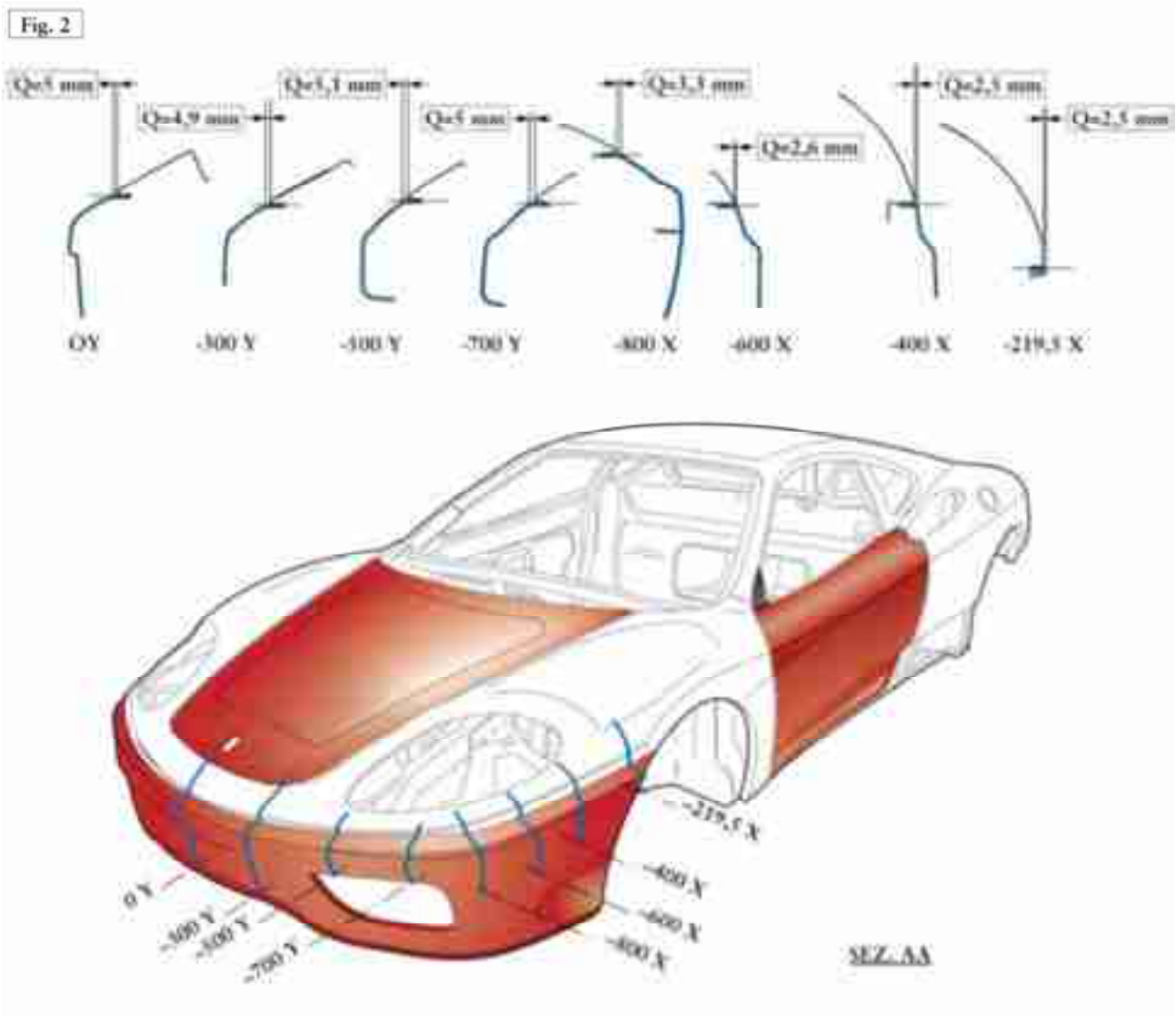


Fig.2

In the event that the bumper has been positioned incorrectly, remove or add other shims **(3)** and change the position of the adjustable fastener **(6)** until reaching the prescribed values.

- Fit the strip **(2)** along the upper edge of the bumper.
- Mount the bumper.
- Tighten the nuts **(4)** and **(8)** and, if needed, tighten also the nut for the adjustable fastener **(6)**, to the prescribed tightening torque.
- Re-fit the components which had been previously removed for this procedure.

M2.04 REAR BUMPER

Tightening Torques

Tightening of screw fastening central bracket to bodywork	**78 Nm**
Tightening of nut fastening central bracket to bumper	**40 Nm**
Tightening of nut for bumper's side fastening	**20 Nm**

Components (Fig. 1)

- Bumpers
2 - Strip
3 – Number plate light
4 - Insulators
5 - Central grille
6 - Right-hand grille
7 - Left-hand grille
8 - Central supporting bracket
9 - Nut fastening central bracket to bumper
10 - Screw fastening central bracket to chassis
11 - Central bracket shim
12 - Adjustable fastener for chassis side bracket
13 - Side fastening bracket
14 - Side shim
15 - Side fastening nut

Disassembly

- Remove the rear wheels (F 3.06).
- Remove the rear parts of the wheelhouses (M 2.05).
- Unscrew the bumper's fixing screws on the rear part of the underfloor (_____).
- Unscrew the nuts **(15)** fastening the bumpers side to the chassis brackets **(13)** and remember to keep the side plates **(14)**.

- Unscrew the screws **(10)** fastening the central brackets **(8)** to the chassis.

- Detach the license plate light connector, on the right-hand side of the bumper.
- Slide out the bumpers **(1)** with strips **(2)**, and remember to keep the central shims **(11)**.

Note for US and CDN versions

In order to obtain approval for circulation in these countries, these cars are equipped with special bumpers (**A**, Fig. **1**) which contribute to dampening the impact generated in a head-on collision.

Re-Assembly

When re-fitting the bumper that had been previously removed, it is mandatory to re-use the original shims **(11)**. In the event that a new bumper is mounted, always use the orig

- Temporarily install the bumper for the purpose of checking the clearance **(** and the alignment with the bodywork (see **Fig. 2**).

In the event that the bumper has been positioned incorrectly, the position of the central supporting brackets **(** with respect to the bumpers has to be changed by loosening the fastening nuts **(9)** and/or the position of the adjustable fastener **(12)** has to be modified until reaching the prescribed values.

- Tighten the nuts **(9)** to the prescribed torque.
- Fit the strip **(2)** along the edge coupling with the mudguard.
- Mount the bumpers.
- Tighten the screws **(10)** and the nuts **(15)** to the prescribed tightening torque.
- Attach the license plate light connection.
- Re-fit the components which had been previously removed for this procedure.

M2.05 WHEELHOUSE

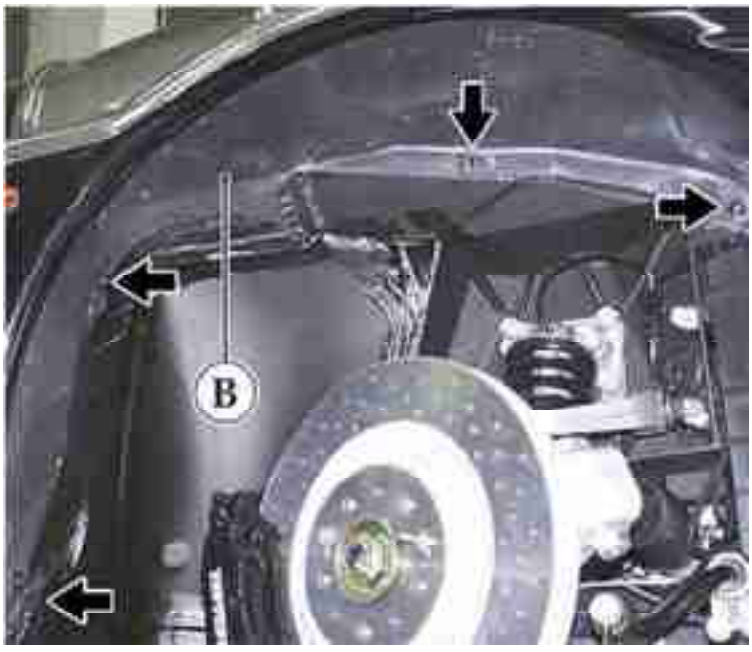
NOTES

The figures illustrate the right-hand side wheelhouse; the disassembly and re-assembly operations of the left-hand side components are identical.

Front

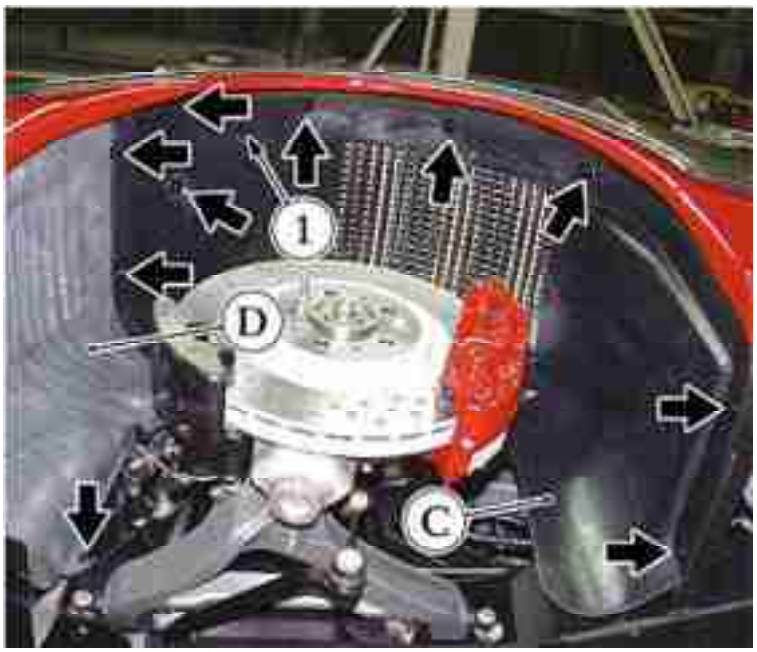
- Remove the front wheel (F 3.06).
- Remove the lower part **(A)** by unscrewing the six screws fastening it to the front chassis.

- Remove the upper part **(B)** from inside the mud-guard by unscrewing the four fastening screws.



Rear

- Remove the rear wheel (F 3.06).
- Remove the upper part **(C)** from inside the mud-guard by unscrewing the nine fastening screws.
- There is a screw **(1)** on the left-hand side which fastens the vacuum tank support bracket.
- Remove the lower part **(D)** by unscrewing the fastening screw.

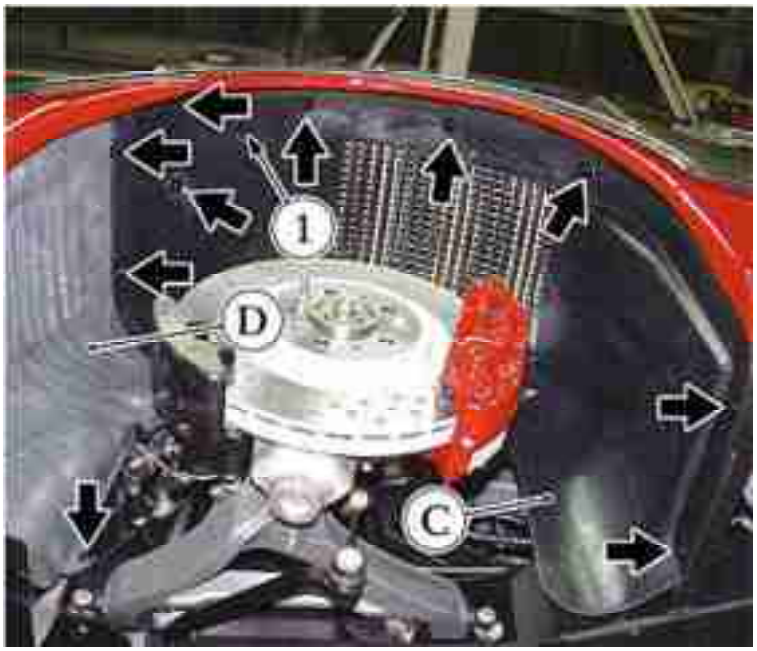


Re-assembly notes

Important

All the wheelhouse components, on the side in contact with the mud-guard, have sealing gaskets which must always be fitted when replacing a component.

- After correctly positioning the components, fix them to the bodywork in the points illustrated in the figures.



- Considering the exposition of the components to atmospheric agents, it is advisable to apply protective water-repellent grease to the thread of the fixing screws.
- Tighten the screws to a **7.4 Nm** torque.

M2.06 WINDSCREEN

The windscreen is composed of a glass and an outer edge strip with connection joint on the lower side.
The glass has a built-in passive aerial, which is connected to the pre-amplifier by means of a special pressure coupling, which is located next to the right-hand lower corner.
The glass is also fitted with the small supporting base for the internal rear view mirror.

Toolkit

BTB Premier Kit

WURTH type supporting and holding frame with suction cups.

Products

	Activator	**BETAWIPE VP 04604**	**code 63397600**
B	Primer for paint/plastic red cap	**BETAPRIMER, RED cap**	**code 62864900**
C	Primer for glass green cap	**BETAPRIMER, GREEN cap**	**code 62864800**

D Adhesive sealant **BETASEAL 1703** **code 64954900**

Replacing the Windscreen

NOTES

Always protect the painted parts of the bodywork and the interior suitably to prevent their being damaged during cutting and fitting of the windscreen.

- Rotate the battery master switch to the **OFF** position (L 2.02).
- In order to remove the damaged windscreen, the following components must be removed:

- upper cover and cover for windscreen pillar trims (M 3.04);
- dashboard (M 3.01);
- luggage compartment bonnet (M 2.02);
- windscreen wiper arms (M 2.07);
- rear view mirror.

- In order to improve visibility conditions when using the cutting blade for the sealing compound and to avoid damaging the painted parts of the bodywork, it is advised to remove the outer edge strip.
- Using the thermal cutter **(1)** - which is endowed with a WK4 blade – and working from within the passenger compartment cut the sealing product on the two sides and on the roof, always starting from the pillar-roof junction.

- Replace the blade of the thermal cutter with the longer one (WK1). Complete the cutting procedure for the sealing product by cutting the lower side.
- Remove the windscreen from its seat by means of suction-cup handles.
- Level the sealing product layer left on the windscreen seat using the thermal cutter fitted with the suitable blade.
- Carefully clean the windscreen bay with compressed air, then degrease with heptane.

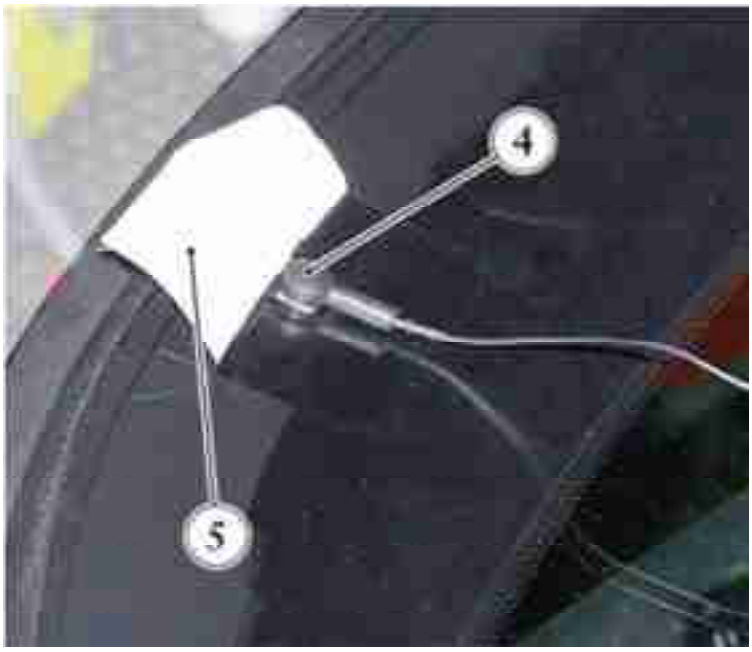
Re-Fitting

NOTES

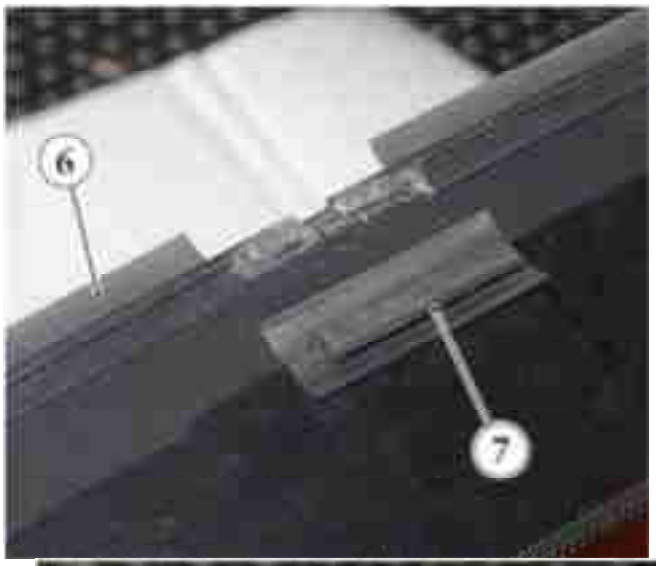
When re-fitting the original windscreen, it is necessary to remove the former layer of sealing product using the thermal cutter. Any product trace must be then scraped off with a suitable scraper, always taking care not to damage the silk-screen printed area of the glass.

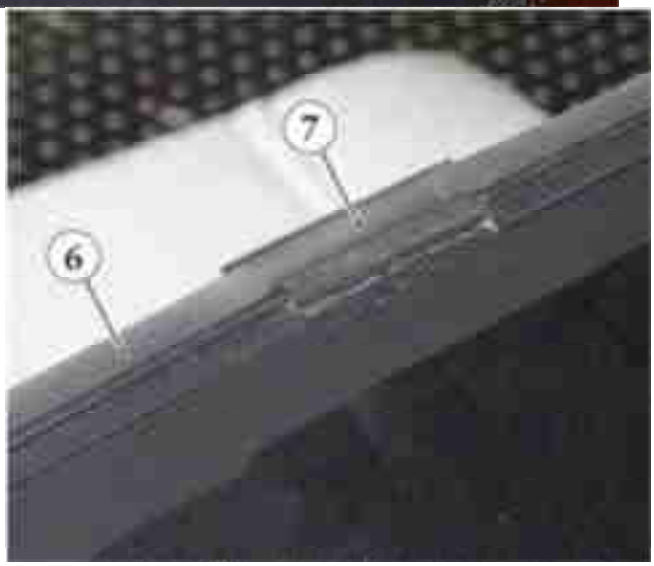
- Degrease the windscreen perimeter edges and its seats on the bodywork using the suitable activator **(A)**.
- Place the windscreen on the suction cup frame **(2)** and protect the silk-screen printed area - adjacent to the area where the primer is applied - with masking tape **(3)**.

- Attach the preamplifier clip **(4)** on the windscreen's aerial coupling, and cover it with masking fabric tape **(5)**.

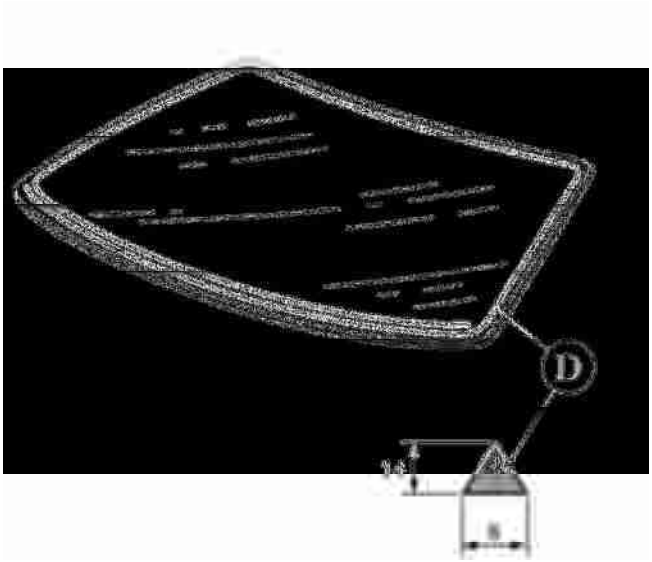


- Apply the primer **(C type, green cap)** on the windscreen, namely in the area where this comes in touch with the strip.
- Take a new strip and apply the primer **(B type, red cap)** in the area which comes in touch with the windscreen.
- Let the products dry for ca. ten minutes, then fit the strip **(6)** on the windscreen.
- Take a lap plate and degrease the internal part using activator (**A**).
- Apply adhesive primer (**D**) to the internal contact zone and even out the layer using a spatula.
- Fit the lap plate **(7)** in the area where the strip **(6)** ends are joined.





- Degrease the glass edges once again using the activator **(A)** and apply a continuous layer of primer **(C type, green cap)** with a brush. This layer must be approximately 20 mm wide.
- Apply the primer **(B type, red cap)** on the bodywork surfaces where the windscreen will be fitted.
- Let the products dry for ca. ten minutes, then apply a continuous layer of adhesive primer **(D)**, starting from the lower RH or LH corner and overlapping the layers for the entire length of the windscreen's lower part. . Use an extrusion gun equipped with a triangular section nozzle.
- Even the end areas of the layer **(8)** using a spatula and apply extra adhesive to the broken stretches.


D

- Fit four adhesive shims **(9)** into the lower windscreen mounting edge, taking care to position them at a suitable distance from each other.

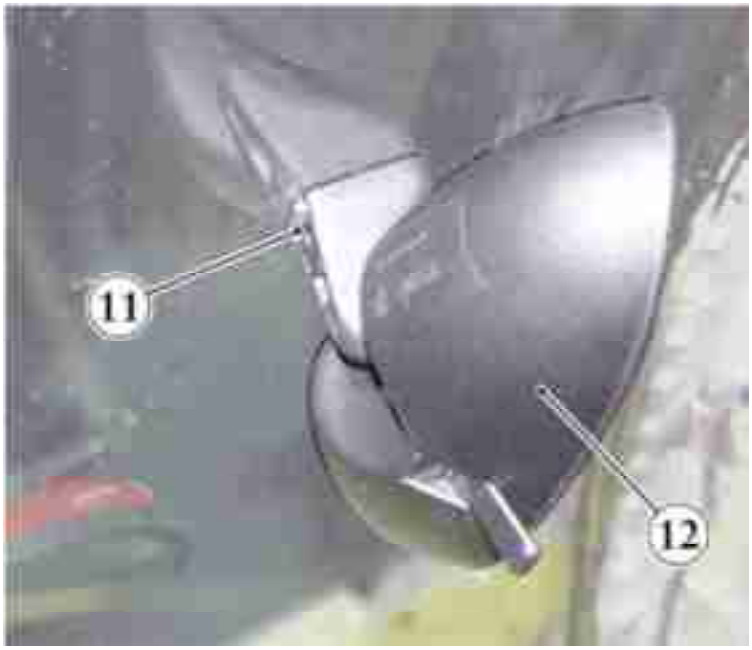
- Mount the windscreen on the bodywork by making it rest on the shims and centring it in the space available.

IMPORTANT

*The windscreen must be absolutely mounted on the bodywork within ten minutes after the adhesive product **(D)** has been applied.*

- Remove the exceeding quantity of primer.
- Secure the holding frame **(2)** onto the bodywork by means of suitable belts **(10)** and let it rest for at least four hours.

- Remove the masking tape and clean the glass and the bodywork using the activator **(A)**.
- Clean the windscreen area where the adhesive tape is mounted and fit the small adhesive base **(11)**.
- Fasten the rear view mirror **(12)** onto the small base, on the windscreen.

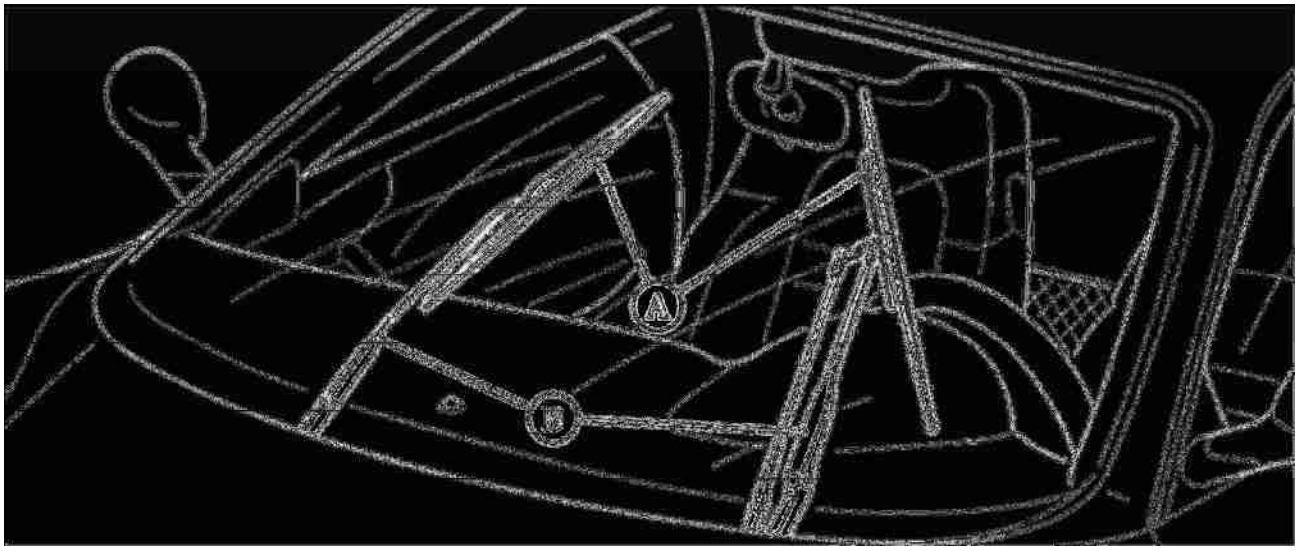


- Re-assemble all components that had been removed for this procedure.

M2.07 WINDSCREEN WIPERS

Replacing the wiper blade

- Turn on the windscreen wiper and stop it (ignition key in position **0**) when the wiper blades **(A)** are in a vertical position.
- Lift the wiper arm **(B)**.



IMPORTANT

To avoid contact with the edge of the luggage compartment lid, only lift the wiper arms when in a vertical position.

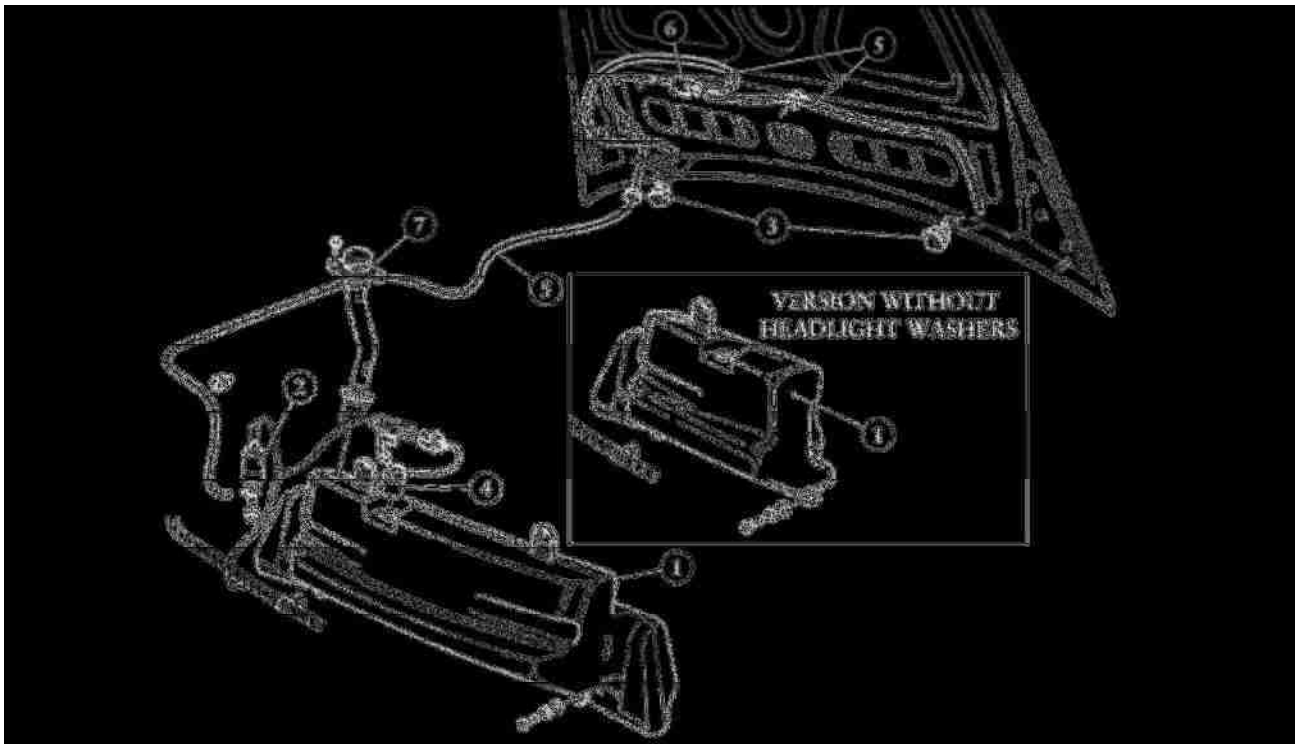
- To detach the blade rubber **(** from the arm, it is necessary to push it in the direction of the arrow before sliding it out.
- Fit the new blade rubber by deeply inserting the arm end (opposite direction to the arrow) into the specific restraint **(C)**.

NOTES

- *For windscreen wiper arm replacement* (L 2.05).
- *For control switch replacement* (H 2.07).
- *For pump and windscreen washer tank replacement* (M 2.08).

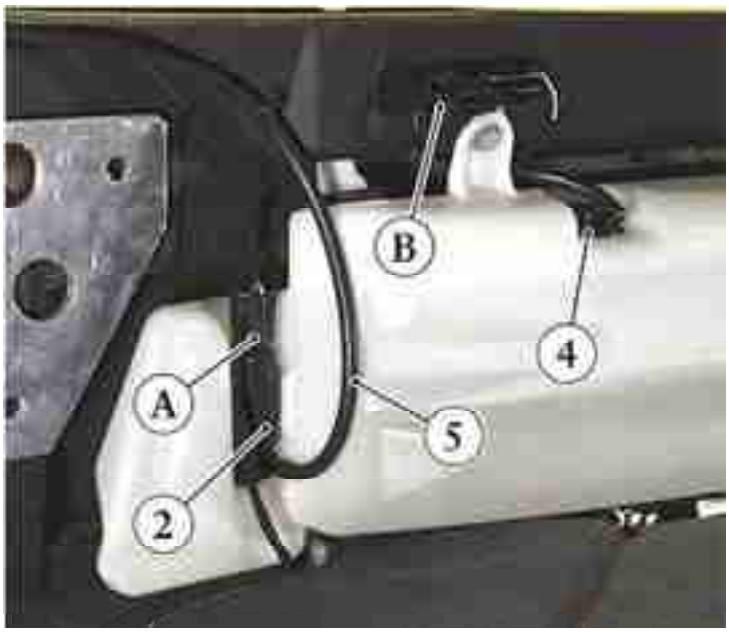
M2.08 WINDSCREEN WASHER

The windscreen washer liquid tank **(1)** is positioned behind the front bumper and is attached to the front panel of the bodywork.
The pump **(2)** feeding the washer nozzles **(3)** and the liquid level sensor **(4)** are fitted inside the tank.
A non-return valve **(6)** is fitted on the pump/washer nozzle connection piping **(5)**, hidden in the cavity wall of the luggage compartment lid.
A filler neck **(7)**, accessed via the luggage compartment, allows for liquid re-filling (A 3.06).
The tank, in the version with headlight washers, besides having a greater capacity, comes with a second pump which feeds the nozzles on the bumper (M 2.14).



Replacing the pump and/or the windscreen washer liquid level sensor

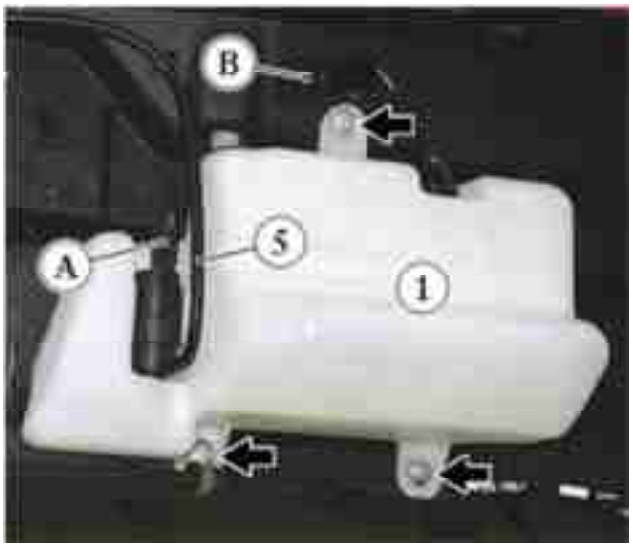
- Remove the front bumper (M 2.03).
- Disconnect the front harness connector **(A)** from the pump **(2)** and detach the piping **(5)**.
- Remove the pump from the gasket on the tank and proceed with the replacement.
- In order to remove the level sensor **(4)**, it is necessary to disconnect it from the front harness by detaching the connector **(B)**.
- Slide-out the sensor from the tank and replace it.

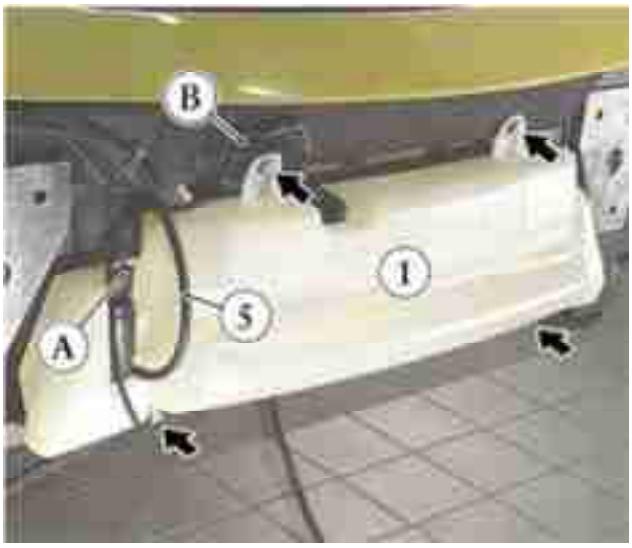


For connection to the system, see Table **A** - ELECTRICAL SYSTEM.

Replacing the tank

- Disconnect the connectors **(A)** and **(B)** and the piping **(5)**, as described above.
- Unscrew the four screws (for the version with headlight washers) or the three screws (for the version without headlight washers) which fasten the tank **(1)** to the bodywork.





- Remove the entire tank, moving it in a downwards direction so that the filler neck can slide out from the tank.

When re-assembling, insert the front harness support brackets under the two lower screws (for the version with headlight washers) or on the lower right-hand screw (for the version without headlight washers) and position the wires and tubes as illustrated.

- Tighten the tank fastening screw to a torque of **10 Nm**.

Replacing the washer nozzles and piping

The washer nozzles **(3)** are fitted into the luggage compartment lid by pressing them down. Periodically, or if clogged, it is necessary to clean them with a jet of compressed air from the supply tube connection.

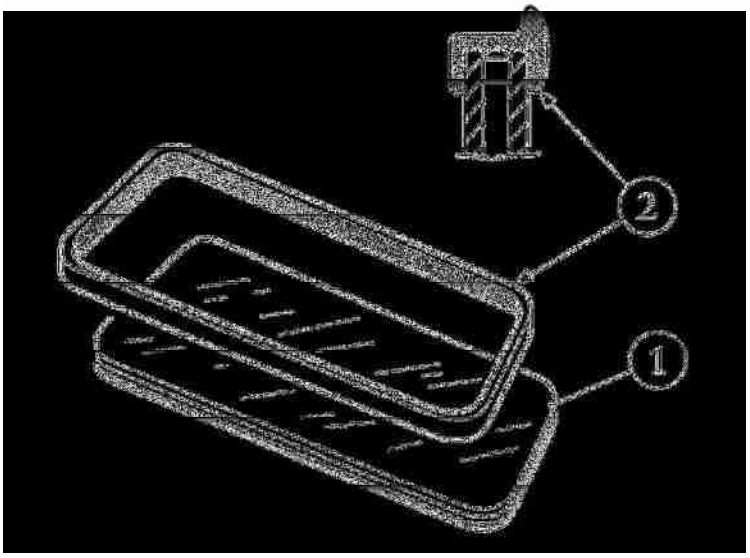
- To extract them from their seat, it is necessary to lever them out using a small, flat screwdriver, taking care not to damage the lid paint-work.
- Remove them from the system by separating them from the piping **(5)** which connects them to the non-return valve **(6)**.

When replacing the connection piping **(5)**, it is necessary to pay particular attention to its position in respect of the right- hand hinge, to avoid it getting damaged when the luggage compartment lid is closed.

Fasten the tube **(5)** to the hinge support bracket using two tear clamps **(7)**, without tightening them excessively, and position it as illustrated.

M2.09 REAR WINDOW

The rear window is mounted on the passenger-engine compartment division panel and is composed of a compound glass **(1)** (double layer glass with inter-space) and an outer-edge strip **(2)**.



Toolkit

- **BTB** Premier Kit

- Suction cup handles
- Suction cup compressor tool **(E)**

Products

	Activator,	**BETAWIPE VP 04604**	**code 63397600**
B	Primer for paint-work/plastic,	**BETAPRIMER**, RED cap	**code 62864900**
C	Primer for glass,	**BETAPRIMER**, GREEN cap	**code 62864800**
D	Adhesive Primer,	**BETASEAL 1703**	**code 64954900**

Replacing the rear window

In order to remove the damaged glass, it is necessary to disassemble the following internal and external components:
- the engine compartment lid side guards (M 2.13);
- the engine compartment lid (M 2.01);

- the internal leather upholstery on the passenger/engine compartment division panel (_____).

NOTES
Take care to suitably protect all the painted parts of the body-work, the engine and the interior to avoid them getting damaged during rear-window disassembly and assembly procedures.

- Using a thermal knife cutter (with a **WK4 blade)**, and working from within the passenger compartment, cut the sealing product along the entire rear-window perimeter.
- Remove the rear-window from its seat using suction cup handles.
- Eliminate the layer of sealant left on the rear-window seat using the thermal cutter.
- Carefully clean the rear-window bay with compressed air, then degrease with heptane.

Assembling a new rear-window

IMPORTANT

Prior to assembly, check that the new components show no sign of imperfection or scratching both on the surface of the glass and the perimeter-edges.

- Degrease the glass perimeter-edges and its seat on the dividing panel using the activator **(A)**.
- Apply the primer (**C**, Green cap) to the window perimeter-edges and let the product dry for about ten minutes.
- Apply the new strip to the window, taking care not to damage the layer of primer.
- Make sure that the strip is correctly positioned on the window and remove any excess primer.
- Apply primer (**B**, Red cap) to the rear-window seat surface and let it dry for about ten minutes.
- Apply a continuous layer of adhesive primer **(D)**, starting from the centre line of the lower edge. This layer must overlap the ends by about **20-30 mm**. Even the layer overlapping the ends using a spatula.
- Place the rear-window in a parallel position to its bay and mount it on the bodywork.

IMPORTANT

*The rear-window must be mounted on the bodywork within five minutes of applying the adhesive primer **(D)**.*

- Working from within the passenger compartment, apply the suction-cup compressor tool **(E)** to the glass and pull the rear-window to the prescribed position.

- Remove any excess primer from inside the passenger compartment.
- Check that the outer-edge strip is correctly positioned.
- Let it rest for at least four hours before removing the compressor tool and re-assembling the parts removed in the procedure.

M2.10 QUARTER WINDOWS

Side fixed windows are supplied as spare parts complete with outer-edge strip, which must never be separated from the glass.

Toolkit

- **BTB** Premier Kit

- Suction cup handles
- Suction cup compressor tool **(E)**

Products

	Activator,	**BETAWIPE VP 04604**	**code 63397600**
B	Primer for paint-work/plastic,	**BETAPRIMER**, RED cap	**code 62864900**
C	Primer for glass,	**BETAPRIMER**, GREEN cap	**code 62864800**
D	Adhesive Primer,	**BETASEAL HV3**	**code 63597000**

Replacement

- In order to remove the damaged glass, it is necessary to remove the internal leather upholstery in contact with the glass perimeter (M 3.04).
- Remove the door weather strip in the side window area.

NOTES

Take care to suitably protect all the painted parts of the body-work, the engine and the interior to avoid them getting damaged during side-window disassembly and assembly procedures.

- Using a thermal knife cutter (with a **WK4 blade)**, cut the sealing product along the entire rear-window perimeter.
- Remove the window from its seat using suction cup handles.
- Eliminate the layer of sealant left on the window seat using the thermal cutter.
- Carefully clean the window bay with compressed air, then degrease with heptane.

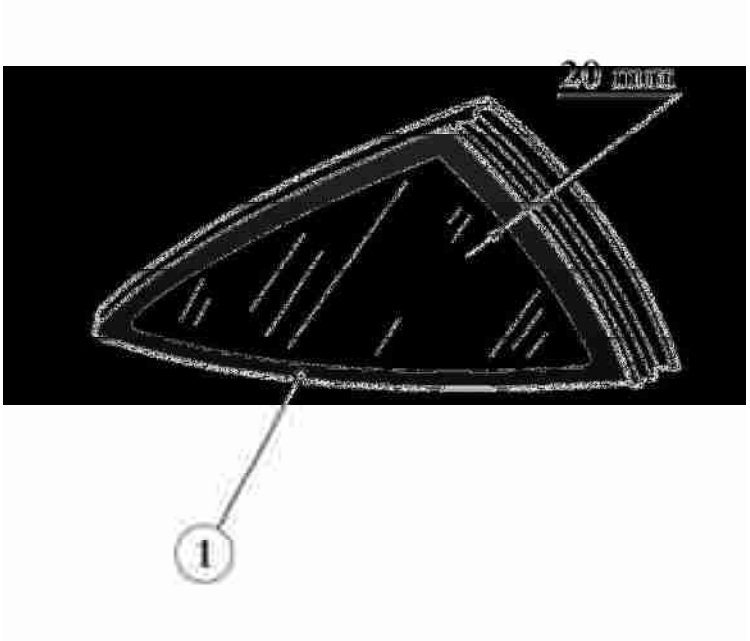
Fitting the new window

IMPORTANT

Prior to assembly, check that the surface of the new glass shows no signs of defects or scratching and that the outer-edge strip has no lacerations or cuts.

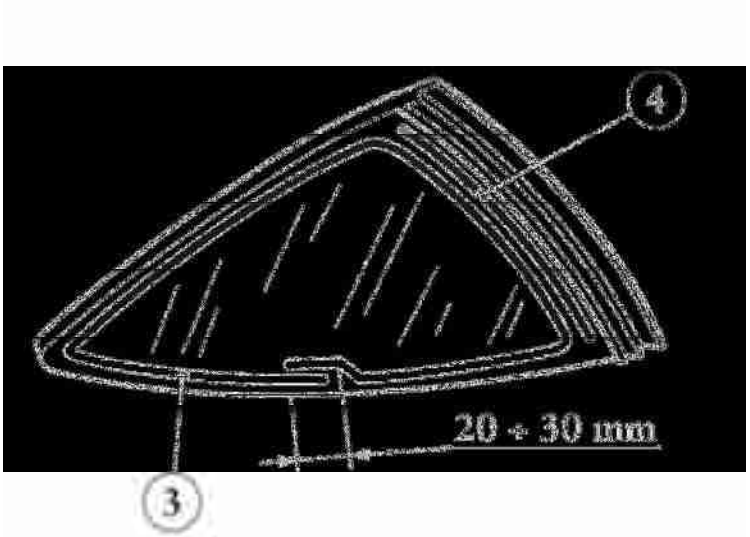
Prior to assembly, the moulding must have been already mounted on the bodywork with outer-edge strips on the external side profile of the roof.

- Degrease the glass perimeter and bay surface on the bodywork using the activator **(A)**.
- Apply the primer (**C**, Green cap) to the window perimeter **(1)** and let the product dry for about ten minutes.



- Apply primer (B, Red cap) to the side window bay surface **(2)** and let it dry for about ten minutes.

- Apply a continuous layer **(3)** of adhesive primer **(D)**, starting from the centre line of the bottom/lower edge. This layer must overlap the ends by about **20-30 mm**. Even the overlapping ends of the layer using a spatula.
- Apply a second layer **(4)**, parallel to the previous one, to the short side of the glass in contact with the door pillar



- Place the side window in a parallel position with its bay and mount it on the bodywork.
- Fix the glass on the bodywork paying attention to the coupling with the moulding **(5)**

and the profiling with the door's waist line **(6)**.

IMPORTANT
*The side-window must be mounted on the bodywork within ten minutes of applying the adhesive primer **(D)**.*

- Apply the suction-cup compressor tool **(E)** to the glass and remove any excess primer working from the passenger compartment.

- Re-attach the previously removed outer-edge door strip (M 2.18).
- Let it rest for at least four hours before re-assembling the parts removed in the procedure.

M2.11 DOORS

Tightening torques		Category	Product
Screws fastening door panel upholstery			
g assenger's door handle	**7,4**	**B**	
Screw fastening internal control handle	**5,5**	**B**	
Internal screw fastening door panel	**7,4**	**B**	
Nut fastening wing mirror to door frame	**15**	**B**	
Screws fastening wing mirror to door frame	**1**		
Screw fastening plastic clip, strip and front (upper) uide	**6,4**		
g windscreen to lower support	**4,4**	**B**	
Screw fastening windscreen to movable guide	**4,4**	**B**	
Screws and nuts fastening side window system	**4,6**	**B**	
Screw and nut fastening rear guide to door frame	**8,5**	**B**	
Nuts for lower fastening of front guide to door frame	**15**	**B**	
Screws fastening outside door handle	**4,1**	**B**	
Screws for lock fastening	**6,4**	**B**	
Nuts fastening lock control block	**4,1**	**B**	
Nut fastening the external window-scraper	**4,0**	**B**	
Screw fastening the door tie-rod	**9,5**	**B**	**Arexon System 52A42**

NOTES

The procedures described here below are aimed at disassembling all the components of the entire door. However, said procedures can be carried out even individually, following a sequence which can also differ from the one illustrated hereunder.

Removing the Internal Upholstery

NOTES

The upholstery of the door panels is extremely delicate. Always protect it suitably, avoiding the use of adhesive products and taking particular care during any assembly or removal procedure

- Unscrew the screws fastening the door panel upholstery **(1)**.

- Remove the door panel upholstery.
- Remove the armrest **(2)** by lifting its rear part and pulling it backwards, thereby sliding it out from the front hooks on the door panel.

- Unscrew the upper screws **(3)** fastening the passenger's door handle.

- Loosen the nut **(4)** on the opening cable adjusting screw, then release it from the mounting bracket and subsequently from the opening lever.

NOTES
For the adjustment of the internal opening lever adjustment position (H 2.04).

- Unscrew the screw fastening the opening handle **(5)**.

- Lift the opening lever to remove the small shield **(6)** which hinders access to the inside screw **(7)** and unscrew the latter.

- Unscrew the lower fastening screw **(8)**.

N.B

From Ass.ly No. 52140 *an electric door locking system activated from inside the vehicle has been introduced. With this system all the leverages that used to connect the lock lever to the lock mechanically have been removed.*

- Remove the rear section of the door framework panel and, on the vehicles produced prior to this, the end of the closing tie-rod must be released from the lever **(9)**.

- Lift the door panel to release the upper retainers **(10)** from the framework and remove the whole panel detaching the micro-switch connection on the opening device.
- In order to remove the passenger's side handle from the door panel, it is necessary to unscrew the outer screw fastening the armrest as well as the internal screw **(11)**.

- When re-assembling, tighten all the screws to the prescribed tightening torque.

Removing the Loudspeaker

- Remove the door panel as previously described.
- Unscrew the screws **(12)** fastening the loudspeaker to the door frame and the respective internal nut.

- Remove the loudspeaker by detaching the door harness connection.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.

Removing the Wing Mirror

- Remove the mirror internal frame **(13)** together with the tweeter loudspeaker and detach the door cable connection.

- Unscrew the upper screw fastening the mirror outer frame to the door frame.
- Unscrew the front nut and the two central screws fastening the mirror to the door frame.
- Detach the door cable connection **(A)** and remove the entire wing mirror.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.

NOTES

The outside temperature sensor is fitted in the left-hand wing mirror. For disassembly (____).

- When refitting the mirror, the nut and the fastening screws must be tightened to the prescribed tightening torques.

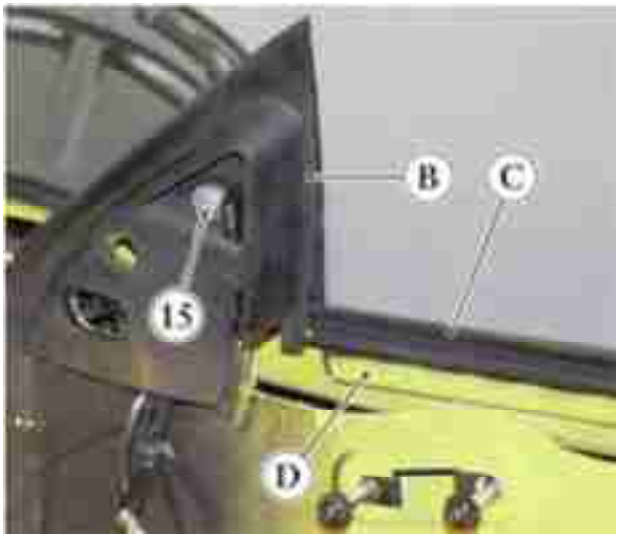
Removing the Window Scrapers

- Remove the wing mirror and the door panel as described above.
- Remove the two rear fastening caps **(14)** for the door frame.

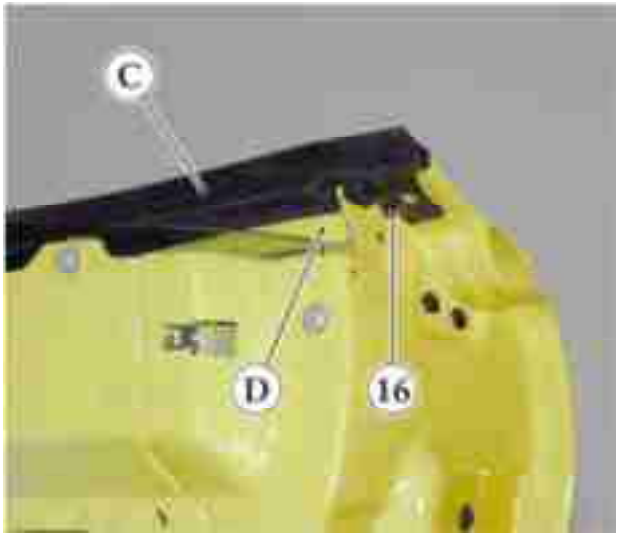
- Remove the internal window scraper.

The outer window scraper consists of two elements sticked on each other.

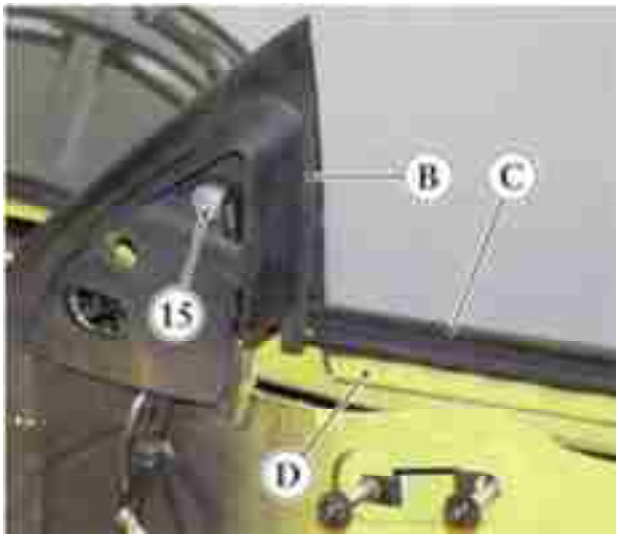
- To remove the part **(B)** covering the frame which bears the wing mirror, it is necessary to unscrew the screw **(15)** fastening the restraining clamp for the internal holding frame as well as the window's front guide.



- To replace part **(C)**, unscrew the rear fastening nut **(16)** and slide out the strip from the door frame.

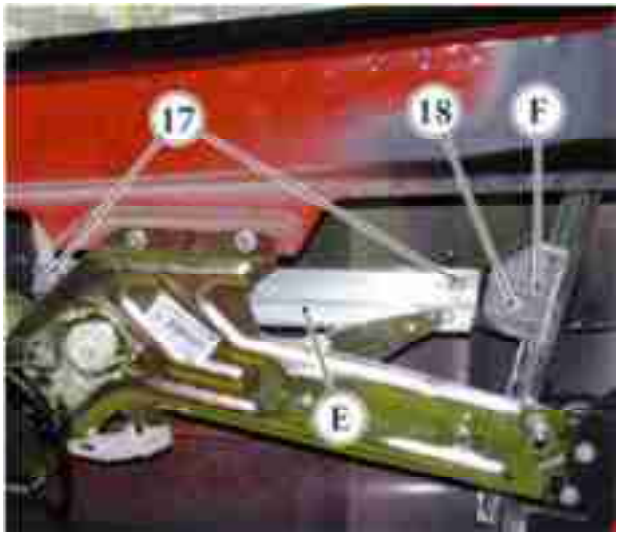


- When refitting the strip, after having aligned its end **(C)** with the door rear edge, the strip must be inserted in the water channel **(D)**, by positioning it so that it fits the door profile. Use a rubber hammer to beat the channel **(D)** and thus lock the strip in position.
- After having fitted the part **(B)** in its seat, the inside, lower, rear end must be fitted into the special notch designed for this purpose, found on the front end of the inside strip.
- Tighten the screw **(15)** to the prescribed tightening torque.



Replacing the Side Window

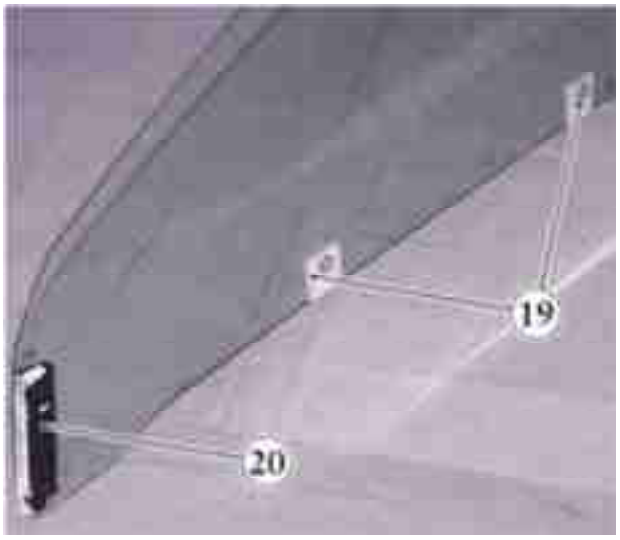
- Remove the door panel, as described above.
- Remove the water-tight fabric shield.
- Lower the window in order to gain access to the lower support fasteners **(E)**.
- Unscrew and remove the screws **(17)** on the lower support as well as the screw **(18)** on the movable guide **(F)**.



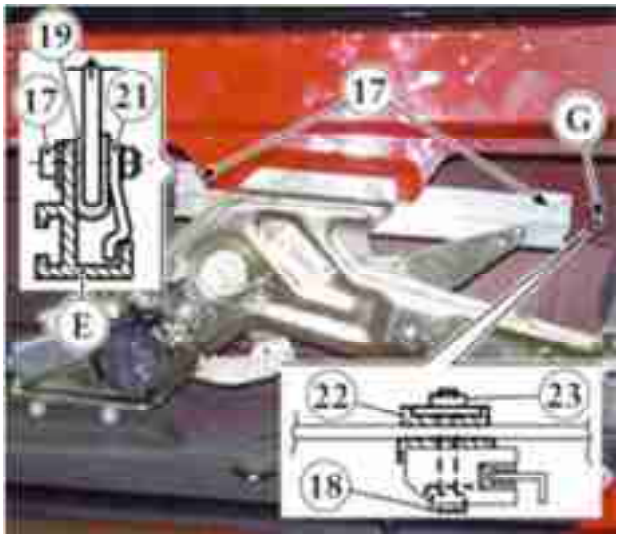
- Lift the front part of the window to extract it from the front slide shoe and remove it from the door.

Re-assembly

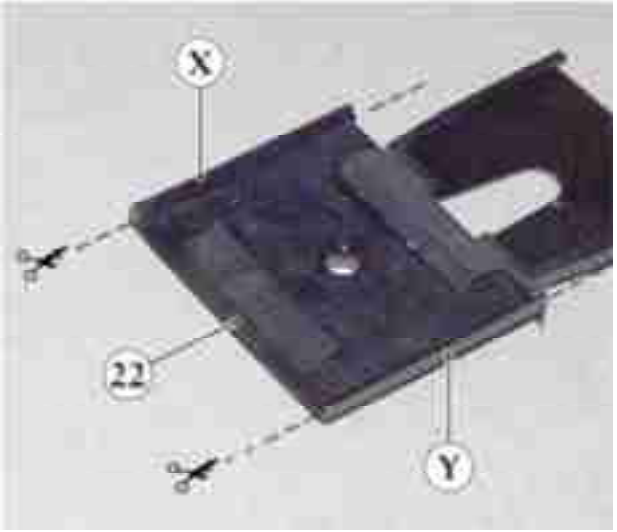
- Mount the strips **(19),** applying **Arexon 4701** adhesive, and the front slide shoe **(20)** with strips and restraining clamps on the new window.



- Fit the front shoe into the window using the respective fastening parts and lubricate the sliding strips with **FIAT TUTELA Z2** grease.
- Insert the window into the door and lock it into the lower bearing **(E)** using the plates **(21)** and the screws **(17)** tightened to the prescribed tightening torque.

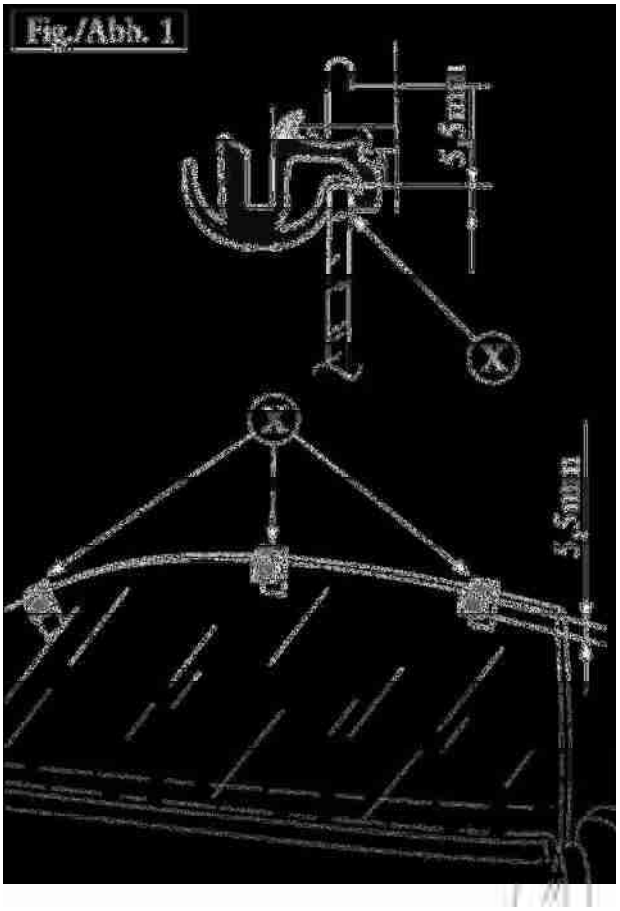


- In the event that the fitting **(22)** fastening the window to the movable guide **(F)** is replaced, the edge (**X** for the LH part) or (**Y** for the RH part) must be cut to prevent any interference with the guide.



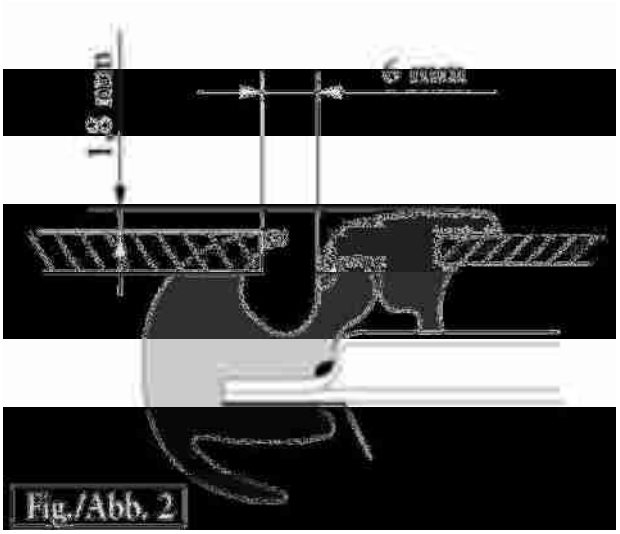
- After having properly lubricated it, mount the movable guide **(F)** on the window and fit it in the rear guide.
- Install the fitting **(22)** on the window and align it with the hole **(G)** to be used for fastening.
- Insert the screw **(18)** and tighten it on the plate **(23)** to the prescribed tightening torque.

- Check that the window glides without any interference.
- To check proper closing and alignment of the window with the upper strip follow this procedure: apply three pieces of gummed paper **(X)** on the window upper edge (see **Fig. 1**) and mark a reference at a **5.5. mm** distance from the window upper profile.

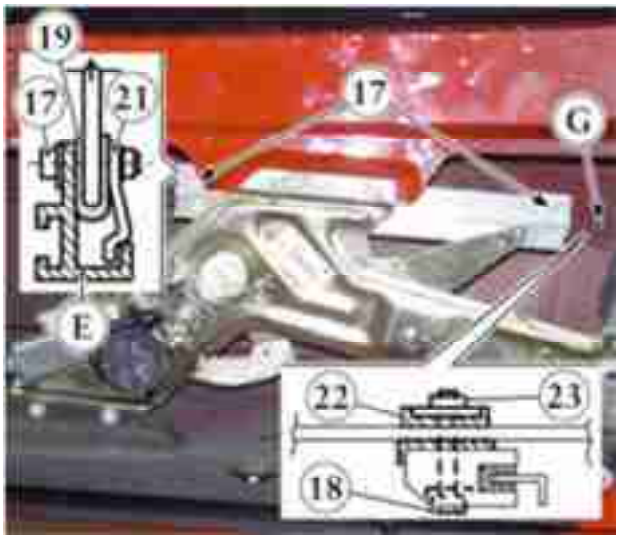


Have the window rise to the upper threshold and close the door to check that the reference marks match the strip edge.

- Also check the window profile with respect to the side strip (see **Fig. 2** sizes).



Adjustments can be made using the screws **(17)** and **(18)** as well as the fastening screws



and nuts for the power window device (see following paragraph).
After correcting the position of the window, always check the window position micro-switch is working correctly, by working on the nuts (**K**, see following paragraph).

Removing the Power Window Device

- Remove the door panel, the water-tight fabric shield and the side window as described above.

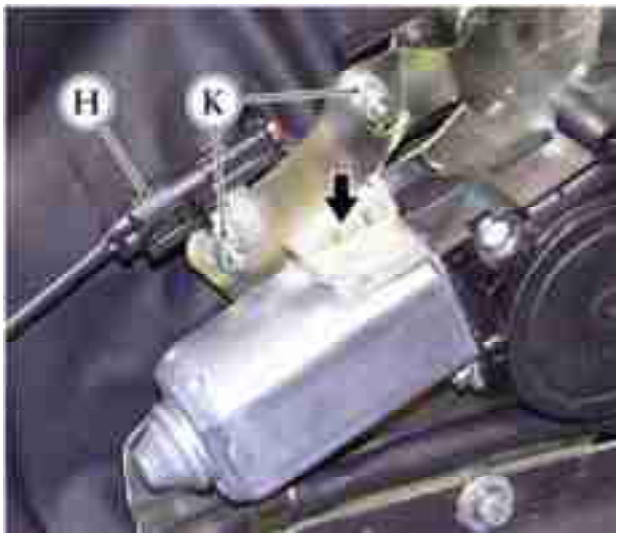
N.B.
From Ass.ly No. 52140 *an electric door locking system activated from inside the vehicle has been introduced. With this system all the leverages that used to connect the lock lever to the lock mechanically have been removed.*

- Detach the micro-switch connection **(H)** as well as the connection for the power window motor from the door cable.

WARNING
It is important to first detach the motor's connection in order to avoid that the micro-switch cut-out, as the consequent lowering of the power window device may injure the operator.

- Free the door cables from the support bracket **(J)**.
- At this point it is possible to remove the window position micro-switch, together with support bracket, by unscrewing nuts **(K)**.

When reassembling, fit the support brackets into the connections on the fastening stud-bolts for the micro-switch support bracket.



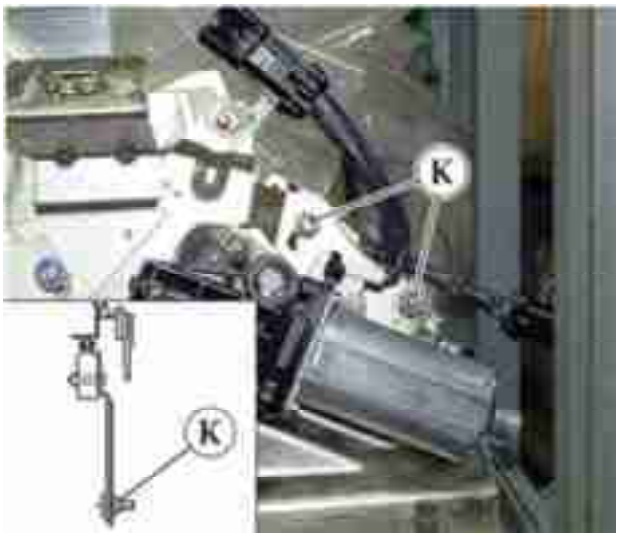
- Unscrew the fastening screws and nuts **(24)** on the door frame.
- On vehicles produced prior to **Ass.ly No. 52140**, detach the vertical door lock activation tie-rod from the lever **(L)**.

- Remove the entire power window device.

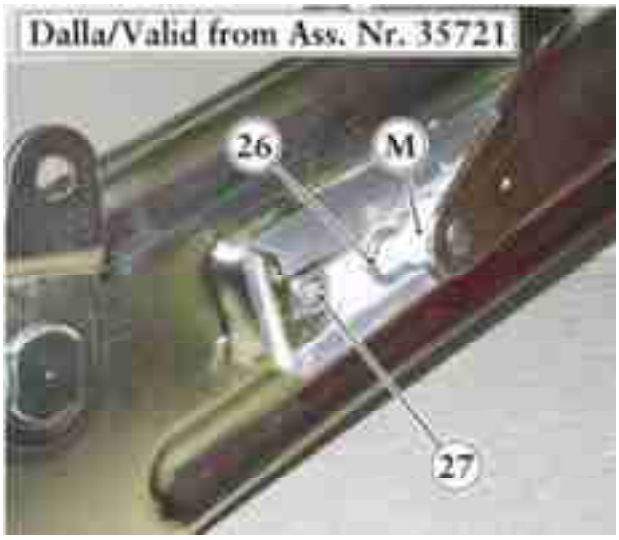
Once removed, it is possible to replace the motor and the slide shoe of the power window device.

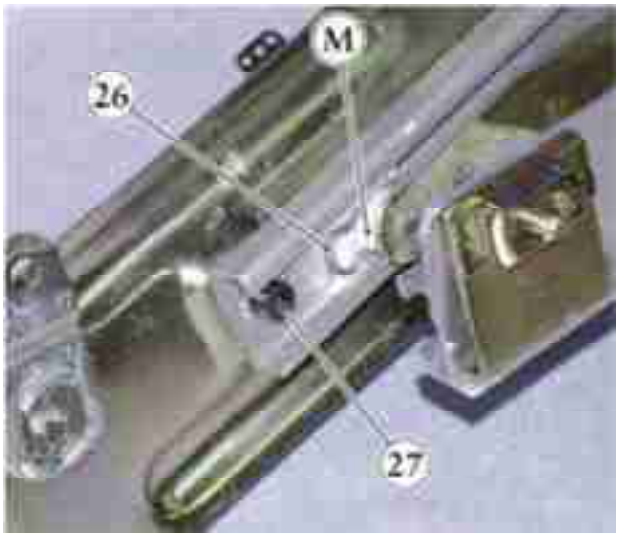
- Unscrew the screws **(25)** on the internal side of the device and remove the motor.

- To adjust the position of the micro-switch on the power window device, loosen nuts (**K**) and turn the micro-switch support bracket until reaching the desired position (H 2.05).



- To replace the slide shoes **(M)** and the respective internal bushing, release the clamp **(26)** and slide them out of the connection arm pin.
- Remove the screw **(27)** and slide the shoe out of the guide together with the internal bushing.





- When reassembling, lubricate the shoe **(M)** and guide sliding surface, the motor gears and the respective toothed parts within the power window device with **FIAT TUTELA Z2** grease.

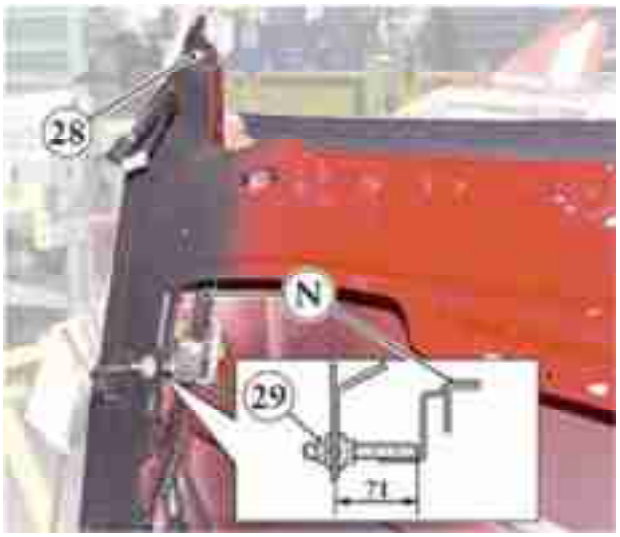
NOTES

*The slots against the fastening screws **(24)** make it possible to carry out small adjustments in the position of the power window device.*

- Check that the window is suitably aligned with the strips, as described above, then tighten the screws and nuts **(24)** to the prescribed tightening torque.

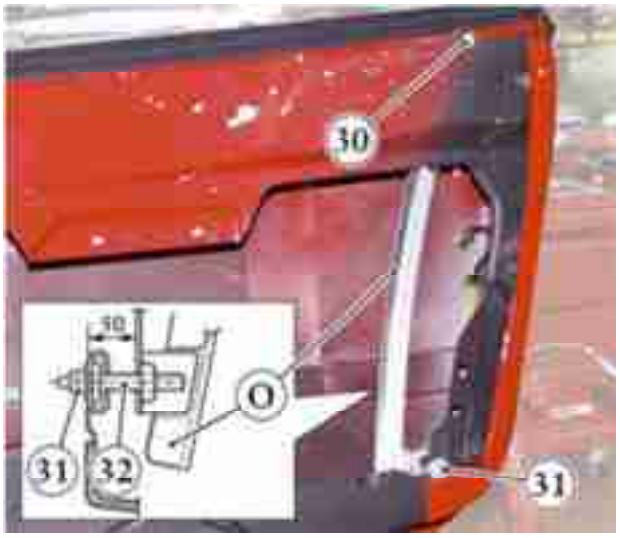
Replacing the Side Window Guides

- Remove the door panel, the water-tight fabric shield, the window and the power window device as previously described.
- Remove the front guide **(N)** by unscrewing the upper fastening screw **(28)** and the outer lock nut **(29)** on the lower part.



- When re-assembling, fit the guide to the value reported in the figure **(N)** on the door framework, by working on the check-nuts **(29)**.

- Tighten the outer check nut **(29)** in this position to the prescribed tightening torque and position the upper screw **(28)** without tightening it.
- Remove the rear guide **(O)** by unscrewing the upper screw **(30)** and the outer lock nut **(31)** on the lower part.



- When re-assembling, fit the guide **(O)** on the door frame to the value reported in the figure, and adjust the pivot **(32)** on the outer check-nut **(31)**.
- Tighten the check-nut **(31)** and the upper screw **(30)** on the pivot to the prescribed tightening torque.
- Re-assemble the components which had been removed for the procedure and check that the window moves properly.

Replacing the Door Outside Handle

- Remove the door panel and the water-tight fabric shield as described above.
- Detach the terminal **(P)** of the lock connection cable from the handle lever.

- Detach the fastening bracket of the micro-switch connector and remove it from the door cable.

- Unscrew the two outer screws **(33)** fastening the handle to the door frame.

- Remove the entire handle from outside and keep any spacers positioned between the door framework and the handle as these must later be refitted.
- Once the handle has been removed, it is possible to replace the micro-switch **(Q)**.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.

- When refitting, lock the screws **(33)** to the prescribed tightening torque.

Replacing the Door Lock

N.B

From Ass.ly No. 52140 *an electric door locking system activated from inside the vehicle has been introduced. Unlike the pre-modification system, to lock the doors, the new system uses an electrical signal produced by a micro-switch which is activated with the LOCK control lever, and connected to the lock electrically.*

- Remove the door panel and the water-tight fabric shield as described above.
- Lift the window to the upper threshold.
- Unscrew the outer fastening screws **(34)**.

- Detach the two connections **(R)** for the door cable from the lower inside part of the lock.
- On vehicles produced prior to **Ass.ly No. 52140**, detach the lower end of the tie-rod **(S)** from the transmission lever.
- Detach the elastic joint **(T)** for the connecting tie-rod on the lock-control block from the lever on the lock.
- Slide out the lock from the door frame and release the cable **(U)** end connecting the outer handle and the tie rod **(V)** connecting the inside handle.

- When re-assembling, tighten the screws **(34)** to the prescribed tightening torque.

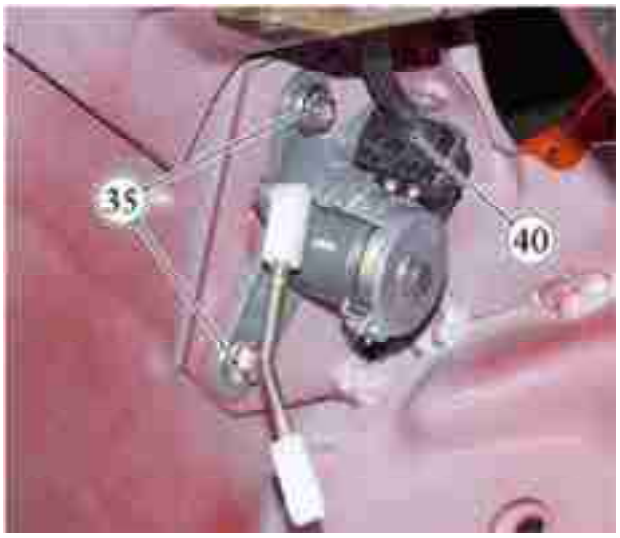
Replacing the Lock-Control Block

- Remove the door panel, the water-tight fabric shield, the window and the external opening handle as described above.
- Detach the micro-switch **(40)** connector, located on the locking system control block, from the door cable block.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.

- Unscrew the two nuts **(35)** and slide out the entire block from the door frame.
- It is possible to replace the individual micro-switch **(40)** after having released it from the clamp which fastens it to the locking system control block.

For connection to the system, see Table **M** and **N** - ELECTRICAL SYSTEM.



IMPORTANT

The Ferrari Spare Part Service supplies all the car locks in a single set. Therefore, if a door-lock block is replaced, it is necessary to replace all the locks in the car.

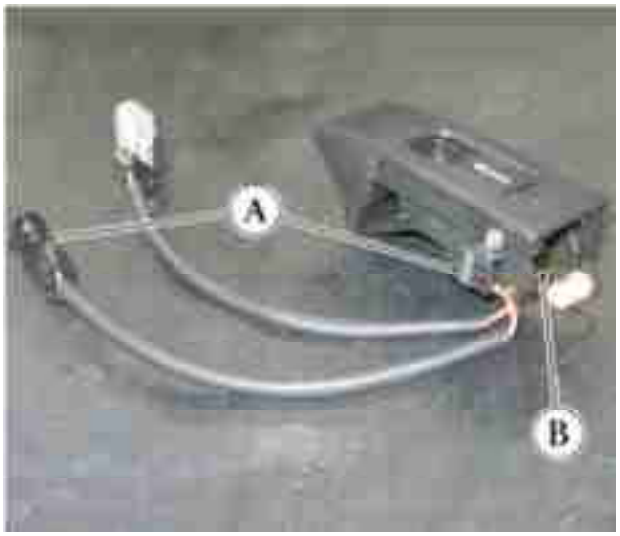
- When re-fitting, lock the nuts **(35)** to the prescribed tightening torque.

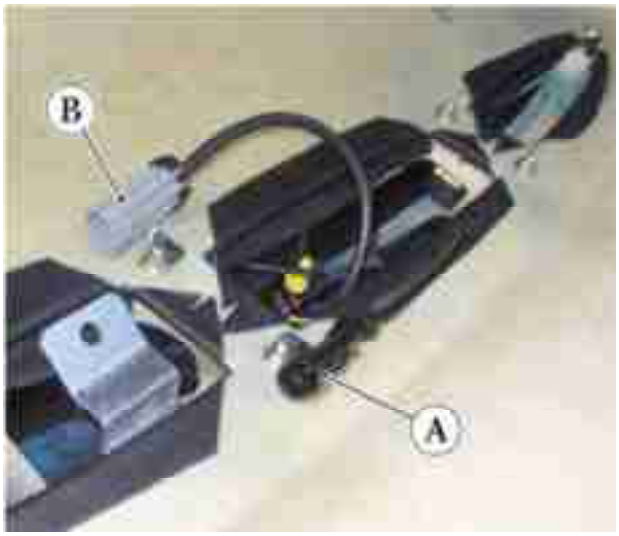
Replacing the micro-switches on the internal door opening handle (from Ass.ly No. 52140)

N.B

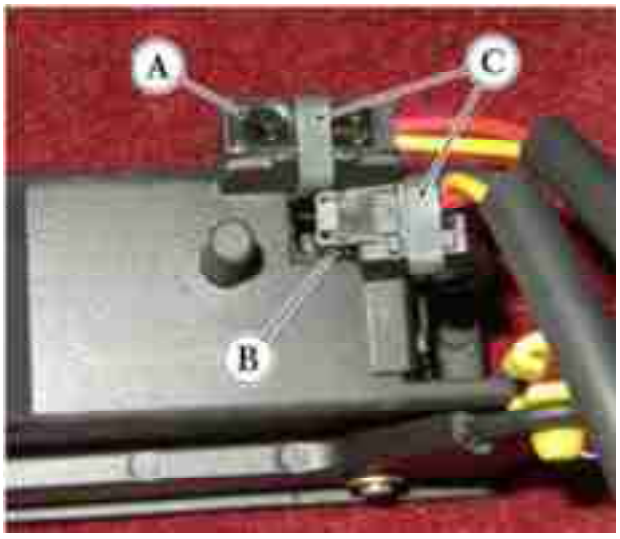
From Ass.ly No. 52140 *an electric door locking system activated from inside the vehicle has been introduced. Unlike the pre-modification system, to lock the doors, the new system uses an electrical signal produced by a micro-switch which is activated with the LOCK control lever, and connected to the lock electrically.*

- Remove the door panel and the waterproof canvas as described earlier.
- Detach the BLACK connector on the opening micro-switch **(A)** and the GREY connector on the door lock micro-switch **(B)** from the small brackets on the internal door panel.



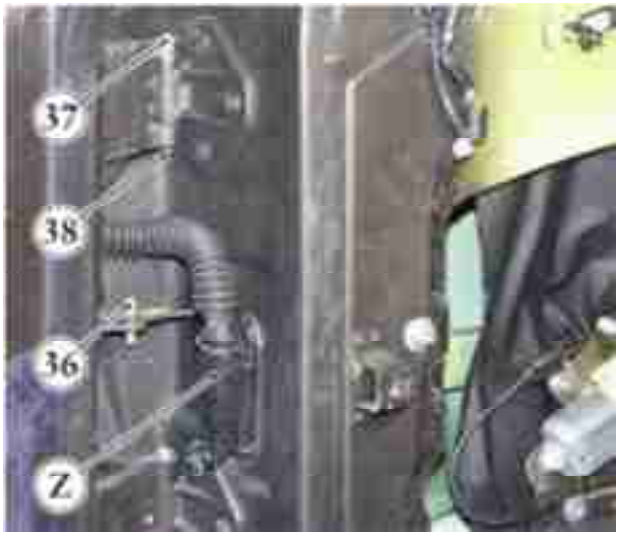


- Take the retaining clip **(C)** out and remove the micro-switch **(A)** and/or **(B)** from the handle.
- Replace the micro-switch and proceed with the refitting by performing the operations described in reverse order.



Removing the Entire Door

- Detach the dashboard harness connector **(Z)** from the door.
- Slide out the plug **(36)** from the tie-rod.
- Remove the stop ring **(37)** on each pivot **(38)**.
- Slide out the pivots **(38)** and remove the entire door from the car.



In the event that the door hinges show excessive clearance, it is possible to replace the bushings fitted on the bodywork fixed hinges.

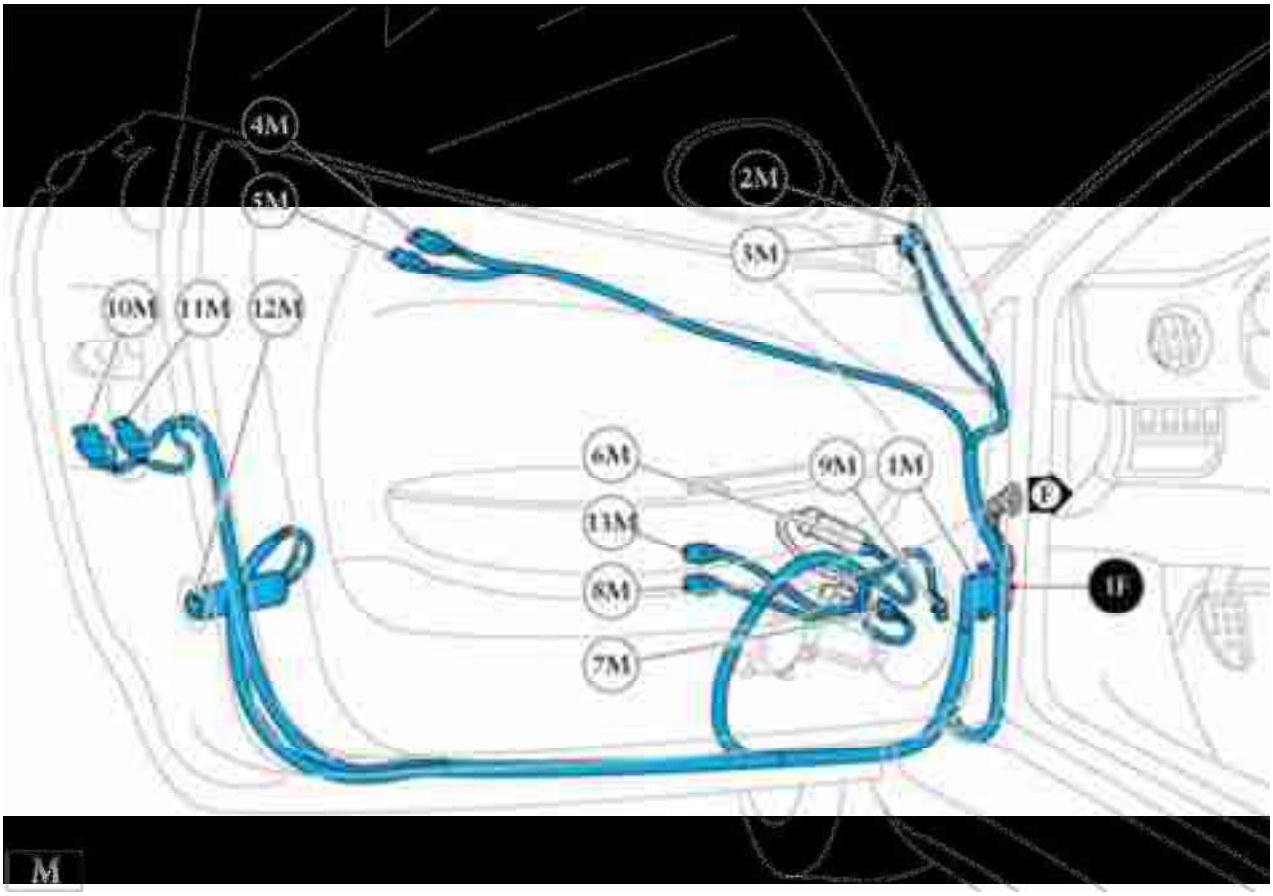
- To replace the door tie-rod **(39)** the two outer fastening nuts (**40**) must be unscrewed.
- When re-assembling, lubricate the pivots and the bushings **(38)** with hydro-repellent grease and tighten the tie-rod fastening nuts (**39**) to the prescribed torque.

Altering the door connection cables (from Ass.ly No. 52140)

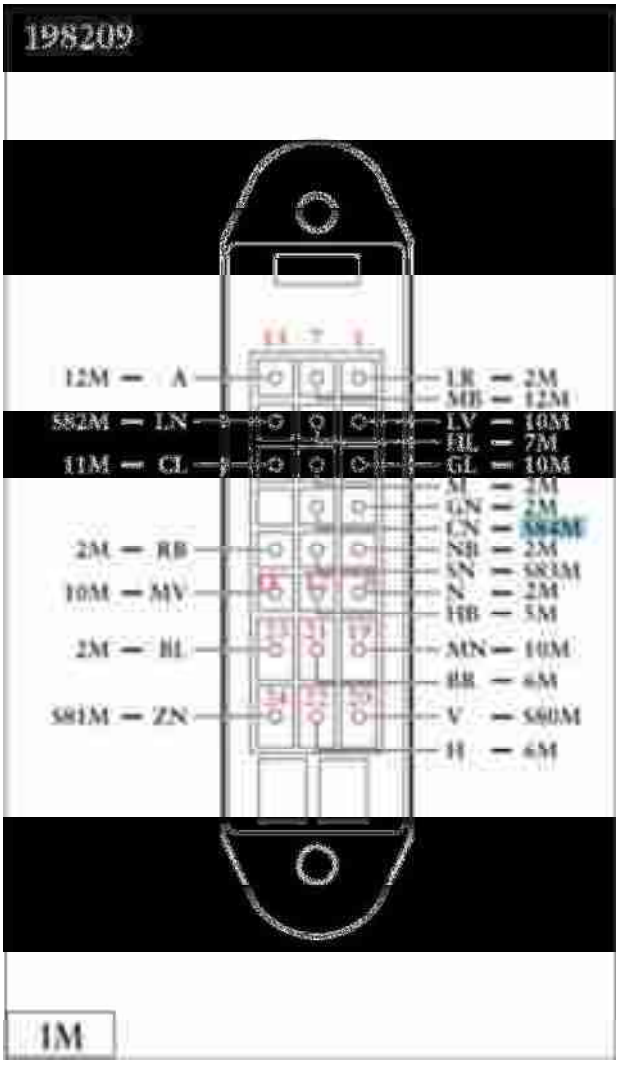
With the introduction of the electric door locking system operated from inside the vehicle the door connection cable has been modified.
On the new cable (code **198209**) the following have been introduced: a connector (**13M-13N**) for linking the door lock micro-switch, a welded joint (**S84M-S84N**) and the relative connections involving the connector (**1M-1N**), for linking the dashboard cable, and the connector (**4M-4N**), for linking the key block.
In the figures below, showing the charts and pinout of the connectors in the “ELECTRIC SYSTEM” section, only the components affected by the service campaign are shown, with the modifications highlighted in yellow.

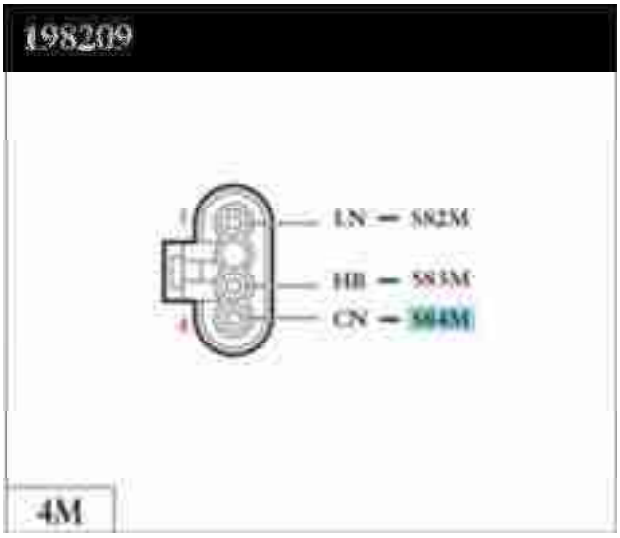
Table M - LH door cables

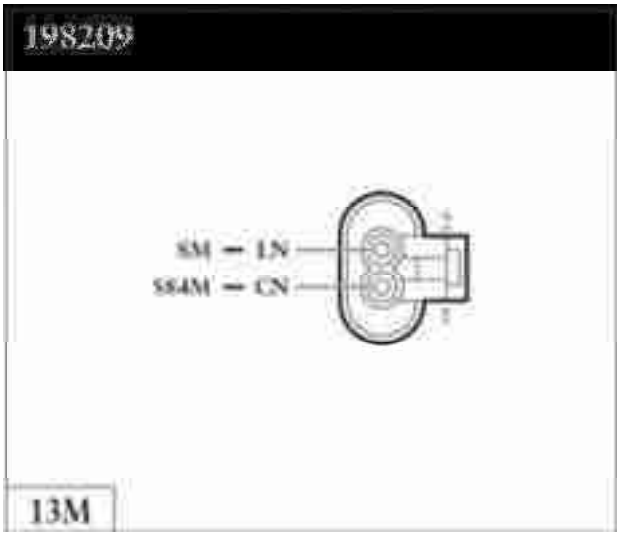
198209 - Door connection cables

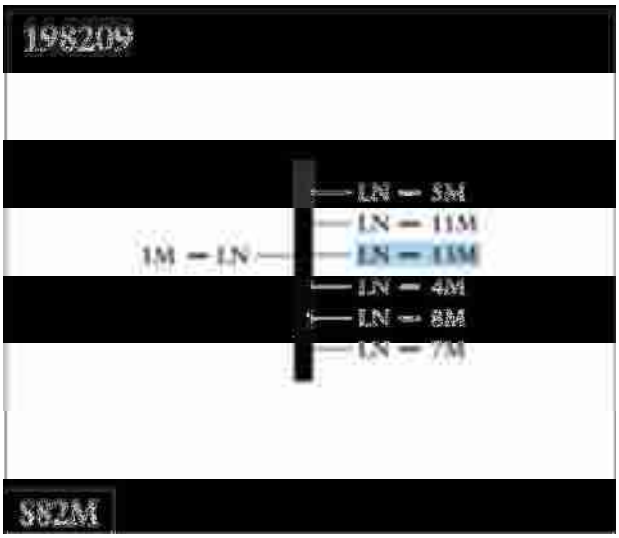


1M - Dashboard cables to driver's door cables joint
4M - Key lock set micro-switch
13M - Door lock micro-switch









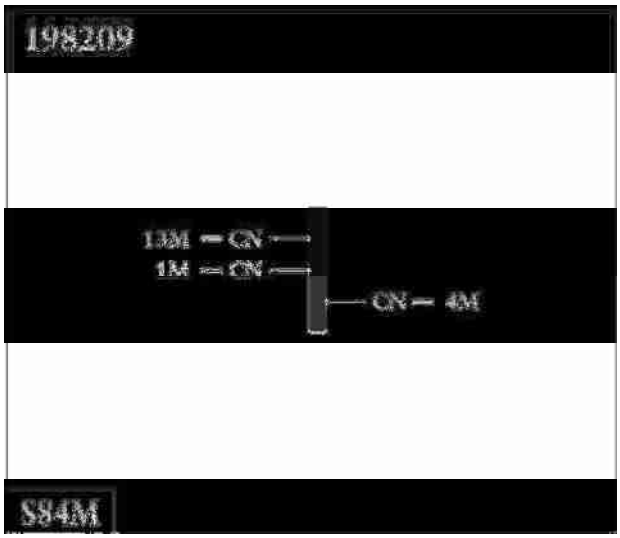
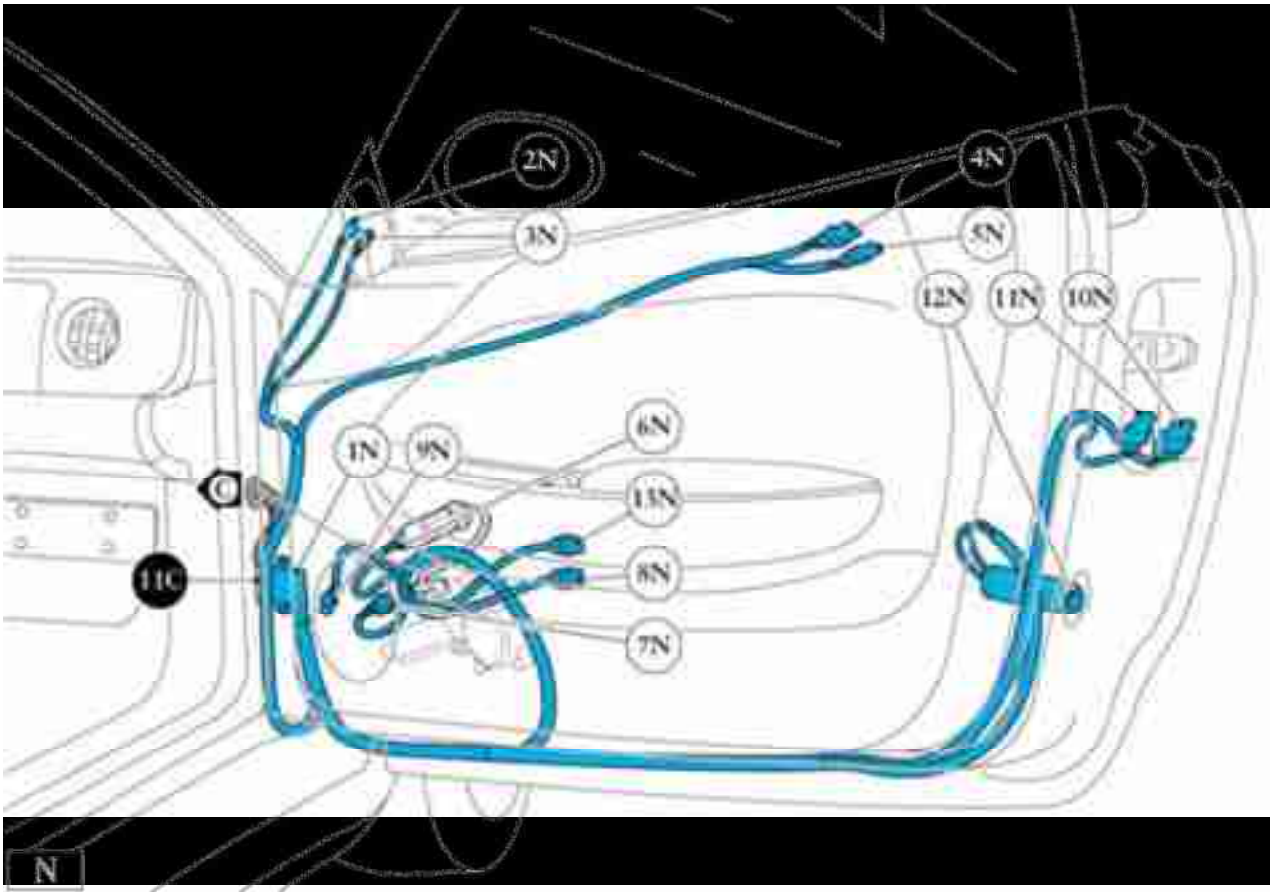
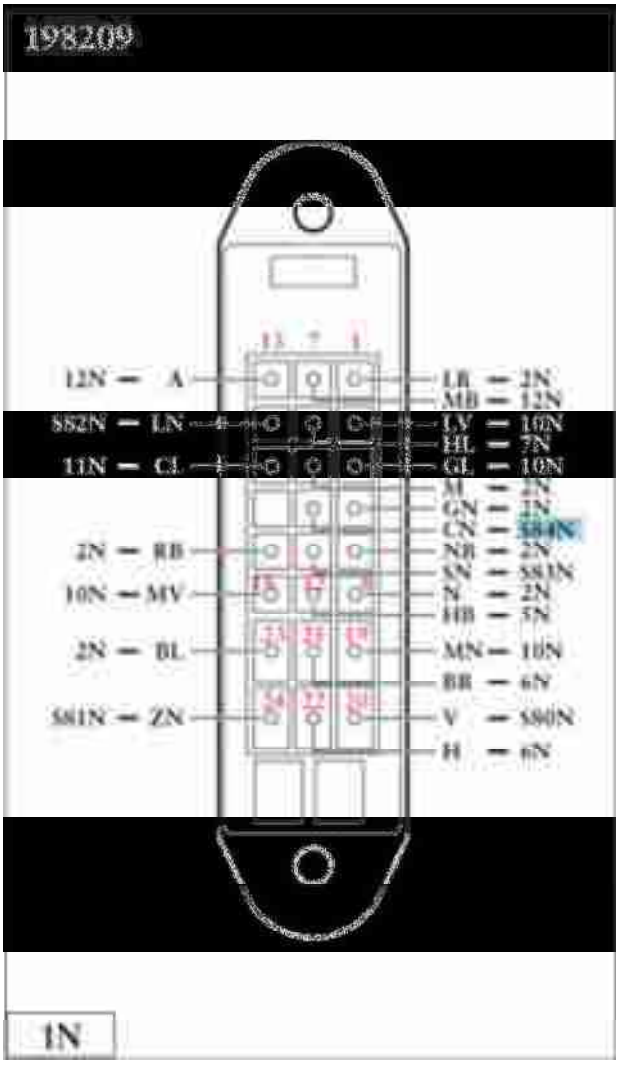


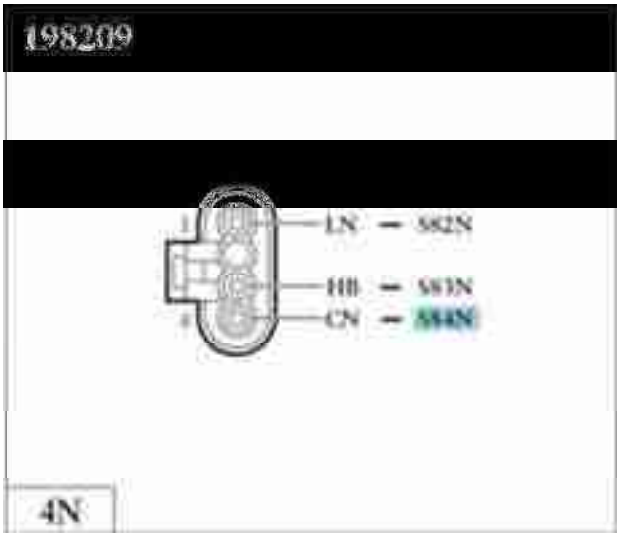
Table N - RH Door Cables

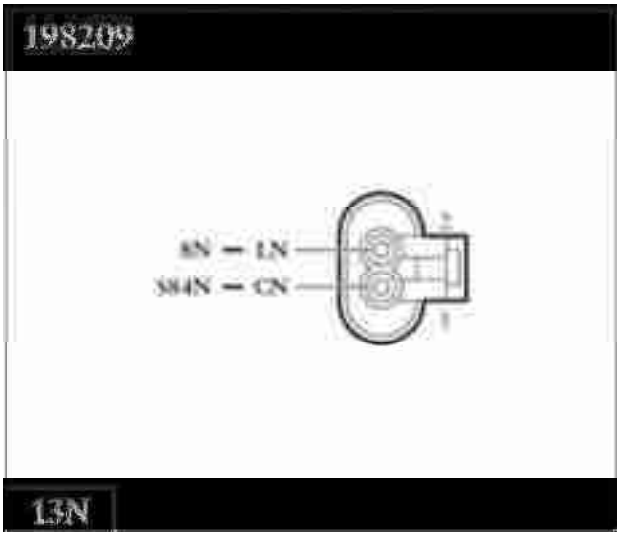
198209 - Door connection cables

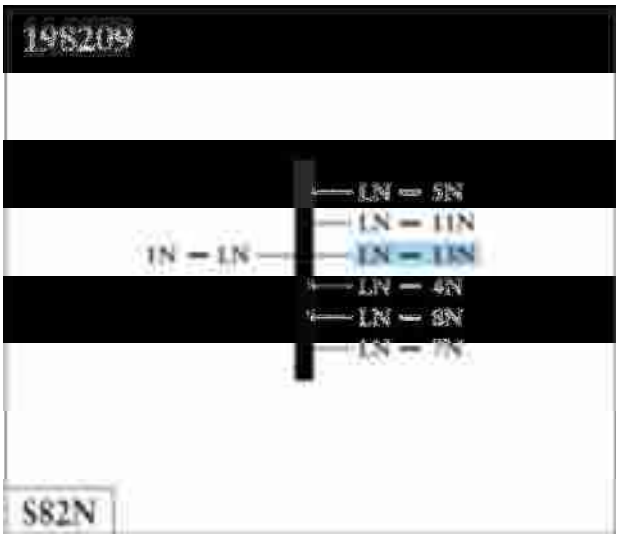


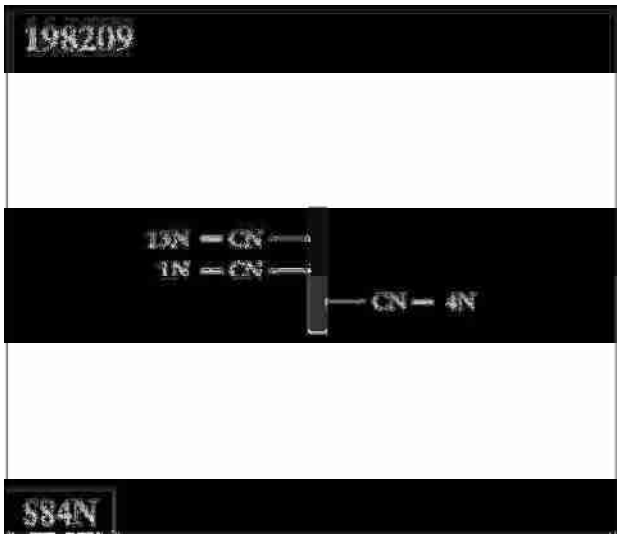
1N - Dashboard cables to passenger's door cables joint
4N - Key lock set micro-switch
13M - Door lock micro-switch







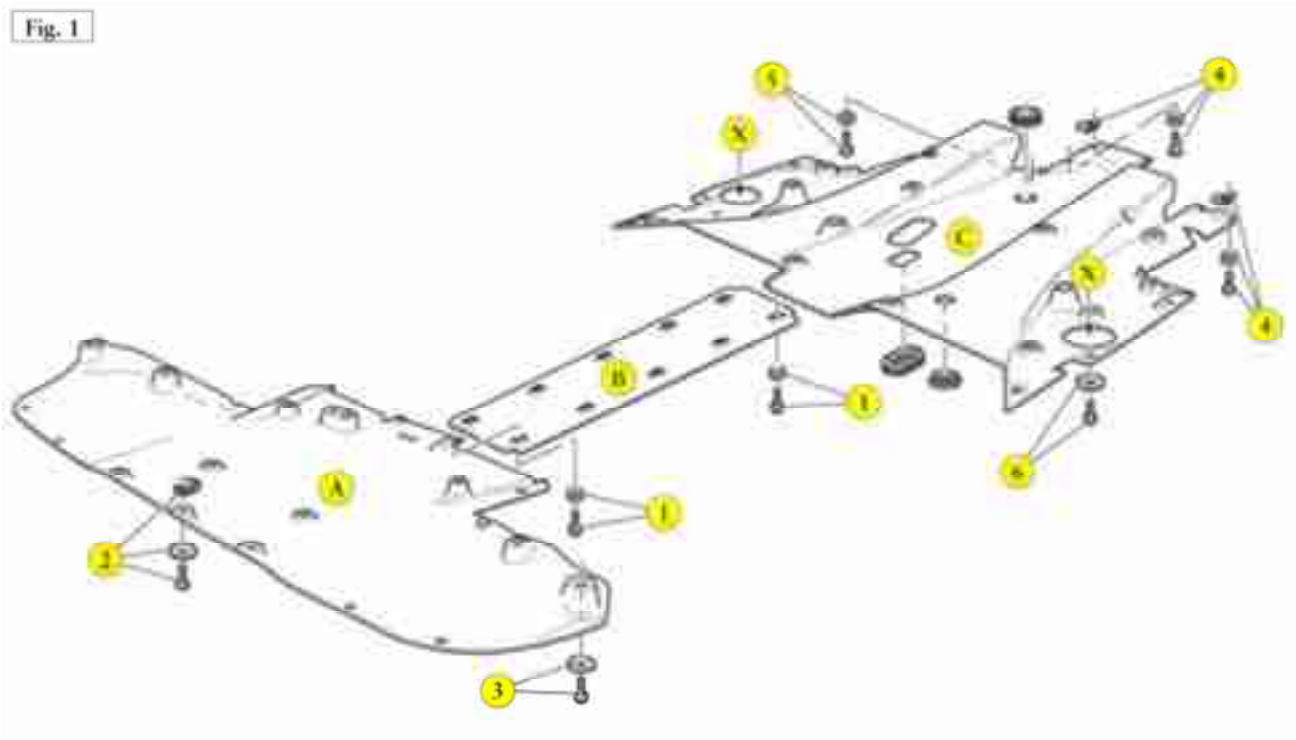




M2.12 UNDERFLOOR PARTS

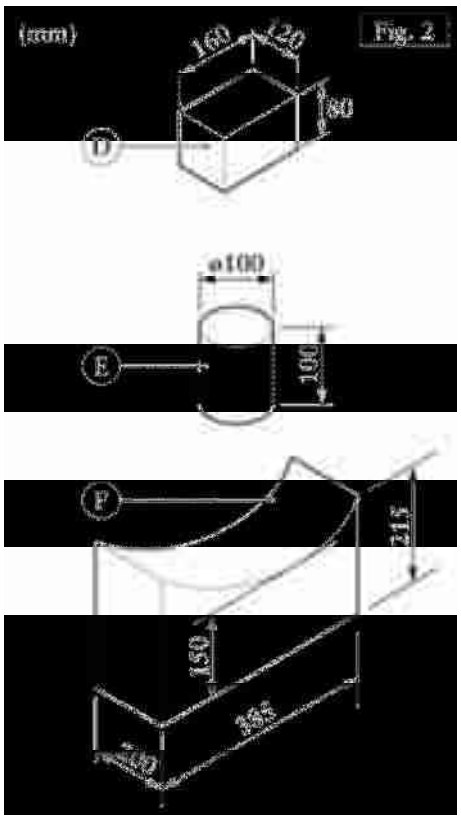
The car underfloor (see **Fig. 1**) consists of a front element **(A)** connecting the bumper to the floor panel, a central shield **(B)** which covers the channel for the underfloor piping, and a rear element **(C)** which covers the whole engine compartment and links the rear edge of the floor panel to the bumper.

Fig. 1



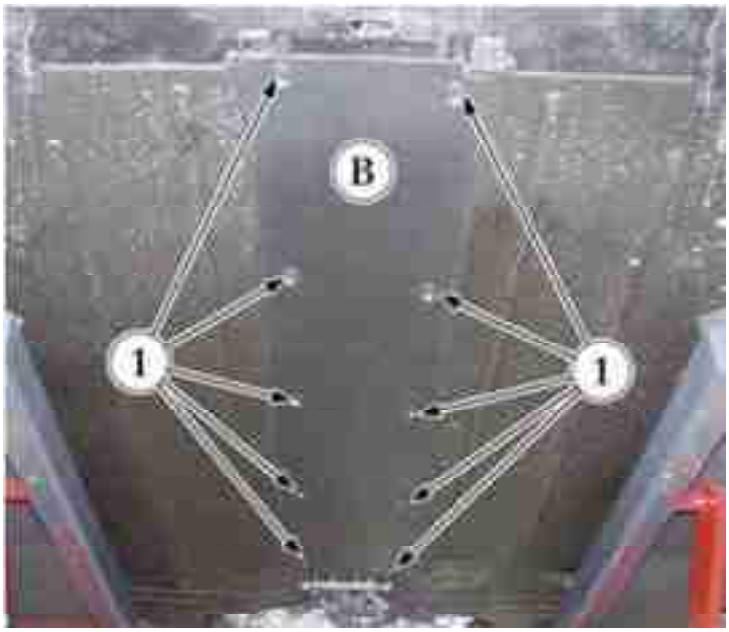
Keys to **Fig. 1**
1 - Central shield fastening screws **(Q.ty 10)**
2 - Screws fastening the front element to the bumper **(Q.ty 7)**
3 - Fastening screws for the front side frames and floor panel **(Q.ty 8)**
4 - Screws fastening the rear element to the bumper **(Q.ty 8)**
5 - Fastening screws for the rear central part **(Q.ty 2)**
6 - Rear element fastening screws **(Q.ty 18)**
A - Front element
B - Central shield
C - Rear element
X - Rear element holes

The latter element is fitted with special holes aligned with the engine and gearbox oil draining caps and in position with the points used for lifting the car.
To remove and refit the rear element using an auto lift with wheel base supporting frame, it is necessary to be equipped with pairs of pads, as below specified (**Fig. 2**):
D - Prismatic pad
E - Cylindrical pad
F - Wheel spacer



Removing the Central Shield

- Unscrew the ten fastening screws **(1)** and remove the central shield **(B)**.



Disassembly of the Front Element

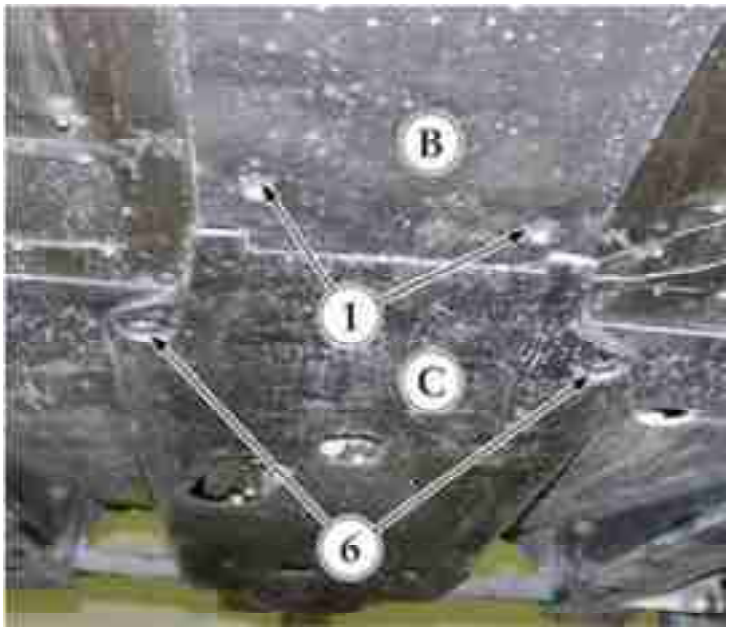
- Remove the central shield as described above.
- Unscrew the seven self-tapping screws **(2)** on the front bumper.

- Unscrew the eight fastening screws **(** on the small front side frames and on the floor panel.
- Remove the front element **(A)** sliding out the draining pipelines from the windscreen shield, the battery outlet and the draining pipe for the A.C. system condensation.

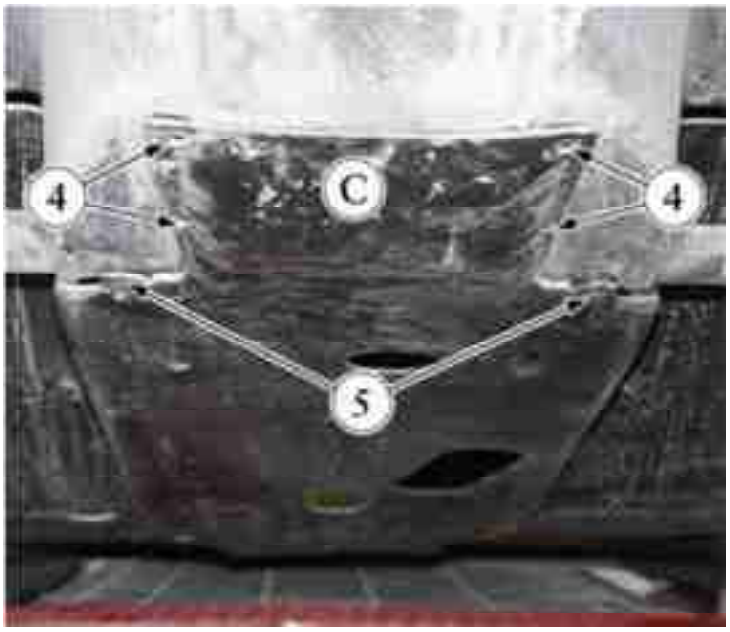
Disassembly of the Rear Element

- Place the prismatic pads **(D)** on the bridge crane tracks, behind the front wheels, and place the cylindrical pads **(E)** in position with the holes **(X)** of the rear part **(C)**.

- Lift the car.
- Unscrew the two screws **(1)** fastening the rear element of the central shield **(B)** and the rear element **(C)** to the floor panel.



- Unscrew the eight self-tapping screws **(4)** that fasten the element **(C)** to the rear bumper.
- Unscrew the two screws **(5)** fastening the rear central part to floor panel.



- Unscrew the eighteen screws **(** and detach the rear element **(** moving it onto the auto lift.

- Position the spacers **(F)** under the rear wheels.

- Lower the car onto the spacers **(F)** and slide out the rear element of the underfloor.

R -assembly

- When the car is positioned on the shims **(F)**, fit the pads **(D)**, as described for the disassembly procedure.
- To adjust part **(C)** correctly with respect to the floor panel and to centre the cylindrical pads **(E)** in the holes **(X)** it is advised to fasten the rear part of element **(C)** to the chassis, by positioning the screws **(5)**.
- Insert the end of the draining pipe for the fuel filler neck compartment into the element's hole **(C),** leaving an overhanging of at least **20 mm**.

- After having positioned the cylindrical pads **(E)**, lift the car.

- Re-assemble the parts that had been removed, following the same sequence as for the removal procedure but in reverse order.
- Lock all the screws to the tightening torque of **6 Nm**.

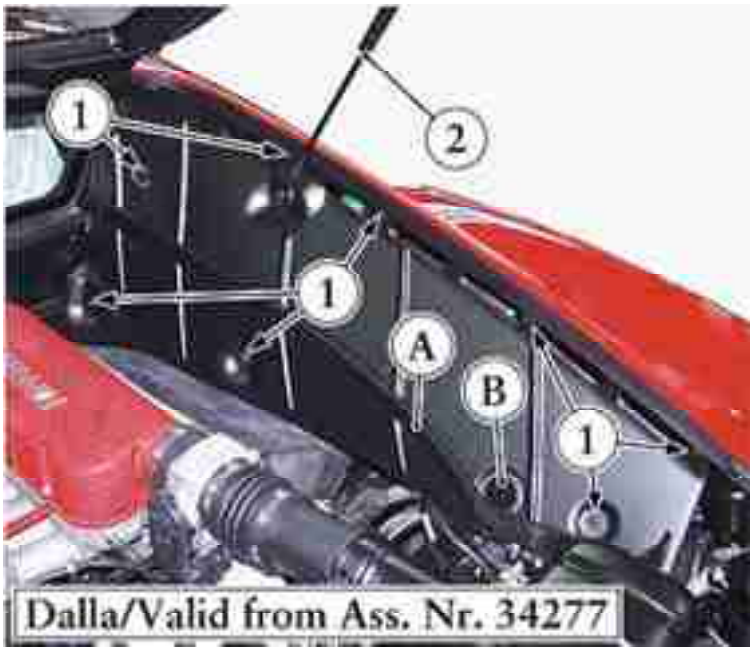
IMPORTANT

To avoid breaking the underfloor elements, it is necessary to use the specific washers on the fastening screws, as these provide a wide resting surface.

M2.13 ENGINE COMPARTMENT GUARDS

These are mounted on the sides of the engine compartment and, besides having an aesthetic function, they contribute to the protection of the electronic components (electronic control units, sensors, etc…) and of the electric parts (solenoid valves, connectors, harnesses, etc…) which are fixed to the internal, upper part of the mud guards.

Starting from car **Ass. Nr. 34277,** the engine compartment protective guards are equipped with a water channel **(A),** which is in turn provided with a pipe **(B)** for collecting and draining the water which could get into the engine compartment.



IMPORTANT
Do not use the car without the engine compartment protective guards.

Disassembly

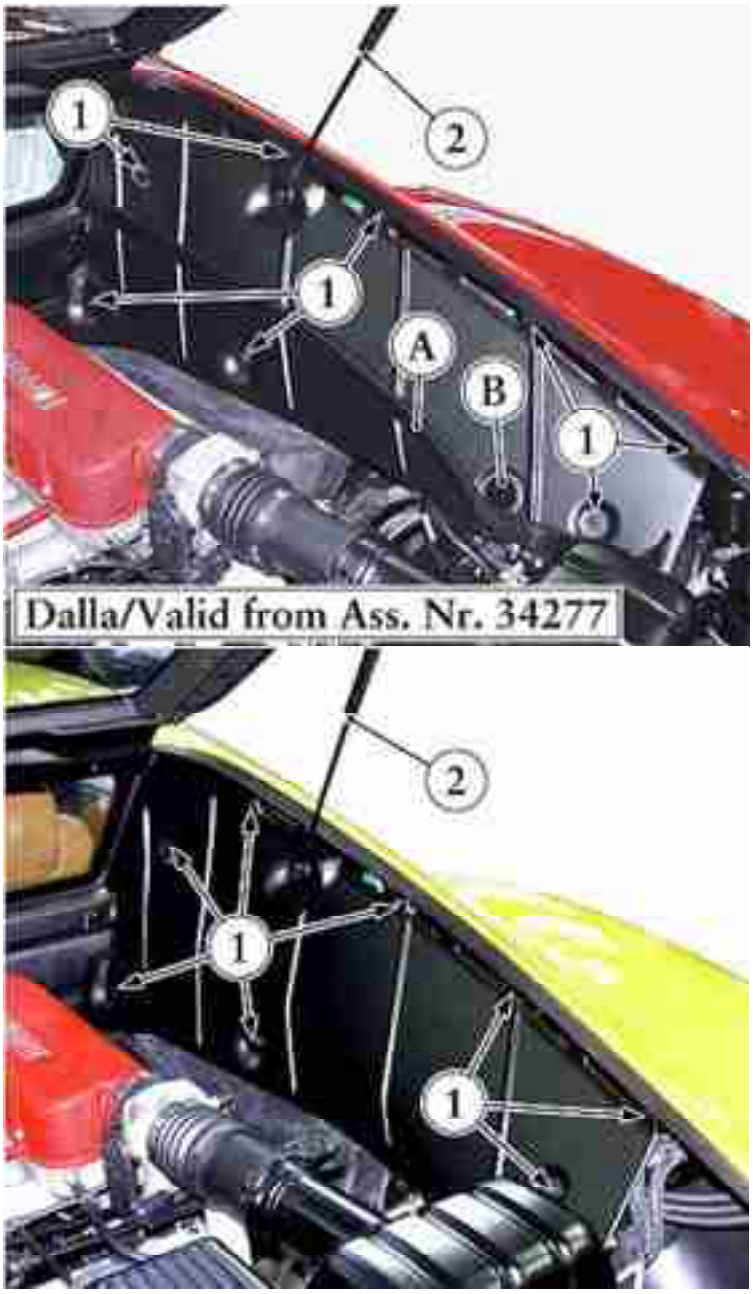
- Lift the engine compartment lid and unscrew the eight screws **(1)** fastening the shield to the chassis frame and to the rear mobile bracket.
- Release the foot of the gas strut **(2)** from the chassis ball and socket joint.

WARNING
Support the engine compartment lid suitably, as only one gas strut, however strong, may not be sufficient to maintain the lid in a lifted position.

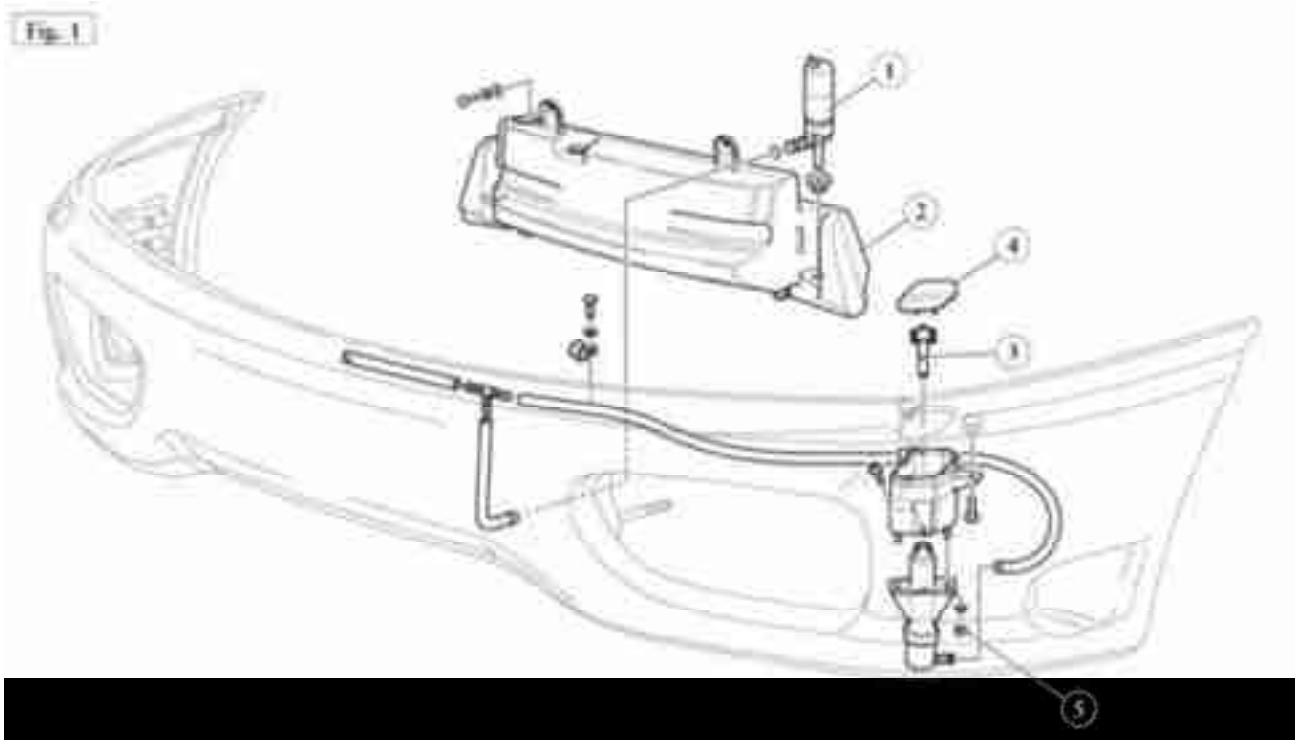
- Remove the shield from the engine compartment.

Re-assembly

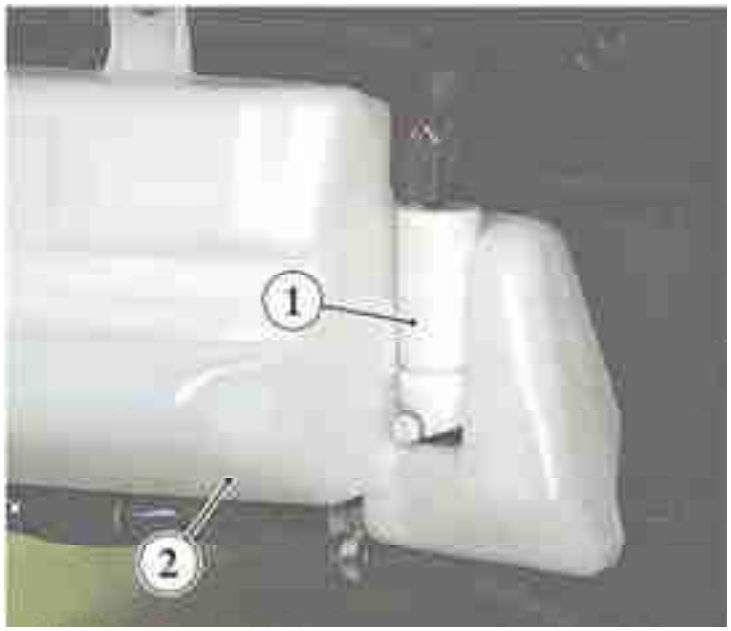
- Insert the upper part of the shield under the mud guard edge, aligning the hole with the fulcrum ball and socket joint for the gas strut on the chassis.
- Tighten the fixing screws **(1)** to a **3,2÷4 Nm** torque.
- Insert the foot of the gas strut **(2)** into the ball and socket joint.



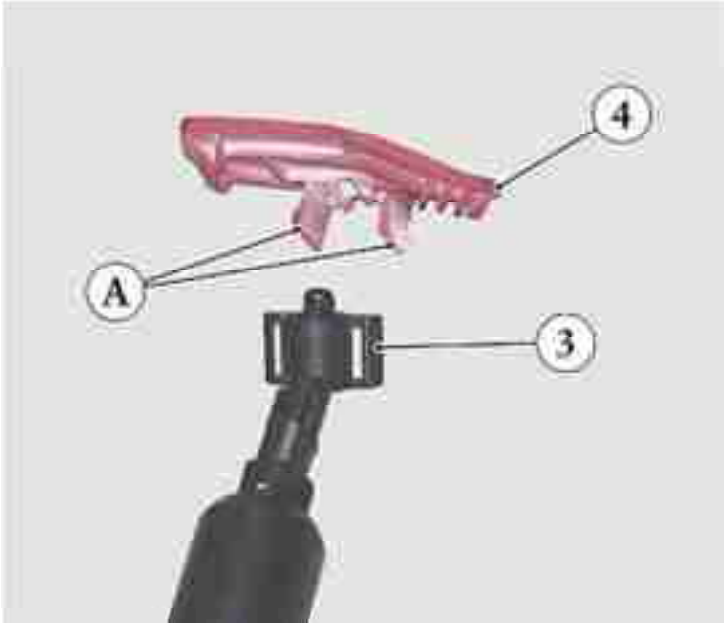
M2.14 HEADLIGHT WASHERS (OPTIONAL)



The headlight washer unit (**Fig. 1**) is composed of an electric pump, a timer, and two telescopic type nozzles, hidden in the front bumper.
The electric pump **(1)** is located in the tank **(2)** which contains the same liquid as the windscreen washer unit. With the addition of the headlight washer device, the tank capacity is almost doubled (**3.5** becomes **7.5 litres**) (M 2.08).



The entire device for headlight movement and washing is integrated in the bumper; in resting conditions the telescopic nozzles **(3)** are hidden by a small protective lid **(4)** integral to the nozzle itself.



IMPORTANT
Do not use the device without the protective lid as the nozzle, lacking a restraint, would fall inside the bumpers.

Optimal headlight washing is obtained by operating the lever on the steering wheel twice consecutively, when the low beams are turned on (H 2.07).
To lift the nozzles and to optimise the aiming of the jet, the circuit uses the pressure generated by the pump in the system. The complete cycle is controlled by a timer. When the cycle is completed, the pump is deactivated and the lowering of the nozzles is determined by their weight.
When the pressure generated by the pump reaches **3.5÷4 Bars**, a non-return valve, placed at the head of the telescopic tube with nozzle, opens and determines its rise (stroke **81 mm**).

Replacing the pump and the tank

Follow the procedure described for the windscreen washer system (M 2.08).

IMPORTANT
The pump is not equipped with a self-priming device: the intake duct must always be immersed in the fluid to work correctly.

Replacing the headlight washer device

- Remove the front bumper, detaching the connection piping from the headlight washer pump (M 2.03).
- Slide out the protection lid **(4)** complete with nozzle from the bumper.

NOTES
It is necessary to pull strongly to overcome the resistance of the O-Rings positioned on the nozzle's telescopic tube.

- The lid can be separated from the nozzle by removing the two retaining clamps **(** .

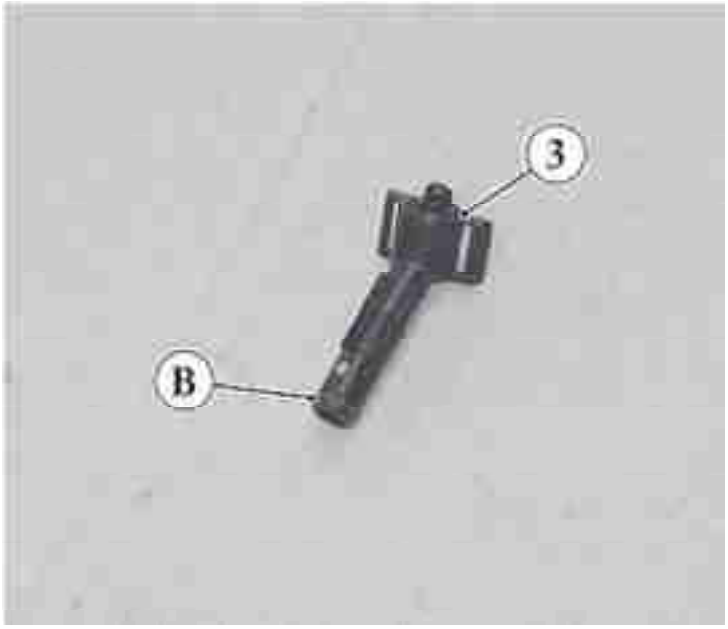
IMPORTANT

The spray device is fitted with a nozzle which is aimed towards the left or right-hand headlight, depending on the current use. When replacing, always fit the spray device with the nozzle facing the external side of the headlight.

- Unscrew the two lower nuts **(5)** fixing the device to the containment support and remove it from the bumpers after having detached the connection piping.

- Proceed with the necessary checks or replacements.

When re-assembling the telescopic nozzle **(3)**, apply a layer of grease to the O-Rings **(B)**.



Replacing the timer

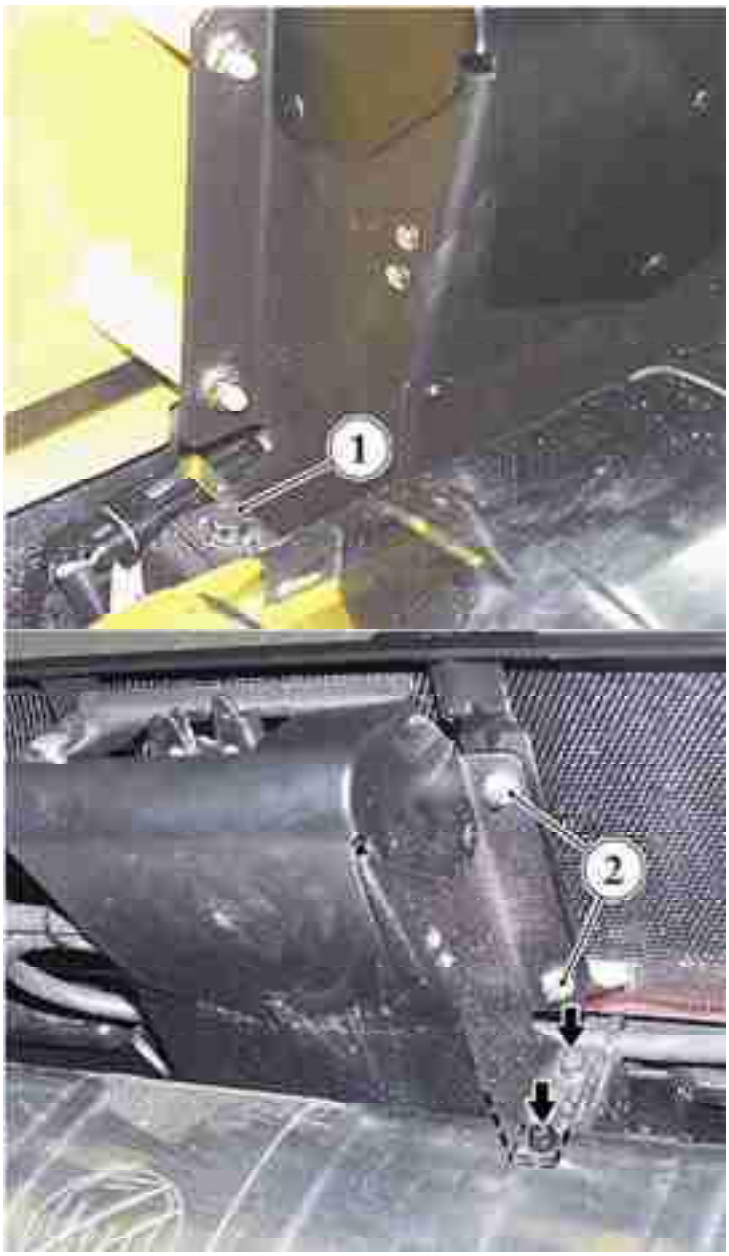
The timer **(6)** is positioned to the side of the power window ECU, on the left-hand side of the under-dashboard.

For connection to the system, see Table **F** - ELECTRICAL SYSTEM.

M2.15 REAR LIGHT SUPPORT COVERING

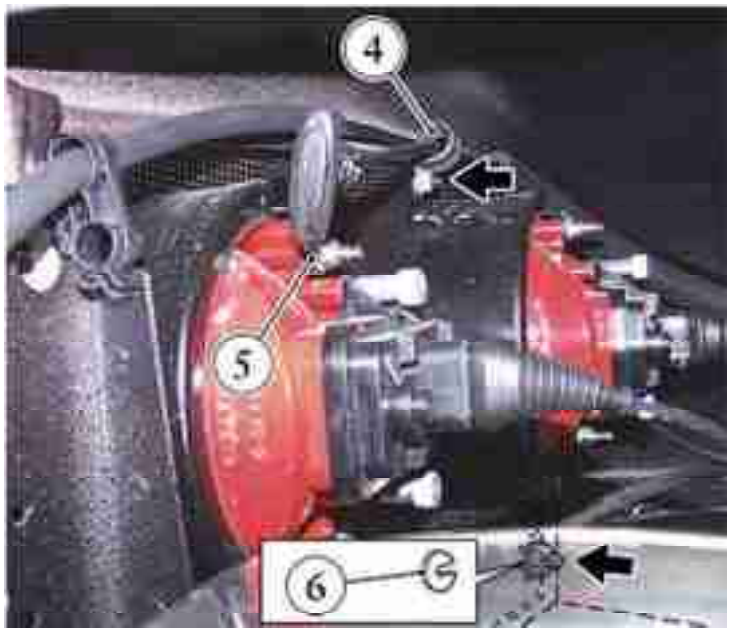
Disassembly

- Working from inside the engine compartment, unscrew the four screws which fasten the lock support bracket of the engine compartment lid to the chassis rear frame. Take care not to touch the support bracket of the number plate light wire connector, which is fixed under the screw **(1)**.
- Unscrew the four nuts **(2)** and detach the bracket complete with lock from the covering, leaving it connected to the opening wires. To assist re-assembly, it is advisable to mark the cross member of the rear frame with the lock support bracket mounting position.



- Disconnect the following connections from the rear wiring of the right-hand side engine compartment:
  - The fixed contact connection of the supplementary stop light
  - The micro-switch connection of the engine compartment lid lock
  - The right side light cable connection
- Disconnect the left side light cable connection **(3)** from the rear cable in the left-hand side engine compartment
- Unscrew the eight fastening nuts at the ends of the covering.

- Remove the cable support clamp **(4)** for the engine compartment lid lock release.
- Unscrew the fastening nut and detach the fuel tank flap's emergency release handle support **(5)** from the covering.
- Remove the rear covering complete with lights, remembering to keep the shims.

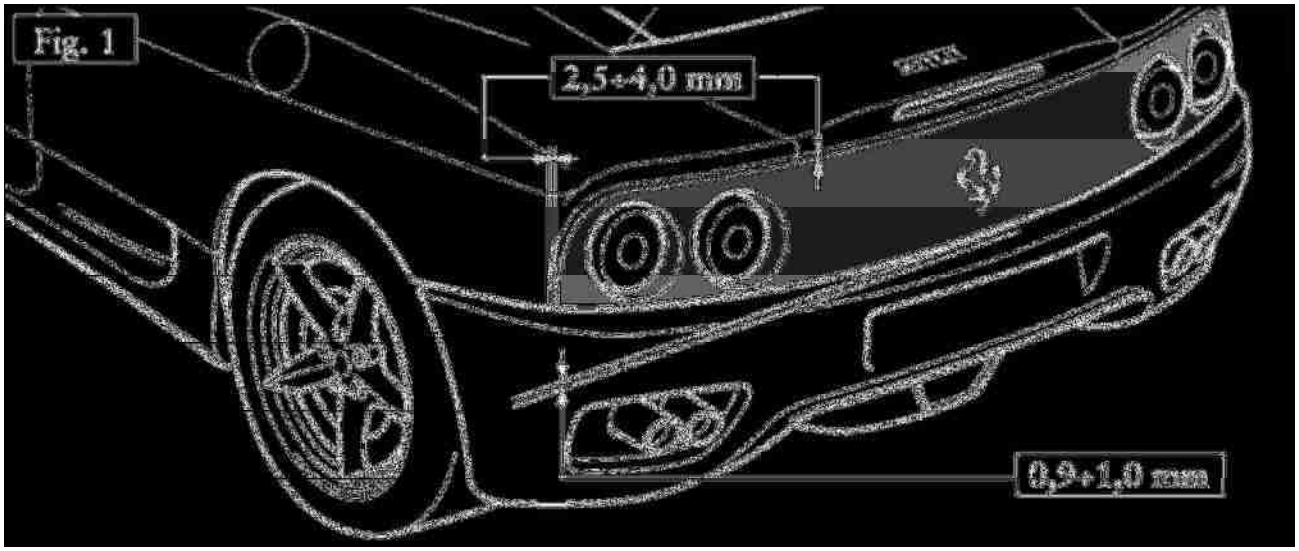


R -assembly

- Before re-assembly, check that the chassis surface bay and the covering are in perfect condition and clean.
- Position the covering on the bodywork, inserting the stud bolts in the rear frame holes. The original shims **(6)** must be re-used if the same covering is being remounted.
- Fit the clamp **(4)** and screw down the eight fastening bolts at the ends of the covering.
- Attach the connections detached during the disassembly procedure.

- Mount the lock support bracket on the central stud bolts of the covering, using the reference markings made previously.
- Insert the number-plate lighting connector support bracket under the screw **(1)** and screw down the four fixing screws.

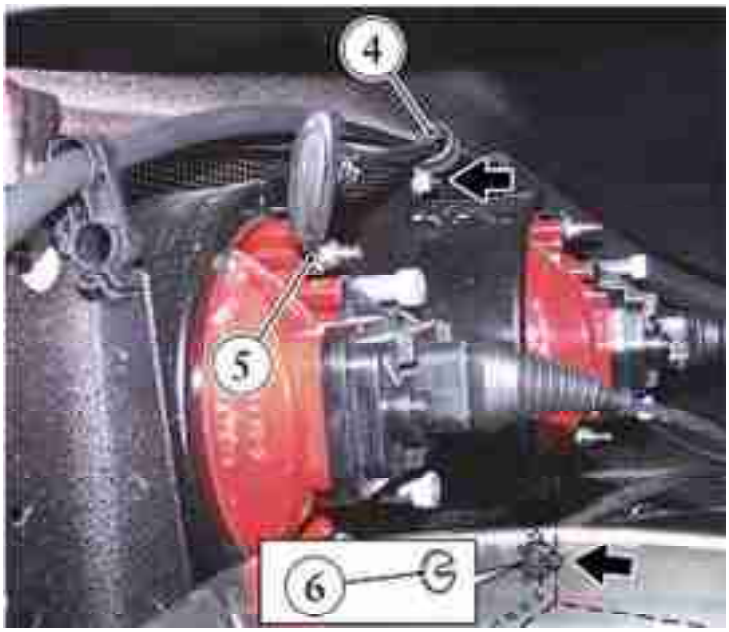
- Check the distance and alignment with the bumpers and the bodywork, respecting the prescribed values (see Fig. **1**).



- If necessary, insert the specific shims **(6)** between the covering and the chassis to obtain an optimal alignment.
- Tighten the fastening components to a **7,4 Nm** torque, following the below order:
  - the four nuts **(2)**;
  - the eight fastening nuts at the ends of the covering;
  - the four screws fastening the lock support to the rear frame.
- Reposition the support **(5)** for the emergency fuel tank flap handle release

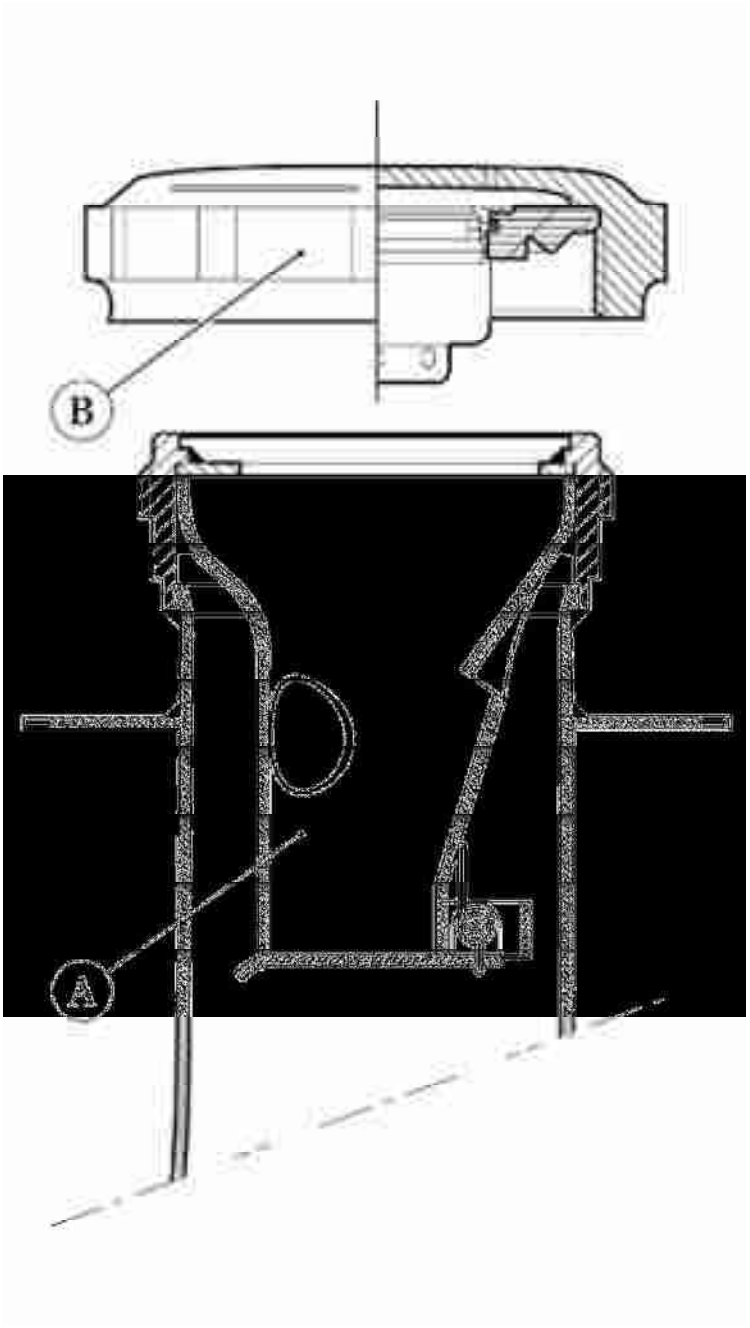
NOTES

The described procedure shall be used also for the rear covering of the perforated lights' support (Challenge type).



M2.16 FUEL TANK FILLER NECK

The tank filler neck can be reached by opening the flap on the rear left-hand mudguard of the car. This is endowed with a valve and a throttling **(A)** to prevent re-filling with leaded fuel through the filling cap **(B)**.



Disassembly

- Remove the left-hand wheelhouse (M 2.05).
- Release the clamps **(1)** and slide out the connection pipes for the left-hand tank.

Note for the US M.Y.2000 version

These cars feature a single pipe which connects the filler neck to the tank..

- Unscrew the filler cap and the screws **(2)** fastening the filler neck to the bodywork.

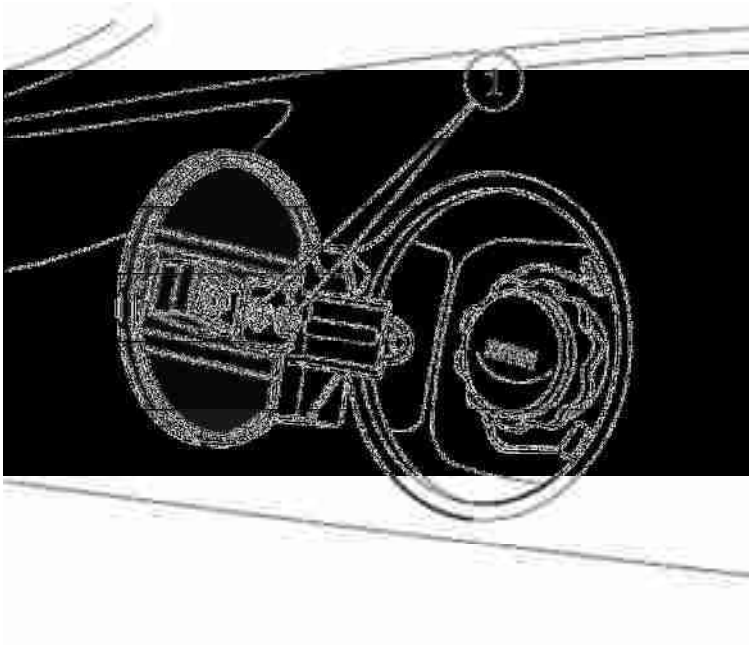
- Rotate the filler neck and slide it out together with the gasket.

M2.17 FUEL TANK CAP FLAP

Disassembly

The flap which allows access to the fuel re-fill cap is usually provided as a single spare part: when replacing it , it is necessary to detach it from the hinge fastening it to the bodywork.

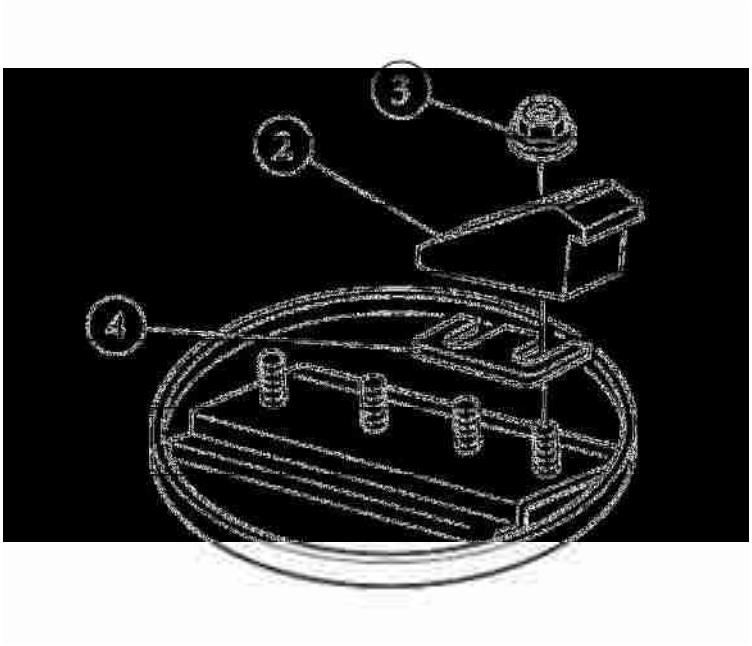
- Unscrew the two nuts **(1)** and remove the flap.



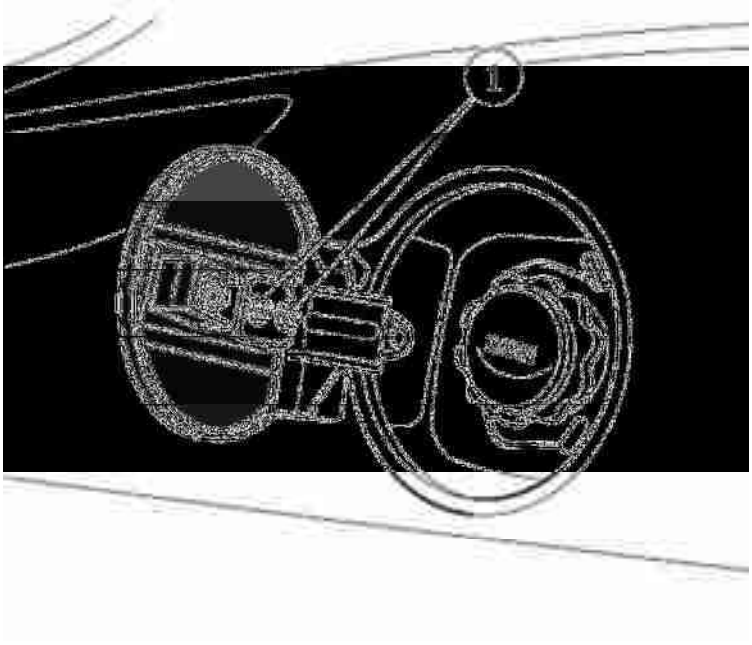
- Detach the striker plate **(2)** from the flap by unscrewing the two nuts **(3)** remembering to keep the shims **(4)**.

Re-assembly

- Position **two** shims **(4)** and the striker plate **(2)** on the flap stud bolts.
- Centre the stud bolts in the striker plate slots and tighten the nuts **(3)**, not over tightly.



- Fit the flap **(1)** onto the bodywork hinge, fastening it with the nuts **(1)**.



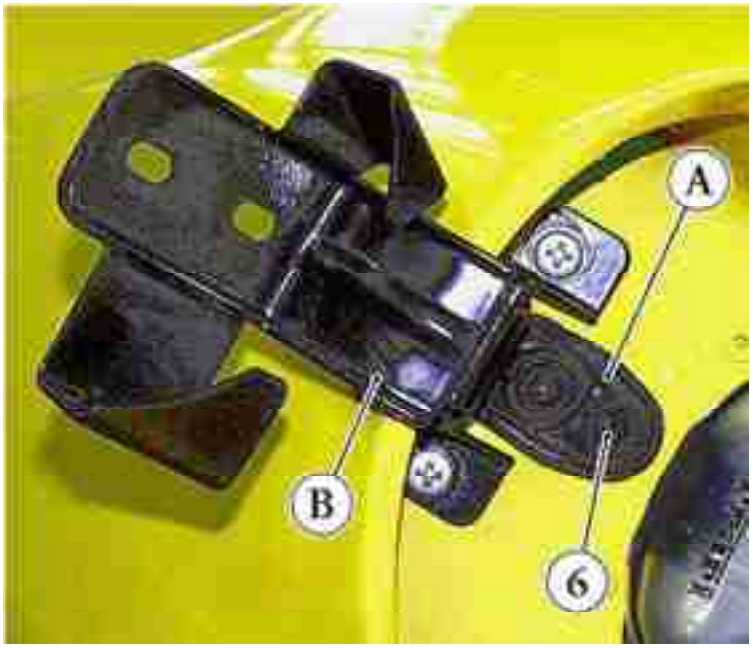
- Check the opening and closing of the flap: if it is not working properly, adjust the position of the striker plate **(2)** in respect of the flap stud bolts, or modify the number of shims **(4)**.
- Definitively tighten the nuts **(3)** to a **3.6 Nm** torque.

- Close the flap and check its alignment with the bodywork; making sure that there is no contact between the flap and the bodywork. Any eventual flap adjustments with respect to the bodywork can be effected by loosening the two screws **(5)** which fasten the hinge to the inside of the fuel re-fill cap compartment.
- Definitively tighten the screws **(5)** and the nuts **(1)** to a **3.6 Nm** torque.

Replacing the switch

The switch **(A)** which controls the warning light on the instrument panel signalling an open fuel tank flap is fitted inside the fuel re-fill cap compartment.
The switch is activated by any flap hinge movement **(B)**.

- To remove the switch **(A)**, it is necessary to unscrew the fastening screw **(6)** and to slice the switch body out of the bodywork.



- Detach the left-hand side engine compartment connector (**29L**, see Table **L** - ELECTRICAL SYSTEM) and replace the switch.
- After having re-fitted the new component, make sure that the warning light is working correctly on the instrument panel.

M2.18 DOOR RING STRIPS AND COVERING

The following components are installed in the door compartment:
- door ring outer-edge strip;
- upper door bay moulding;
- strip cover;
- kick plate;
- external under-door panelling.

IMPORTANT
The strip cover, the kick plate and the external under-door covering are painted components: for touch-ups or complete re-paint procedures follow the instructions given in the chapter "M4 PAINTING".

Tightening torques

Moulding fastening screw	**2.4 Nm**
Door post cover fastening screw	**10 Nm**
Door striker plate	**20 Nm**
Kick plate fastening screw	**2.4 Nm**
Under-door panelling fastening screw and nut	**4.4 Nm**

Door ring outer- edge strip

The door outer-edge strip is in one entire piece and is inserted in the relief cut into the plates around the door. The assembly is carried out without using sealing products or bonding agents.
- When re-assembling, it is necessary to have the outer-strip completely adhered to its seat, hammering it sufficiently along all its perimeter using a plastic mallet. Pay particular attention to the points in the bodywork where there are plated fastening rivets.
- Apply specific silicone lubricant to the outer-edge strip, in position with the door window's sliding surface **(X)**.

Door bay

The upper moulding door compartment is composed of a metallic section **(A)** and an outer-edge strip.

NOTES

In the case of outer-edge strip damage or wear and tear, this individual component can be supplied by the Spare-part Service.

- In order to remove the moulding from the bodywork, it is necessary to detach the upper part of the outer-edge strip, as previously described, and remove the fixed side glass (_____).
- Take note of the moulding rear end position **(Y)** in respect of the bodywork, and unscrew the thirteen fastening screws.

- Remove the moulding complete with outer-edge strip.
- When replacing the outer-edge strip, it is necessary to remove the damaged component from the section and fit the new one into the special groove, cutting it to the length of the moulding.

- Prior to mounting, check the condition of the blocks **(** in position with the fastening screws **(** .

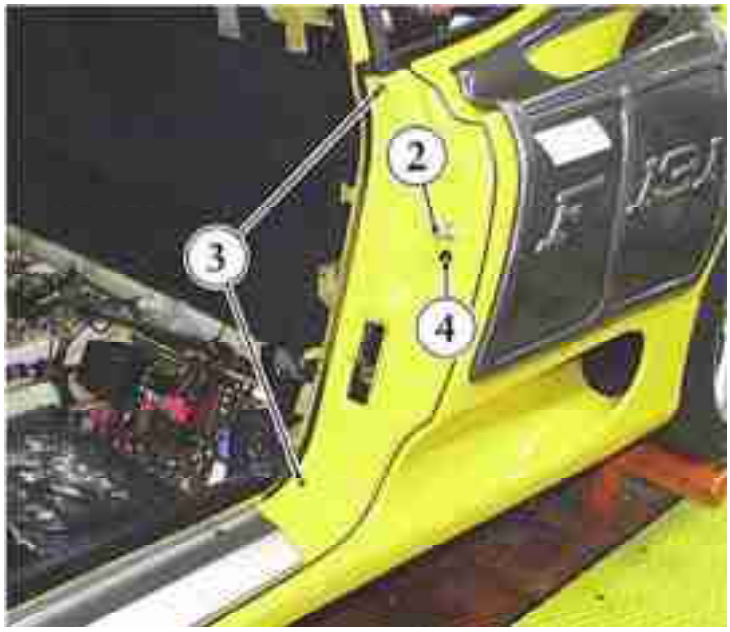
IMPORTANT

*The blocks **(C)** are equipped with a guide pin **(P)** which must be inserted in the prescribed slots for fastening. Correctly position the blocks to avoid the guide pins getting under the moulding, thereby compromising the door strip seal.*

- Fix the complete moulding, aligning the rear end to the previously marked reference **(Y)**.
- Tighten all the screws **(1)** to the prescribed tightening torque.
- Check that the outer-edge strip **(B)** is perfectly adhered to the bodywork.
- Re-assemble the components removed in the procedure.

Strip cover

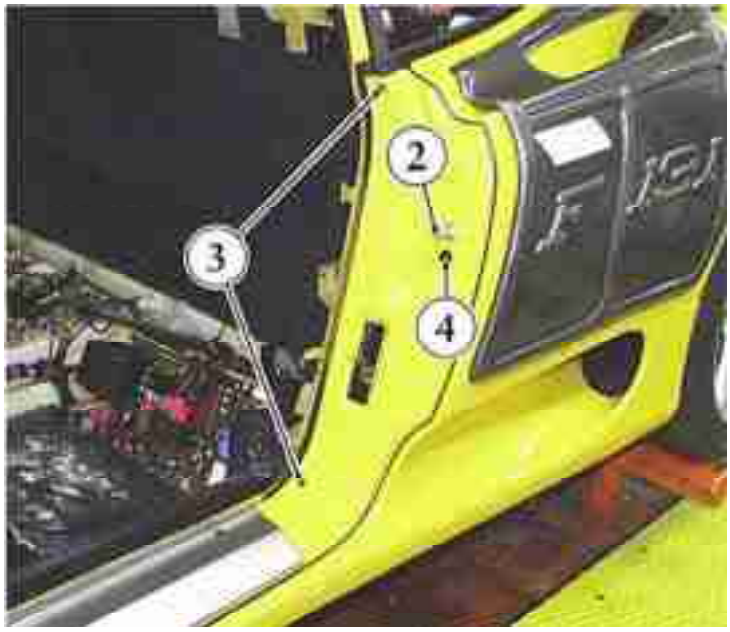
- To detach the strip cover from its pillar, the engine compartment lid release handle must be removed (H 2.13).
- Detach the length of outer-edge door strip in question as described above.
- Unscrew the door striker plate **(2)**.
- Unscrew the two upper and lower fastening screws **(3)** and the central screw **(4)**.



- Remove the strip cover complete with outer-edge strip from the rear door post .

When replacing or re-painting the strip cover it is necessary to apply the outer-edge strip on the external side before re-assembly.

- Adhere the outer-edge strip along the whole external length of the strip cover, cutting off any eventual excess.
- Check the condition of the blocks in position with the fastening screws, fit the strip cover on the door post, aligning the external profile with the bodywork.
- Tighten the fastening screws **(3)** to the prescribed torque.
- Fit the door striker plate **(2)** and the central screw **(4)**, tightening them temporarily.

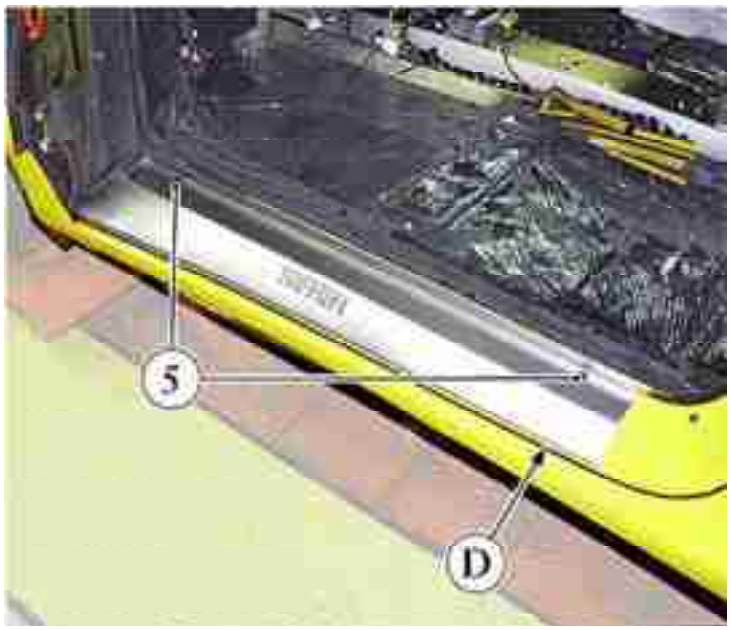


- Check that the door opens and closes correctly. If it is not working well, the fastening position of the striker plate in respect of the door post can be adjusted, by loosening the central screw **(4)** and the striker plate itself. Once the correct position has been found, definitively tighten the striker plate **(2)** and the screw **(4)** to the prescribed torque.
- Re-assemble the components removed in the procedure.

Kick plates

- Remove the strip cover, as previously described.
- Lift off the door outer-edge strip from the length in question.
- Unscrew the two screws **(5)** fastening the kick plate to the cross member.
- Remove the kick plate, complete with outer-edge strip.

When replacing the kick plate, the specific outer-edge strip **(D)** must be mounted along the new component's external and internal profile.



Check the condition of the blocks in position with the fastening screws before positioning the kick plate on the cross member, aligning the holes with the screws and paying attention to the external profile.

- Tighten the fastening screws **(5)** to the prescribed torque.
- Re-assemble the components removed in the procedure and refit the door strip.

External unde

- To gain access to the hidden fastening nuts, it is necessary to remove the upper part of the rear wheelhouse and unscrew the two lower screws fastening the upper part of the front wheelhouse to the bodywork (M 2.05).
- Remove the kick plate as previously described.
- Unscrew the nine lower screws and the six upper screws fastening the panelling to the cross member.

- Working from within the mudguard, unscrew the four nuts **(6)** which fasten the rear part of the panelling to the chassis.

- Unscrew the nut in position with the pin **(** fastening the front part of the panelling to the chassis.

- Remove the panelling, complete with grid, from the bodywork.
- If replacing or re-painting the panelling, the rear grid **(E)** must be removed along with the "Pininfarina" logo adhesive **(F)**.

- Re-assemble the panelling by screwing down the fastening screws and nuts and assuring that the profile is in line with the bodywork.

If the panelling has been replaced, it may be necessary to adjust the distance of the areas to be coupled with the bodywork, by inserting shims in position with the rear and/or front fastening pins.

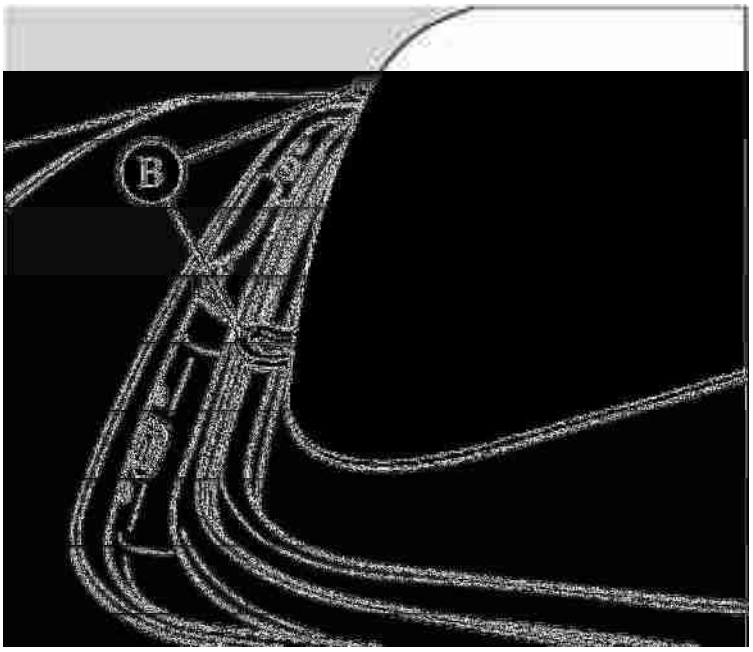
- After adjusting, definitively tighten the fastening screws and nuts to the prescribed torque.
- Re-assemble the parts removed in the procedure.

M2.19 REMOVABLE SUN-ROOF (OPTIONAL)

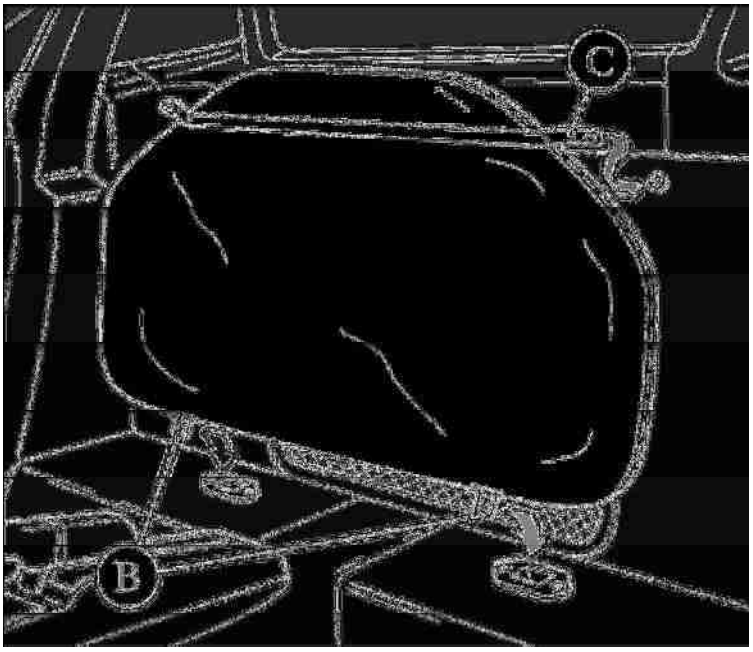
Opening

- To remove the sun-roof, press the release button located on the hand-grip **(A)** and lift the rear end of the sun-roof to free it from the hook.

- Lift and pull back the sun-roof to detach the front retaining hooks **(B)** from the car roof.

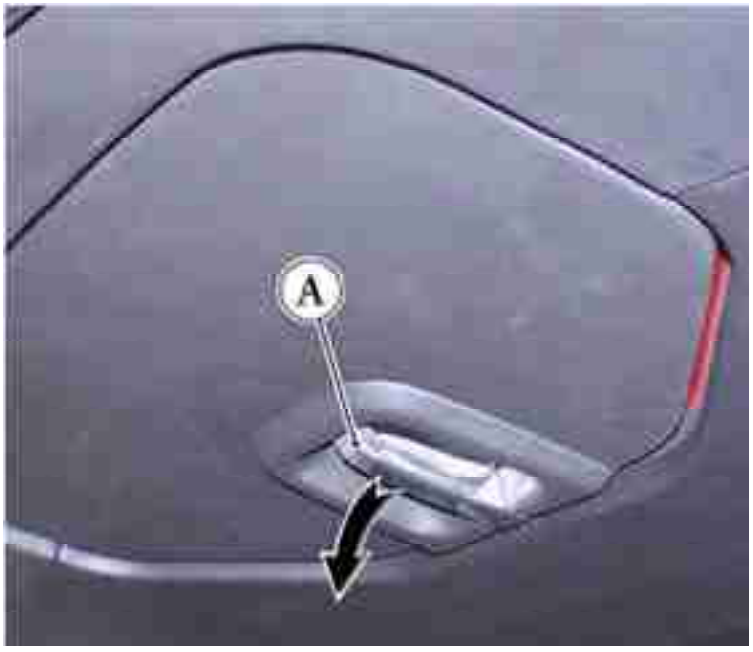


- Place the sun-roof in its special protective bag, position it on the passenger-engine compartment partition panel and insert the hooks **(B)** into their specific seats.
- Fasten the sun-roof to the panel using the specific straps **(C)**.



Closing

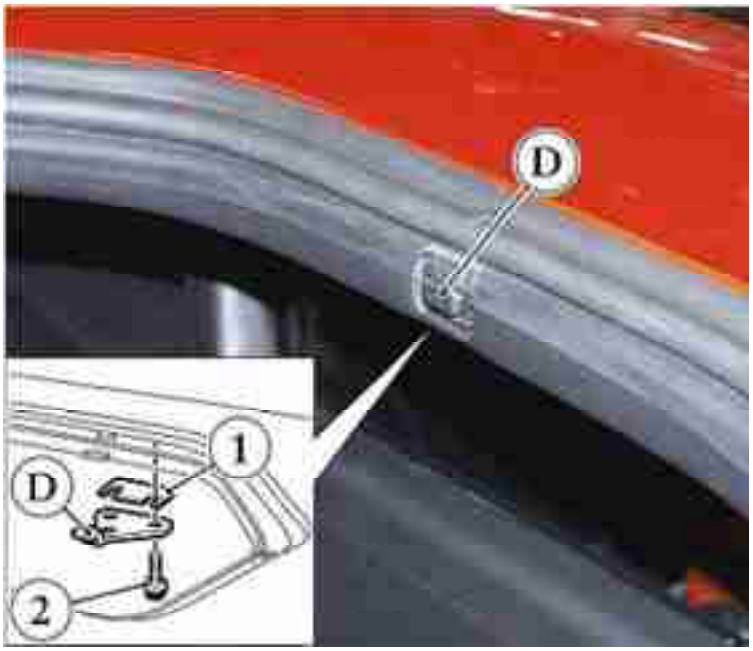
- Insert the hooks **(B)** into their seats on the roof and lower the sun-roof by pressing the front deflector.
- Lock the sun-roof on the car roof by pulling down the hand-grip **(A)** until the button clicks, so indicating it is locked in place.



Closing and aligning adjustment

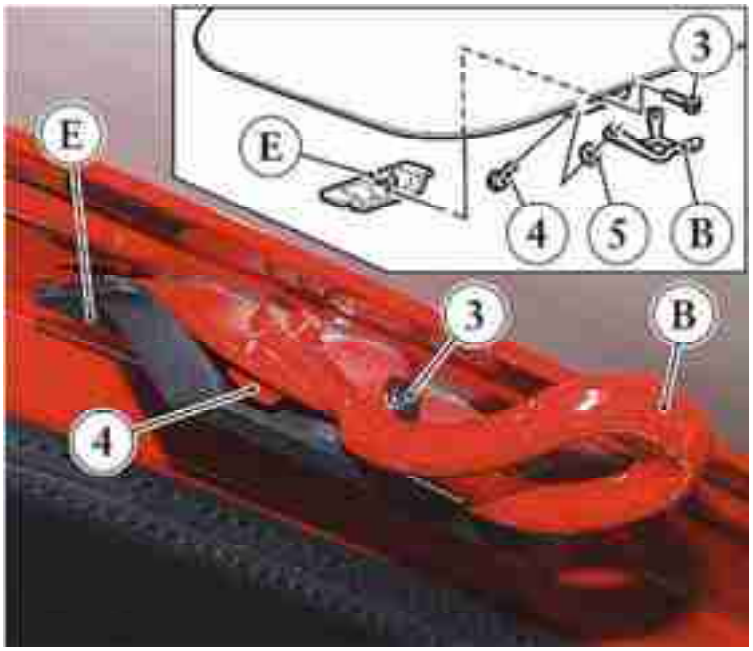
After replacing the release device or the retaining hooks, it is necessary to adjust the closure and to check the alignment of the roof's external sheets.
To adjust the closure it is necessary to regulate the adjustment shims **(1)** positioned under the striker-plate**(D)** and fastened under the roof's rear lining.

- Remove the roof's rear upholstery (M 3.04).
- Unscrew the two fastening screws **(2)** and remove the striker plate **(D)**.
- Adjust the thickness of the adjustment shims **(1)** until obtaining a correct closure; these are supplied as spare parts with a thickness of **1** and **0,5 mm**.



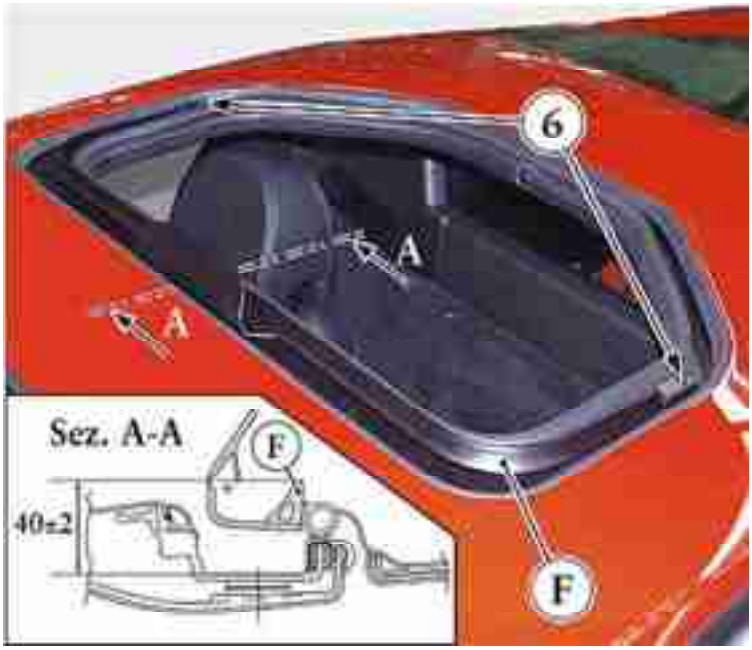
Adjust the hooks **(B)** fitted to the sun-roof in order to align the sun-roof and car roof's external sheets.

- Remove the cover **(E)** on each hook by unscrewing the screw **(3)**.
- Unscrew the two screws **(4)** and remove the hook from the sun-roof.
- To align the external sheet correctly, fit or remove the washers **(5)** between the hook and the sun-roof.



After replacing the spoiler **(F),** it is necessary to adjust its height in respect of the bottom of the roof's draining channel.

- Fasten the spoiler using the screws **(6)**. The spoiler's height, from its upper end to the bottom of the channel, should be **40 ±2 mm**. This measurement must be taken from the centre line of the car roof.



- To adjust this height, regulate the adjustment dowels **(7)**, on both sides of the spoiler **(F)**, until obtaining the prescribed value.

M3.01 DASHBOARD

The dashboard consists of an upper element containing the passenger compartment air vents, the instrument panel and the passenger's side air bag.
The lower element, on the left-hand side, contains the switch-holding frame and the small A.C. instrument panel as well as the radio in the central part.
A movable frame supports the two dashboard elements and the glove compartment. The anti-lift sensor for the alarm system (H 3.01) and the **OBD II** connector for plugging-in the diagnosis tester are also mounted on this structure.
The A.C. system air diffuser is mounted underneath the upper element.
Besides these components, the dashboard is also fitted with the passenger's compartment air temperature sensor and the sun radiation sensor (I 2.09).

NOTES
The procedures described here below are aimed at disassembling the entire dashboard and the supporting frame. However, said procedures can be carried out even individually, following a sequence which can also differ from the one illustrated hereunder.

Rotate the battery master switch to the **OFF** position (L 2.02).

Removing the A.C. Instrument Panel

- Unscrew the screws **(1)** fastening the A.C. instrument panel to the dashboard's upper element.

- Remove the entire dashboard and detach the central connector from the A.C. controls and the side connectors from the power window switches.

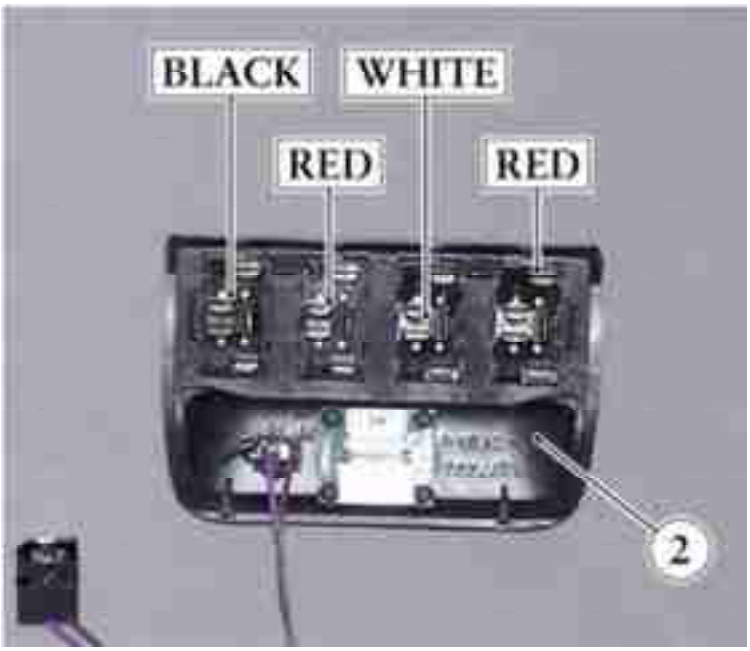
For connection to the system, see Table **D** and **R** - ELECTRICAL SYSTEM.

Removing the Switch Holding Frame

NOTES
*The **US** car version does not have a rear fog light (**A**) switch: this has been replaced with a false switch.*

- Remove the frame **(2)**, taking extreme care not to damage the dashboard leather upholstery.

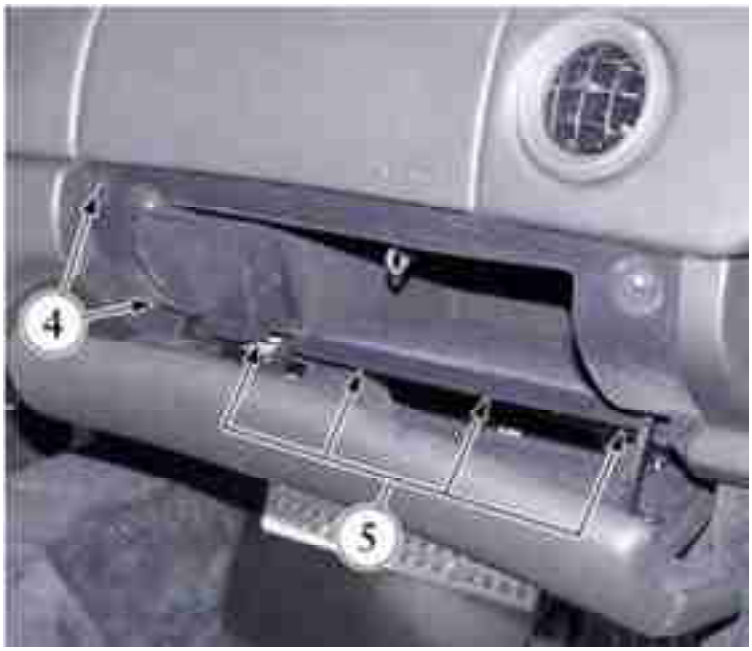
- Detach the dashboard cable connectors from the various switches mounted on the frame (H 2.03).
- When re-connecting the upper switches to the system, always observe the connectors' colours as shown in the figure (see Table **F** - ELECTRICAL SYSTEM).



Removing the Glove Compartment

- Open the compartment lid and unscrew the four screws **(3)** fastening the compartment upper part to the dashboard upper element.

- Unscrew the two front screws **(4)**, on the left-hand side of the compartment.
- Unscrew the four nuts **(5)** fastening the hinge to the stud bolts of the movable frame.



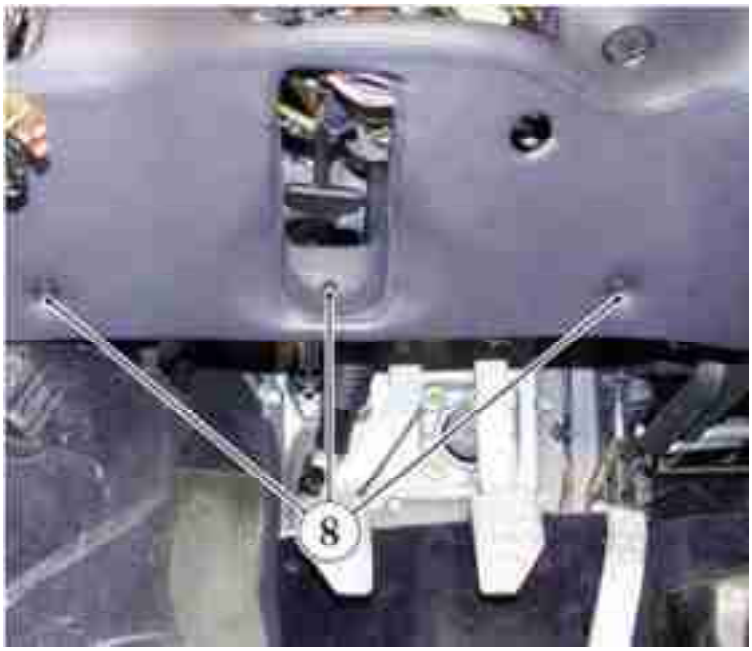
- Slide out the entire compartment and detach the light connection.

For connection to the system, see Table **C** - ELECTRICAL SYSTEM.

Disassembly of the Dashboard Lower Element

- Remove the A.C. instrument panel, the switch holding frame and the glove compartment as described above.
- Unscrew the screw **(6)**, inside the switch holder frame compartment and the lower screw **(7)**.

- Unscrew the three screws **(8)** fastening the lower element to the dashboard frame, in the lower area.



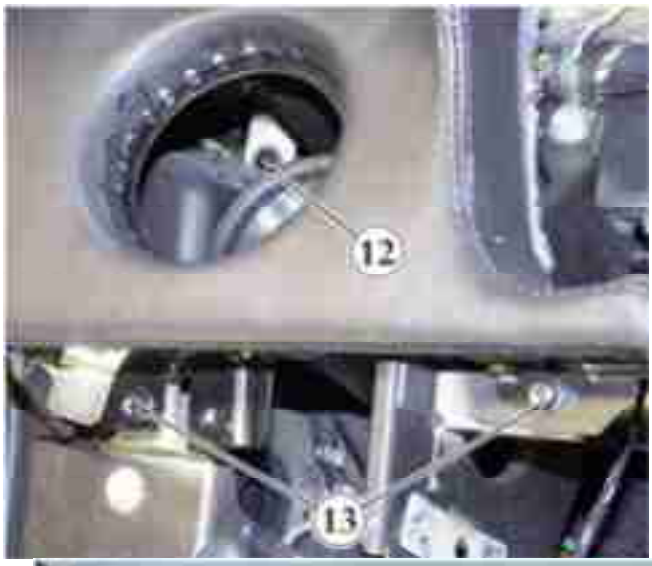
- Unscrew the screws **(9)** within the A.C. instrument panel compartment and detach the connection for the passenger compartment temperature **(10)**.

- Remove the stereo **(11)** and the dashboard lower element, by detaching the connections from the stereo housing.

For connection to the system, see Table **D** and **R** - ELECTRICAL SYSTEM.

Disassembly of The Dashboard Upper Element

- Remove the steering wheel (H 2.06).
- Remove the wheel hub (E 2.05).
- Remove the instrument panel (H 1.01).
- Remove the windscreen trim pillars upholstery (M 3.04).
- Remove the lower element of the dashboard as described above.
- Remove the passenger's side air bag module (H 3.02).
- Slide out the side air vents.
- Gaining access from the air vent seats, unscrew the internal screw **(12)** on the two sides of the dashboard.
- Unscrew the six lower screws **(13)** fastening the upper element of the dashboard to the movable frame.



- Unscrew the screws **(14)**, fastening the air bag compartment to the structure.

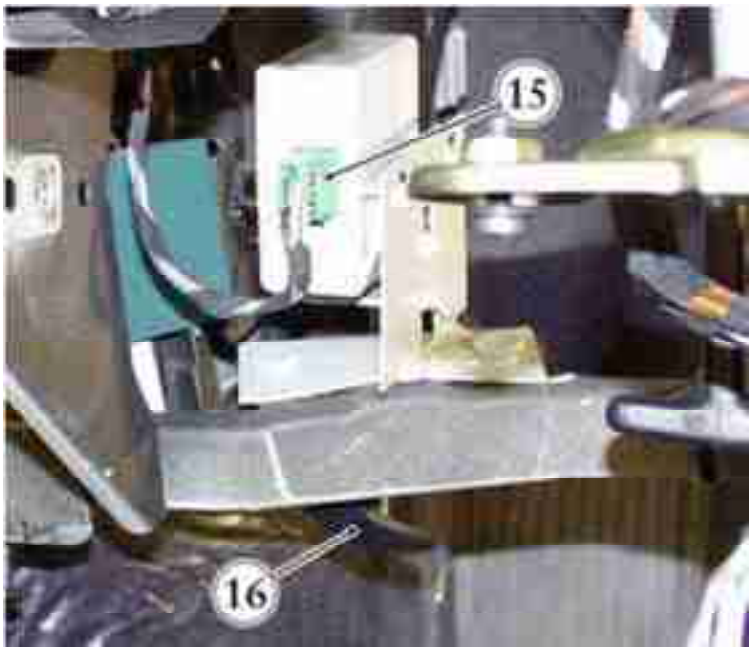
- Gaining access from the dashboard lower side, remove the three screws fastening the upper element to the air flow duct.
- Detach the connection for the sun radiation sensor and remove the dashboard upper element.

Disassembly of the Movable Frame

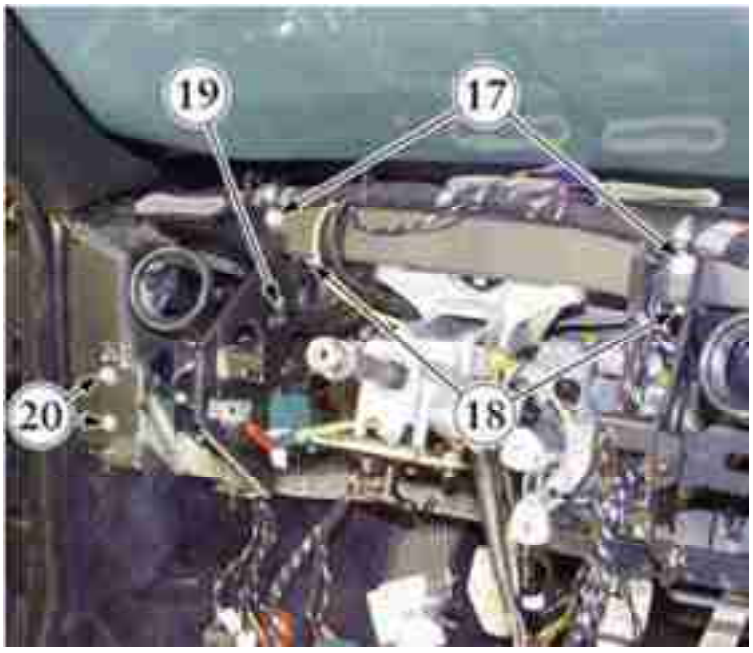
- Remove the dashboard upper element, as described above.
- Detach the connection **(15)** from the anti-lift sensor.

For connection to the system, see Table **E** - ELECTRICAL SYSTEM.

- Detach the wire of the emergency opening handle **(16)** for the luggage compartment lid from the bracket mounted on the lower part of the frame and remove the **OBD II** connector.



- Unscrew the two upper screws **(17)** that fasten the supporting clamps for the dashboard cable as well.
- Unscrew the two fastening screws **(18)** on the lower part of the frame cross element.
- Unscrew the screw **(19)** fastening the left-hand channel to the movable frame.


19
17
20
18

- Unscrew the four side screws **(20)** and the fastening screws **(21)** on the supporting bracket of the frame cross element.

- Remove the movable frame

Re-assembly notes

Re-assemble the parts that had been removed, following the same sequence as for the removal procedure but in reverse order.
All fastening screws, for all of the components, must be tightened to the standard torque, on the basis of the thread diameter.
As far as the electrical components are concerned, besides the above explanations, it is possible to check the connections and harnesses by following the instructions given in section ELECTRICAL SYSTEM.

M3.02 TUNNEL

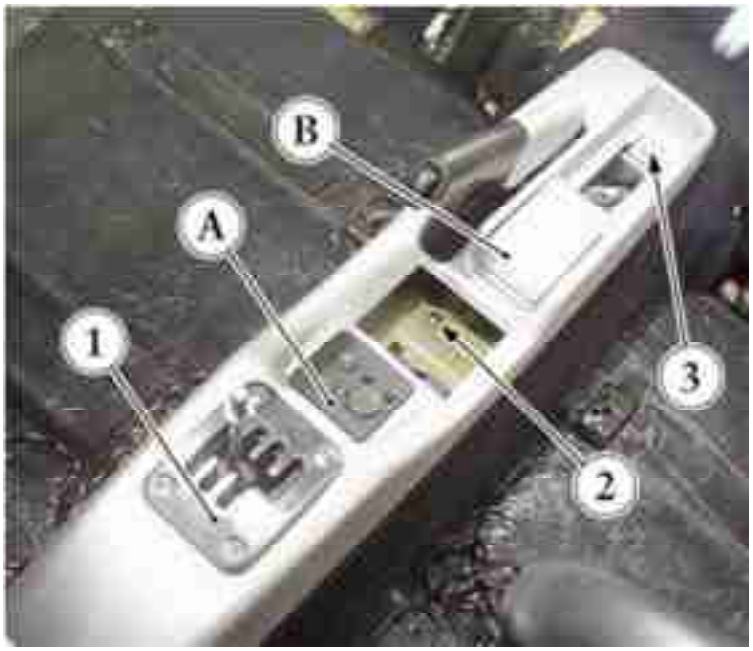
It consists of an upper aluminium central console which is mounted on a lower cover by means of a middling element. On the front part of the console is located the gear selector (mechanical gearbox) or the small instrument panel (electronically-controlled gearbox) as well as the light-holding frame (H 2.01).
The ashtray, the switches for opening the luggage compartment bonnet and the fuel tank flap, as well as the parking brake control lever are located on the rear part (H 2.10).

Disassembly of the Central Console

NOTES
The surface of the central console is extremely delicate. Always protect it suitably and take extreme care during disassembly and re-assembly procedures.

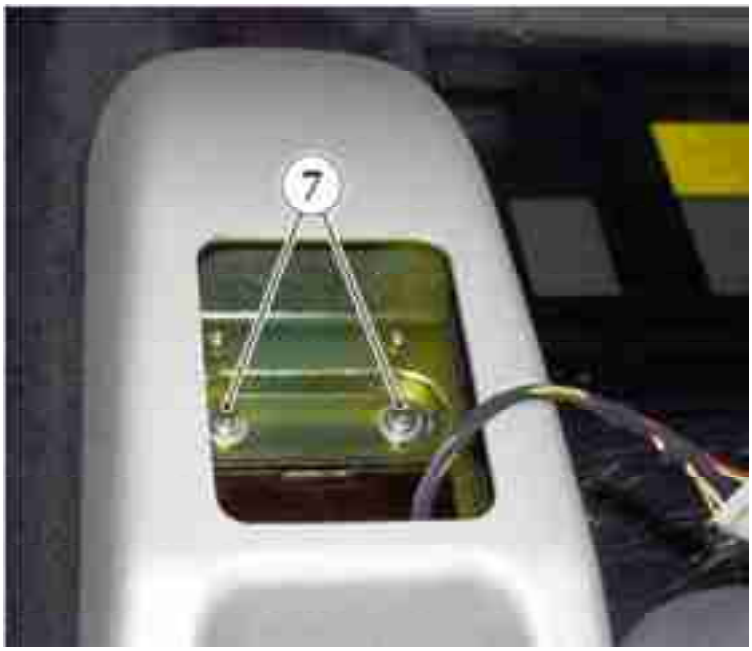
Mechanically controlled gearbox version

- Remove the knob on the gearshift lever.
- Unscrew the fastening screws and remove the gear selector **(1)**.



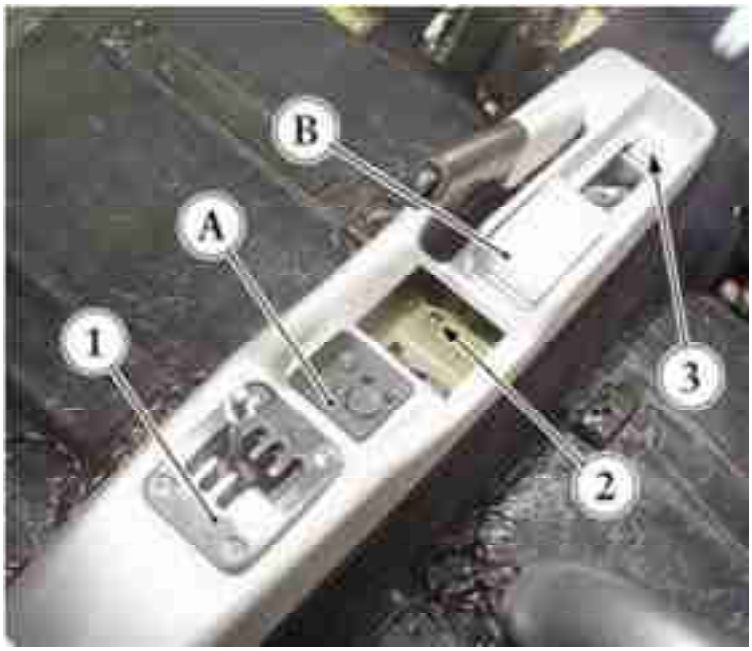
Electronically-controlled gearbox version

- Remove the small instrument panel (H 2.11).
- Unscrew the screws **(7)** fastening the central console to the lower mounting.



- Remove the ashtray by unscrewing the internal screw and detach the cable from the cigar-lighter.
- Remove the surrounding edge of the change pocket tray.
- Unscrew the screw **(2)** on the ashtray and the screw **(3)** on the oddments tray.
- Lift the console and detach the connections from the small instrument panel **(A)** and from the switches under the lid **(B)**.

For connection to the system, see Table **D** and **P** - ELECTRICAL SYSTEM.



- Remove the entire central console, including the middling element.

Disassembly of the Lower Covering

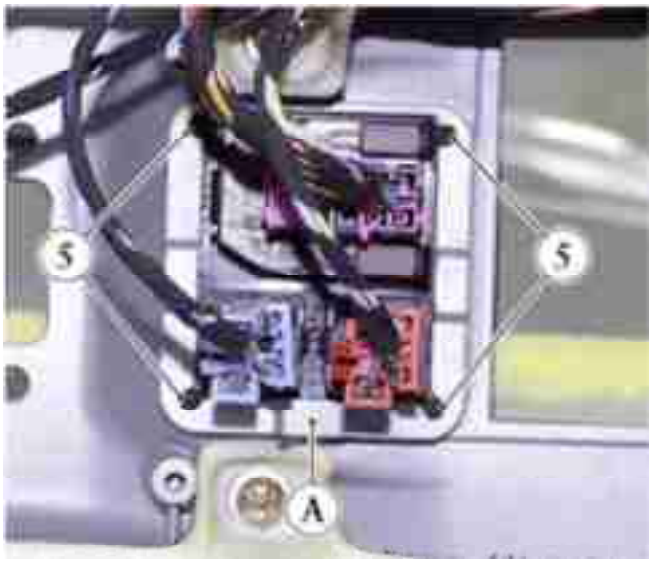
- Remove the upper console together with the middling element, as described above.
- Remove the ECUs' covers, behind the seats (M 3.04).
- To gain access to the side fastening screws, it is advisable to remove the seats (M 3.03).
- Unscrew the fastening screws **(4)** inside the cover and the six outside fastening screws.

- Remove the lower cover by sliding it out of the front one.

Replacing the Console Components

- To detach the switches opening the luggage compartment bonnet **(C)** and the fuel tank flap **(D)** from the console, remove the ashtray as explained above.

- Gaining access from the opening in the ashtray compartment, push them towards the outside and detach them from the tunnel harness.
- To remove the small instrument panel **(A)** it is necessary to remove the central console, as illustrated above, and to unscrew the inside fastening screws **(5)**.



Dalla/Valid from Ass. Nr. 35381
5
A
5

- To replace the lid **(B)**, unscrew the two fastening screws **(6)** on the oddments tray.

Re-assembly notes

Re-assemble the parts that had been removed, following the same sequence as for the removal procedure but in reverse order.
All fastening screws, for all of the components, must be tightened to the standard torque, on the basis of the thread diameter.
As far as the electrical components are concerned, besides the above explanations, it is possible to check the connections and harnesses by following the instructions given in Section - ELECTRICAL SYSTEM.

M3.03 SEATS

Tightening torques

Fastening screw for manually and electrically controlled seats	**38÷42 Nm**
Fastening screw for sports seats	**20÷24 Nm**
Screw fastening the seatbelt to the seat	**38÷42 Nm**

Removing the complete seats

- Remove the protection cap from the side covering (only for manually and electrically controlled seats) and unscrew the screws fastening the safety belt to the outer side of the seat. When removing the driver's seat, the connection for the fastened seat belts indicator must be disconnected.

- Remove the shield from the front end of the slide (only for manually and electronically controlled seats).
- Move the seat backwards and unscrew the two front screws fastening the seat guides.

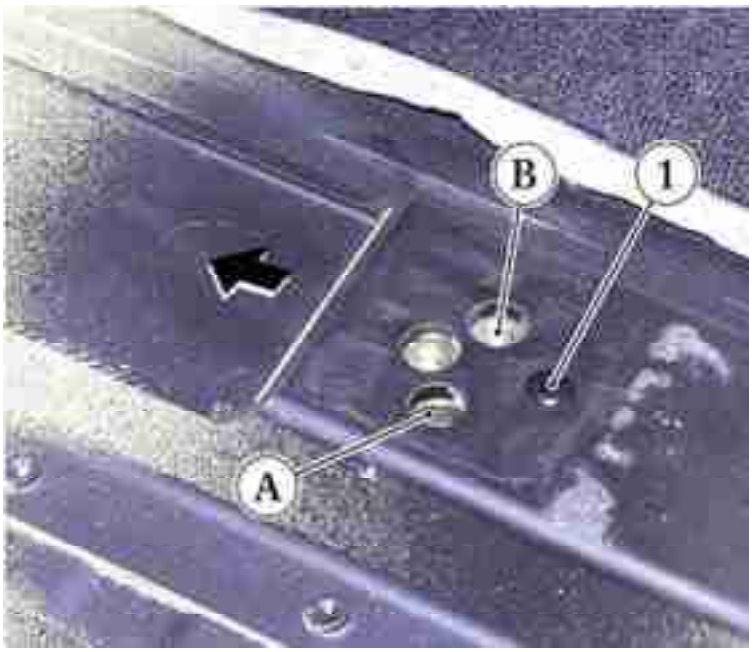
- Push the seat forwards and unscrew the two rear screws fastening the seat guides.

- Remove the entire seat from the passenger compartment.
- In the case of electrically controlled seats, it is necessary to detach the dashboard-central tunnel cable connector positioned under the seat.

Re-assembly

When re-assembling, it is necessary to check that the seat's lock pin hole **(A)** on the stop plate is in perfect condition. Also check the threading **(B)** for the rear seat fastening screw.

- If it shows signs of damage, it is possible, after having removed the rivet **(1)**, to remove the stop plate from the underfloor cross member and replace it.



- Lubricate the guide's sliding surfaces with grease then position the seat on the underfloor by inserting the guide's lock pins **(C)** in the holes **(A)** on the stop plates.

- For both electrically controlled seats or for the single manually controlled driver's side seat, it is necessary to re-attach the previously detached central tunnel-dashboard connector to the wire.

For connection to the system, see Table **D** - ELECTRICAL SYSTEM.

- Fit the screws with the special washer and tighten them to the prescribed torque.
- Check that seat moves smoothly in the guides and that all the adjustment controls function properly.

M3.04 PASSENGER COMPARTMENT AND ROOF LINING

- It is advisable to remove the seats in order to be able to work easily within the passenger compartment (M 3.03).

Remove the door strip(_____).

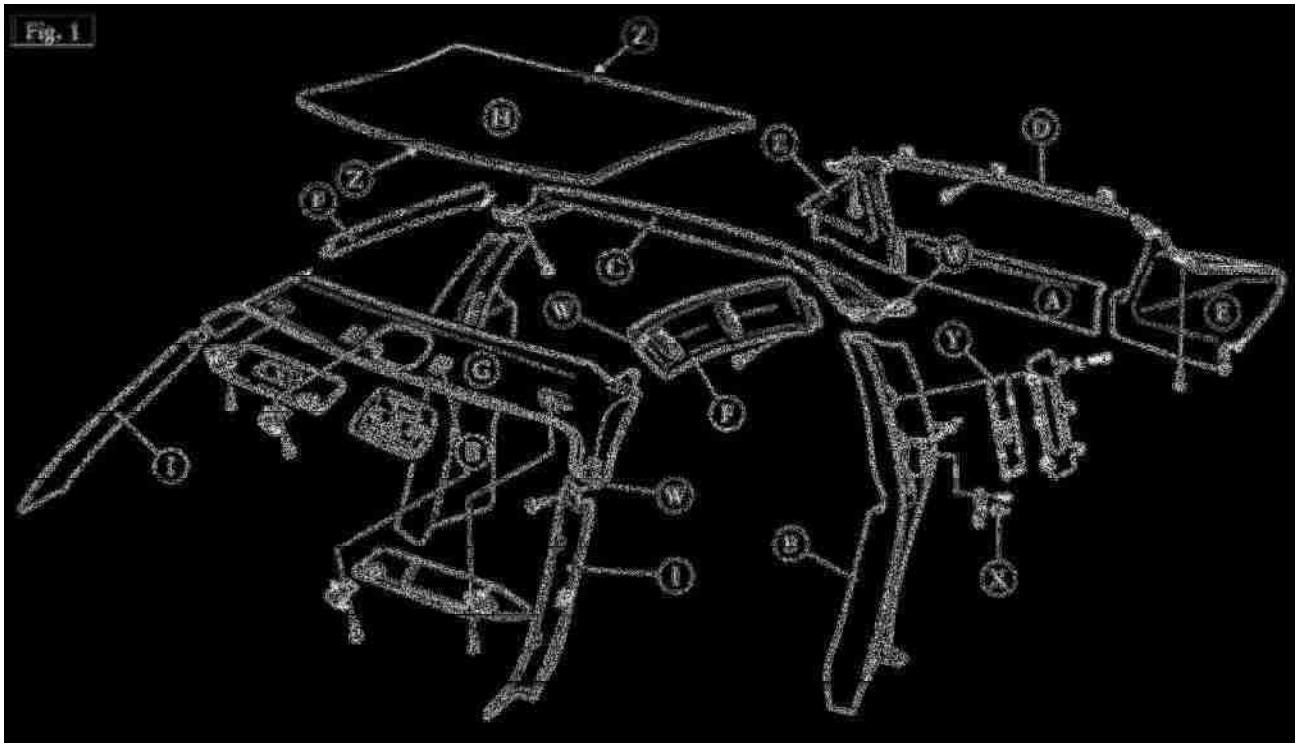
Roof lining (version without removable sun-roof)

NOTES

These instructions describe the removal of all the roof compartment lining: to avoid damaging the components and the fixing devices, always follow them in the indicated sequence, even when carrying out partial procedures.

IMPORTANT

*Most of the covering is fixed using inserts (**X**, Fig. **1**) which must be pressed into the corresponding holes in the bodywork. To disassemble the said components, it is necessary to lever them using a plastic blade in the points indicated by the arrows, paying particular attention not to damage the leather upholstery.*



- Remove the cross member under the rear window **(** .

- Detach the safety belt feeders from the door frame and slide out the belt hooking ends from the central coverings (H 3.03).
- Remove the central coverings **(B)** from the door frames, detaching the four pressed-in inserts. Inside every covering there is a bracket with support (**Y**, Fig. **1**) for adjusting the height of the safety belt.

- Remove the rear roof covering **(** by unscrewing the screw **(** fastening it to the chassis, on both sides, and detaching the two pressed-in central coverings.

- Remove the rear over-rear-window cross member **(D)** by unscrewing the three fastening screws **(2)**.

- Remove the rear window side coverings **(** unscrewing the two fastening screws and detaching the two pressed-in lower inserts **(3)**.

- Unscrew the rear fastening screw **(4)** and remove the right and left side member coverings **(F)** by detaching the two front inserts.

- From the upper windscreen covering **(** , remove the left-hand and right-hand sun visors by unscrewing the two screws **(5)** fastening their supports to the roof compartment frame.

- Unscrew the fixing screw **(6)** and remove the central sun visor supports.

Remove the complete roof lighting from the upper windscreen covering by unscrewing the three fixing screws and detaching it from the dashboard cable **(7)** (_____).

- Remove the upper windscreen covering **(G)** by unscrewing the central fastening screw **(8)** and the two side screws **(9)**.

- When necessary, proceed with the removal of the roof covering **(** applied to the roof frame with adhesive product.

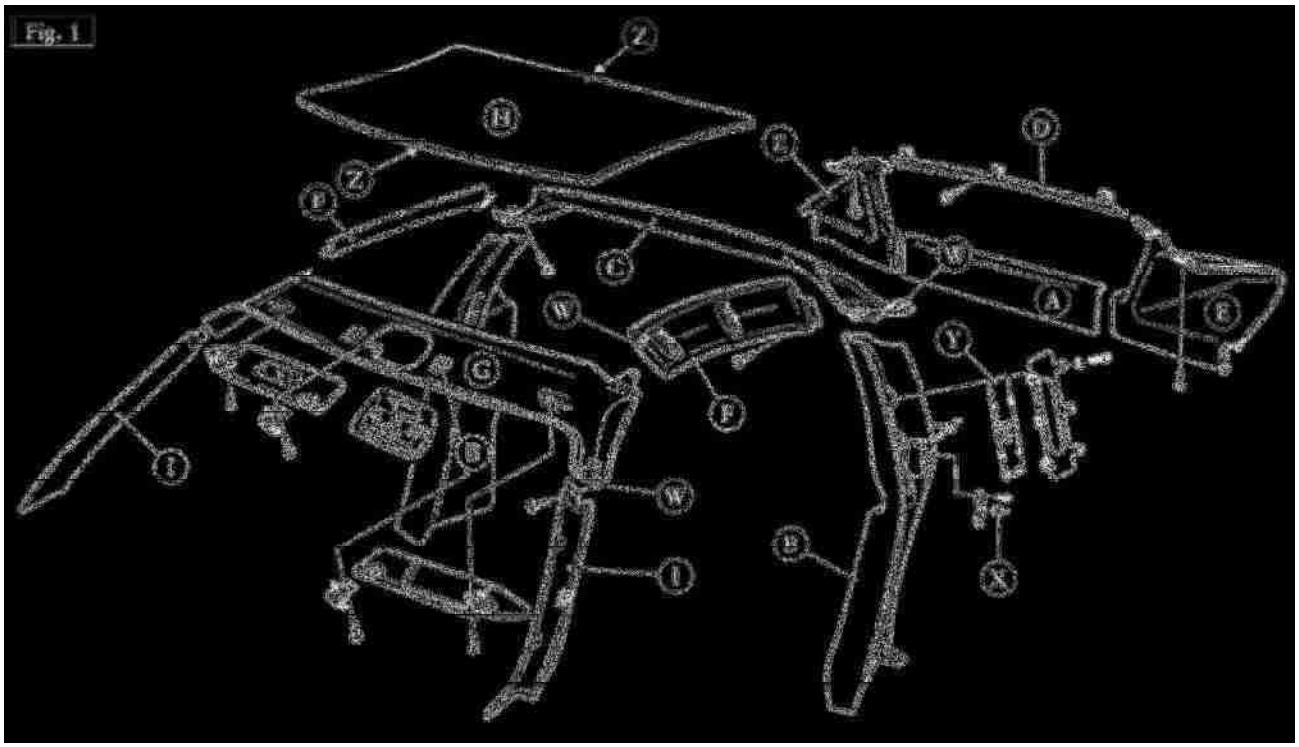
- Unscrew the two fastening screws **(10)** and remover the coverings **(1)** by sliding them out from the holding clamps on the dashboard.

RE-ASSEMBLY NOTES

IMPORTANT

*Before re-assembling the removed components, always check the coverings are in perfect condition and that they are tightly fitted into their relative holding brackets; also check that the clamps (**W**, Fig. **1**) feature a suitable shape.*

Carry out the re-assembly following the disassembly instructions in reverse order, minding the alignment with the dashboard and its various components.



- Before mounting the covering **(H)**, it is necessary to clean the roof surface with heptane.
- Remove the protective paper and apply the cover to the roof making sure to match the two reference marks (**Z**, Fig. **1**) on the panel with the framework's two central holes, in position with the ceiling lights and the rear roof covering **(C)**.
- Tighten all the fastening screws to a **4,4 Nm** torque.

NOTES FOR THE VERSION WITH REMOVABLE SUN-ROO

The car's roof lining is equipped with a removable sun-roof and is composed of a front element (**G1**, Fig. **2**) and a rear element .

The front element houses the sun-visors and the dome lights for the passenger compartment.
To remove them, follow the instructions concerning the version without the removable sun-roof.

- Remove the front element **(G1)** by detaching the inserts **(X)** in the position indicated by the arrows.

- Remove the rear element **(C1)** by unscrewing the four screws (**11**, Fig. **2**) which fasten it onto the roof, on both sides, and by removing the three pressed-in inserts **(X)**.

IMPORTANT

*There are two pipes for draining any eventual remaining water from the roof run channels (**12**, Fig. **2**). These are fastened under the windscreen's side coverings **(I)**. To avoid water leaking through the sun-roof, clean the roof run channel at regular intervals and check that the said pipes are not clogged.*

Passenger compartment upholstery and carpets

The following components are installed inside the passenger compartment:
- central right-hand **(L)** and left-hand **(M)** ECU covering;
- utility net pockets **(N)** (M 3.05);

- division panel upholstery **(** (M 3.05);
- lower tunnel covering **(P)** (M 3.02);

- under-pedal covering **(Q)**;
- front tunnel covering **(R)**;
- passenger footrest **(S)** (A 3.28);
- battery support frame;
- right-hand **(T)** and left-hand **(U)** floor carpets.

NOTES

The screws and their relative covering fastening washers are specific for light or dark carpets.

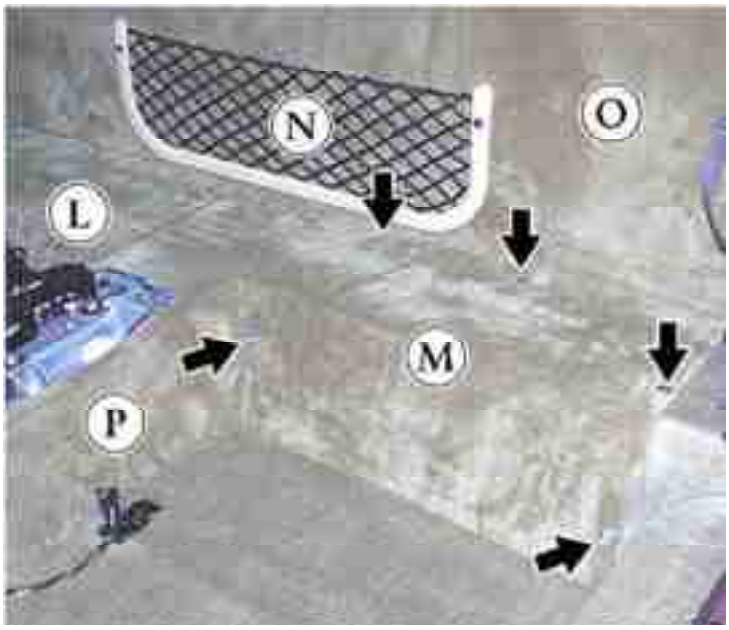
ECU COVERING

Removing the right-hand covering **(L)** allows access to the F1 gear box ECU (D 6.03) and to the electric system's relay and fuse boxes (L 2.10).

The alarm system ECUs are installed under the left-hand covering **(M)** (H 3.01),

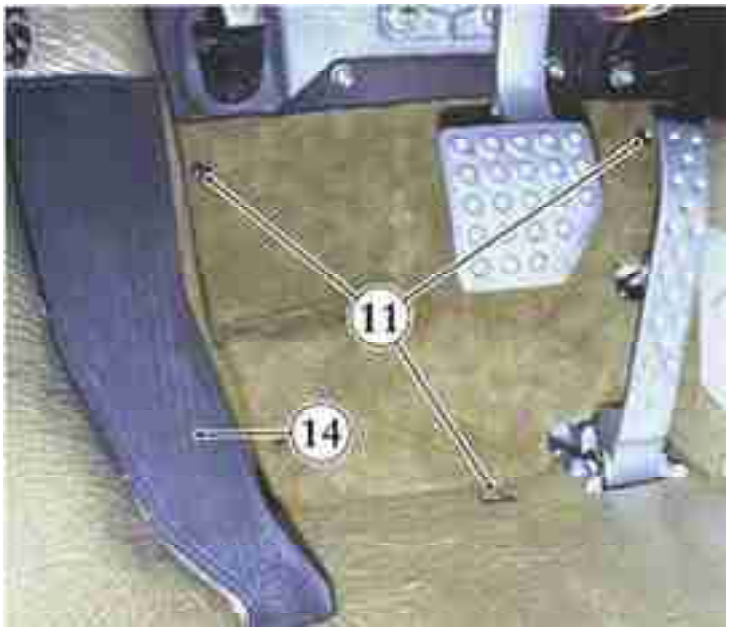
along with the relay and fuse boxes and the terminal board connecting the engine service wiring loom with that of the passenger compartment (L 2.10).

- In order to remove the coverings, it is necessary to incline the seats forwards and to unscrew the five fastening screws with tapered washers.



UNDER-PEDAL COVERING

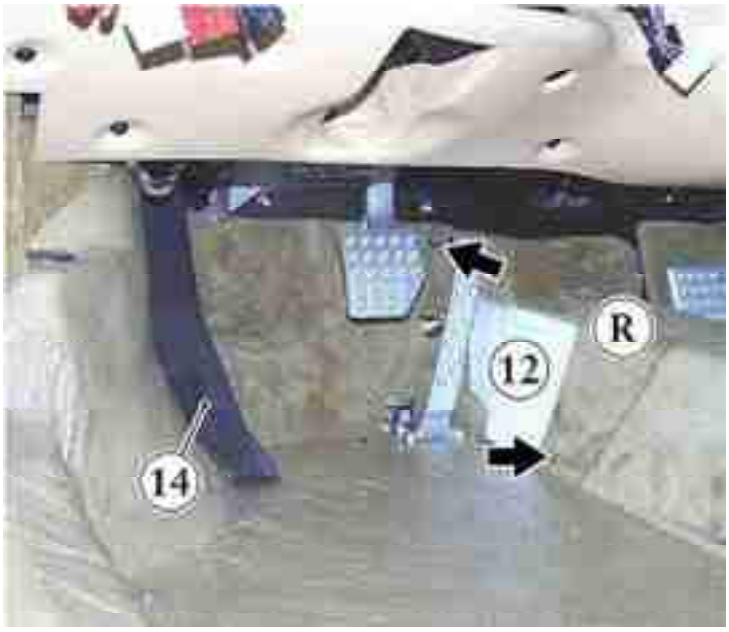
This is fastened with three screws **(11)** to the floor panel and to the flame damper panel's support brackets as well as to the front part of the tunnel covering.



FRONT TUNNEL COVERING

In order to remove the front tunnel covering **(R)**, it is necessary to detach the pedal covering, as previously described, and unscrew the upper fastening screw which also holds the under-pedal support bracket coverings, and the lower side ones.

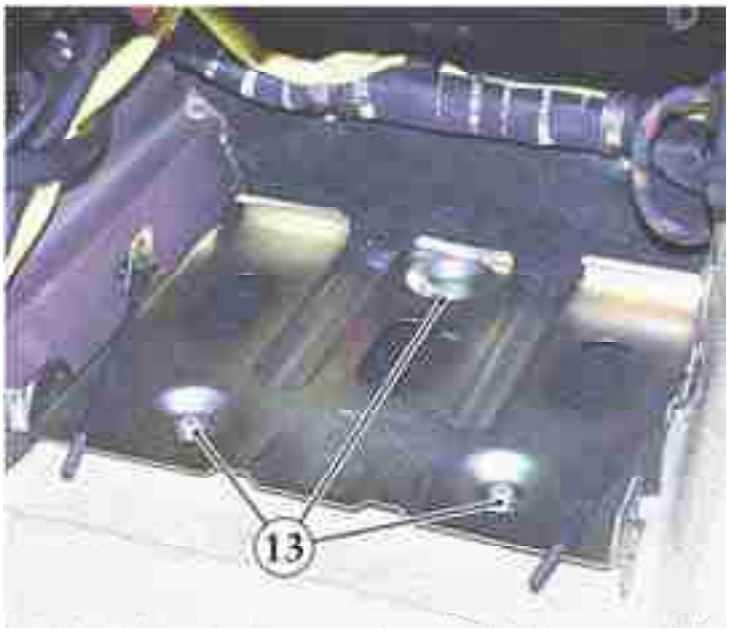
In the left-hand drive version, a guard **(12)** is mounted on the accelerator pedal covering.



BATTERY SUPPORT BASKET

This is fixed to the floor panel, under the passenger foot-rest mat, and has the function of supporting and holding the battery.

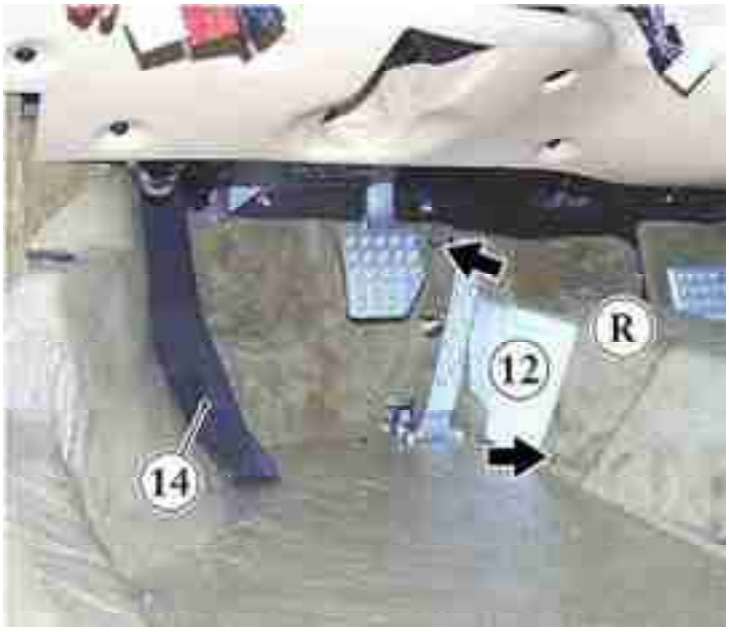
- To remove it, the battery must be detached (A 3.28).
- Unscrew the three screws **(13)** and remove them from the floor panel.



FLOOR CARPETS

They consist of two pre-shaped elements fitted onto the floor panel with double sided interposed adhesive tape.

- To replace the carpets, it is necessary to remove the front and rear tunnel coverings along with the battery support basket and then remove the outer-edge door strip from the part in question.
- Detach the sole **(14)** which is attached to the driver's foot-rest support bracket with adhesive tape.



- Remove the five rivets fastening the bracket to the chassis by drilling them out with a **Ø 4 mm** bit.
- Remove the pre-shaped carpets from the floor panel.

When re-assembling, apply the double sided adhesive tape to the carpet flat surfaces and position them on the floor panel, lifting out the electric seat connectors (**21D** and **28D**, see Table **D** - ELECTRICAL SYSTEM)

M3.05 ENGINE INSPECTION LID

Tightening Torques

Screw fastening seatbelt to seat	**38÷42 Nm**
Nut fastening seatbelt pass-through tang	**38÷42 Nm**
Screw fastening seat to manual and electrical control	**38÷42 Nm**
Screw fastening sports seat	**20÷24 Nm**
Fastening screw for map pocket	**5,5 Nm**
Lid fastening screw	**7,4 Nm**

Through the opening found on the panel separating the passenger compartment from the engine compartment, it is possible to carry out several maintenance and repair works on the engine.
To gain access to this opening, it is necessary to remove the lid which covers it.

Disassembly

- After having removed the cap on the side upholstery, detach the safety seatbelt from each seat by unscrewing the fastening screw.

When removing the driver's seat, the connector for the fastened seat-belt indicator must be detached.

- Detach the driver and passenger seats from the floor panel by unscrewing the front and rear fastening screws for the slides.

IMPORTANT
To avoid damaging the console and doors' upholstery, protect the leather and aluminium parts suitably.

- Remove the seats from the passenger compartment. If the seats are electrically controlled, detach the connector from the electrical harness located under each seat.
- Detach the central upholstery under the rear window.

- Detach the seatbelt pass-through tang from the door seat panels, by unscrewing the fastening nut

- Detach the lower coverings from the ECU cover.
- Detach the upholstery from each door panel, keeping the safety seatbelt linked to it.
- Detach the lower ECUs' coverings.
- Remove the map pocket from the supporting brackets.
- Detach the supporting brackets from the fastener on the engine inspection lid.

- Detach the covering on the partition panel.
- Unscrew the screws fastening the lid to the partition panel.

- Remove the lid together with the strip and the insulator.

Re-assembly notes

- To preserve the original soundproofing and insulating conditions within the passenger compartment, the rear side of the lid must be fitted with insulating material and with the outer edge strip.
- Since the contact surface is quite big, the partition panel seat on the upholstery should be covered with both-sides adhesive tape, in order to keep it in proper position during re-assembly.
- Re-fit the seatbelts using all the original fastening parts.

CAUTION

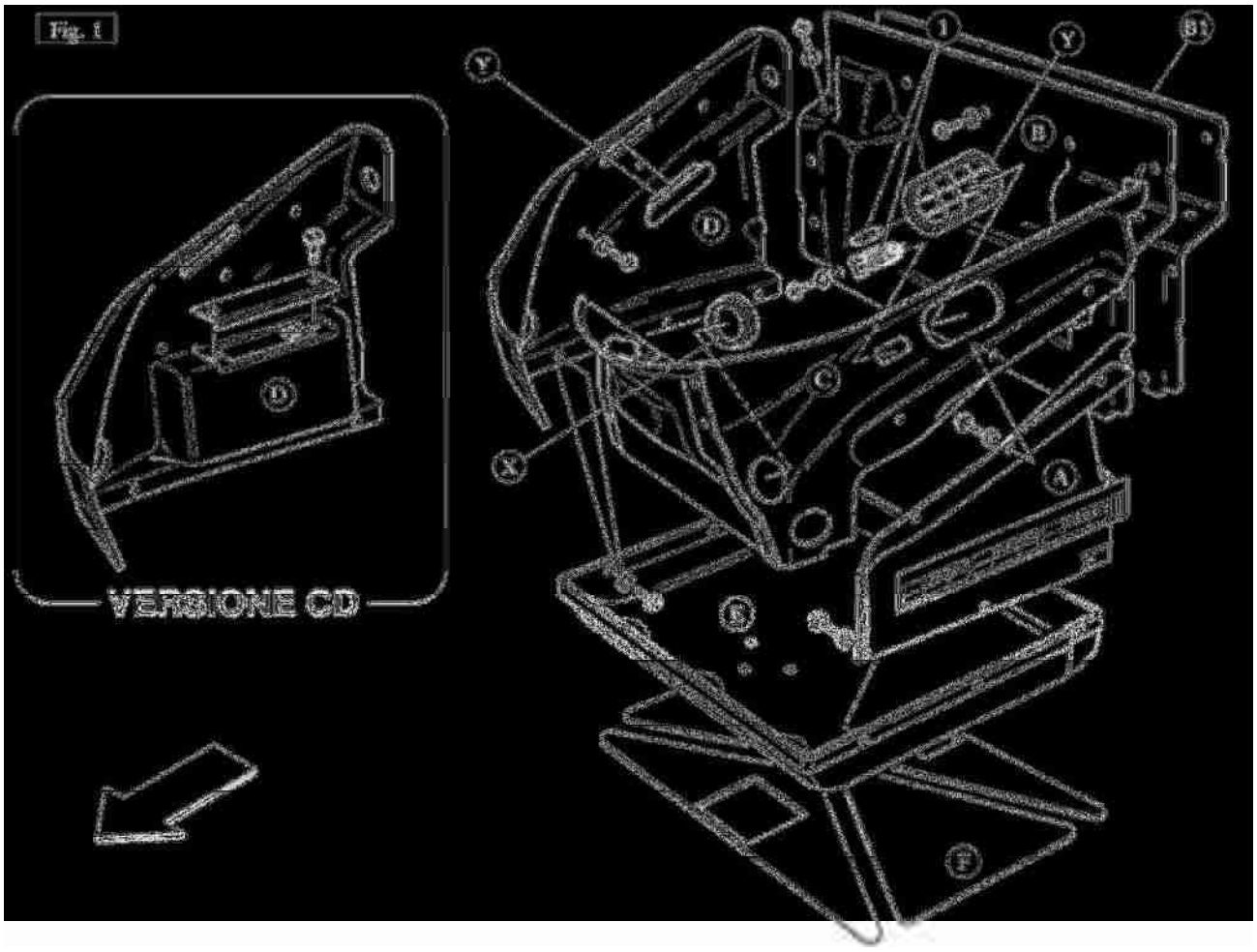
Fastening seatbelts correctly is an extremely important procedure to guarantee the driver's and passengers' safety.

Before re-fitting the seatbelts, always check that the fastening screws and nuts' threads and their respective seats are in perfect conditions.

Lock the screws and the nuts to the prescribed tightening torque.

M3.06 LUGGAGE COMPARTMENT LINING

The tool-kit bag and the tyre repair spray are fixed inside the luggage compartment with special belts.
The spare tyre kit and the CD changer, which are optional elements, can also be found in the luggage compartment.
This also includes two mobile panels (**A** and **B**, Fig. **1**), which can be easily removed to gain access to the fuse and switch boxes and to the devices positioned in front of the flame damper panel (electro-hydraulic ABS/ASR unit, air-conditioning system intake/exhaust connections, brake servo, hydraulic steering, etc.).
Caps **(X)** are installed on the luggage compartment's side upholstery (**C** and **D**) which allow access to the bumper fastening nuts and caps **(Y)** for headlamp adjustment.
On lifting the lid, the compartment is lit by a lamp positioned on the left-hand side ceiling light unit.



-

Removing

- In order to remove the left-hand side panel **(A)**, to gain access to the fuse and switch boxes, it is necessary to unscrew the six fastening screws.

- When dismantling the rear panel **(B)** the fifteen fastening screws must be unscrewed, after having removed the left-hand side panel.

When re-assembling, watch out for the four lower screws (black arrow), in that they are shorter than the others.

- Tighten the fastening screws to a torque of **9 Nm**.

A waterproof canvas (**B1**) is fitted under the rear panel. This is the same size as the overlying panel and it is glued to the bodywork.

IMPORTANT
Always replace the canvas after every disassembly.

- Remove any trace of the original canvas using a non metallic spatula and degrease the contact surfaces with heptane.
- Remove the protective paper and apply an new canvas (**B1**) to the bodywork.

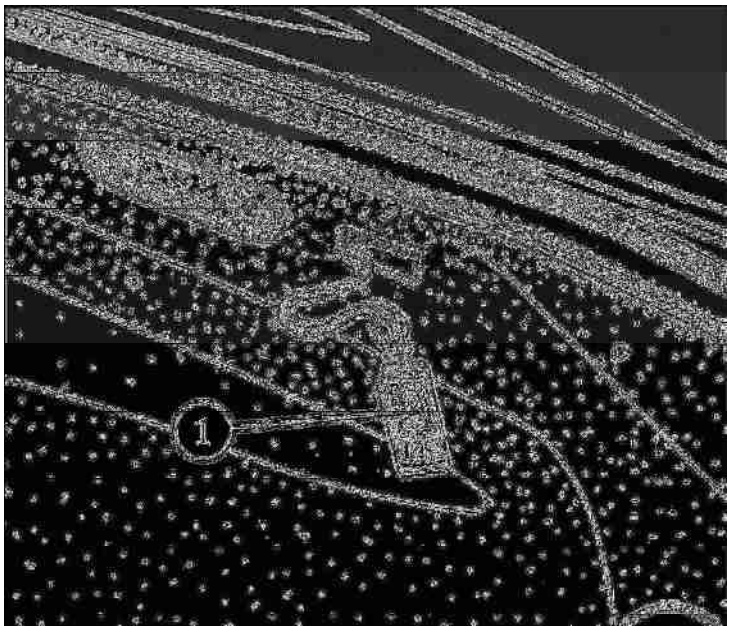
When re-assembling the rear panel (**B**), watch out for the four lower screws (black arrow), in that they are shorter than the others.

- Tighten the fastening screws to a torque of **9 Nm**.

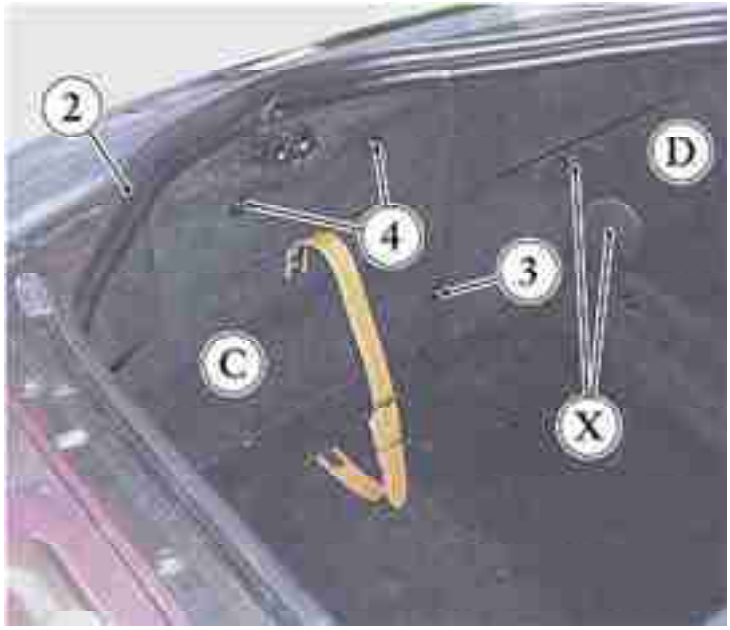
Covering and insulation coating replacement

- Detach the mobile panels **(A)** and **(B)**, as described above.
- Slide out the ceiling lights **(1)** from the left hand side upholstery and detach the front cable connectors.

For connection to the system, see Table **A** - ELECTRICAL SYSTEM.



- To remove the luggage compartment upholstery, the compartment lid's water-tight strip must be detached.
- Unscrew the lower screw **(3)** fastening the left-hand side upholstery **(C)** to right-hand one **(D)**.



- Unscrew the two upper screws **(4)** and remove the upholstery **(C)**.

- Unscrew the six fastening screws and remove the upholstery **(** .

- Remove the bottom upholstery (**E**, Fig. **1**) from the luggage compartment
- When works must be carried out on the bodywork, it is necessary to remove the insulating panels (**F**, Fig. **1**) fixed to the bottom panel of the luggage compartment with adhesive tape.

M4.01 RE-PAINTING CYCLES AT THE WORKSHOP

General Information

When repairing a damaged part of the car, the repairer's goal is to restore the car body or part to its original conditions.
To this end, it is necessary to use painting products which exactly reproduce the protective/aesthetic features of the painting materials used in the first coating cycle at the manufacturer's plant.
Therefore, the phosphatation and cataphoresis phases are substituted by applying phosphating or epoxy primers.
As far as primer bases are concerned, the primers used are the polyurethane bi-component type, which feature tinting and hardening characteristics exactly reflecting those of primers originally stoved at 160° at the plant.
This is the same reason for which today workshops use bi-component acrylic coats. Compared to other similar products, these are particularly smooth, glossy, long-lasting and 100% tintable.
A re-coating cycle may be a partial one when it concerns only a part of the body work, or a total one when it is carried out on the entire body work. Even if these two cycles require different execution times, both of them must be carried out following all or some of the below procedures.

Removing the Paint

We recommend not to remove the paint with traditional means, as improper or careless washing can originate poor adhesion and corrosion. It is advised to dry sand with abrasive paper no. 180-220.

Sealing

Sealing is carried out to avoid infiltration of water, exhaust gases etc.. It is realized by means of filling, insulating and protective materials applied through cartridge or paintbrush extrusion.

Stoppering

The purpose of stoppering is to improve the sheet straightening, thereby eliminating waving and depression by applying a suitable stopper layer (mainly polyester).
Particular care must be taken while carrying out catalysis. Should this be excessive, it may show yellow spots on top coating due to peroxide. To prevent this problem, automatic devices which are able to proportion stopper and catalyst quantities are currently available on the market.
Also sanding must be state-of-the-art, above all on edges or curved parts.

Sanding

Sanding of stoppers, primers or coats can be carried out manually using rubber pads of various shapes, or by means of electric or pneumatic sanding machines, depending on the accessibility of the area and on the surface to be treated. Sanding must be dry type.

Masking

It consists in protecting the car parts which do not need painting by covering them with paper sheets secured with adhesive tape. These must be removed when paint has thoroughly dried.

Primer Application

It is applied after having cleaned the area to be coated with an anti-dust Tack-Rag. The primer can be insulating, tintable or strongly tintable, depending on the quantity of solvent used for thinning.
Preparation and application must be carried out carefully, following the instructions (quantity and type of thinner and catalyst) given by the manufacturer, which take environmental conditions into account in order to prevent the material from sagging or marking by pricks. A light veil of coating (the so-called inspection application) is sometimes applied on the primer to highlight any possible imperfection. After drying, the surface must be sanded with P500 ÷ 600 abrasive paper, washed with water, dried with velvet leather and compressed air to eliminate any residual humidity. We recommend to further wash with silicone-removing solvent.

Revision

It must be done by applying thin layers of stopper on the primer surface in case of slight waving.
When dry, the surface must be levelled with P 600 grane abrasive paper, washed and further dried.

Finishing

The requested colour can be obtained by mixing the basic tints according to the ratios specified in the tint composition formulas. The coats so obtained however, do not feature the suitable viscosity to be utilized. Before being applied, if needed, coats must be catalyzed and then thinned according to the ratios mentioned in the cycle. It is utmost important to use a painting product with the suitable viscosity, in order to prevent some painting defects (sagging, marking by pricks etc.).
Coating of the surface to be painted must be always done after having checked that the hue of the colour prepared is the same as the car's original colour hue.
To perform this test, the repairer shall apply a sample of the product prepared on a small test plate, following the same procedures to be used when coating the surface to be treated.
Sometimes, when the painting surface is large enough, it is possible to apply the sample product directly on a tiny area of the surface to be repaired.
The test plate, which must be polished beforehand, shall be compared with one or more car body areas and, in the event that hues look different, the repairer has to adjust the tint by adding basic components.
Once the desired hue has been obtained, before applying the coat, the repairer has to ensure that the surface has been perfectly degreased, is thoroughly dry and dust-free. Furthermore, he must be very careful never to touch the surface when it is ready for spraying.
Besides these precautions, the good result of this process is affected by environmental conditions such as temperature and humidity.
A temperature which is higher than that requested for application shall cause a quick drying of the coat, as a consequence of the solvent evaporation. This will start as soon as the product is sprayed by the gun, and it shall therefore prevent the film from spreading evenly, thereby affecting gloss as well.
On the other hand, high humidity in the environment causes a slow evaporation of the solvents and consequently of the film drying, thus increasing the risk of sagging and marking by pricks).
Coats are generally applied crosswise, at the intervals dictated by the required flash off time in between.
During second coating, the nozzle jet must be projected in the middle of the first coating sprayed.
The number of coats in case of solid base colours ranges form a minimum of 2 to maximum of 4 approximately, while on metallic base colours two cross coats must be applied on the base and three on the clear. In any case, always comply with the instructions given by the chosen product manufacturer.
If the product is high solid clear, it can be applied by the repairer with one single coating.
Metallic base paints may look different, depending on the aluminium particles present on their surface.
A metallic colour can be brightened or darkened by means of "dryer" or "wetter" application. When the coat is dryer, the aluminium particles spread more evenly within the colour layer, thereby reflecting more light and giving the tints a brighter aspect.

M4.02 TOUCH-UP TECHNOLOGIES

Carrying out a partial touch-up of painted parts is a rational and modern choice, which is made possible thanks to new technologies that reduce working times, materials and energy used if drying is carried out with "IR" lamps.
Partial spotting-in will not be recognizable from the original car paint, provided that the specific working procedure for touch-ups is respected.

Blended-In Touch-Up, Why?

Touch-ups are needed especially when metallic and micaceous tints do not permit a net cut due to "flops".
This method is recommended for double coat solid colours, and for solid colours where pigments (some kinds of light blue) tend to float.

How to Apply Touch-Ups for Metallic-Metallescent and Micaceous Colours?

After having carried out all preliminary procedures for the preparation of the area to be touched-up, the technique used to gradually "blend-in" the colour is of basic importance.
Metallic, metallescent and micaceous colours tend to form a dark halo originated by "dry" blending-in gases. To avoid this drawback, it is necessary to use a special touch-up thinner called "fixative".
Besides absorbing gases, this product also permits a good control of mica scales and aluminium particles. Such fixative material must be used before applying the primer, and has to be applied on the touch-up edges. When the area to be repaired has been entirely covered, the colour must be blended-in by moving the gun from the outside to the inside of the surface, with gradual, circular movements. After ca. 10 minutes of flashing off, the clear product must be applied on the entire part.

Touching-Up the Solid Coat

This operation can be performed using three different methods. The choice depends on the position and dimension of the area to be repaired as well as to economical and aesthetic aspects.

1. Touch-up with clear finishing
2. Blended-in touch-up with clear finishing
3. Blended-in touch-up

1. Touch-up with clear finishing

This technique guarantees a top-quality aesthetic and long-lasting result. The solid base coat, properly thinned, is applied on the area to be repaired. Once the area has been entirely covered, it must be blended in to render the tint even. A second shading is made with clear application, always moving the gun from the outside to the inside. In the end, the clear product must be 50% thinned and applied on the entire part.

2. Blended-in touch-up with clear finishing

Once the part has been covered as described for the above technique, a first coating has to be blended in with the clear product. This has to be then further thinned (5:1 ratio) and a second blended in coating must be applied. After the paint has thoroughly dried, this technique only requires polishing.

3. Blended-in touch-up

Once the part has been covered as described for the above techniques, the coat has to be thinned up to a 3:1 ratio and a first blended-in coating is to be applied. The same product is then further thinned up to a 5:1 ratio, and the last blended-in coating is applied, always moving the gun from the outside to the inside. After thorough drying, proceed with polishing.

Finishing on Plastic Materials

The vehicle's plastic parts have become more and more important over time due to the increase in the percentage of plastic materials used for the bodywork.
The actual difficulty in choosing the suitable repair cycle lies in being able to recognize the type of plastics.
As a matter of fact, there are several sorts of plastic materials which differ from each other in their chemical composition (polypropylene, polycarbonates, polybutadiene etc.), in their mechanical characteristics and in the fact that they can or cannot be sanded.
Choosing the suitable primer depends on the type of plastic substrate.
On the back of all plastic parts whose size exceeds 10 cm2 is marked the production date and a code (e.g.: PP, Pc, PA, ABS, SMC, PUR, PBT+Pc, etc..) within the pictogram "**> <**", to specify the type of plastic and therefore the repair cycle.

M4.03 PREPARATION AND PAINTING OF BUMPERS WITH "SMC" TECHNIQUE

- Clean the part to be repaired with antistatic degreasing product **D846**
- Dry-sand the area involved with **Abrasive paper P320**
- Clean the sanded area with antistatic degreasing product **D846**
- Apply epoxy-primer **DP40- D834** on the sanded area

- Catalyst:	**D835**
- Mixing ratio:	**1/1 in vol.**
- Drying:	**70°C / 30 min.**

- Dry-sand with **P400** abrasive paper
- Clean the substrate with anti-silicone degreasing product **D846**
- Apply tintable, **2K** primer **K93 - D825**

- Catalyst:	**D803**	
- Thinner:	**D866**	
- Ratio:	**D825**	**4 vol.**
	D803	**1 vol.**
	D866	**1 vol.**
- Tint with	**DXXX**	**1 vol.**
- Drying:	**70°C / 30 min.**	

- Dry-sand with **P600** abrasive paper.
- Apply Matt Base **DELTRON BC** in the car tint.

- Catal st:	**D841**	
- Thinner	**D807**	
- Mixing ratio:	**DELTRON BC**	**1 vol.**
	D841	**0,2 vol.**
	D807	**1 vol.**

- Flashing off at room temperature until the base has become completely matt.
- Clear application **2K DELTRON D800** with addition of soft-face primer **D814**

- Catalyst:	**D841**	
- Soft-face primer:	**D814**	
- Thinner:	**D807**	
- Mixing ratio:	**D800**	**3 vol.**
	D841	**2 vol.**
	D814	**1 vol.**
	D807	**0,4 vol.**
- Drying:	**70°C / 30 min.**	

M4.04 PAINTING

NOTES

The type of paint and its correct colour are specified on the plate located in the engine compartment and can be obtained through the tintometric system GLOBAL DELTRON PPG, or can be requested to any PPG center.

Below please find the main instructions to apply the above mentioned paint.

General information

Always use the following PPG products for any repair works:

- ANTI-CORROSIVE EPOXY PRIMER DP 40 - D 834
- TINTABLE, INSULATING PRIMER K 93 D 825
- POLYESTER STOPPER GALVAPLAST 77 A 656
- SOLID COLOUR BASE COAT DELTRON BC
- CLEAR DELTRON GLOBAL D800

The above said products meet Ferrari's quality standards and are available on the market the PPG authorized sales points.

Should any of the listed products be unavailable, or should you require technical information on the products replacing the above, please contact the PPG technical assistance centre in your country (see the attached list) for a prompt solution of the problem.

Application Methods

Preparation of the substrate

A . Pre-clean (silicon removal) with **DX 330** solvent **D 837**

B . To repair down to the substrate (iron, aluminium, resin)

- Appl **ANTICORROSIVE PRIMER DP 40**	**D 834**
- Cataly	**D 835**
- Catalysis ratio	**1 : 1**
- Thinner	—
- Pot - life a 20°C	**16 hours**
- Viscosity at 20°C	**16 sec. DIN 4**
- Air pressure	**4 bar**
- Nozzle for gravity gun	**1,4 mm**
- Nozzle for suction gun	**1,8 mm**
- No. of coats	**n. 2 = 30 ÷ 50 micron**
- Stoving	**30 minutes at 70°C** or **40 minutes at 60°C**

C . To level local, significant defects, apply **GALVAPLAST 77 - A656 STOPPER**

D . Sand with abrasive **P 400 – 800,** manual, wet, **P 320-400** with rotary-orbital sander, dry

E . To repair down to the substrate or **EDP**

- Apply insulating, tintable primer **K93**	**D 825**
- Catalizzatore	**D 803-D 841-D 861**
- Catal sis ratio	**5 : 1**
- Thinner	**D 866**
- Pot - life a 20°C	**1 hour**
- Viscosity at 20°C	**25 ÷ 30 sec. DIN 4**
- Air pressure	**4 bar**
- Nozzle for gravity gun	**1,6 mm**
- Nozzle for suction gun	**1,8 mm**
- No. of coats	**n. 2 = 60 ÷ 70 micron** **n. 3 = 90 ÷ 100 micron**
- Stoving	**30 minutes at 70°C** or **40 minutes at 60°C**
- Sanding with abrasive	**P600 ÷ 800 awet or P 360 dry**

Coat application methods

A . Solid colour base coat deltron bc

- Thinner	**D 808 - D 807**
- Viscosity at 20°C	**16 sec. DIN 4**
- ir pressure	**4 bar**
- Nozzle for gravity gun	**1,2 mm**
- Nozzle for suction gun	**1,4 mm**
- No. of coats	**n. 2 = 20 ÷ 25 micron**
- Flash off at 20°C	**5÷10 minutes** between one coating and the following **10 minutes** for the last coating

Flashing off must be considered as completed only when the coat has become thoroughly mat. Applying clear product on a partially flashed surface can produce stains, poor hardness and adhesion.

B . Base coat metallic colour deltron b.c.

- Thinner	**D 808 - D 807**
- Viscosity at 20°C	**16sec. DIN4**
- Air pressure	**4 bar**
- Nozzle for gravity gun	**1,2 ÷ 1,4 mm**
- Nozzle for suction gun	**1,4 mm**
- No. of coats	**n. 2 = 20 ÷ 25 micron**
- Flash off at 20°C	**5÷10 minutes** between one coating and the following **10 minutes** for the last coating

Flashing off must be considered as completed only when the coat has become thoroughly mat. Applying clear product on a partially flashed surface can produce stains, poor hardness and adhesion.

Clear application methods

C . Clear for 2ct paint, global deltron D800
Product to be used on a solid or metallic base coat

- MS catalyst	**D 803 - D841 - D861**
- Thinner	**D 808 - D 807 - D 812**
- Pot - life a 20°C (tempo di impiego)	**6 hours**
- Viscosity at 20°C	**17 ÷ 18 sec. DIN 4**
- Air pressure	**4 bar**
- Nozzle for gravity gun	**1,4 ÷ 1,6mm**
- Nozzle for suction gun	**1,6 ÷ 1,8 mm**
- No. of coats	**n. 2 = 50 - 60 micron**
- Stoving	**20 minuti a 80°C** (special temperature) or **30 minutes at 60°C** (special temperature)
- Drying with lamp	

IMPORTANT
Do not use I.R. lamps on resin components (bumpers, wing mirrors, engine lid).