Bravo/Brava

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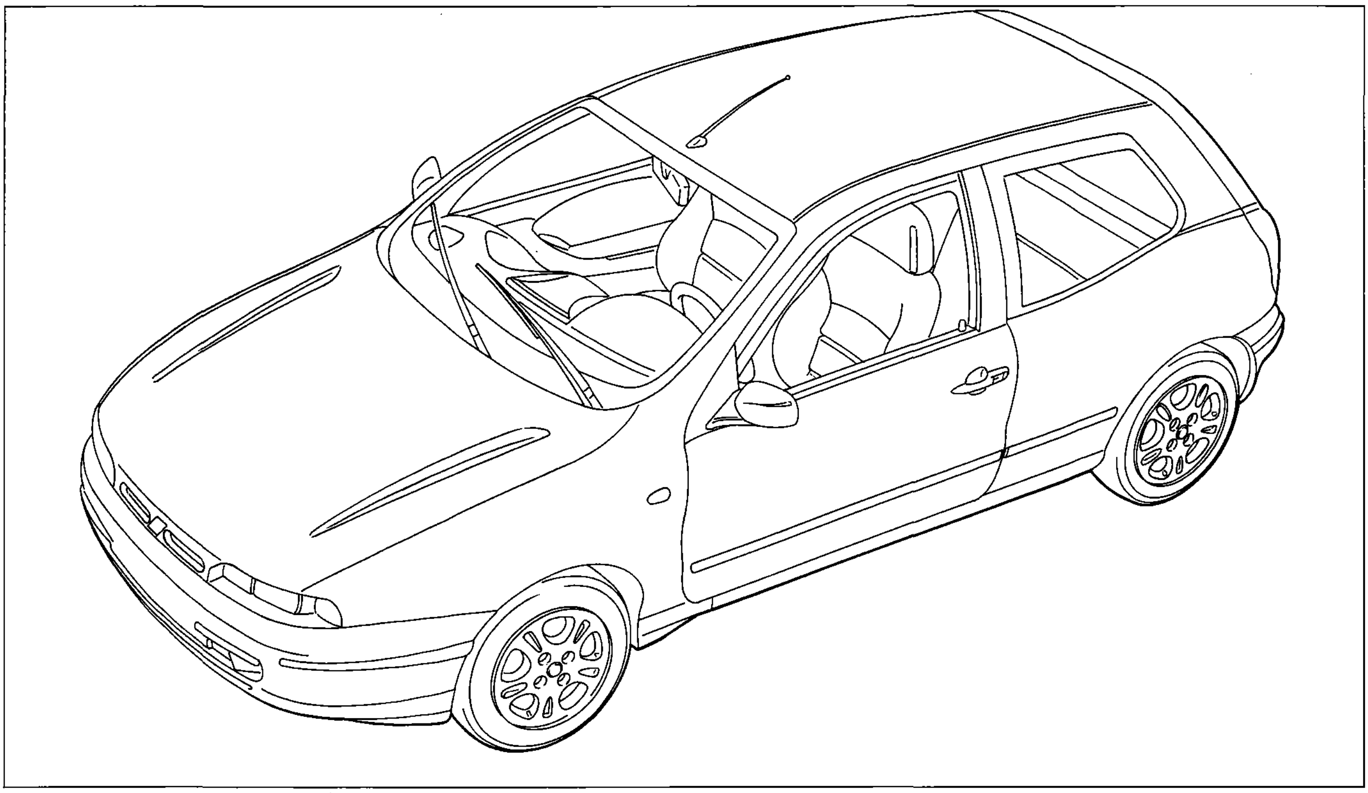
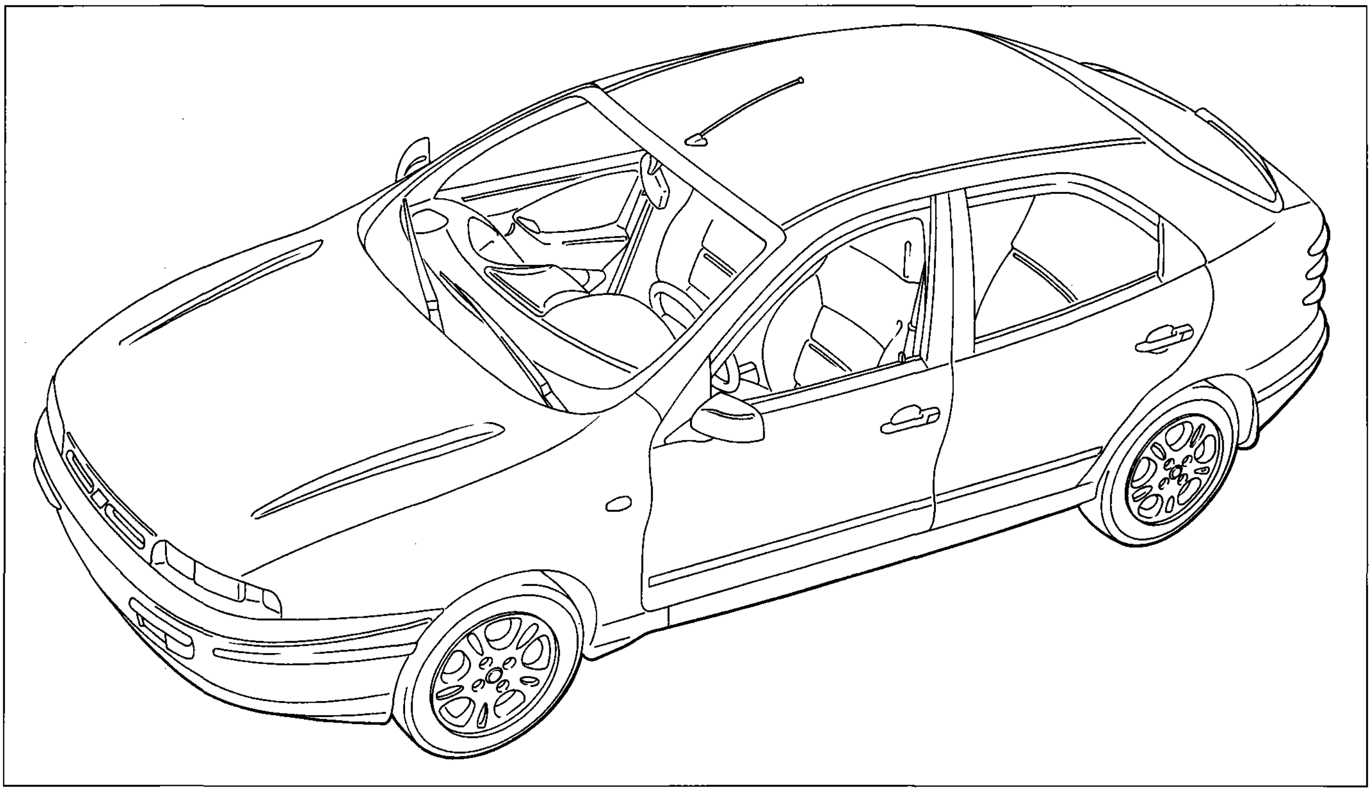
N.D. *Data not available at the time of printing*

The missing data for the Diesel and 1581 versions with automatic transmission are contained in the 3rd Volume.



P4A001A01

3/4 front view - Bravo



P4A001A02

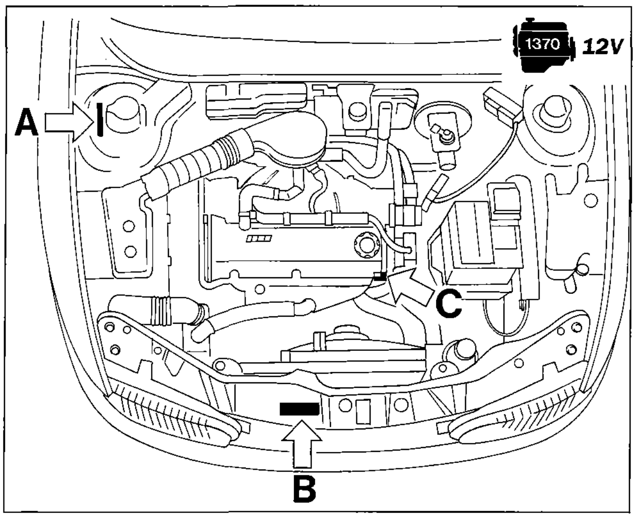
3/4 front view - Brava

	CHASSIS	ENGINE	VERSION	3 Door	5 Door	GEARBOX
1370 12V	ZFA 182 000	182 A3.000	182 AA 1AA 00	●		●
			182 BA 1AA 10		●	
		182 A5.000 (●)	182 AG 1AA 07 (●)	●		
			182 BG 1AA 16 (●)		●	
1581 16V		182 A4.000	182 AB 1AA 01	●		●
			182 AB 1AA 01 B (▲)	●		
			182 BB 1AA 11		●	
			182 BB 1AA 11B (▲)		●	
1747 16V		182 A6.000 (●)	182 AH 1AA 08 (●)	●		
			182 BH 1AA 17 (●)		●	
1998 20V		182 A2.000	182 AC 1AA 03	●		●
			182 AC 1AA 03B (▲)	●		
			182 BC 1AA 13		●	
			182 BC 1AA 13B (▲)		●	
			182 AC 1BA 04 (*)	●		
			182 BC 1BA 14 (*)		●	
1929 D		182 A1.000	182 AD 1AA 05	●		●
			182 AD 1AA 05B (▲)	●		
		160 A7.000	182 AE 1AA	●		●
			182 BE 1AA		●	
1910 TD		N.D.	N.D.	●	●	●

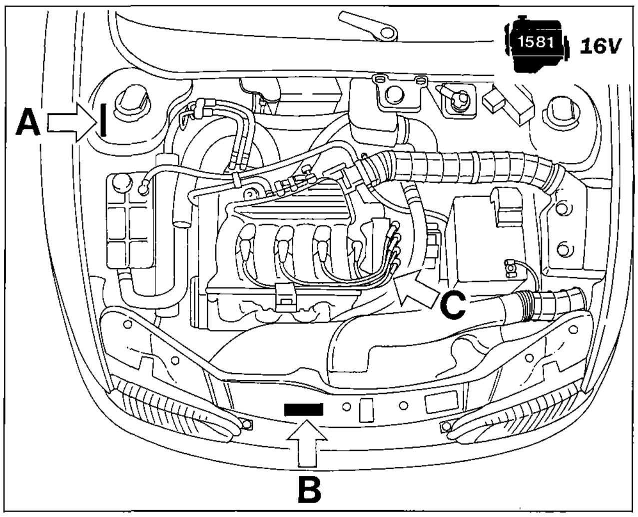
(●) Versions for specific markets (Germany)

(*) Versions for specific markets (France)

(▲) Voluntary - Germany

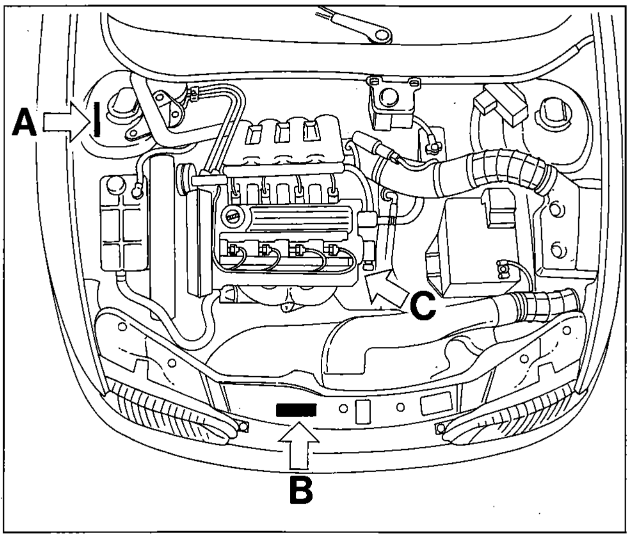


P4A002A01



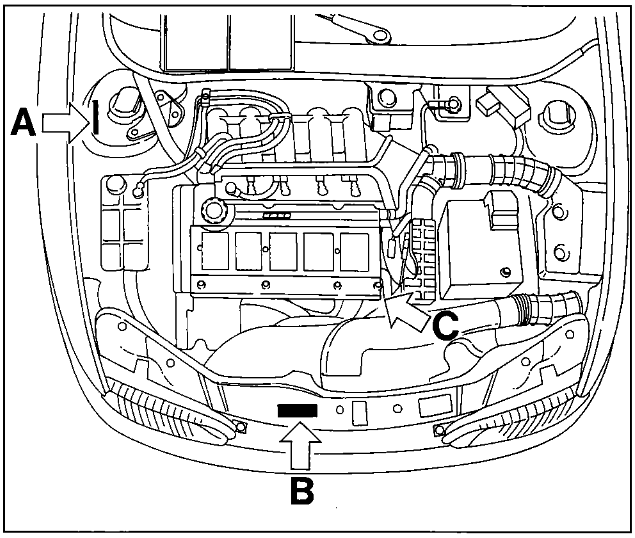
P4A002A02

1747 *16V*



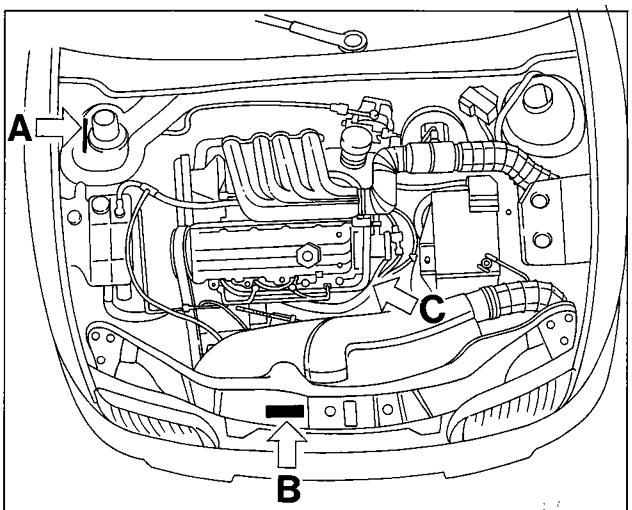
P4A003A01

1998 *20V*



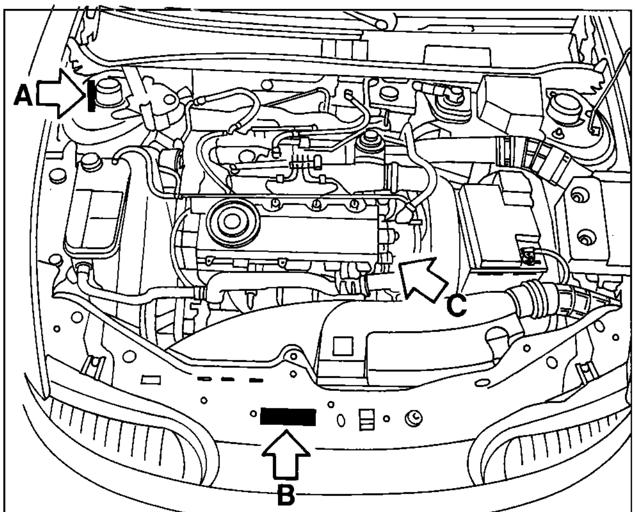
P4A003A02

1929 *D*



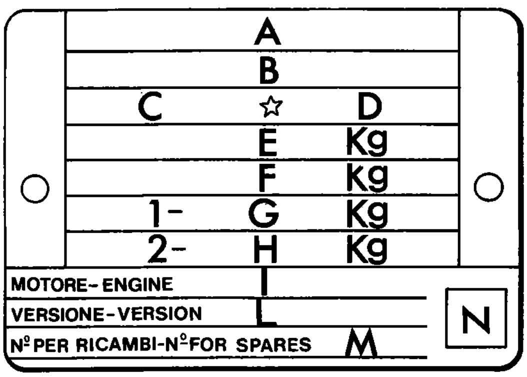
P4A003A03

1910 *TD*



P4A003A04

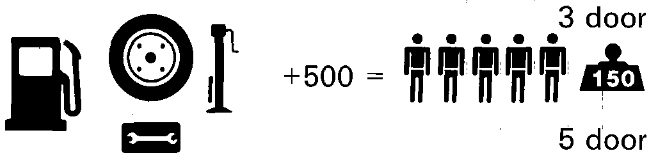
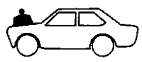
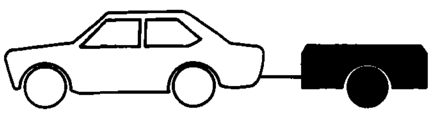
1. **Vehicle type identification code and chassis manufacture number**
2. **Engine type and number.**
3. **V.I.N. Plate**
   (EEC regulations)



F4A003A01

A. Name of manufacturer
B. Homologation number
C. Vehicle type identification code
D. Chassis manufacture number
E. Maximum authorized weight of vehicle fully laden
F. Maximum authorized weight of vehicle fully laden plus tow
G. Maximum authorized weight on first axle (front)
H. Maximum authorized weight on second axle (rear)
I. Engine type
L. Bodywork version code
M. Spares number
N. Correct value of smoke absorption coefficient (Diesel engines only)

WEIGHTS (in kg)

ENGINE TYPE		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
	3 door	1010	1050	1100	1190	1100	N.D.
	5 door	1040	1090	1130	-	1130	N.D.
 +500 = 150	3 door	1510	1550	1600	1690	1600	N.D.
	5 door	1570	1630	1680	-	1650	N.D.
Maximum permissible loads on the axles ■	3 door 	850	850	900	970	850	N.D.
	5 door	850	850	900	-	850	N.D.
	3 door 	850	850	900	900	850	N.D.
	5 door	850	850	900	-	850	N.D.
Maximum permissible load on the roof		80	80	80	80	80	N.D.
Load on the tow hook (trailer with braking system)	Minimum	-	-	-	-	-	N.D.
	Maximum	70	70	70	70	70	N.D.
	Without braking system	400	400	400	400	400	N.D.
	With braking system	1000	1100	1200	1300	1200	N.D.

■ Loads which must never be exceeded

NOTE FOR VERSIONS WITH ACCESSORIES: If special equipment is fitted (non standard air conditioner, sun roof, trailer towing device), the empty weight increases and therefore the carrying capacity may decrease, in relation to the maximum permissible loads.

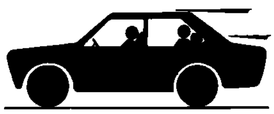
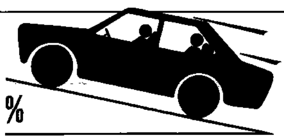
The fuel consumption figures according to the 80/1268/EEC standards given overleaf have been defined in the course of official tests and in accordance with procedures laid down by EEC regulations. In particular the bench tests measure simulated urban cycle figures whilst consumption at constant speeds of 90 and 120 kph are measured directly on a flat, dry road and in equivalent bench tests. The fuel consumption figures according to the 93/116E standards have been defined in the course of homologation tests involving:

- an urban cycle which includes cold starting followed by a varied urban cycle simulation.
- an extra-urban cycle which includes frequent acceleration in all gears simulating normal extra-urban usage of the vehicle. The speed varies between 0 and 120 kph.
- The average combined consumption is obtained from 37% of the urban cycle and 63% of the extra-urban cycle.
  The type of journey, traffic conditions, driving styles, atmospheric conditions, trim level/equipment/accessories, whether a roof rack is fitted, the presence of special equipment and the general state of the vehicle can lead to fuel consumption figures which differ from those obtained through the above mentioned procedures.
  The CO_2 exhaust emissions (in g/km) are obtaine from the average combined cycle

VII-97 - Cancels and replaces

Print no. 506.670/12

(●) For French versions

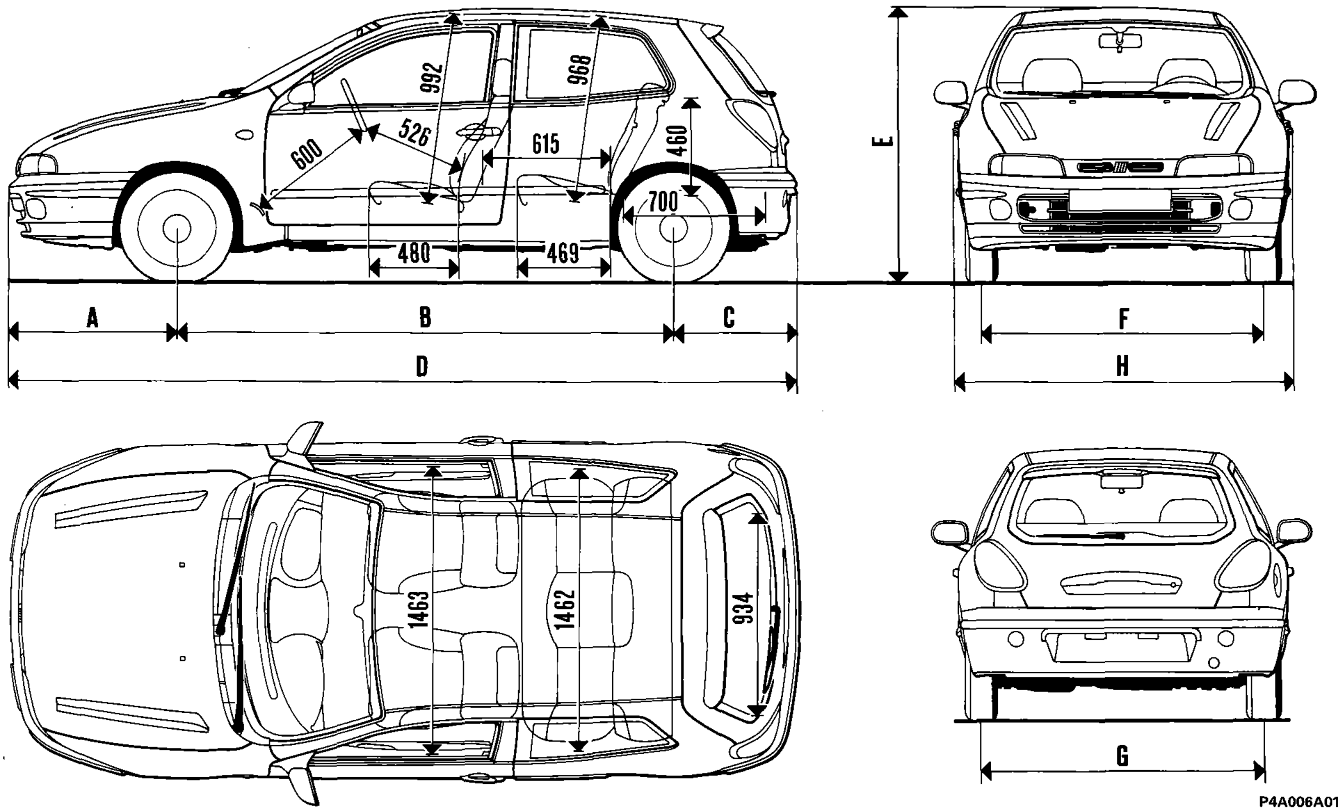
		ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Speed kph (average load) 	1	45 (46▲)	52	50 (55●)	56	35	N.D.
	2	82 (80▲)	90	87 (95●)	89	61	N.D.
	3	120 (118▲)	132	128 (140●)	131	94	N.D.
	4	158 (155▲)	175	169 (191●)	172	132	N.D.
	5	170 (168■)	184 (180■) 180 (177■)	193 (190●) 190 (190●)	210	155	N.D.
	R	46	53	50 (55●)	55	35	N.D.
 %	Maximum climable gradient	37 (36▲) (35▲)	37				
Fuel consumption according to 80/1268/CEE stand. (litres/100 km) (*) 	Urban cycle (A)	9	9,3	9,8 (9,5●)	11	6,5	N.D.
	Constant speed 90 kph (B)	5,2	5,5	5,8 (5,6●)	7,1	4,9	N.D.
	Constant speed 120 kph (C)	7	7,5	7,6 (6,9●)	8,7	6,9	N.D.
	Av. consumption (CCMC proposal) $\frac{A+B+C}{3}$	7,1	7,4	7,7 (7,3●)	8,9	6,1	N.D.
Fuel consumption according to 93/116/CE standards (litri/100 km) (*)	Urban	11,3 11,4	11,0 11,3	11,3(11●) 11,5(11,2●)	13,8 -	- -	- -
	Extra-urban	6,0 6,1	6,5 6,6	6,5(6,3●) 6,6(6,3●)	7,2 -	- -	- -
	Combined	7,9 8,0	8,2 8,3	8,3(8,0●) 8,4(8,1●)	9,6 -	-	-
CO2 exhaust emissions (g/km)		188 191	194 197	197(191●) 199(193●)	228 -	- -	- -

(●) Versions for specific markets (France)
(■) Versions for specific markets (Germany)
(▲) Versions with C513 gearbox

(*) See specifications on previous page

NOTE *The figures with the shaded background refer to the Fiat Brava*

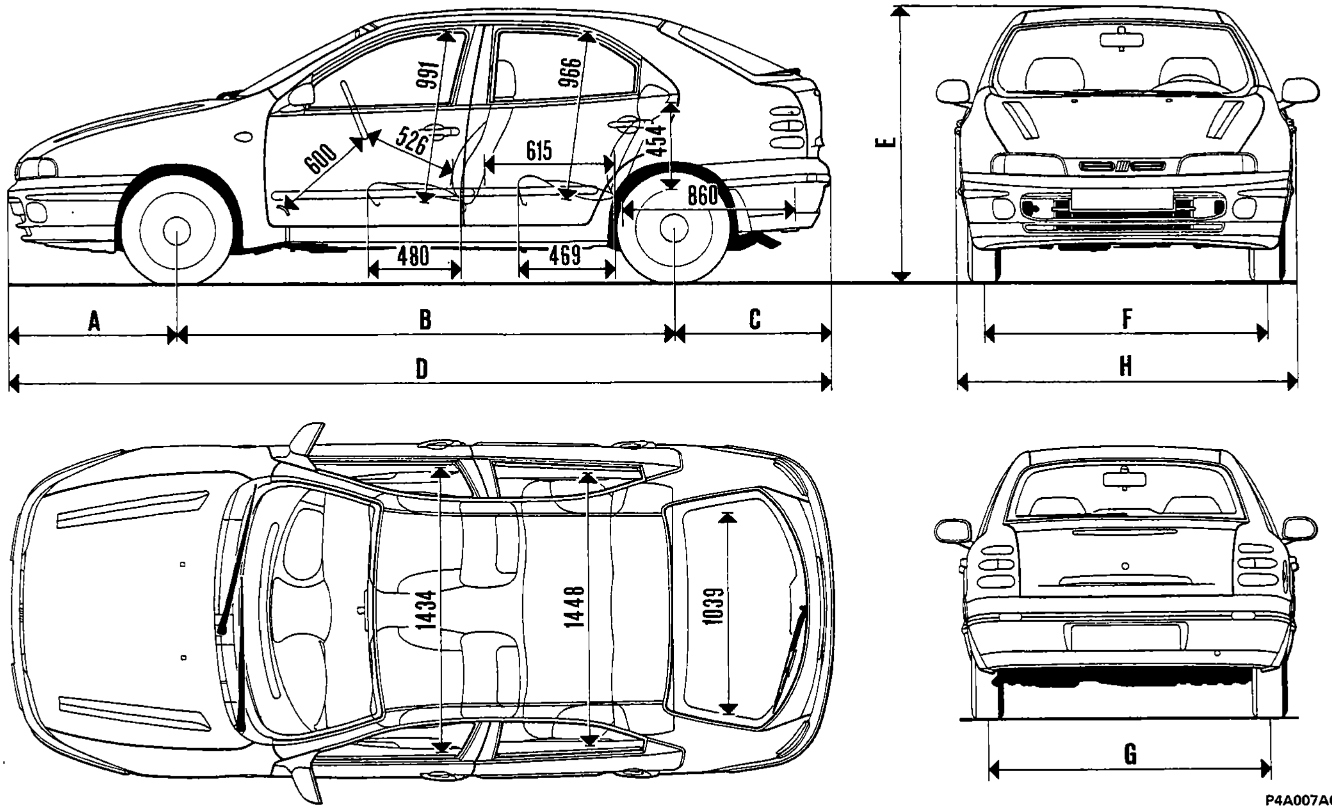
3 DOOR VERSIONS



P4A006A01

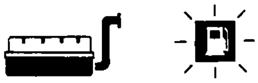
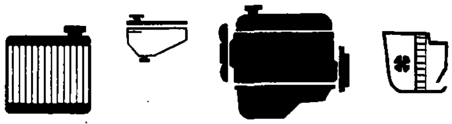
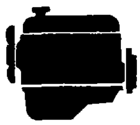
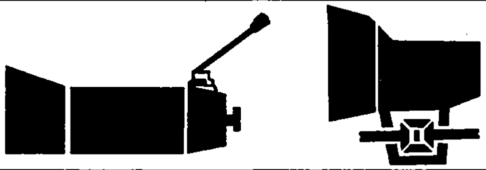
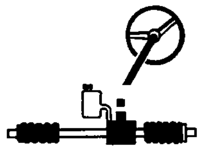
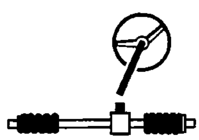
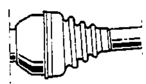
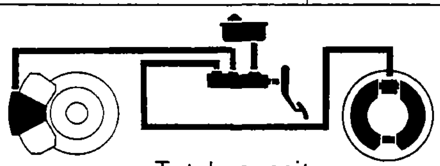
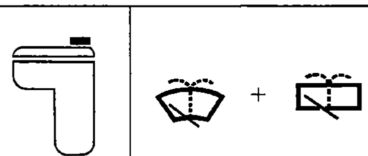
Engine type	Wheel rim	DIMENSIONS (mm)							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
1370 12V	5½J×14"-32 5½J×14"-37	858	2540	627	4025	1416	1461 1451	1463 1453	1755
1581 16V	6J×14"-43	858	2540	627	4025	1416	1439	1441	1755
1747 16V	6J×14"-43 6J×15"-40	858	2540	627	4025	1416	1439 1442	1441 1447	1755
1998 20V	6J×15"-49 6½×15"-49	864	2540	627	4025	1416	1471	1430	1755
1929 D	5½×14"-37	858	2540	627	4025	1416	1451	1453	1755
1910 TD	5½×14"-37 6J×14"-43	858	2540	627	4025	1411	1439	1441	1755

5 DOOR VERSIONS



P4A007A01

Engine type	Wheel rim	DIMENSIONS (mm)							
		A	B	C	D	E	F	G	H
1370 12V	5½J×14"-32 5½J×14"-37	858	2540	789	4187	1413	1461 1451	1463 1453	1741
1581 16V	5½J×14"-37 6J×14"-43	858	2540	789	4187	1413	1451 1439	1453 1441	1771
1747 16V	5½J×14"-37 6J×14'-43	858	2540	789	4187	1413	1451 1439	1453 1441	1741
1929 D	5½J×14"-37	858	2540	789	4187	1143	1451	1453	1741
1910 TD	5½J×14"-37 6J×14'-43	858	2540	789	4187	1408	1451 1439	1453 1441	1741

Capacities	Unit		Quantity dm³(l)	Quantity (kg)
Petrol ≥ O.R. 95 Unleaded		1370-1581	50	–
		1747-1998	60	–
Diesel		1910 TD-1929 D	60	–
50% + H_2O (▲) Paraflu 11	 Total capacity of cooling system	1370	6(5,6■)	–
		1581	7(6,7■)	–
		1747	6,7(6,2■)	–
		1998	7,4(7,3■)	–
		1929 D	7,6(7,4■)	–
Petrol engines: SELENIA 20K (SAE 10 W/40)	Total capacity 	1370	4,3	3,8
		1581	4,5	4
		1747	4,9	4,4
		1998	5,5	4,9
		1929 D	5,5	4,9
Diesel engines SELENIA Turbo Diesel (SAE 15 W/40)	 Partial capacity (periodic replacement)	1370	4,1(3,9●)	3,7(3,5●)
		1581	3,8(3,5●)	3,4(3,1●)
		1747	4,3(3,9●)	3,9(3,5●)
		1998	5(4,5●)	4,45(4●)
		1929 D	4,9(4,2●)	4,4(3,8●)
a = TUTELA ZC 75 Synt		1370 **a**	1,7	1,5
		1581-1747 1998-1929 D **a**	2	1,8
b = TUTELA GI/A		**b**	–	–
a = TUTELA GI/A	**a**  **b** 	**a**	–	0,8
b = K 854		**b**	–	0,08
b = TUTELA MRM2	**c** 	**c**	–	0,003
TUTELA TOP 4 (270°C)	 Total capacity	w/out ABS	0,40	–
		with ABS	0,455 (0,54)* (0,43)**	–
H_2O + DP1 AREXONS	❄ 3%; ☼ ~ - 10°C 50%; ~ - 20°C 100% 		2,5÷5 (6,4 with headlamp washer)	–

(▲) Distilled water
(●) Engine sump only
(■) For versions with air conditioning
(*) For 1998 20V versions
(**) For 1929 D versions

X-96 - Cancels and replaces

Print no. 506.670/10

Service News
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Tecnologie Assistenziali

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Various models

models: Fiat Bravo-Fiat Brava - Fiat Marea - Fiat barchetta - Coupé Fiat

0010 T 120 AA **CHANGING ENGINE OIL**

Service literature update with new oil capacity figures

Cancels and replaces the subject in question published in Service News 4/97 through the variation of the figures for the Fiat Bravo TD, Fiat Brava TD and Fiat Marea TD

TYPE OF PROBLEM

The oil capacity figures in the "Owner's Handbook" and the Service Manuals are not consistent with actual capacities of the engine.

OPERATIONS IN THE NETWORK

When changing the engine oil stick to the figures given below which update the corresponding ones in the Service Manual and the Owner's Handbook.
Provide the Customer with appropriate information on the subject, as necessary.

Model/version	**Engine sump, filter and pipes (1st filling)**		**Engine sump**		**Engine sump and oil filter**	
	dm³	**Kg**	**dm³**	**Kg**	**dm³**	**Kg**
Fiat Bravo 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Brava 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Marea 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Bravo 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat Brava 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat Marea 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat barchetta	4,7	4,2	3,7	3,3	4,0	3,6
Coupé Fiat 1.8	5,0	4,5	4,0	3,6	4,4	3,9

IF14L7

Model/version	**Engine sump, filter and pipes (1st filling)**		**Engine sump**		**Engine sump and oil filter**	
	dm³	**Kg**	**dm³**	**Kg**	**dm³**	**Kg**
Fiat Bravo TD 75 and TD 100	5	4,35	4,2	3,75	4,5	4,0
Fiat Brava TD 75 and TD 100	5	4,35	4,2	3,75	4,5	4,0
Fiat Marea TD 75	4,7	4,2	4,2	3,75	4,5	4,0
Fiat Marea TD 100	5	4,35	4,2	3,75	4,5	4,0
Fiat Marea TD 125	5,8	5,1	5,0	4,4	5,3	4,7

Service News

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Various models

models: Fiat Bravo-Fiat Brava - Fiat Marea - Fiat barchetta - Coupé Fiat

0010 T 120 AA **CHANGING ENGINE OIL**

service literature update with new oil figures.

TYPE OF PROBLEM

The oil figures given in the "Owner's Handbooks" and the Service Manuals are not consistent with the actual engine capacities

OPERATIONS IN THE NETWORK

When changing the engine oil, refer to the figures given below which update the corresponding figures given in the Service Manual and the Owner's Handbook.

Please provide the Customer with suitable information on this subject, as appropriate.

Model/version	Engine sump, filter and pipes (1st filling)		Engine sump		Engine sump and oil filter	
	dm^3	Kg	dm^3	Kg	dm^3	Kg
Fiat Bravo 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Brava 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Marea 1.6	4,5	4,0	3,5	3,1	3,8	3,4
Fiat Bravo 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat Brava 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat Marea 1.8	4,6	4,1	3,9	3,5	4,3	3,85
Fiat barchetta	4,7	4,2	3,7	3,3	4,0	3,6
Coupé Fiat 1.8	5,0	4,5	4,0	3,6	4,4	3,9

IF11D7

Model/version	Engine sump, filter and pipes (1st filling)		Engine sump		Engine sump and oil filter	
	dm³	Kg	dm³	Kg	dm³	Kg
Fiat Bravo TD 75 and TD 100	4,7	4,2	4,2	3,75	4,5	4,0
Fiat Brava TD 75 and TD 100	4,7	4,2	4,2	3,75	4,5	4,0
Fiat Marea TD 75 and TD 100	4,7	4,2	4,2	3,75	4,5	4,0
Fiat Marea TD 125	5,9	5,2	5,0	4,4	5,3	4,7

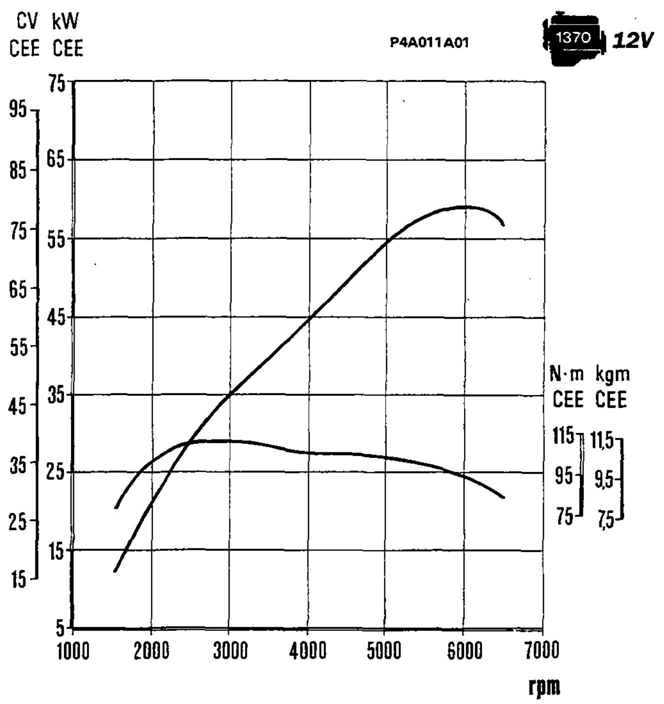
Name of product	Description International designation	Application
SELENIA SAE 15 W/40	Semi-synthetic multigrade engine oil. Exceeds specifications API SH, CCMC-G5 and UNI 20153	Temperature - 25°C ÷ 40°C
VS MAX SAE 15 W/40	Mineral based multigrade engine oil. Exceeds specifications API SG, CCMC-G4 and UNI 20153	Temperature - 15°C ÷ 40°C
SELENIA Turbo Diesel SAE 15 W/40	Semisynthetic, multigrade engine oil. Exceeds specifications API CD, CCMC-PD2, UNI 20153	Temperature - 15°C ÷ 40°C
VS MAX Diesel SAE 15 W/40	Multigrade mineral based engine oil. Exceeds specifications API CD, CCMC and UNI 20153	Temperature - 15°C ÷ 40°C
TUTELA ZC 80S	SAE 80W EP oil. Satisfies standards MIL-L-2105 and API GL4	Manual gearboxes and differentials
TUTELA ZC 90	Non EP SAE 80 W/90 oil, for manual gearboxes, containing anti-wear additives.	Gearboxes and non hypoid differentials
TUTELA W 90/M DA	Special SAE 80 W/90 EP oil for normal and self-locking differentials. Satisfies standards MIL–L–2105 D and API GL5	Hypoid differentials Self-locking differentials. Steering boxes
TUTELA GI/A	"DEXRON II" type oil for automatic transmissions	Automatic gearboxes. Power assisted steering
TUTELA CVT Universal	Oil for continuous variation automatic transmissions.	Continuous variation automatic transmissions
TUTELA JOTA 1	Lithium soap based grease, consistency NLGI = 1	Greasing the vehicle except for components particularly exposed to water requiring special greases
TUTELA MRM2	Water-repellant, lithium soap based grease containing molybdenum disulphide, consistency NLGI = 2	Constant velocity joints
TUTELA MR3	Lithium soap based grease, consistency NLGI= 3	Wheel hub bearings, st. rod, various components
TUTELA PLUS 3 (240 °C)	Synthetic fluid, F.M.V.S.S. n° 116 DOT 3 ISO 4925, CUNA NC 956-01	Hyd. brakes and hydraulically op. clutches
TUTELA TOP 4 (270 °C)	Synthetic fluid, F.M.V.S.S. n° 116 DOT 4 ISO 4925, CUNA NC 956-01	Hyd. brakes & hydraulically op. clutches
K 854	Lithium soap based grease, consistency NLGI = 000, containing molybdenum disulphide	Rack and pinion steering boxes
SP 349	Special grease compatible with brake fluid	Load proportioning valve Load proportioning valve rod bush
Arexons DP1	Mix. of alcohol, H20 & surf. act. agents CUNA NC 956-11	To be used neat or diluted in windscreen washer systems
Paraflu"	Mono-ethylene glycol based anti-freeze for cooling system, CUNA NC 596 - 16	Cooling circuits. Percentage to be used 50% up to - 35°C
Diesel Mix Arexons	Additive for diesel fuel with protective action for diesel engines	To be mixed with diesel fuel (25 cc per 10 litres)

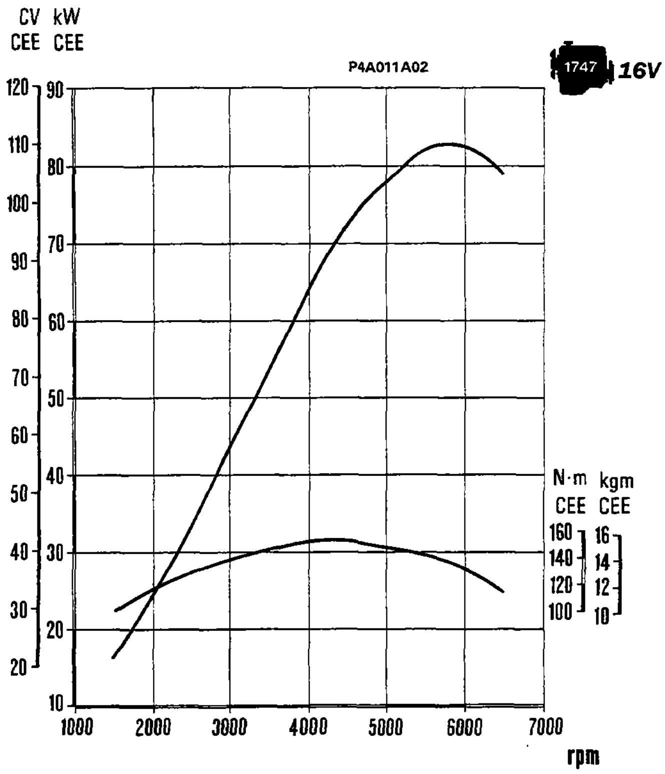
CHARACTERISTICS

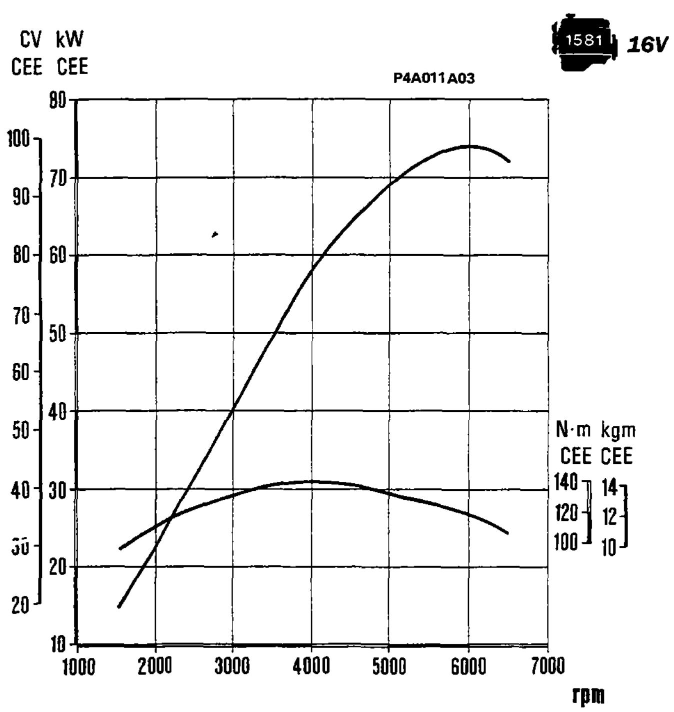
		1370 12V	1581 16V	1747 16V	1998 20V
Cycle		OTTO 4 stroke			
Timing		single overhead camshaft	twin overhead camshaft		
Type of fuel system		integrated electronic injection/ignition			
Number of cylinders		4			5
Cylinder liner (bore)	mm	82	86,4	82	82
Stroke	mm	64,87	67,4	82,7	75,65
Capacity	cc	1370	1581	1747	1998
Compression ratio		9,85±0,15	10,15±0,15	10,3±0,15	10±0,15
Max power EEC	kW (CV)	59 59(*) (80) (75)(*)	76 66(*) (103) (90)(*)	83 (113)	108 (147)
	rpm	6000	5750 6000(*)	5800	6100
Max torque EEC	daNm (kgm)	11,2 (11,4)	14,4 14(*) (14,7) (14,3)(*)	15,4 (15,7)	18,6 (19)
	rpm	2750	4000	4400	4500

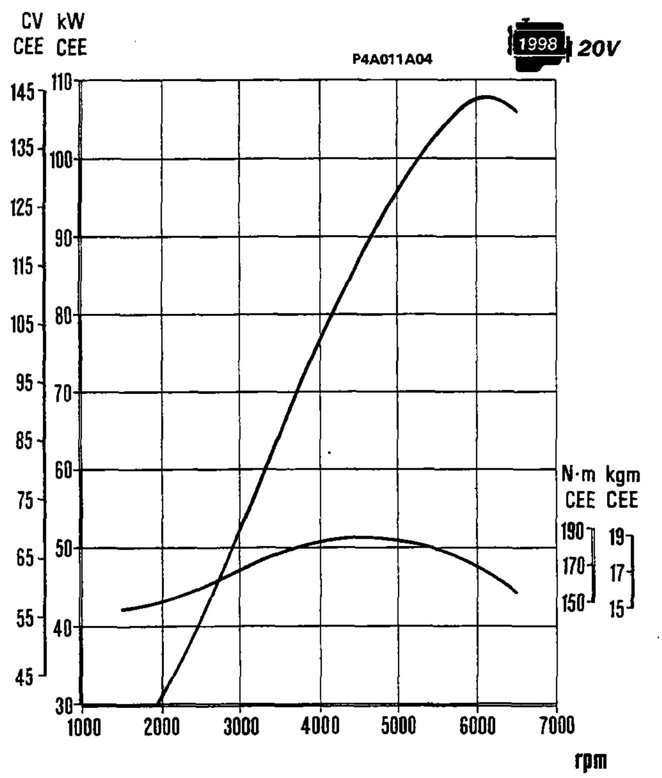
(*) For specific markets

Print no. 506.670/02



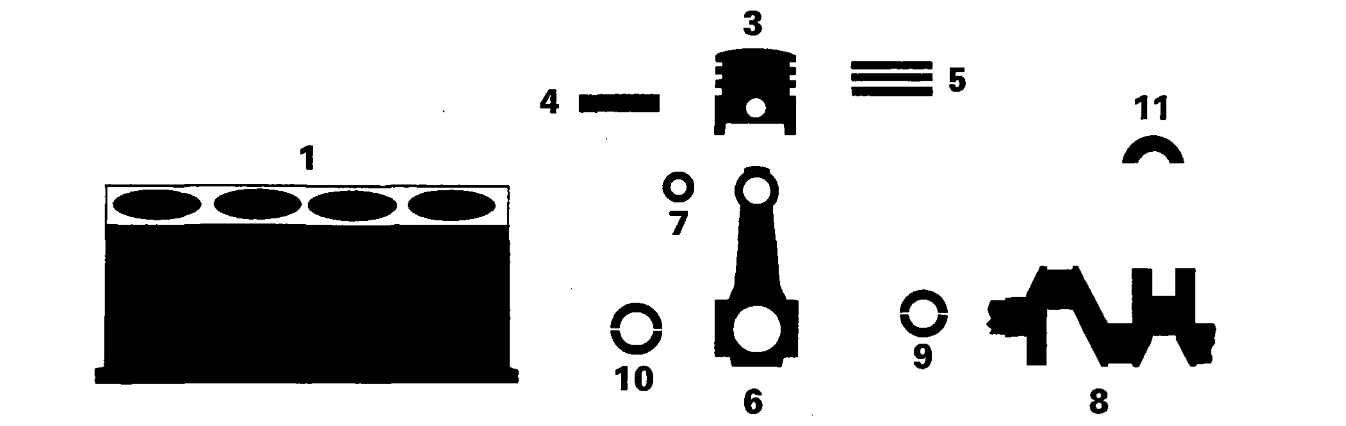


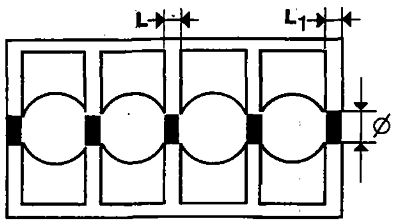
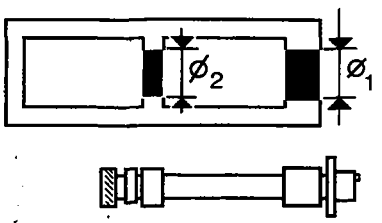
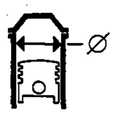




Engine power curves obtained by EEC method

The power curves illustrated can be obtained with the engine overhauled and run in, without a fan and with a silencer and air filter fitted at sea level.



DESCRIPTION			1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
1		L	21,72÷21,80	-	21,72÷21,80	
		L_1	-	22,14÷22,20	-	
	Main bearing supports	Ø	56,705÷56,718	54,507÷54,520	56,705÷56,718	63,705÷63,718
		$Ø_1$	-	38,700÷38,730	-	-
	Auxiliary shaft bush housings	$Ø_2$	-	35,036÷35,066	-	-
	 Cylinder bore Ø	A	82,000÷82,010	86,400÷86,410	82,000÷82,010	
		B	82,010÷82,020	86,410÷86,420	82,010÷82,020	
		C	82,020÷82,030	86,420÷86,430	82,020÷82,030	

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Fiat Bravo-Fiat Brava 1581 16v

10
05.96

1028 C 301 AA **ENGINE PISTONS**
rectifying diameter value indicated in the Service Manual

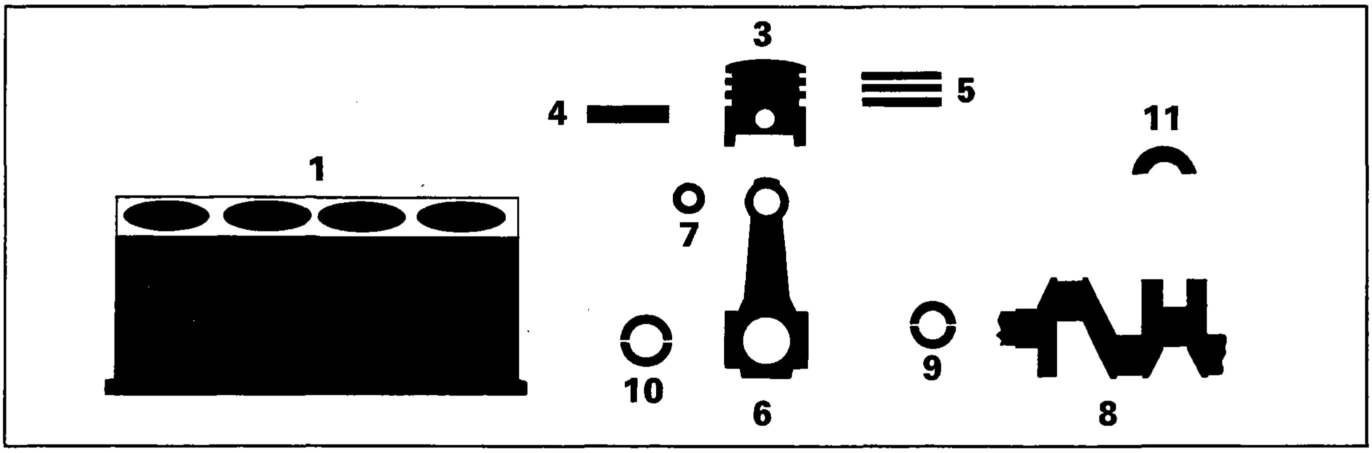
With reference to what is stated on page 13 of section 00 in the Service Manual Print no. 506.670, we wish to point out that the exact values for the engine piston diameters for the model in question are as follows:

A	**86,352 ÷ 86,362**
B	**86,359 ÷ 86,371**
C	**86,368 ÷ 86,378**

Please make a note, by hand, of the correct figures in the above mentioned publication.

DESCRIPTION

			1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
3	Piston	X	12,5	13,2	12,5	
	Ø	A	81,952÷81,962	~~83~~86,352÷~~83~~86,362	81,952÷81,962	
	Ø	B	81,959÷81,971	~~83~~86,359÷~~83~~86,371	81,959÷81,971	
	Ø	C	81,968÷81,978	~~83~~86,368÷~~83~~86,378	81,968÷81,978	
	Ø FIAT >		0,4			
3	Difference in weight between pistons		±5 g			
3-1	Piston Cylinder bore Ø	A	0,038 ÷ 0,058			
		B	0,039 ÷ 0,061			
		C	0,042 ÷ 0,062			
3	Gudgeon pin housing Ø		20,002÷20,007	21,997÷22,001	20,002÷20,007	
4	Gudgeon pin Ø		19,996÷20,000	21,990÷21,995	19,996÷20,000	
	Ø FIAT >		0,2			
4-3	Gudgeon pin - Housing		0,002 ÷ 0,011			
3	Piston ring grooves	1	1,540÷1,560	1,525÷1,545	1,540÷1,560	1,520÷1,540
		2	1,530÷1,550	1,510÷1,530	1,530÷1,550	1,510÷1,530
		3	3,020÷3,040	3,010÷3,030	3,020÷3,040	3,010÷3,030



DESCRIPTION

Ref.	Description		1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
5	Piston rings (L)	1	1,470÷1,490		1,475÷1,490	
		2	1,475÷1,490	1,470÷1,490	1,475÷1,490	
		3	2,935÷2,945		2,975÷2,990	
	Ø FIAT >		0,4			
5-3	Piston rings – Piston ring grooves	1	0,050÷0,090	0,035÷0,075	0,050÷0,085	0,030÷0,065
		2	0,040÷0,075	0,020÷0,060	0,040÷0,075	0,020÷0,055
		3	0,075÷0,105	0,065÷0,095	0,030÷0,065	0,020÷0,055
5-1	Opening at end of piston rings in cylinder bore	1	0,250÷0,500	0,200÷0,450	0,300÷0,500	
		2	0,300÷0,500	0,250÷0,500	0,300÷0,500	
		3	0,400÷1,400	0,400÷1,400	0,250÷0,450	0,250÷0,500
6	Small end bush or pin housing	Ø1	22,939÷22,972	23,939÷23,972	22,939÷22,972	
	Big end bearing housing	Ø2	44,000÷44,012	48,630÷48,646	53,897÷53,909	51,354÷51,366

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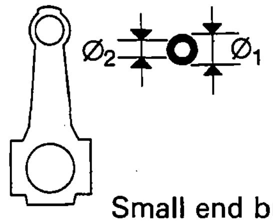
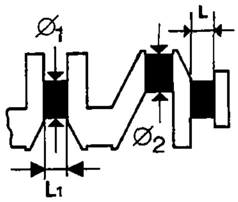
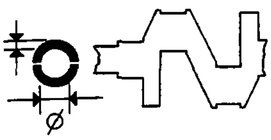
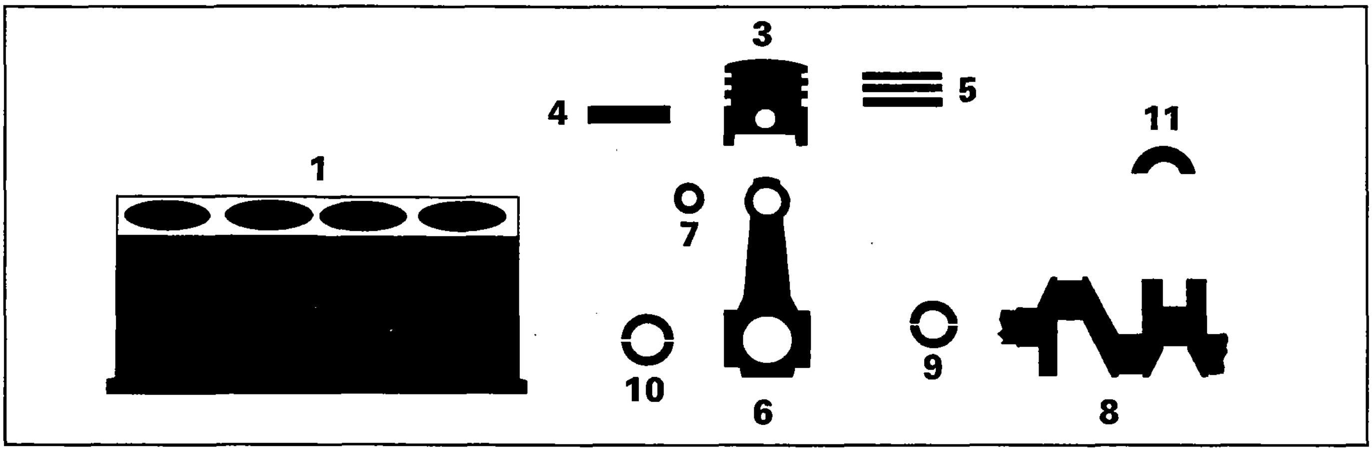
DESCRIPTION			1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
7	 Small end bush	Ø1	23,007÷23,027	24,016÷24,041	23,007÷23,027	
		Ø2	20,006÷20,012	22,004÷22,010	20,006÷20,012	
4-7	Gudgeon pin Small end bush		0,006÷0,016	0,009÷0,020	0,006÷0,020	
7-6	Small end bush Bush housing		0,035÷0,088	0,044÷0,102	0,035÷0,088	
8	 Main journals Ø1	1	52,994÷53,000	50,790÷50,800	52,994÷53,000	59,994÷60,000
		2	52,988÷52,994	50,780÷50,790	52,988÷52,994	59,988÷59,994
		3	52,982÷52,988	-	52,982÷52,988	59,982÷59,988
	Crank pins Ø2	A	40,884÷40,890	45,513÷45,523	50,799÷50,805	48,238÷48,244
		B	40,878÷40,884	45,503÷45,513	50,793÷50,799	48,232÷48,238
		C	40,872÷40,878	-	50,787÷50,793	48,226÷48232
		L	-	26,975÷27,025	-	
		L_1	26,575÷26,625	-	26,575÷26,625	
9	Crankshaft bearings  L	1	1,836÷1,840	1,840÷1,844	1,836÷1,840	
		2	1,839÷1,843	1,845÷1,849	1,839÷1,843	
		3	1,842÷1,846	-	1,842÷1846	
	Ø FIAT		0,254 - 0,508			
9-8	Crankshaft bearing - Main journals		0,025÷0,052	0,019÷0,050	0,025÷0,052	



DESCRIPTION

			1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
10	Crankshaft bearings L	A	1,536÷1,540	1,535÷1,541	1,527÷1,531	1,536÷1,540
		B	1,539÷1,543	1,540÷1,546	1,530÷1,534	1,539÷1,543
		C	1,542÷1,546	-	1,533÷1,537	1,542÷1,54
	Ø FIAT <		0,254 - 0,508			
10–8	Big end bearings - Main journals		0,030÷0,056	0,025÷0,063	0,030÷0,056	
11	Thrust washers	S	2,342÷2,358	2,310÷2,360	2,342÷2,358	
	S FIAT >		0,127			
11–8	Crankshaft end float		0,059÷0,161	0,055÷0,265	0,059÷0,161	

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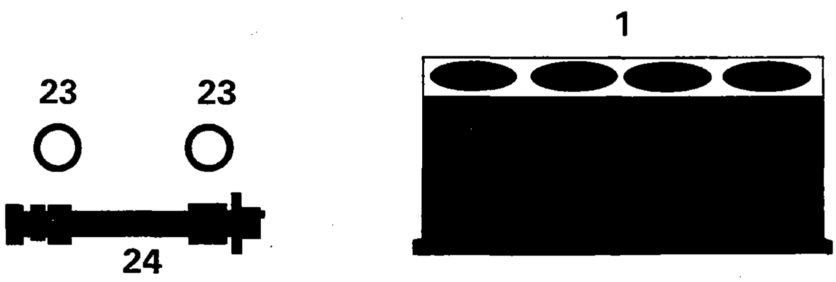
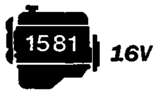
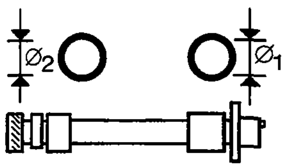
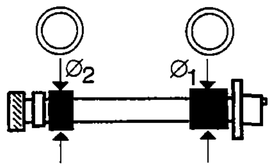
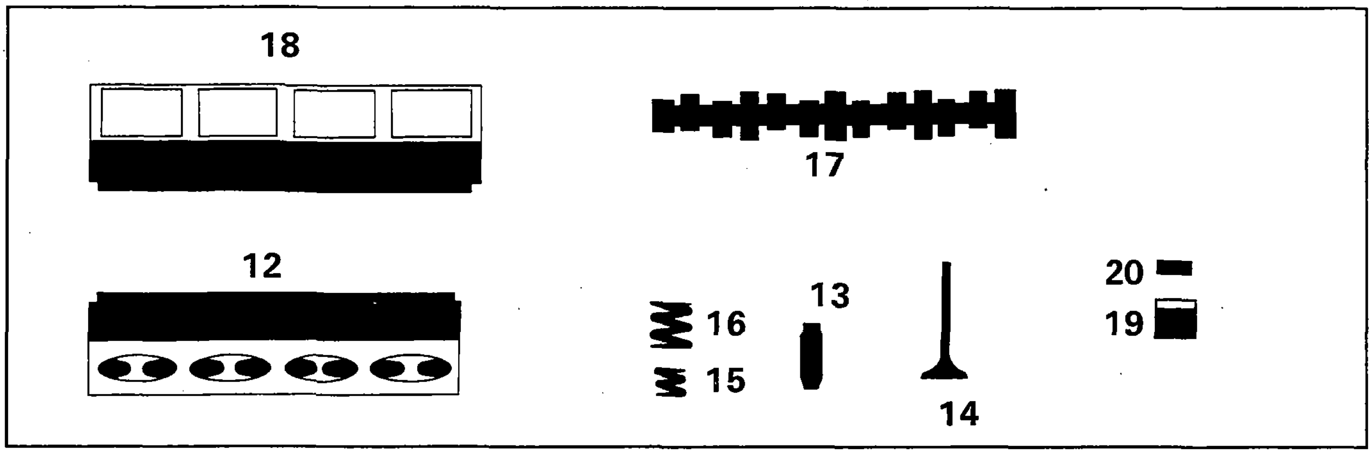


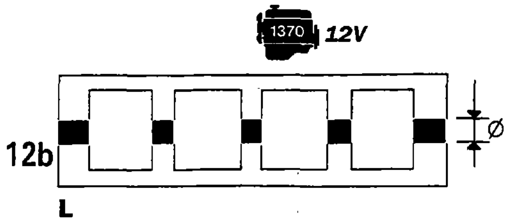
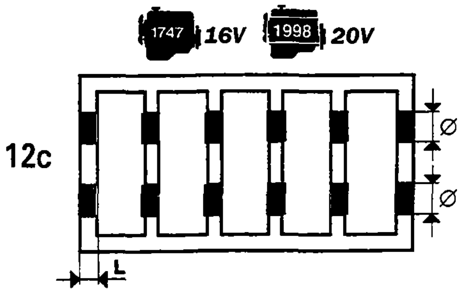
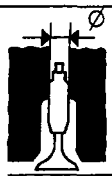
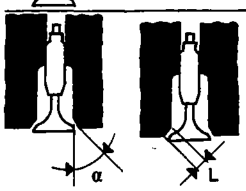
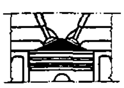


DESCRIPTION

			Values in mm
23	 Bushes for auxiliary shaft in housing	Ø1	35,664 ÷ 35,684
		Ø2	32,000 ÷ 32,020
24	 Auxiliary shaft bearings	Ø1	35,593 ÷ 35,618
		Ø2	31,940 ÷ 31,960
23-1	Bushes for shaft Cylinder block seats		must be an interference fit
24-23	Shaft bushes Bushes	Ø1	0,046 ÷ 0,091
		Ø2	0,040 ÷ 0,080



DESCRIPTION

Ref.	Description		1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
12b	Camshaft supports in cylinder head 	∅	26,045÷26,070	-	26,045÷26,070	
12c		L (*)	19,100÷19,150	-	19,100÷19,150	
12	 Valve guide bore in cylinder head	∅	12,950 ÷ 12,977			
	 Valve bore	α (intake)	45° ± 5′			
		α (exhaust)	45° ± 5′			
		L	about 2			
	 Volume of combustion chamber in cylinder head	cm^3	-	37	-	39

(*) Measurement of cap

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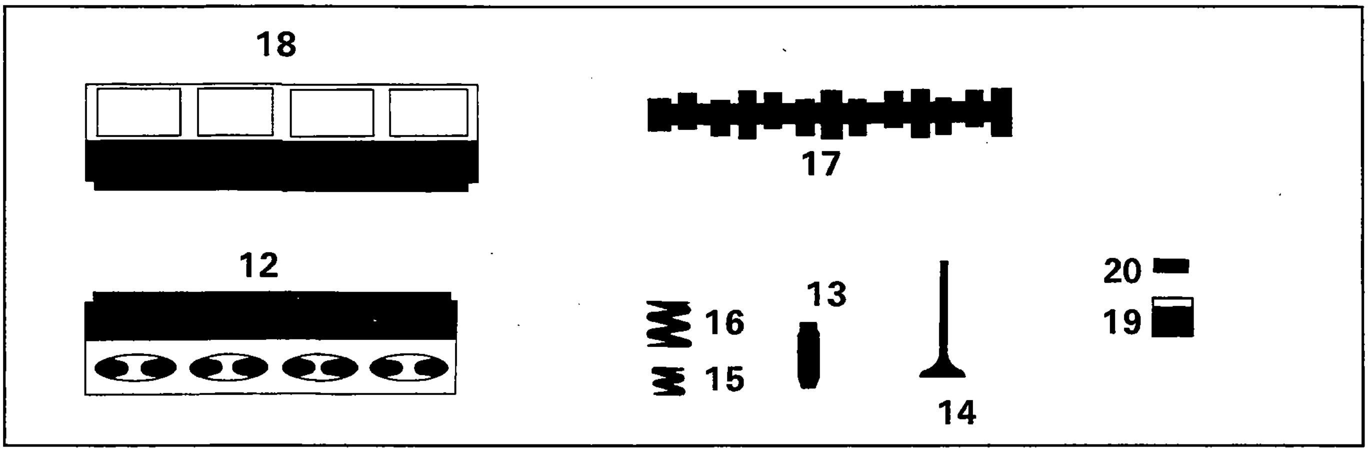
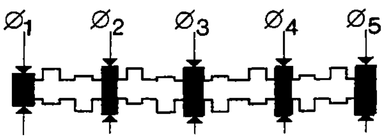
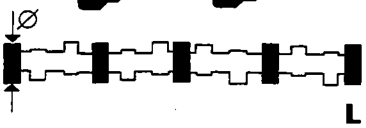
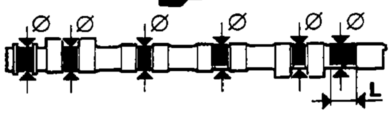
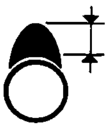
DESCRIPTION			1370 12V	1581 16V	1747 16V	1998 20V
			Values in mm			
12	Tap. housing in cyl. head	Ø	14,000÷14,027	-	33,000÷33,025	
13	Valve guide	Ø1	7,022 ÷ 7,040			
		Ø2	13,010 ÷ 13,030			
		Ø2 FIAT	0,05 - 0,10 - 0,25			
13-12	Valve guide Bore in cylinder head		0,033 ÷ 0,080			
14	Valve	$Ø_1$	6,982÷7,000		6,975÷6,990	
		$Ø_2$	30,200÷34,500		33,400÷37,700	29,900÷30,200
		α	45°30′ ± 5′			
		$Ø_1$	6,982÷7,000	6,974÷6,992	6,960÷6,975	
		$Ø_2$	34,500÷35,700	29,750÷30,050	27,900÷28,200	25,900÷26,200
		α	45°30′ ± 5′			
14-13	Valve Valve guide		0,022÷0,058		0,032÷0,065	
			0,022÷0,058	0,030÷0,066	0,047÷0,080	
15	Internal valve spring	P1	-		9,61÷10,6 daN	11,08÷12,07daN
		H1	-		29,5	29,5
		P2	-		20,11÷22,07daN	21,58÷23,54daN
		H2	-		20	20
16	External valve spring	P_1	33,35÷37,28 daN	23,54÷25,7 daN	27,07÷29,43 daN	
		H_1	37	32	34	
		P_2	55,42÷60,53 daN	46÷49,93 daN	48,46÷52,38 daN	
		H_2	28,1	23,5	24,5	



DESCRIPTION

		1370 12V	1581 16V	1747 16V	1998 20V
		Values in mm			
Camshaft bearings 1581 16V	Ø1	-	29,944÷29,960	-	
17a 	Ø2	-	52,400÷52,415	-	
	Ø3	-	52,800÷52,815	-	
1370 12V 1747 16V	Ø4	-	53,200÷53,215	-	
17b 	Ø5	-	53,600÷53,615	-	
1998 20V	Ø	26,000÷26,015	-	26,000÷26,015	
17c 	L	19,250÷19,330	-	19,250÷19,330	
17a 17b  Cam lift	intake	8,9	8,5	7	9
	exhaust			7,5	8
12b-c 17b-c Camshaft bushes Cylinder head supports	radial	0,030÷0,070	-	0,030÷0,070	
	axial	0,100÷0,230	-	0,100 ÷ 0,230	

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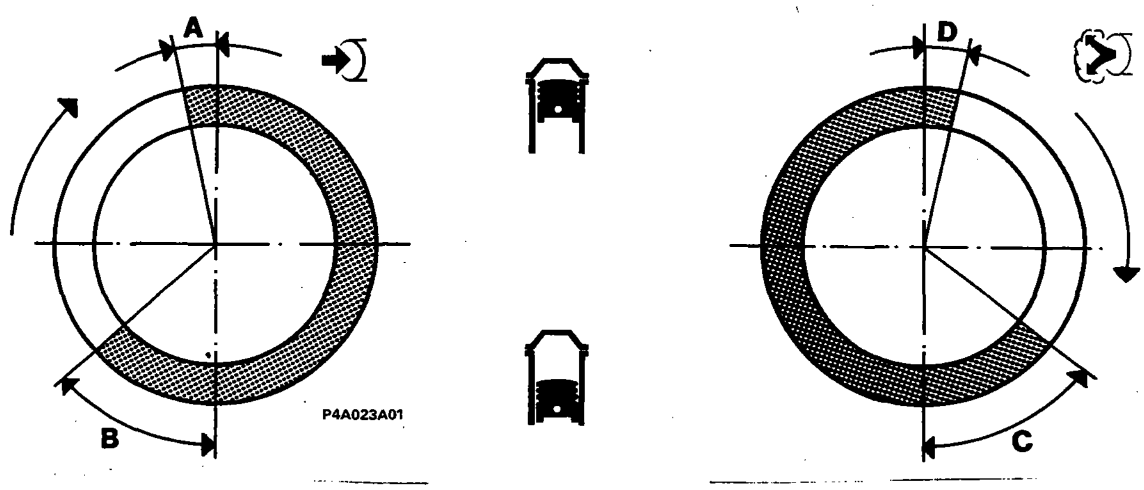
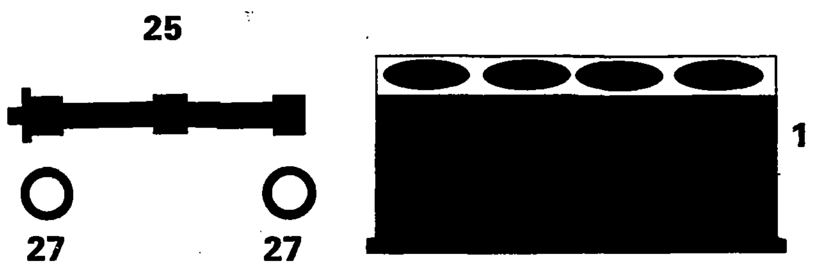
DESCRIPTION		1370 12V	1581 16V	1747 16V	1998 20V
		Values in mm			
18 Camshaft bearings in camshaft housing	Ø1	–	29,989÷30,014	–	
	Ø2	–	52,445÷52,470	–	
	Ø3	–	52,845÷52,870	–	
	Ø4	–	53,245÷53,270	–	
	Ø5	–	53,645÷53,670	–	
Tappet housings	Ø	–	30,000÷33,025	–	
17-18 Camshaft bearings Camshaft housing supports		–	0,030÷0,070	–	
19 Tappet	Ø	13,972÷13,984	32,959÷32,975		
19-12 Tappet Housing in cylinder head		0,016÷0,055	–	0,025 ÷ 0,066	
19-18 Tappet - Housing in camshaft housing		–	0,025÷0,066	–	
17-20 clearance for timing check	intake	0,45			
	exhaust	0,45			
operational clearance	intake / exhaust	Hydraulic tappets			

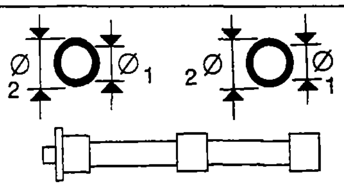
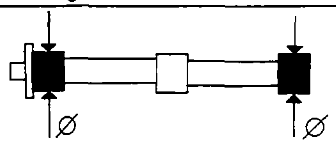
TIMING DIAGRAMS

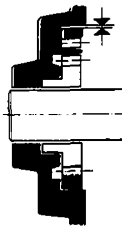
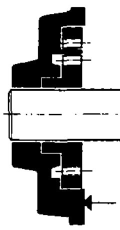
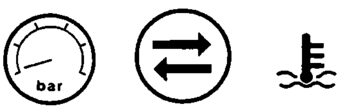
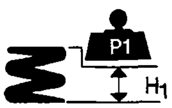


Timing angles

			1370 12V	1581 16V	1747 16V	1998 20V
A	Inlet	opens before TDC	8°	4°	0°	9° after TDC
B	Inlet	closes after BDC	25°	34°	27°	49°
C	Exhaust	opens before BDC	29°	36°	29°	27°
D	Exhaust	closes after TDC	7°	2°	2°	2°



DESCRIPTION		Values in mm
25 Counter-balance shaft operation		through oil pump driven gear
27  Ball bearings for counter-balance shaft	Ø1	19,900 ÷ 20,000
	Ø2	46,989 ÷ 47,000
25  Counter-balance shaft bearings	Ø	19,980 ÷ 19,993
1 Bear. seats in cyl. block-cr/case	Ø	46,975 ÷ 47,000
27-1 Ball bearings Cylinder block seats		+0,011 ÷ – 0,025
25-27 Shaft bushes Ball bearings		+0,020 ÷ – 0,003

	 12V	 16V
LUBRICATION - Description	Values in mm	
Engine lubrication system	forced feed via lobe gear pump with cartridge filter in series	
Oil pump	lobe gears	
Pump operated	through crankshaft	
Oil pressure relief valve	incorporated in crankshaft front cover	
 between pump casing housing and driven gear	0,080 ÷ 0,186	
 between the upper side of the gears and the pump cover	0,025 ÷ 0,061	0,025 ÷ 0,070
Full flow filter	cartridge	
Insufficient oil pressure sender unit	electrical	
 Operating pressure at a temperature of 100°C	idling 1 bar at 4000 rpm 4 bar	3,43 ÷ 4,93 bar
 Oil pressure relief valve spring P_1	6,28 ÷ 7,03 daN	
H_1	36	

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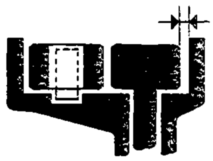
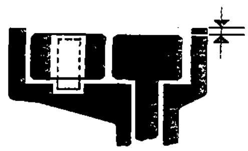
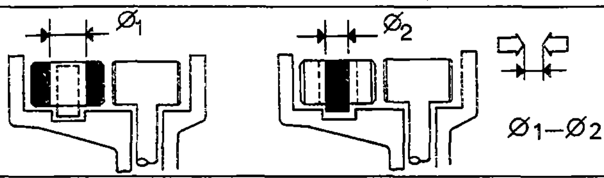
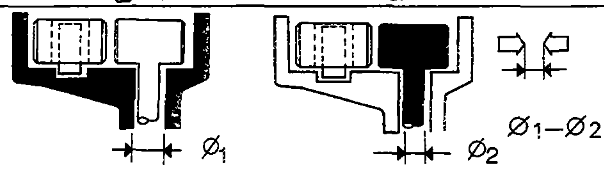
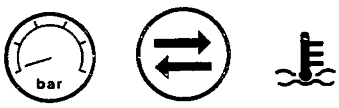
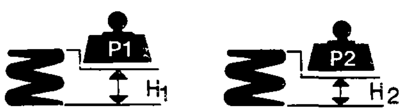
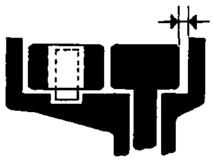
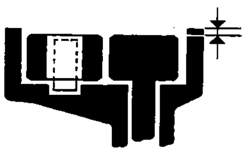
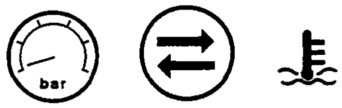
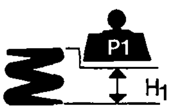
	 16V

LUBRICATION – Description

	Values in mm
Engine lubrication system	forced feed via geared pump with cartridge oil filter in seriew
Oil pump: type	gears
Pump operated	through auxiliary shaft
Oil pressure relief valve	incorporated in oil pump
Full flow filter	cartridge
Insufficient oil pressure sender unit	electrical
 between the edge of the gears and the pump cover	0,110 ÷ 0,180
 between the upper side of the gears and the pump cover	0,040 ÷ 0,106
	0,015 ÷ 0,048
	0,016÷0,048
 between the drive gear and the driven gear	0,30
 Operating pressure at a temperature of 100°C	idling > 1 bar at 4000 rpm > 3,7 bar
 P1	6,52 ÷ 6,82 daN
H1	22,5
P2	6,92 ÷ 7,21 daN
H2	21

	1998 20V
LUBRICATION	Values in mm
Engine lubrication system	forced feed, via lobe geared pump with cartridge oil filter in series
Oil pump	gears, located in the crankshaft front cover
Pump operated	through chain operated by crankshaft
Oil pressure relief valve	incorporated in crankshaft front cover
Full flow filter	cartridge
Insufficient oil pressure sender unit	electrical
 between the edge of the gears and the pump casing	0,110 ÷ 0,180
 between the upper edge of the gears and the pump cover	0,016 ÷ 0,086
 between the drive gear and the driven gear	0,30
 Operating pressure at a temperature of 100°C	idling 1 bar at 4000 rpm 4 bar
 Oil pressure relief valve spring — P1	11,73 ÷ 12,51
H1	35

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COOLING SYSTEM

		1370 12V	1581 16V	1747 16V	1998 20V
Cooling circuit		coolant circulation via centi, radiator, expansion tank and electric fan operated by thermostatic switch			
Water pump operation		through belt			
Thermal switch to engage fan (*) — engage	1st stage	90° ÷ 94°C			
	2nd stage	95° ÷ 99°C (●)			
Thermal switch to engage fan (*) — stop	1st stage	85° ÷ 89°C			
	2nd stage	90° ÷ 94°C (●)			
Engine coolant thermostat	opening	81° ÷ 85°C			
	max opening	101°÷105°C	99°÷103°C	98°÷102°C	101°÷105°C
	valve travel	9,5 mm		⩾7,5 mm	9,5 mm
Fitting clearance between impeller vanes and pump casing		-	0,3÷1,1 mm	-	-
Press. for checking rad. water tightness		0,98 bar			
Pressure for checking calibration of exhaust spring on expansion tank cap		0,98 bar			

(●) For versions with air conditioning
(*) For the 1747 16v version the electric fan is operated by the control unit

FUEL SYSTEM

	1370 12V	1581 16V	1747 16V	1998 20V
Type	Bosch Monomotronic SPI integrated electronic injection/ ignition	Weber-Marelli I.A.W MPI integrated electronic injection/ ignition	HITACHI MPI integrated electronic injection/ ignition	Bosch Motronic integrated electronic injection /ignition Motronic
Pump	Electrical, immersed in tank			
Capacity	⩾120 l/h			
Fuel pressure regulator setting	1 bar	3 bar		

CHECKING IDLE CONCENTRATION OF POLLUTANT EMISSIONS	CO (%)	HC (p.p.m.)	CO_2 (%)
Upstream of the catalytic converter	0,4 ÷ 1	⩽600	⩾12
Downstream of the catalytic converter	⩽0,35	⩽90	⩾13

INTEGRATED ELECTRONIC INJECTION/IGNITION SYSTEM COMPONENTS	1370 12V
Electronic control unit	Bosch 0.261.203.868
Butterfly casing	Bosch 0.438.201.523
TDC and rpm sensor	Bosch 0.281.002.102
Fuel vapour solenoid valve	Bosch 0.280.142.300
Detonation sensor	Bosch 0.261.231.007
Coolant temperature sensor	Bosch 0.280.130.026
Electric fuel pump	Bosch 0.580.453.514
Lambda sensor	Bosch 0.258.008.688
Fuel filter	Bosch

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COMPONENTS OF INTEGRATED ELECTRONIC INJECTION-IGNITION SYSTEM

	1581 16V
Electronic control unit	I.A.W. - IAF.13 I.A.W. - IAF.17 (*) I.A.W. - IAF.23 (●)
Absolute pressure sender unit (barometric capsule)	M.Marelli PRT 03/02
Fuel vapour control solenoid	M.Marelli/SIEMENS EC1
Throttle case	M.Marelli 54 CFA 26
Idle adjustment actuator	B02/01
Injector	M.Marelli IWP 001
Air temperature sender unit	JAEGER ATS-04/01
Fuel pressure regulator	M.Marelli RPM 40
Coolant temperature sender unit	JAEGER 401930-01
Top dead centre and rpm sensor	JAEGER CVM 01
Throttle valve position sensor (potentiometer)	M.Marelli PF 1C
Dual relay activating fuel pump and injection-ignition control unit	BITRON NDRS 240 103/00
Electric fuel pump	WALBRO MSS 071/03
Lambda probe	NTK 0ZA112-A1
Fuel filter	Bosch A.450.024.262
Timing sensor	JAEGER SFA 200
Ignition coils	COOPER BAE 92 OA

(*) For specific markets

(●) For version with automatic transmission

COMPONENTS OF INTEGRATED ELECTRONIC INJECTION-IGNITION SYSTEM

	1747 16V
Electronic control unit	HITACHI MFI-0
Air flow meter (hot wire)	HITACHI BX 106833
Injector	HITACHI GL 212264
Fuel pressure regulator	RPM 40/3 bar
Coolant temperature sensor	Bosch 0.280.130.055
Electric fuel pump	WALBRO MSS 071/01
Lambda probe	NTK 0ZA112-A2
Fuel filter	G.M. 25121074
Idle actuator	HITACHI GL 326716
Throttle valve position sensor (potentiometer)	HITACHI GL 326686
Fuel vapour control solenoid	DELCO REMY 1997199
Power module	HITACHI GE 107765
Top dead centre and rpm sensor	HITACHI GE 108101
Knock sensor	NGK KUE-03
Timing sensor	Bosch B.232.070.023
Throttle case	HITACHI GL 007582

INTEGRATED ELECTRONIC INJECTION/IGNITION SYSTEM COMPONENTS

	1998 20V
Injection/ignition system electronic control unit	Bosch 0.261.203.994
Butterfly casing	N.D.
Fuel pressure regulator	Bosch 0.280.160.515
Injector	Bosch 0.280.150.443
Idle adjustment actuator	Bosch 0.280.140.553
Electric fuel pump	Bosch 0.580.453.408
Air flow meter	Bosch 0.280.217.111
Fuel filter	Bosch A.450.024.262
Butterfly valve position sensor (potentiometer)	Bosch 0.280.122.001
Coolant temperature sensor	Bosch 0.280.130.026
Lambda sensor	Bosch 0.258.003.466
Fuel vapour solenoid valve	Bosch 0.280.142.300
Detonation sensor	Bosch 0.261.231.095
Hall effect injection timing sensor	Bosch 0.232.101.026
Intake air temperature sender unit	Bosch 0.280.130.073
TDC and rpm sensor	Bosch 0.281.002.102

CHARACTERISTICS

		1929 D	1910 TD
Cycle		DIESEL 4 stroke	
Timing		single overhead camshaft	
Type of fuel system		Indirect mechanical injection	
Number of cylinders		4	
Cylinder liner (bore)	mm	82,6	N.D.
Stroke	mm	90	N.D.
Capacity	cc	1929	N.D.
Compression ratio		21 ± 0,5	N.D.
Total volume of combustion chamber	cc	24,11	N.D.
Max power EEC	kW (CV)	48 (65)	N.D.
	rpm	4600	N.D.
Max torque EEC	daNm (kgm)	11,9 (12,1)	N.D.
	rpm	2000	N.D.

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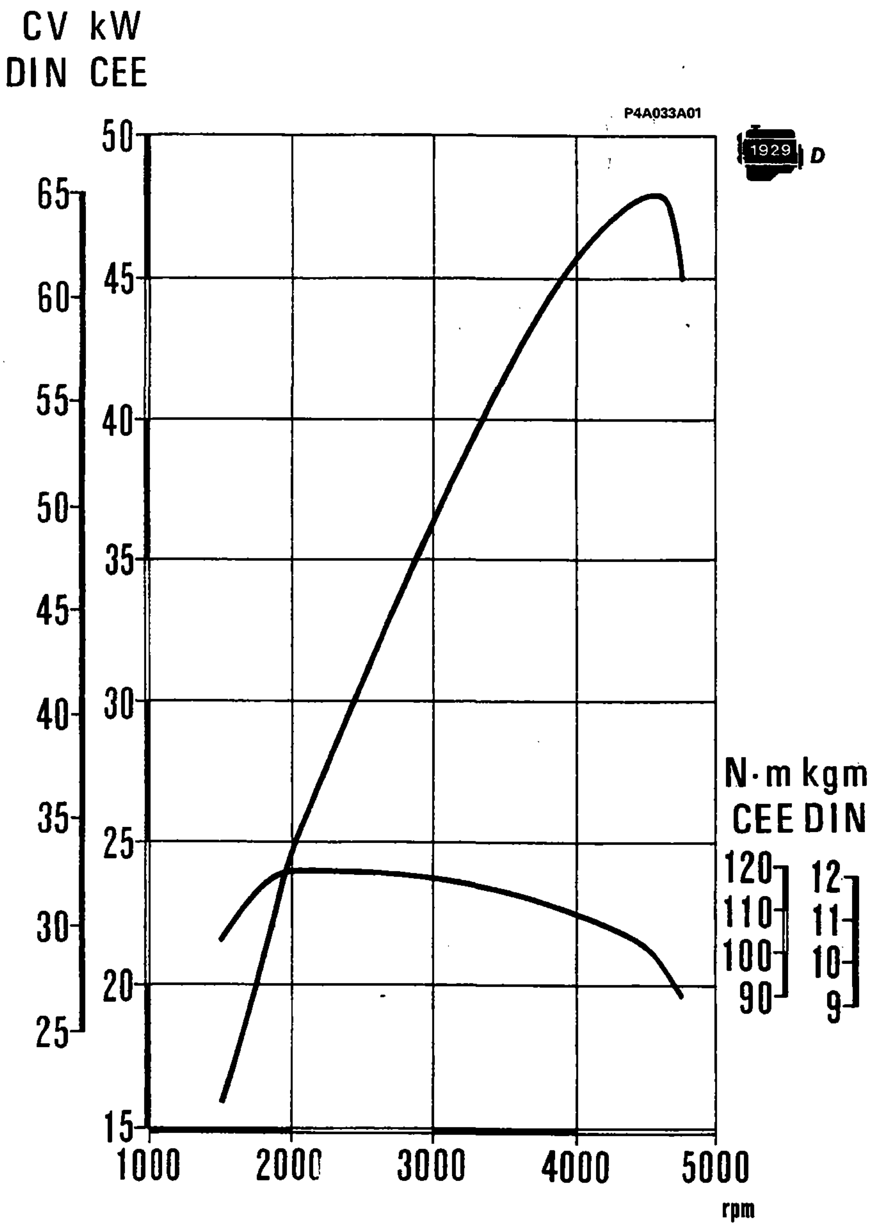


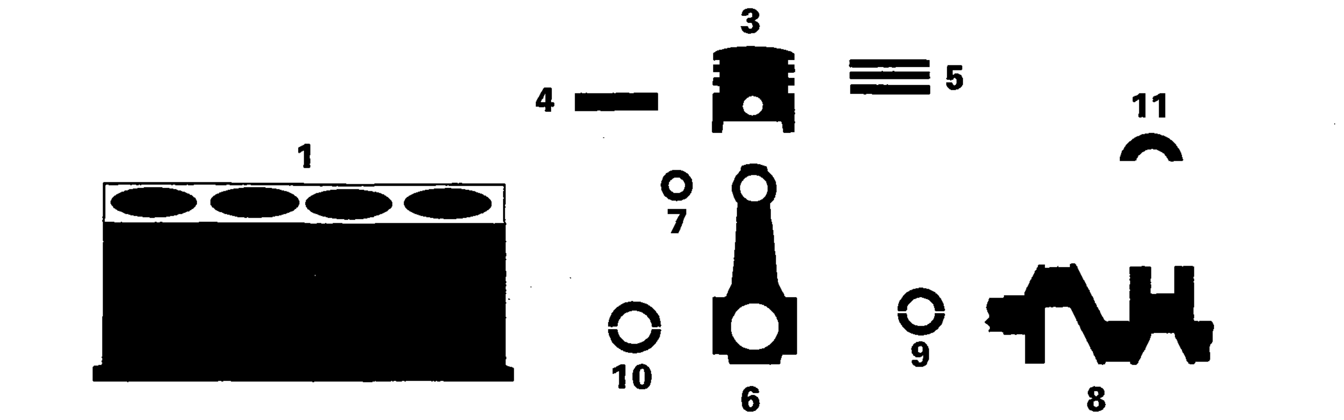
Test speed (rpm)	Time in minutes	Load on the brakes
800÷1000	10′	no load
1500	10′	no load
2000	10′	no load

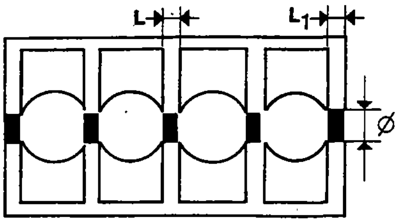
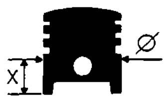
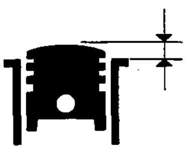
Test bench cycles of overhauled engines

During the bench test of the overhauled engine it is not advisable to run the engine at maximum speed, but to stick to the figures given in the table; complete the running in of the engine in the vehicle.

Engine power curves obtained by EEC method

The power curves illustrated can be obtained with the engine overhauled and run in, without a fan and with a silencer and air filter fitted at sea level.



			1929 D	1910 TD
DESCRIPTION			Values in mm	
1	 Main bearing supports	L	-	21,720 ÷ 21,800
		L1	23,100 ÷ 23,200	-
		Ø	56,717 ÷ 56,735	56,705 ÷ 56,718
	Cylinder bore	Ø A	82,600 ÷ 82,610	82,000 ÷ 82,010
		Ø B	82,610 ÷ 82,620	82,010 ÷ 82,020
		Ø C	82,620 ÷ 82,630	82,020 ÷ 82,030
3	 Piston	X	15	10
		Ø A	82,520 ÷ 82,555	81,930 ÷ 81,940
		Ø C	82,530 ÷ 82,540	81,940 ÷ 81,950
		Ø E	82,540 ÷ 82,550	81,950 ÷ 81,960
		Ø FIAT >	0,4	
3-1	 Piston projection		0,367 ÷ 0,832	-
3	Diff. in weight between pistons		± 5 g	
3-1	Piston Cylinder bore		0,070 ÷ 0,090	0,060 ÷ 0,080

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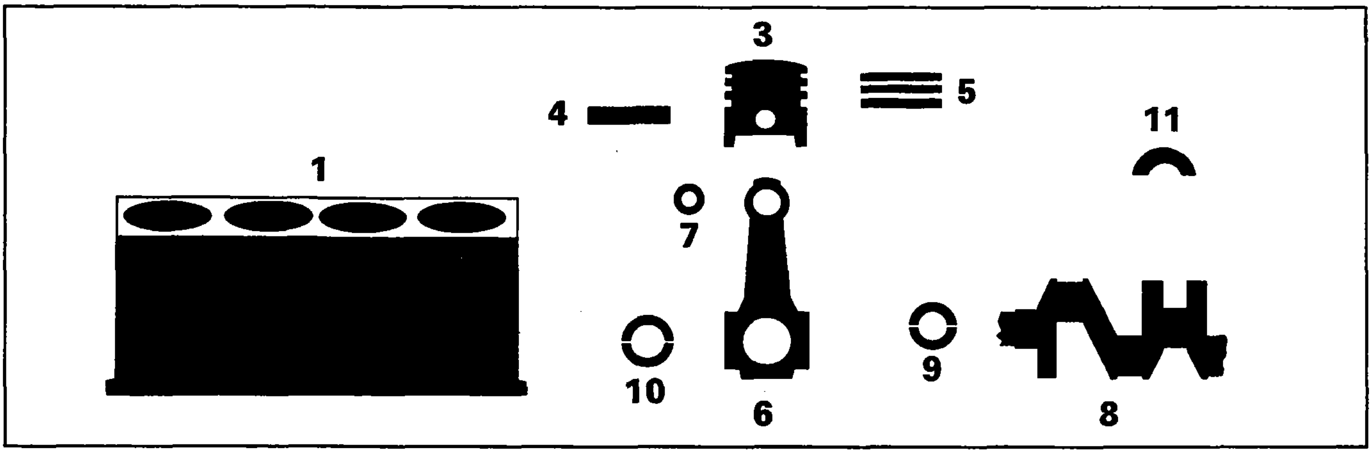
DESCRIPTION

			1929 D	1910 TD
			Values in mm	
3	Gudgeon pin housing	Ø	24,994 ÷ 24,999	25,991 ÷ 25,996
3	Piston ring grooves	1	2,175 ÷ 2,205	2,675 ÷ 2,705 (*)
		2	2,010 ÷ 2,030	
		3	3,020 ÷ 3,040	
4	Gudgeon pin	Ø	24,987 ÷ 24,991	25,982 ÷ 25,987
		Ø FIAT >	0,2	
4-3	Gudgeon pin - Housing		0,003 ÷ 0,012	0,004 ÷ 0,014
5	Piston rings	L 1	2,075 ÷ 2,095	2,575 ÷ 2,595 (**)
		L 2	1,978 ÷ 1,990	1,970 ÷ 1,990
		L 3	2,975 ÷ 2,990	2,975 ÷ 3,010
		Ø FIAT >	0,4	
5-3	Piston rings Piston ring grooves	1	0,080 ÷ 0,130 (**)	
		2	0,020 ÷ 0,052	0,020 ÷ 0,060
		3	0,030 ÷ 0,065	0,010 ÷ 0,065
5-1	Opening at end of piston rings in cylinder bore	1	0,300÷ 0,500	0,200÷ 0,400
		2	0,300 ÷ 0,500	0,250 ÷ 0,500
		3	0,250 ÷ 0,500	0,250 ÷ 0,500

(*) Measured at the 79.6 mm diameter (**) Measured 1.5 mm from outside edge



	DESCRIPTION		1929 D	1910 TD
			Values in mm	
6	Small end bush or pin housing	Ø1	26,939÷26,972	28,939÷28,972
6	Big end bearing housing	Ø2	53,897 ÷ 53,913	53,897 ÷ 53,909
6	Difference in weight between con rods		± 2,5 g	
7	Small end bush	Ø1	27,020 ÷ 27,060	29,018 ÷ 29,038
7	Small end bush	Ø2	25,004 ÷ 25,009	26,006 ÷ 26,012
4-7	Gudgeon pin Small end bush		0,013 ÷ 0,022	0,019 ÷ 0,030
7-6	Small end bush Bush housing		0,048 ÷ 0,121	0,046 ÷ 0,099
8	Main journals	Ø1 1	52,995 ÷ 53,004	52,994 ÷ 53,000
8	Main journals	Ø1 2	52,986 ÷ 52,995	52,988 ÷ 52,994
8	Main journals	Ø1 3	-	52,982 ÷ 52,988
8	Crank pins	Ø2 A	50,796 ÷ 50,805	50,799 ÷ 50,805
8	Crank pins	Ø2 B	50,787 ÷ 50,796	50,793 ÷ 50,799
8	Crank pins	Ø2 C	-	50,787 ÷ 50,793
8		L	27,975 ÷ 28,025	-
8		L1	-	26,575 ÷ 26,625

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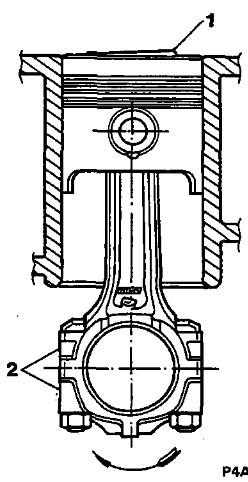
			1929 D	1910 TD
DESCRIPTION			Values in mm	
9	Crankshaft bearings	L 1	1,839 ÷ 1,843	1,836 ÷ 1,840
		L 2	1,843 ÷ 1,847	1,839 ÷ 1,843
		L 3	-	1,842 ÷ 1,846
		Ø FIAT <	0,254 - 0,508	
9–8	Crankshaft bearings - Main journals		0,027 ÷ 0,062	0,025 ÷ 0,052
10	Big end bearings	L A	1,528 ÷ 1,532	1,527 ÷ 1,531
		L B	1,533 ÷ 1,537	1,530 ÷ 1,534
		L C	-	1,533 ÷ 1,537
		Ø FIAT <	0,254 - 0,508	
10–8	Big end bearings - Main journals		0,028 ÷ 0,061	0,030 ÷ 0,056
11	Thrust washers	S	2,310 ÷ 2,360	2,342 ÷ 2,358
		S FIAT >	0,127	
11–8	Crankshaft end float		0,055 ÷ 0,305	0,059 ÷ 0,179

Diagram showing fitting of connecting rod-piston assembly and direction of rotation in engine

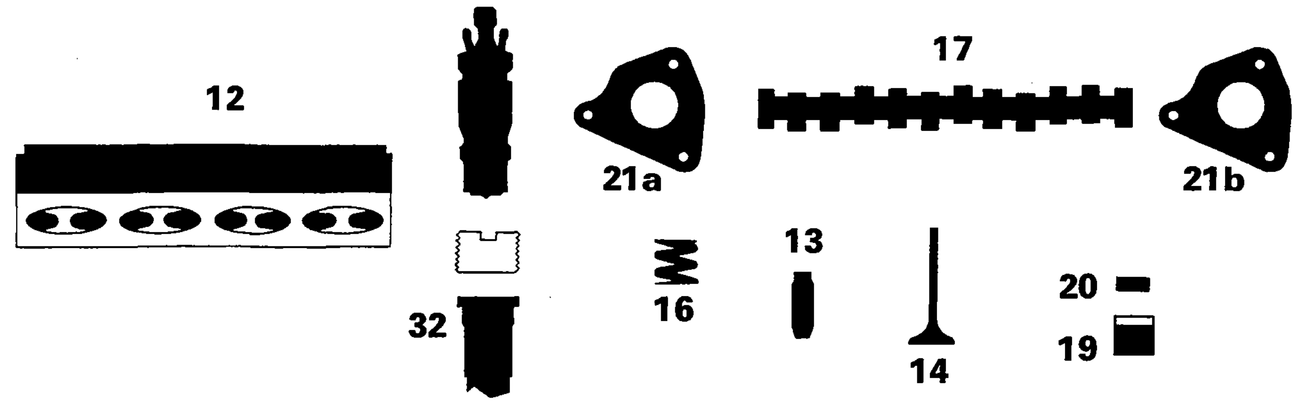
1929 D

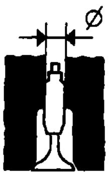
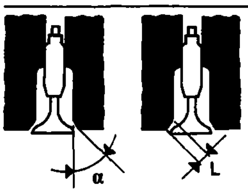
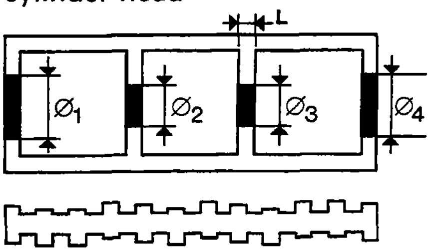
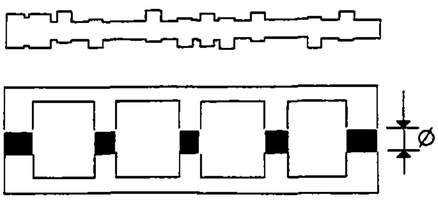
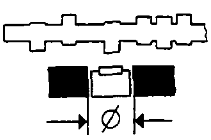


P4A037A01

1. Projection on piston crown
2. Area where matching number of cylinder bore to which connecting rod belongs is stamped

The arrow shows the direction of rotation of the engine as seen from the timing side



DESCRIPTION		1929 D	1910 TD
		Values in mm	
 Valve guide bore in cylinder head	∅	13,950 ÷ 13,977	
 Valve seats	α (intake)	45° ± 5'	
	α (exhaust)	45° ± 5'	
	L	about 2.7	
12 Camshaft bearing housings in cylinder head 	$\varnothing_1$	43,020 ÷ 43,040	-
	$\varnothing_2$	25,545 ÷ 25,570	-
	$\varnothing_3$	24,045 ÷ 24,070	-
	$\varnothing_4$	43,020 ÷ 43,040	-
	L*	18,950 ÷ 19,030	-
 L Camshaft supports	∅	-	26,045 ÷ 26,070
	L*	-	19,100 ÷ 19,150
 Tap. housing	∅	37,000 ÷ 37,025	

(*) Measurement of cap

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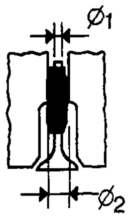
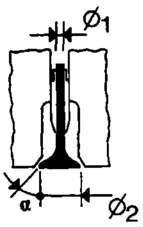
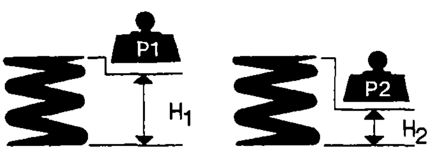
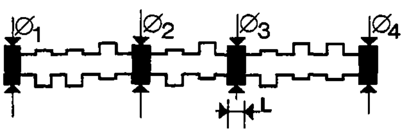
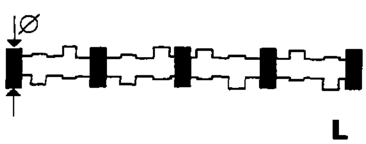
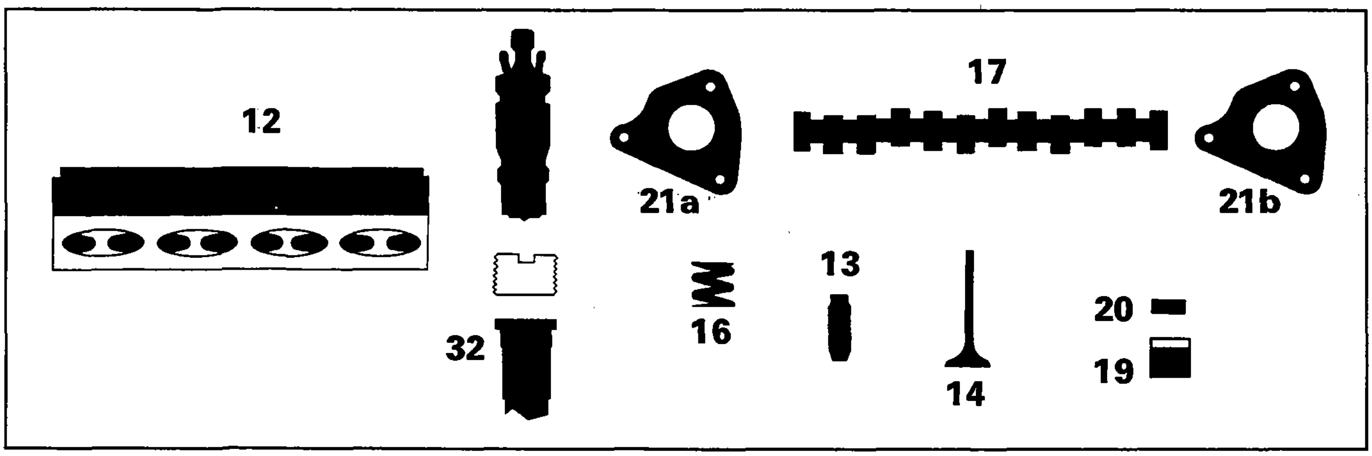
DESCRIPTION		1929 D	1910 TD
		Values in mm	
13  Valve guide	Ø1	8,022 ÷ 8,040	
	Ø2	14,040 ÷ 14,058	14,010 ÷ 14,030
	Ø2 FIAT >	0,05 - 0,10 - 0,25	
13-12 Valve guide Bore in cylinder head		0,061 ÷ 0,108	0,033 ÷ 0,080
14  Valve	Ø1	7,974 ÷ 7,992	
	Ø2	37,300 ÷ 37,600	
	α	45°30′ ± 7′	
	Ø1	7,974 ÷ 7,992	
	Ø2	33,300 ÷ 33,600	30,900 ÷ 31,200
	α	45°30′ ± 7′	
14-13 Valve - Valve guide		0,030 ÷ 0,066	
16  Valve spring	P_1	36,69 ÷ 39,63 daN	
	H_1	36	
	P_2	55,91 ÷ 60,82 daN	
	H_2	26,5	
17  Camshaft bearings	Ø1	29,945 ÷ 29,960	-
	Ø2	25,500 ÷ 25,515	-
	Ø3	24,000 ÷ 24,015	-
	Ø4	23,945 ÷ 23,960	-
	L	19,100 ÷ 19,200	-
	Ø	-	26,000 ÷ 26,015
	L	-	19,250 ÷ 19,330



DESCRIPTION

		1929 D	1910 TD
		Values in mm	
17-12	radial	0,030 ÷ 0,070	
	axial	0,070 ÷ 0,250	0,100 ÷ 0,230
17	Cam lift	9,7	8,5
		9,7	8,5
19	Tappet Ø	36,975 ÷ 36,995	
19-12	Tappet - Cylinder head	0,005 ÷ 0,050	
20	Shim S (0,05)	3,25 ÷ 4,70	
17-20	clearance for timing check	0,50	
		0,50	
	operational clearance	0,30 ± 0,05	
		0,35 ± 0,05	

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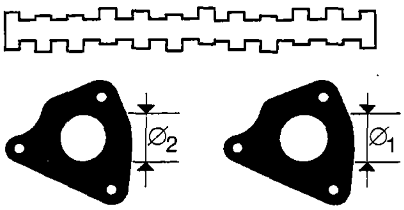
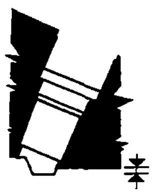
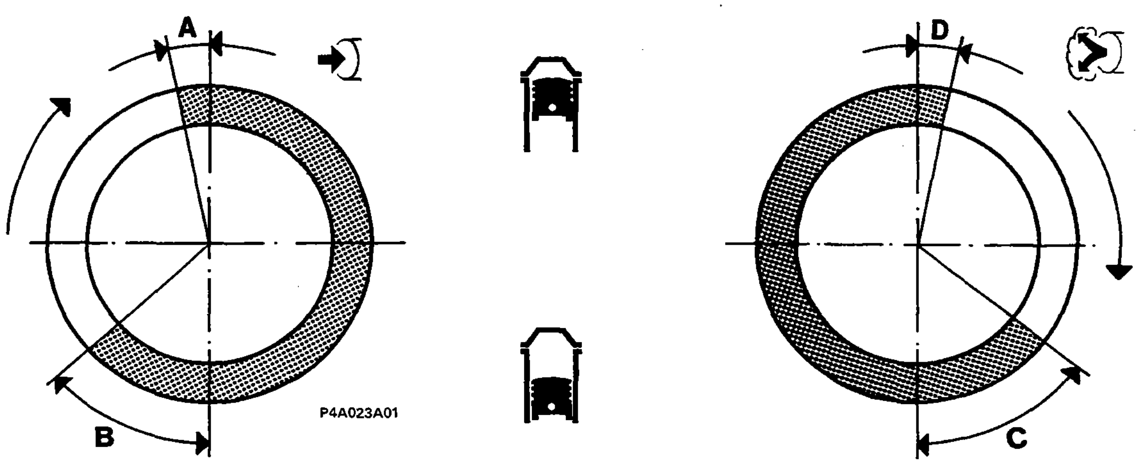
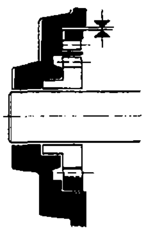
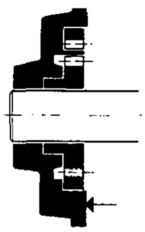
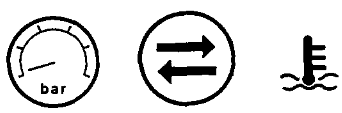
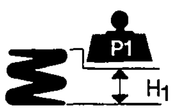
DESCRIPTION	1929 D	1910 TD
	Values in mm	
21a-21b Camshaft supports  Ø1	23,990 ÷ 24,015	-
Ø2	29,990 ÷ 30,015	-
17-21a **17-21b** Camshaft Supports	0,030 ÷ 0,070	-
32-12  Variation between ante-chamber plane and cylinder head plane	- 0,765 ÷ 0,055	- 0,150 ÷ -0,3

TIMING DIAGRAMS



Timing angles

A	Inlet	opens before TDC	10°	N.D.
B		closes after BDC	42°	N.D.
C	Exhaust	opens before BDC	50°	N.D.
D		closes after TDC	2°	N.D.

	1929 D	1910 TD
LUBRICATION	Values in mm	
Engine lubrication system	forced circulation via lobe gear pump with cartridge filter in series	
Oil pump	lobe gears	
Pump operated	through crankshaft	
Oil pressure relief valve	incorporated in crankshaft front cover	
 between pump casing housing and driven gear	0,080÷0,186	
 between the upper side of the gears and the pump cover	0,025÷0,056	
Full flow filter	cartridge	
Insufficient oil pressure sender unit	electrical	
 Operating pressure at a temperature of 100°C	3,43÷4,9 bar	
 Oil pressure relief valve spring P_1	6,27÷7,06 daN	
H_1	36	

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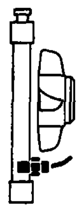
COOLING SYSTEM

		1929 D	1910 TD
Cooling circuit		coolant circulation via centrifugal pump, radiator and two speed electrical fan operated by two speed thermostatic switch	
Water pump operation		through belt	
Thermal switch to engage fan		1st speed	2nd speed
	⇄	86°÷90°C	90°÷94°C
	stop	81°÷85°C	85°÷89°C
Engine coolant thermostat	opening	78°÷82°C	
	max opening	86°÷90°C	
	valve travel	⩾7,5 mm	
Fitting clearance between impeller vanes and pump casing		0,53÷1,37 mm	
Press. for checking rad. water tightness		0,78 bar	
Pressure for checking calibration of exhaust valve on expansion tank cap		0,78 bar	



FUEL SYSTEM

Firing order		1 - 3 - 4 - 2	
Rotary type injection pump	LUCAS	FT 05	N.D.
Injector	LUCAS	LCR 6734 202D or LRC 6734 202D	N.D.
Nozzle holder type	LUCAS	LCR 67342 or LRC 67342	N.D.
Nozzle type	LUCAS	RDN OSDC 6888D or BDN OSDC 6888D	N.D.
Injector setting pressure		124÷131 bar (new) 116÷123 bar (run in)	N.D.
Injection pump operation: with cylinder no. 1 piston at TDC (compression stroke)		0°±1° at TDC	N.D.
Engine idle speed		780÷820 rpm	N.D.
Maximum free running engine speed		5100÷5200 rpm	N.D.

DATA FOR CHEKCING LUCAS FT05 INJECTION PUMP FOR 1929 TD ENGINE

GENERAL TEST CONDITIONS
- Test oil: ISO 4113 (SHELL S-9365)
- Temperature of test oil: 40° ± 2°C
- Injectors ISO 40 10
- Injector setting 125÷128 bar

N.B. If when measuring the advance the instrument is used with the reading directly in (°) then it is necessary to divide the values in the table by 0.75
- Supply pressure: 0.1 bar
- Direction of rot.: clockwise (seen from cntrl side)
- Injection piping: 2×6×600mm

- Max engine speed no load 5150±50 rpm
- Engine idle speed 800±20 rpm
- Correction: 0±1° with cyl. n° 1 at TDC

Type of check or adjustment	Op. No.	Adjustment lever pos.	Rotation speed rpm	Supply voltage V	Advance check mm	Transfer pressure bar	Av. capacity per cyl. mm³/cycle	Max. disc. btwn 4 flow rates mm³/cycle	Operations or checks to be carried out
Before starting the tests, remove the cold starting rod and move the valve lever parallel to the pump axis towards the hydraulic head									
Filling and bleeding	1	Max	100÷1250	12	-	-	-	-	Check that the supply to the injectors is regular, recovery without air
Pre-adjust. transfer pressure	2	Max	1250	12	-	4,75±0,2	-	-	
Stop the bench for at least 10 secs and until the internal pressure goes down to < 0,1bar									
Advance instrument calibration	3	Min	0	12	- 2,6	-	-	-	Adjust the instrument to this value
Enrichment exclusion pre-adjust.	4	Min	125	12	0±0,5	-	-	-	Measure the reflux flow rate which should be 3-12 l/h if > enrichment off
Zeroing advance instrument	5	Max	270	12	0	-	-	-	Zero the advance check instrument
Checking metering valve closure	6	Min	400	12	-	-	≤ 5,0	-	
Stop of supply	7	Min	400	0	-	-	≤ 2,0	-	Remove the electrostop supply
Stop the bench for at least 10 secs and until the internal pressure goes down to ≤ 0,1bar									
Transfer pump inlet	8	Min	100	12	-	- 0,5	-	-	Inlet pipe closed, in less than 60 secs
Transfer pump pressure	9	Min	70	12	-	≥ 0,35	-	-	
Calib. of ad. & trans. press.	10	Max	1750	12	3,8	5,3÷6,5	-	-	
No load advance check	11	Min	1750	12	4,1÷5,6	-	-	-	
Full load advance check	12	Max	2200	12	4,8÷6,2	-	-	-	
Checking casing pressure	13	Min	2000	12	-	-	-	-	The pressure of the casing should be 0.6-0.9 bar
Checking recirc. flow rate	14	Min	2000	12	-	-	-	-	The recirc. capacity should be 21.6-42 l/h
Max capacity cal.	15	Max	1750	12	-	-	35,0±1	≤ 3,0	

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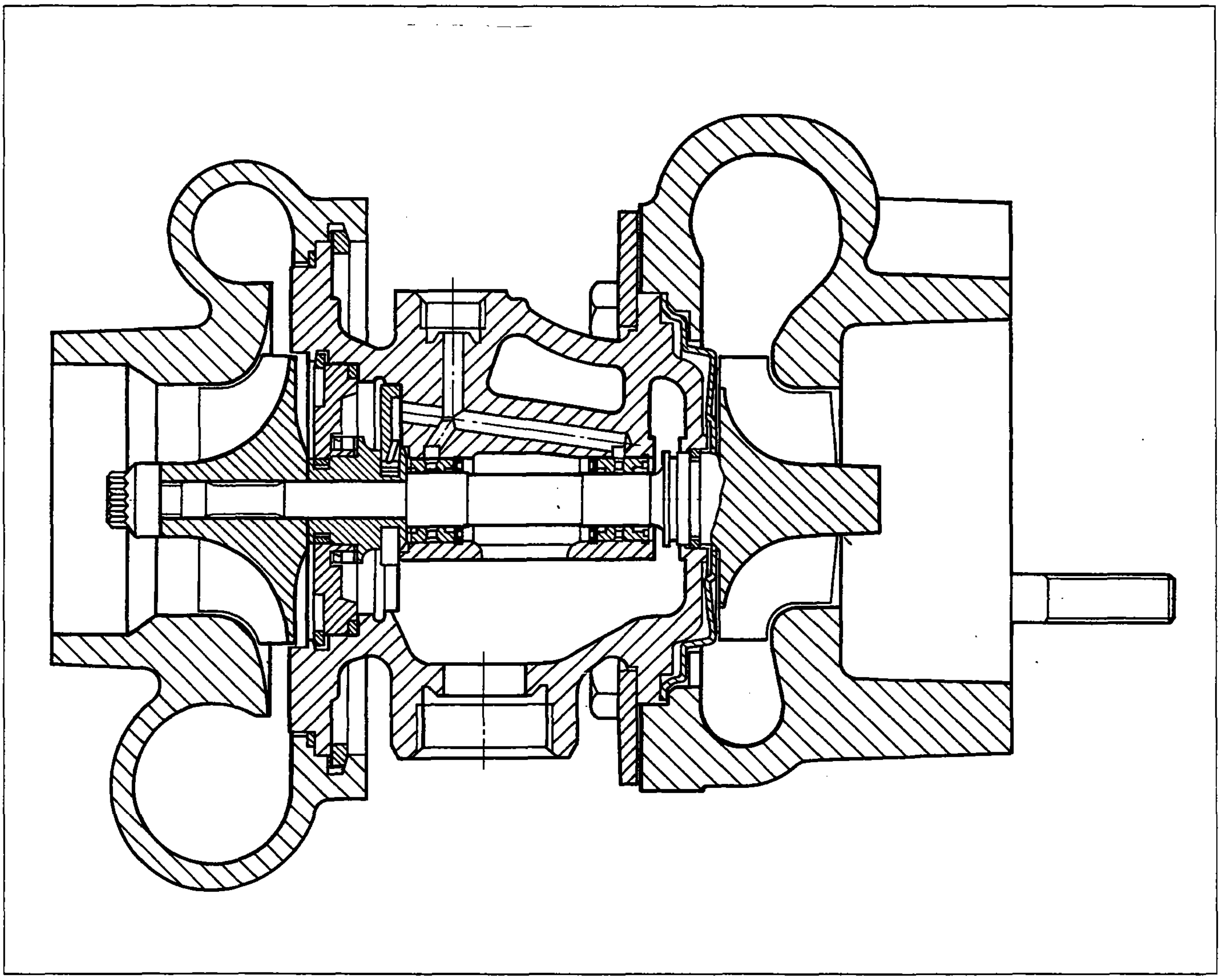
Type of check or adjustment	Op. No.	Adjust. lever position	Rotation speed rpm	Supply voltage V	Advance check mm	Transfer pressure bar	Av. capacity per cyl. mm³/cycle	Max. disc. btwn 4 flow rates mm³/cycle	Operations or checks to be carried out
Anti-stall setting	16	Min	400	12			7 ÷ 9		MIN lever in stop position place a 1.2 mm shim between the max lever/stop
Idle setting	17	Min	400	12			8 ÷ 10	⩽3,0	*Remove the anti-stop shim (1.2 mm)*
Regulator check	18	Max	2250	12					Make a note of the capacity
Reg. start of int. setting	19	Max	2400	12			23,0 ÷ 25,0		
Max no load check	20	Max	2800	12			⩽10		No supply above 11 mm³/cycle
Full load advance check	21	Max	2800	12	5,6 ÷ 6,2				
Regulator check	22	Max	2250	12					Check that the capacity is ⩾ that measured at point 18
Stop the bench for at least 10 secs and until the internal pressure has gone down to 0 bar									
Delay during starting check	23	Max	0	12	-1,9 ÷ 2,6				
Enrichment capacity	24	Max	100	12			32,0 ÷ 48,0		
End of enrichment	25	Max	110 ÷ 270	12	0 ÷ 0,4				Accelerator lever released
Max. capacity check	26	Max	270	12			⩽35,0		
Max. capacity check	27	Max	1350	12			31,0 ÷ 35,0		
Full load advance check	28	Max	1350	12	0,6 ÷ 1,8				
Max. capacity check	29	Max	2200	12			35,5 ÷ 39,5		
Check and/or adjust the length of the cold advance control rod at 65 mm and reconnect it to the valve lever									
Advance when cold check	30	Min	400	12	1,3 ÷ 1,7				Insert a 4 mm shim between the Min lever and stop
Advance when cold check	31	Min	400	12	0 ÷ 0,1				Insert a 2 mm shim between the Min lever and stop
Determine "V" outlet internal stage	32	Apply a pressure of 80 bar simultaneously to the 4 high pressure outlets and 2 bar (compressed air) to the diesel inlet union. Fit the special instrument and rotate the pump shaft with a torque of 0.16 N/m until a hardening is obtained, then measure the distance on the dial gauge							
Determine engine timing	33	Add 4 mm to the figure measured (point 32) and note the resulting value on the introduction adjustment access hole sealing cap. This value should be set for the engine when cylinder no. 1 is at TDC							

SUPERCHARGING Turbocharger operated by exhaust gases with waste gate valve and air/air heat exchanger (intercooler)

	1910 TD
Turbocharger type	Garrett
Maximum supercharging pressure	N.D.



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CROSS SECTION OF TURBOCHARGER

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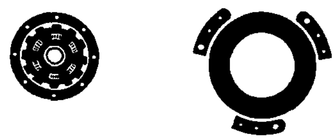
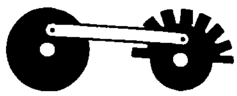
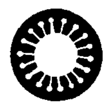
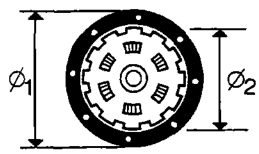
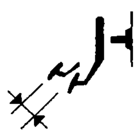
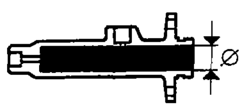
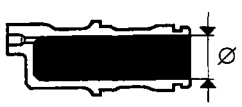
	1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
	Values in mm					
Type	 dry, single plate with bearing					
 Operating mechanism	 diaphragm spring					
Spring loading daN	400	450	500	525	420	485
 Lining $\varnothing_1$	190	200	215	230	200	215
Lining $\varnothing_2$	130	137	145	155	137	145
 Distance between pedal in end of travel position and rest position	155±10	170±10				
Clutch release	mechanical			hydraulic	mechanical	
 Clutch pump operation ∅	–			19,05 (3/4")	–	
 Operating cylinder ∅	–			25,4 (1")	–	

GEARBOX

<table>
<tr><td></td><td>1370 12V</td><td>1581 16V</td><td>1747 16V</td><td>1998 20V</td></tr>
<tr><td></td><td colspan="4">1 3 5 / 2 4 R</td></tr>
<tr><td>Type</td><td>C.514.5.13</td><td>C.513.5.13</td><td>C.510.5.17</td><td>C.510.5.21</td></tr>
<tr><td>Synchronizers – spring ring (Porsche type)</td><td colspan="4">–</td></tr>
<tr><td>Synchronizers – baulk ring type</td><td colspan="4">1 3 5 / 2 4</td></tr>
<tr><td>Gears – straight toothed</td><td colspan="4">R</td></tr>
<tr><td>Gears – helical toothed</td><td colspan="4">1 3 5 / 2 4</td></tr>
<tr><td>Gear ratios – 1</td><td colspan="3">3,909</td><td>3,545</td></tr>
<tr><td>Gear ratios – 2</td><td>2,158</td><td colspan="3">2,238</td></tr>
<tr><td>Gear ratios – 3</td><td>1,480</td><td colspan="3">1,520</td></tr>
<tr><td>Gear ratios – 4</td><td>1,121</td><td colspan="3">1,156</td></tr>
<tr><td>Gear ratios – 5</td><td>0,902</td><td colspan="2">0,971</td><td>0,946</td></tr>
<tr><td>Gear ratios – R</td><td>3,818</td><td colspan="3">3,909</td></tr>
</table>

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DIFFERENTIAL

		1370 12V	1581 16V	1747 16V	1998 20V
Ratio crown wheel & pinion reduc.		3,886 (15/58)	3,353 (17/57)	3,353(3,053●) (17/57) (19/58●)	3,562 (16/57)
Ratio at the wheels	1	15,112	13,107	13,107 (11,934●)	12,627
	2	8,343	7,504	7,504 (6,833●)	7,971
	3	5,722	5,096	5,096 (4,640●)	5,414
	4	4,334	3,876	3,876 (3,529●)	4,118
	5	3,487	3,256	3,256 (2,964●)	3,476
	R	14,760	13,107	13,107 (11,934●)	13,924
Differential internal casing bearing		conical roller bearings			
Adjustment of bearing pre-loading		by shims			
Thickness of shims FIAT mm	0,05	-	1,70÷2,60		
	0,10	2,00 ÷ 3,00	-		
Interference to obtain exact bearing pre-loading	mm	bearings not pre-loaded = 0,12 bearings pre-loaded (350 daN) = 0,08			
Clrnce btwn planet and satellite gears	mm	≤0,10			
Adjust. of clrnce btwn planet/satellite gears		do not carry out any adjustment	by shims	do not carry out any adjustment	
Thickness of shims FIAT (0,05)	mm		0,80 ÷ 1,25	-	

● French versions

		1929 D	1910 TD
		1 3 5 2 4 R	
	Type	**C.513.5.13**	**C.510.5.17**

GEARBOX

Synchronizers	spring ring (Porsche type)	–	
	baulk ring type	1 3 5 2 4	
Gears	straight toothed	R	
	helical toothed	1 3 5 2 4	
Gear ratios	1	3,909	N.D.
	2	2,238	N.D.
	3	1,444	N.D.
	4	1,029	N.D.
	5	0,816	N.D.
	R	3,909	N.D.

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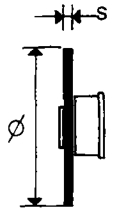
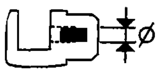
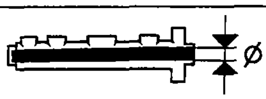
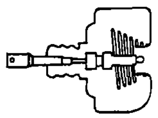
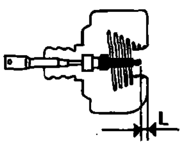
DIFFERENTIAL

		1929 D	1910 TD
Ratio crown wheel & pinion reduction		16/57 (3,562)	ND
Ratio at the wheels	1	13,923	ND
	2	7,972	ND
	3	5,143	ND
	4	3,665	ND
	5	2,906	ND
	R	13,923	ND
Differential internal casing bearing		conical roller bearings	
Adjustment of bearing pre-loading		by shims	
Thickness of shims	mm 0,05	1,70÷2,60	-
	mm 0,07	-	1,70÷2,89
Interference to obtain exact bearing pre-loading	mm	Bearings not pre-loaded = 0,12 bearings pre-loaded (350 daN) = 0,08	
Clearance btwn planet/satellite gears	mm	⩽ 0,10	
Adjustment of clrnce btwn planet/sat. gears		by shims	no adjustment is carried out
Thickness of shims	(0,05) mm	0,80÷1,25	-

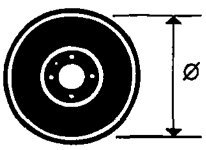
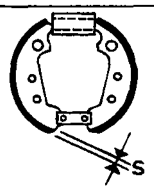
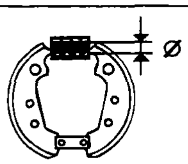
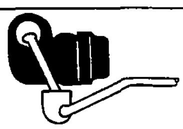
				1370 12V 1929 D	1581 16V 1910 TD 75	1747 16V 1581 16V (●) 1910 TD 100

FRONT BRAKES

				Values in mm		
	Discor		∅	257		
		s		11,80 ÷ 12,10		19,80 ÷ 20,10
				11,10		18,55
			< allowed	10,20		18,20
	Brake pads	s	< allowed	1,5		
	Caliper		∅	54		
	Master cylinder (pump)		∅	22,225 (7/8")		
	Brake servo			Iso-Vac 8" pneumatic vacuum servo acting on all four wheels		
	Distance of hydraulic piston push rod from master cylinder support plate		L	22,45 ÷ 22,65		

(●) With automatic transmission

REAR BRAKES

	Drum	∅		180,00÷180,25	203,10÷203,40	
				180,95	204,10	
			> allowed	181,35	204,70	
	Shoes	s	< allowed	1,5		
	Wheel cylinders		∅	22,00		
	Load proportioning valve			acting on rear wheels		
	Ratio (reduction)			0,36		

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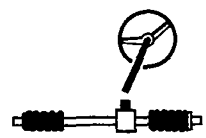
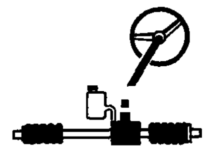
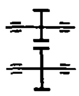
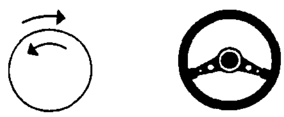
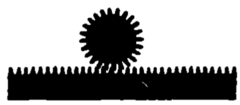
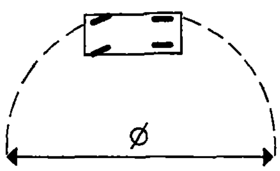
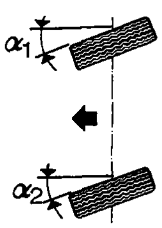
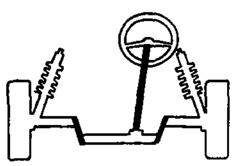
1998 20V

FRONT BRAKES

		Values in mm
Disc	∅	283,800±284,200
Disc	s	21,900÷22,100
Disc	s	20,55
Disc	s < allowed	20,20
Brake pads	s < allowed	1,5
Caliper	∅	54
Master cylinder (pump)	∅	23,81 (15/16")
Servo brake		ISO-VAC 8"+7" pneumatic vacuum servo acting on all four wheels
Distance of hydraulic piston push rod from master cylinder support plate	L	22,45 ÷ 22,65

REAR BRAKES

		Values in mm
Disc	∅	240
Disc	s	10,80 ÷ 11,10
Disc	s	10,10
Disc	s < allowed	9,20
Brake pads	s < allowed	1,5
Caliper	∅	34
Load proportioning valve		acting on rear wheels
Ratio (reduction)		0,36

ENGINE TYPE	1370 12V	1370* 12V, 1581 16V, 1747 16V, 1998 20V, 1929 D, 1910 TD
Type	 rack and pinion	 rack and pinion power assisted
 Ratio –  no. of turns lock to lock	3,5	3
Ratio –  rack travel	142 ±0,8 mm	142 ±1,5 mm
 Turning circle	10,4 m	
 Steering angle – outer wheel α_1	31° ± 30′	31° 30′ ± 30′
Steering angle – inner wheel α_2	37° 20′ ± 30′	38° 15′ ± 30′
 Steering col.	 with 2 universal joints	

(*) Hydraulic power steering available on request

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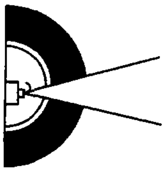
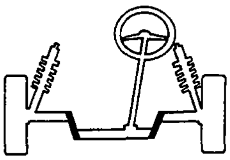
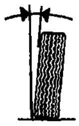
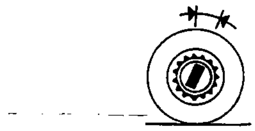
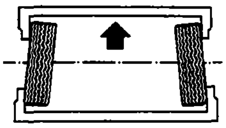
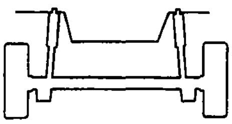
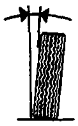
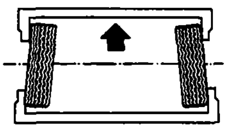
ENGINE TYPE		Wheel rim type	Radial, tubeless type tyre	Tyre inflation pressure in bar			
				Front		Rear	
				average load	heavy load	average load	heavy load
1370 12V		5½J×14"- 32 5½J×14"- 37	165/65 R14 78T (●) 175/65 R14 82T	2,2	2,3	2,2	2,5
1581 16V	**Brava**	5½J×14"- 37 6J×14"- 43 5½J×14"- 37	175/65 R14 82T 185/60 R14 82H 185/60 R14 82H	2,2	2,3	2,2	2,5
1581 16V	**Bravo**	6J×14"- 43	185/60 R14 82H	2,2	2,3	2,2	2,5
1747 16V	**Brava**	5½J×14"- 37 6J×14"- 43	175/65 R14 82H 185/60 R14 82H	2,2	2,3	2,2	2,5
1747 16V	**Bravo**	6J×14"- 43 6J×15"- 40 6J×15"- 40	185/60 R14 82H 185/55 R15 81V(■) 195/50 R15 82V (■)				
1998 20V	**Bravo**	6J×15"- 49 6J×15"- 49	195/55 R15 84V 205/50 ZR15 (■)	2,5	2,7	2,2	2,4
1929 D		5½J×14"- 37	175/65 R14 82T	2,3	2,3	2,2	2,5
1910 TD	**Brava**	5½J×14"- 37 5½J×14"- 37 6J×14"-43	175/65 R14 82T 185/60 R14 82H 185/60 R14 82H	2,3	2,3	2,2	2,5
1910 TD	**Bravo**	5½J×14"-37 6J×14"-43	175/65 R14 82T 185/60 R14 82H				
SPARE WHEEL (*)		4B×14"- 43 4B×15"- 35	105/70 R14 84M 115/70 R15 90M	4,2			

(*) Speed limit: 80 km/h
(●) Only for versions with mechanical steering
(■) Not to be used with chains because it could interfere with the wheel arch

WHEEL GEOMETRY



unladen car (■)

 Front suspension	camber (**)		-7'± 30' -33'± 30' (only for Bravo 1998) -9' ± 30'(●●)
	caster (**)		3°30' ± 30' 2°50' ± 30'(●) 2°18' ± 30'(●●)
	toe in		-1 ÷ 1 mm
	front wheel offset ▲		0°
 Rear suspension	camber (**)		–1° ± 0°30' – 0°46' ± 30' (from chassis no. 4.050.320)
	toe in (**)		-2,5 ÷ 1,5 mm 0 ÷ 4 (from chassis no. 4.050.320)
	rear wheel thrust angle ▲		0°

(**) Angles cannot be adjusted
(■) With tyres inflated to the correct pressure and vehicle in running order with 5 litres of fuel

(▲) Angular values which cannot be adjusted, used for the correct alignment of the vehicle
(●) Versions with power assisted steering and for Bravo 1998
(●●) For versions with 1910 TD 75 engine

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Front suspension independent, Mac Pherson type with steel track control arms anchored to an auxiliary cross member. Offset coil springs and double acting telescopic shock abosrbers. Anti-roll torsion bar.

Coil springs

ENGINE TYPE		1370 12V	1581 (●) 16V	1747 16V	1998 20V
Diameter of wire	mm	12,2±0,05		12,5 ± 0,05 (12,7±0,05)*	13,2 ± 0,05
Number of turns		3,75			
Direction of coil		clockwise			
Height of spring released	mm	449,2 (461)*		461 (454)*	404,5 (419,6)*
Height of spring under a load of: 303 ÷ 335 daN (320,5 ÷ 346,5 daN)*	mm	192			–
Height of spring under a load of: 340 ÷ 368 daN (352 ÷ 382 daN)*	mm	–		192	–
Height of spring under a load of: 344 daN (369 daN)*	mm	–			192
The springs are subdivided into two categories, identifiable by a mark					
yellow (1) for those under a load of: 319 daN (333,5 daN)* height of	mm	>192		–	–
yellow (1) for those under a load of: 354 daN (367 daN)* height of	mm	–		>192	–
yellow (1) for those under a load of: 344 daN (369,2 daN)* height of	mm	–		–	>192
green (1) for those under a load of: 319 daN (333,5 daN)* height of	mm	≤192		–	–
green (1) for those under a load of: 354 daN (367 daN)* height of	mm	–		≤192	–
green (1) for those under a load of: 344 daN (369 daN)* height of	mm	–		–	≤192

(1) Springs of the same category must be fitted.
(*) For vehicles with air conditioning.
(●) For versions with automatic transmission, see the third volume.

Shock absorbers

Type: telescopic, double acting (low pressure gas)		WAY-ASSAUTO	
Open (start of damping action)	mm	518 ± 2,5	511 ± 2,5
Closed (metal against metal)	mm	361 ± 2,5	354 ± 2,5
Travel	mm	157	157

Stabilizer bar

Diameter of stabilizer bar	mm	22	23

Coil springs

			1929 D	1910 TD
Diameter of wire		mm	12,5±0,05(12,7±0,05)*	12,7±0,05(12,9±0,05)*
Number of turns			3,75	3,75
Direction of coil			clockwise	
Height of spring released		mm	461 (454)*	454 (449)*
Height of spring under a load of:	340 ± 368 daN (352 ± 382 daN)*	mm	192	-
	352 ± 382 daN (366 ± 396 daN)*	mm	-	192
The springs are subdivided into two categories, identifiable by a mark				
yellow (1) for those under a load of:	354 daN (367 daN)*	height in mm	>192	-
	367 daN (381 daN)*	height in mm	-	>192
green (1) for those under a load of:	354 daN (367 daN)*	height in mm	≤192	-
	367 daN (381 daN)*	height in mm	-	≤192

(1) Springs of the same category must be fitted.
(*) For vehicles with air conditioning

Shock absorbers

Type: telescopic, double acting (low pressure gas)		WAY-ASSAUTO
Open (start of damping action)	mm	518 ± 2,5
Closed (metal against metal)	mm	361 ± 2,5
Travel	mm	157

Stabilizer bar

Diameter of stabilizer bar	mm	23

VI-96 - Cancels and replaces

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Rear suspension independent with cast iron track control arms. Coil springs and shock absorbers with vulcanized bushes. Anti-roll torsion bar. Rigid H shaped auxiliary frame made up of a transverse tubular element and two pressed side members connected to it.

Coil spring

VERSIONS	BRAVO	BRAVO 1998 20V	BRAVA
Diameter of wire mm	11, 5±0,05 (11,9±0,05)*	11,6±0,05	11,9±0,05
Number of turns	4,75(5)*	4,25	5
Direction of coil	clockwise		
Height of spring released mm	311 (309)*	291	309
Height of spring under a load of: 270 ÷ 298 daN (286÷ 316 daN)* mm	194	-	-
Height of spring under a load of: 258,4 ÷ 285,6 daN mm	-	194	
Height of spring under a load of: 286 ÷ 316 daN mm	-	-	194
The springs are subdivided into two categories, identifiable by a mark			
yellow (1) for those under a load of: 284 daN (301 da)* height of mm	>194	-	-
yellow (1) for those under a load of: 272 daN height of mm	-	>194	-
yellow (1) for those under a load of: 301 daN height of mm	-	-	>194
green (1) for those under a load of: 284 daN (301 da)* height of mm	≤194	-	-
green (1) for those under a load of: 272 daN height of mm	-	≤194	-
green (1) for those under a load of: 301 daN height of mm	-	-	≤194

(1) Springs of the same category must be fitted.
(*) For 1910 TD vehicles with air conditioning and 1581 16v vehicles with automatic transmission, air conditioning and ABS.

Shock absorbers

Type: telescopic, double acting (low pressure gas)	WAY-ASSAUTO		
Open (start of damping action) mm	322,5 ± 2	312 ± 2	322,5 ± 2
Closed (metal against metal) mm	223 ± 2	223 ± 2	223 ± 2
Travel mm	99,5	89	99,5

Anti-roll bar

Diameter of anti-roll bar mm	17	19	17

	1370 12V	1581 16V	1747 16V	1998 20V
STARTER MOTOR	M. Marelli E80E-12V-0,9KW (M. Marelli E80E-12V-1KW)*		M. Marelli M70R-12V-1,4kW (with reduction gear) Bosch (■) ø 74,5-1,1/1,2	M. Marelli M70R-12V-1,4kW (with reduction gear)
ALTERNATOR	M. Marelli A115I-14V-38/65A M. Marelli A115I-14V-45/85A(●)	M. Marelli A115I-14V-40/75A M. Marelli A127IR-14V-50/85A(●)		M. Marelli A127I-14V-50/85A
VOLTAGE REGULATOR	BUILT IN ELECTRONIC			
BATTERY	12V-40Ah-200A	12V-50Ah-250A		12V-60Ah-380A
IGNITION SYSTEM	Bosch SPI Monomotronic integrated electronic injection/ignition	Weber-Marelli I.A.W. MPI integrated electronic injection/ignition	HITACHI MPI integrated electronic injection/ignition system	Bosch MPI Motronic integrated electronic injection/ignition
IGNITION COIL	Bosch 0.221.503.407	Cooper BAE 920	HITACHI GE 212331	Bosch 0.221.504.006
SPARK PLUGS	NGK BKR 6EKC GOLDEN LODGE 2HLDR CHAMPION RC8BYC		NGK BKR 6EHC CHAMPION RC7BMC GOLDEN LODGE 2HLDR CHAMPION RC8BYC	CHAMPION RC7BMC

(●) For vehicles equipped with air conditioning
(*) For 1581 16v version with automatic transmission
(■) From chassis no. 4366551 and n° 6051091

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	1929 D	1910 TD
STARTER MOTOR	M. Marelli E 95RL - 12V - 2,2 kW (with reduction gear)	M. Marelli E 95RL - 12V - 2,2 kW (with reduction gear) Bosch ⌀78,5-2,00/12 (●●)
ALTERNATOR	M. Marelli A 115I - 14V - 38/65A M. Marelli A 115I - 14V - 45/65A(●)	M. Marelli A 115I - 14V - 40/75A M. Marelli A 127IR - 14V - 50/85A(●)
VOLTAGE REGULATOR	Built in electronic	
BATTERY	12V - 60 Ah - 380A	
PRE-HEATING ELECTRONIC CONTROL UNIT	SIPEA 2961 BITRON CCD 48C	(Bosch 0.281.003.004) ■ SIPEA 2904 BITRON CCD 47µP/F2
INJECTION ADVANCE ELECTRONIC CONTROL UNIT (■)	-	LUCAS 41000087 - 101
EGR ELECTRONIC CONTROL UNIT (▲)	-	MARELLI MCR 108A MARELLI MCR 109A (●)
HEATER PLUGS	CHAMPION CH 68 BERU 0.100.221.145 BOSCH 0.250.201.005 M. Marelli UX 2A	BERU 0.100.226.249

(●) For vehicles equipped with air conditioning
(■) For vehicles with 1910 TD 100 engine
(▲) For vehicles with 1910 TD 75 engine
(●●) From chassis no. 4364699

STARTER MOTOR

		1370 12V / 1581 16V	1747 16V / 1998 20V	1929 D / 1910 TD
Type		M. Marelli E80-12V-0,9 kW (E80E-12V-1kW)	M. Marelli M70R-12V-1,4 kW (with reduction gear)	M. Marelli E95RL-12V-2,2 kW
Voltage	V	12		
Nominal power	kW	0,9 (1)	1,4	2,2
Rotation, pinion side		clockwise		
No. of poles		4		4
Field coil		series		series - parallel
Engagement		free wheel		
Operation		solenoid		
End float of armature shaft	mm	0,1 ÷ 0,5 (0,15 ÷ 0,45)		0,15 ÷ 0,45
Data for bench test				
Operating test (*):				
current	A	180 (200)	360 ÷ 380	600
speed	rpm	1720 (2200)	1150	1400
voltage	V	9,5 (9,8÷10)	8,15	7,9
torque developed	daNm	0,37 (0,38)	1,30	1,6
Engagement test (*):				
current	A	324 (440)	680 ÷ 700	1110 ÷ 1150
voltage	V	7,1 (7,6)	4,9	4,4 ÷ 4,6
torque developed	daNm	⩾0,97 (⩾1,25)	3,11	⩾3,9
Free running test (*):				
current	A	40 (44÷48)	60 ÷ 80	120 ÷ 140
voltage	V	11,4 (11,4÷11,5)	4,9	11
speed	rpm	8500 ÷ 9000 (11400÷12300)	4040	4500 ÷ 4750
Relay				
Winding resistance (*)	pull in Ω	0,30 ÷ 0,32 (0,32)	0,33 ÷ 0,37	0,23 ÷ 0,27
	hold in Ω	1,2÷1,3 (1,09)	1,13 ÷ 1,27	0,93 ÷ 1,07
Lubrication				
Internal splines and shaft bushes		VS+ SAE 10 W		
Sleeve and intermediate disc		TUTELA MR3		

(*) Data obtained at an ambient temperature of 20°C.
The data in brackets refers to the starter motor fitted on the 1581 version with automatic transmission.

NOTE *When overhauling it is not necessary to under the insulator between the commutator bars*

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ALTERNATOR

		1370 12V 1929 D	1929 D(●)	1581 16V 1747 16V 1910 TD	1998 20V 1581 16V (●) 1747 16V (●) 1910 TD (●)
Type		M.Marelli A115I-14V-38/65A	M.Marelli A115I-14V-40/65A	M. Marelli A115I-14V-40/75A	M.Marelli A127IR-14V-50/85A
Nominal voltage	V	14			
Maximum current	A	65	65	75	85
Nominal current at 1800 rpm	rpm	38	45	40	50
Nominal current at 6000 rpm	A	65	65	75	85
Field winding resistance between the slip rings (*)	Ω	2,4		2,587÷2,613	
Direction of rotation (seen from control side)		clockwise			
Diode rectifiers		bridge			

(*) Data obtained at an ambient temperature of 20°C.
(●) For vehicles equipped with air conditioning

VOLTAGE REGULATOR

		Built in electronic	
Type		RTM 151 A	RTM 151 B
Alternator speed for test	rpm	7000	
Thermal stabilization current	A	-	
Test current	A	-	
Regulation voltage (*)	V	14,3÷14,6	

(*) Data obtained at an ambient temperature of 23°C.

INTEGRATED ELECTRONIC INJECTION/IGNITION CONTROL MODULE	1370 12V
Make	Bosch 0.261.203.868
Firing order	1 – 3 – 4 – 2

IGNITION COIL WITH 4 HIGH TENSION SOCKETS

Make		Bosch
Type		0.221.503.407
Ohmic resistance of primary winding at 20°C	Ω	0,45 ÷ 0,55
Ohmic resistance of secondary winding at 20°C	Ω	12000 ÷ 14600

TDC AND RPM SENSOR

Make and type		Bosch 0.281.002.102
Sensor winding resistance at 20° C	Ω	486 ÷ 594
Distance (gap) between the sensor and the crankshaft pulley teeth	mm	0,8 ÷ 1,5

ADVANCE ON ENGINE

With engine idling (850 ± 50 rpm)	N.D.

SPARK PLUGS

Make and type		NGK BKR6EKC GOLDEN LODGE 2HLDR
Thread		M 14×1,25
Electrode gap	mm	0,8

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INTEGRATED ELECTRONIC INJECTION-IGNITION SYSTEM

	1581 16V
Type	I.A.W. M.P.I WEBER - MARELLI
Firing order	1-3-4-2

INJECTION-IGNITION CONTROL UNIT

Make and type	I.A.W. - 1AF.13

COIL WITH 4 HIGH TENSION OUTLETS

Type		M. Marelli
Code		BAE 920 A
Resistance of primary winding at 20°C	Ω	0.580
Resistance of secondary winding at 20°C	Ω	9100

SPARK PLUGS

Make and type		NGK BKR6EKC GOLDEN LODGE 2HLDR
Thread		M 14 x 1.25
Electrode gap	mm	0.8

TOP DEAD CENTRE AND RPM SENSOR

Type		JAEGER
Code		CVM 01
Sensor winding resistance	Ω	575 - 750
Gap between sensor and crankshaft pulley teeth	mm	0.5-1.5

ADVANCE ON ENGINE

With engine idling 800 ± 30 rpm	10°

INTEGRATED ELECTRONIC INJECTION-IGNITION SYSTEM	1747 16V
Type	HITACHI MFI-O
Firing order	1 – 3 – 4 – 2

IGNITION COIL (1 FOR SPARK PLUG)

Type	HITACHI
Code	GE 212331
Ohmic resistance of primary winding at 20°C Ω	0.495 - 0.605
Ohmic resistance of secondary winding at 20°C Ω	-

RPM AND TOP DEAD CENTRE SENSOR

Make and type	HITACHI GE 108101
Sensor winding resistance Ω	513 - 627
Distance (gap) between sensor and crankshaft pulley tooth mm	0.4 - 1.2

KNOCK SENSOR

Make and type	NGK KUE-03

TIMING AND CYLINDER RECOGNITION SENSOR

Make and type	Bosch B 232.070.023

ADVANCE ON ENGINE

With engine idling (850±50/min)	10° ± 5°

SPARK PLUGS

Make and type	NGK BKR6EKC Champion RC7BMC Golden Lodge 2HLDR
Thread	M 14×1.25
Electrode gap mm	0.8

INTEGRATED ELECTRONIC INJECTION/IGNITION SYSTEM

	1998 20V
Make	Bosch 0.261.203.994
Firing order	1 – 2 – 4 – 5 - 3

IGNITION COIL (1 PER SPARK PLUG)

Make	Bosch
Type	0.221.504.006
Ohmic resistance of primary winding at 20°C Ω	0,4
Ohmic resistance of secondary winding at 20°C Ω	8500

TDC AND RPM SENSOR

Make and type	Bosch 0.281.002.102
Sensor winding resistance at 20 °C Ω	774 ÷ 946
Distance (gap) between the sensor and the crankshaft pulley teeth mm	0,8 ÷ 1,5

DETONATION SENSOR

Make	Bosch
Type	0.261.231.095

SPARK PLUGS

Make and type	CHAMPION RC7BMC
Thread	M 14×1,25
Electrode gap mm	0,8

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
ENGINE							
1850132000	Spanner (13 mm), with 1/2" socket, for removing inlet manifold fixings				●		
1850167000	Spanner (13 mm) for fuel injection pump securing screws					●	
1850184000	Spanner for removing and refitting spark plugs	●	●	●	●		
1852128000	Tool for removing and refitting injectors					●	●
1852138000	Spanner for adjusting injector pipe pressure connectors					●	●
1852147000	Spanner for removing cylinder head					●	
1852154000	Spanner, 1/2" socket, for cylinder head fixing bolts	●		●	●		●
1852157000	Spanner, 1/2" socket, for cylinder head fixing bolts		●				
1852159000	Spanner for removing-refitting belt tensioner				●		
1852161000	Spanner for phase transformer				●		
1852162000	Spanner for alternator pulley				●		
1860054000	Drift (ø 22 mm) for removing and refitting connecting rod pin bush		●				
1860183000	Pliers (ø 75-110 mm) for removing and refitting piston circlips	●	●	●	●	●	●
1860251000	Drift for removing gudgeon pin from piston		●				
1860303000	Tool for fitting gudgeon pin circlips on piston		●				
1860313000	Drift for fitting oil seal on valve guide	●	●	●	●	●	●
1860395000	Drift for removing valve guide	●	●	●	●	●	●
1860443000	Pressure lever for inserting tool for retaining tappets whilst adjusting valve clearance					●	●

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Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1860443000	Tool for tensioning timing belt	●					
1860454000	Drift for fitting oil seal on valve guide		●	●			
1860460000	Drift for fitting valve guides		●				
1860470000	Tool for supporting cylinder head whilst overhauling	●	●	●	●	●	●
1860486000	Drift for fitting valve guides					●	
1860490000	Tool for retaining valve leakage test equipment 1895868000 (to be used with 1860470000)						●
1860644000	Tool, valve removal and refitting (to be used with 1860877000 and 1860804000)	●					
1860644000	Tool for removing and refitting valves (to be used with 1860322000)					●	
1860644000	Tool for removing and refitting valves (to be used with 1860749000)						●
1860647000	Flywheel lock (at the bench)					●	
1860650000	Drift (⌀ 25 mm) for removing and refitting small end bush					●	
1860662000	Tool for removing cartridge oil filter or fuel filter					●	
1860666000	Tool for retaining camshaft whilst removing and refitting side supports					●	
1860700000	Band (⌀ 60-125 mm) for introducing normal and oversize pistons in cylinders	●	●	●	●	●	●
1860724000	Tool for retaining tappets whilst replacing shims					●	●
1860745100	Tool for tensioning toothed belts (to be used with specific tools)					●	
1860745200	Tool for timing system toothed belt tensioning (to be used with 1860745100)					●	

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1860749000	Support for cylinder head whilst removing and refitting valves						●
1860757000	Tool for removing cartridge oil filter						●
1860758000	Tool for removing cartridge oil filter	●	●	●			
1860765000	Tool for retaining toothed pullies and injection pump drive pulley		●			●	
1860766000	Flywheel lock					●	
1860771000	Flywheel lock		●				
1860790000	Lever for removing and refitting valves (to be used with 1860786000-1860787000-1860788000-1860789000)		●	●			
1860810000	Dummy spark plug for ante-chamber (to be used when refitting ante-chamber fixing bush)						●
1860812000	Tool for refitting valve guides	●		●	●		●
1860813000	Guide for fitting oil seal on valve guides	●	●	●	●		
1860814000	Drift for fitting oil seal on valve guides						●
1860815000	Adaptor for rotating crankshaft	●	●	●	●	●	●
1860816000	Drift for fitting oil pump gasket	●		●	●	●	●
1860817000	Tool for centering crankshaft cover gasket	●		●	●		●
1860818000	Tools for camshaft timing				●		
1860821000	Tool for removing small end bush	●		●	●		●
1860822000	Tool for timing oil pump				●		

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Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1860824000	Tool for introducing camshaft gasket				●		●
1860831000	Spanner for rotating timing pullies	●					●
1860833000	Spanner for removing-refitting oil sump				●		●
1860834000	Spanner for removing-refitting oil sump				●		●
1860835000	Tool for extracting oil seal on valve guide	●	●	●	●		●
1860836000	Tool for locking rotation of crankshaft			●	●		
1860844000	Tool for fitting gasket for camshaft, inlet side			●			
1860845000	Spanner for tensioning timing belt			●			
1860846000	Flywheel lock (operations at the bench)	●	●	●			●
1860848000	Spanner for camshaft pulley, exhaust side			●			
1860856000	Spanner for timing pulley, inlet side			●			
1860859000	Supports for removing-refitting power unit (to be used with 1860860000)		●	●			●
1860859001	Connecting bracket for removing-refitting power unit (to be used with 1860859000 and 1860860000)	●					
1860859002	Adaptor for removing-refitting power unit (to be used with 1860859000 and 1860860000)				●		
1860859003	Adaptor for removing-refitting power unit (to be used with 1860859000)					●	
1860860000	Support for removing-refitting power unit	●	●	●	●	●	●
1860874000	Tools for camshaft timing		●				

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1860875000	Tools for camshaft timing			●			
1860876000	Tool for tensioning timing belt		●				
1860877000	Tool for removing valves	●					
1860878000	Tool for fitting crankshaft front cover gasket		●				
1860879000	Grip for tool for fitting crankshaft rear cover gasket		●			●	
1860880000	Tool for fitting crankshaft rear cover gasket (to be used with 1860879000)		●				
1860881000	Tool for fitting crankshaft rear cover gasket (to be used with 1860879000)					●	
1860882000	Tool for fitting camshaft cover gasket and auxiliary shaft cover		●				
1860883000	Pin for centering ante-chamber					●	
1860884000	Spanner for removing-refitting combustion ante-chamber					●	●
1860885000	Spanner for rotating camshaft pullies (to be used with 1860831001)		●				
1860886000	Tool for extracting injection pump pulley					●	
1860887000	Tool for positioning rpm sensor		●				
1860892000	Tool for timing camshafts				●		
1860893000	Spanner for fuel pump cover	●	●	●	●		
1860895000	Vertical support for dial gauge for detecting T.D.C.		●				
1860896000	Graduated disc for engine timing		●				
1860898000	Flywheel lock (on vehicle)			●	●		

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1860899000	Tool for timing camshaft	●					
1860901000	Tool for positioning T.D.C.	●					
1860905000	Tool for positioning T.D.C.						●
1861001011	Pair of brackets for fixing engine to rotating stand					●	
1861001039	Pair of brackets for fixing engine to rotating stand				●		●
1861001041	Pair of brackets for fixing engine to rotating stand			●			
1861001042	Pair of brackets for fixing engine to rotating stand		●				
1865091000	Tool for checking injection pump advance					●	
1867019000	Drift for removing and refitting bush in crankcase for oil pump drive gear		●				
1867029000	Flywheel lock				●		
1867030000	Flywheel lock (on vehicle)	●					
1870404000	Support for dial gauge for measuring cylinder liner recesses or projections				●		●
1890385000	Reamer for valve guide openings	●	●	●	●		
1895762000	Dynamometer for checking auxiliary shaft drive belt tension	●	●	●	●	●	●
1895868000	Valve leakage test equipment	●	●	●	●	●	●
1895890000	Fuel pump delivery pressure gauge with unions	●	●	●	●		
1895897000	Graduated disc for angular tightening of cylinder head fixing nuts	●	●	●	●	●	●

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1895942000	Graduated disc for angular tightening of cylinder head fixing nuts						●
1896245000	Gauge to check valve stem height after valve seat grinding					●	

CLUTCH

1870081000	Guide pin for centering clutch disc					●	
1870447000	Guide pin for centering clutch disc		●				
1875086000	Guide pin for centering clutch disc	●		●	●		

GEARBOX-DIFFERENTIAL

1842133000	Tool for removing differential bearing and gearbox gear	●					
1842134000	Tool for removing gearbox gears and hubs	●					
1845028000	Reaction tool for removing differential bearings	●					
1845057000	Tool for removing bush for lay shaft 5'h speed gear	●					
1845062000	Tool for removing constant velocity joint from front wheel drive shaft (to be used with 1847017001)		●	●	●	●	
1847017001	Mass (to be used with 1860889000)	●	●(*)	●	●	●	●
1847017004	Plate for extracting flanged shaft from planet gear (to be used with 1847017001)		●	●	●	●	
1847056000	Tool for extracting differential output shafts	●					
1850132000	Spanner for bolts fixing differential casing cover				●		
1850113000	Spanner (12 mm) for gearbox oil drain plug	●	●	●	●	●	

(*) Tools for Aisin automatic gearbox

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Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1855035000	Spanner (19 mm) for removing and refitting gearbox	●	●	●	●	●	
1860691000	Drift for removing and refitting gear hardening ball plug	●					
1860851000	Cross member for removing-refitting gearbox	●	●(*)	●	●	●	●
1860851001	Transverse adaptor for removing-refitting gearbox (to be used with 1860851000)	●	●(*)	●	●	●	●
1860870000	Connector for checking line pressure		●(*)				
1860873000	Bracket for removing-refitting gearbox	●	● ●(*)	●	●		
1860889000	Two-way connector for mass (to be used with 1847017001)	●	● ●(*)	●	●	●	●
1870007000	Universal handle	●	●	●	●	●	
1870152000	Drift for fitting hubs and gears on main and lay shafts	●	●				
1870419000	Tool for fitting main shaft gasket on bell housing (to be used with 1870007000)	●	●	●	●	●	
1870448000	Tool for fitting front bearing inner race		●	●	●	●	
1870469000	Tool for fitting differential bearing (to be used with 1870007000)	●					
1870478000	Tool for fitting 4'h speed gear bush and rear bearing		●	●	●	●	
1870629000	Drift for fitting differential casing cover gasket (to be used with 1870007000)	●	● ●(*)				
1870630000	Drift for fitting differential casing gasket (to be used with 1870007000)	●					
1870631000	Drift for fitting main and lay shaft bearings and gears	●					
1870632000	Drift for fitting bearings	●					

(*) Tools for Aisin automatic gearbox

Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1870633000	Drift for fitting clutch release shaft bush	●					
1871001014	Support for gearbox-differential unit whilst overhauling (to be fitted to 1861000000 or 1871000000)	●					
1874140005	Pair of tools for staking gearbox shaft nuts (to be used with 1874140001)	●					
1874541000	Tool for fitting differential bearing outer race				●		
1875016000	Drift to fit gasket on axle shaft flange		●	●	●	●	
1875017000	Tool to remove and refit differential bearing rings (to be used with 1840005003)		●	●	●	●	
1875088000	Drift for fitting main and lay shaft bearings	●					
1881124000	Pliers for adjusting main and lay shaft rear bearing circlips	●					
1895411000	Pipe and 1/4" connectors for checking automatic gearbox oil pressure		●(*)				
1895424000	Pressure gauge (0÷25 bar) for checking automatic gearbox oil pressure		●(*)				
1895655000	Tool to select differential bearing adjusting shims (to be used with 1895884000)	●					

BRAKES

Tool number	DESCRIPTION OF TOOL	12V	16V	16V	20V	D	TD
1856132000	Spanner (10-11 mm) for adjusting brake fluid pipe unions	●	●	●	●	●	●
1856133000	Spanner for adjusting rear brake caliper self-adjusting device				●		
1872273000	Set of tools to hold cylinder pistons when installing brake shoes	●	●	●		●	●
1895899000	Vacuum gauge with connectors for checking operation on vehicle of vacuum pump					●	
1895901000	Tool for adjusting position of load proportioning valve	●	●	●	●	●	

(*) Tools for Aisin automatic gearbox

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Tool number	DESCRIPTION OF TOOL	ENGINE TYPE					
		1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
STEERING							
1847035000	Puller for steering rod ball pins	●	●	●	●	●	●
1860888000	Tool for removing-refitting bearing for power steering pump support		●				
SUSPENSION							
1845028000	Tool for removing front hub bearing inner race from flange (to be used with 1840005003, 1840005302 and 1840005400)	●	●	●	●	●	●
1847014000	Percussion extractor for wheel hub caps	●	●	●	●	●	●
1874551000	Tool for retaining front shock absorber stem whilst adjusting fixing nut	●	●	●	●	●	●
1874555000	Pneumatic tool for compressing suspension springs when removing shock absorber	●	●	●	●	●	●
1875055000	Drift to fit front wheel hub bearings (to be used with 1870007000)	●	●	●	●	●	●
1875059000	Drift for fitting rear wheel hub caps	●	●	●	●	●	●
ELECTRICAL EQUIPMENT							
1860893000	Tool for removing fuel gauge ring nut	●	●	●	●		
1860897000	Tool for extracting radio	●	●	●	●	●	●
BODYWORK							
1860890000	Spanner for removing-refitting door hinges	●	●	●	●	●	●
1878034000	Tool for removing window opening handles	●	●	●	●	●	●
1878077000	Tool for removing door panel or fixing buttons	●	●	●	●	●	●
1878080000	Tool for positioning door check strap whilst refitting flexible retaining pin (to be used with 1878081000)	●	●	●	●	●	●
1878081000	Pliers for removing-refitting door check strap flexible retaining pin (to be used with 1878080000 whilst refitting)	●	●	●	●	●	●

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Tool number	DESCRIPTION OF TOOL	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD

ORDINARY TOOLS

Tool number	Description of tool	1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
1840005000	Universal extractor	●	●	●	●	●	●
1840206000	Percussion extractor (to be used with specific tools)	●	●	●	●	●	●
1846017000	Base for puller half-rings	●	●	●	●	●	●
1847017001	Percussion extractor (to be used with specific tools)	●	●	●	●	●	●
1861000000	Rotating stand for overhauling engine (also used for gear-boxes and differentials)	●	●	●	●	●	●
1861000001	Pair of sections for brackets supporting the engine on rotating stand 1861000000	●	●	●	●	●	●
1870007000	Universal handle	●	●	●	●	●	●
1870404000	Support for measuring recesses and projections (to be used with 1895881000)	●	●	●	●	●	●
1871000000	Rotating column for overhauling gearboxes and differentials	●	●	●	●	●	●
1876048000	Extractor for MINI HYLOK CONTACT (MHF) ⌀ 2,15 mm type terminals	●	●	●	●	●	●
1881138000	Adjustable plires for pipe restricting bands and tabs	●	●	●	●	●	●
1882002010	Tool panel to be fixed to wall or stand 1882003000 (with hooks)	●	●	●	●	●	●
1882003000	Stand to hold two tool panels	●	●	●	●	●	●
1882011000	Set of additional hooks (50) for tool panel	●	●	●	●	●	●
1895113000	Dial gauge (0,05-0,10...0,80 mm) for checing various clear-ances	●	●	●	●	●	↙
1895881000	Dial gauge to be used with specific tools (measuring capacity mm 10; shank length mm 16,7)	●	●	●	●	●	●
1895882000	Dial gauge to be used with specific tools (measuring capacity mm 10; shank length mm 88)	●	●	●	●	●	●
1895884000	Dial gauge to be used with specific tools (measuring capacity mm 5; shank length mm 16,5)	●	●	●	●	●	●

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ENGINE

DESCRIPTION	Thread size	Tightening torques daNm	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Main bearing caps fixing, flanged blot	M10	8		●				
	M12	2+100°	●		●	●	●	●
	M12×1,25	2,5+100°			●			
(Dust) shield fixing, bolt	M6	0,9	●		●	●		●
Sump oil drain plug	M14	2,5	●					
	M18	2			●	●		●
	M22	5		●				
Oil sump fixing, bolt	M6	0,9	●	●	●	●		●
	M8	2,5	●		●	●		●
Flywheel side and timing side cover fixing, bolt	M6	0,7		●				
		0,9	●		●	●		●
Timing belt shields fixing, bolt	M6	0,9	●	●	●	●		●
	M8	2,5		●				
	M10×1,25	5		●				
Cylinder head to crankcase fixing, bolt	M10×1,25	4+ 90°+90°	●	●				
Cylinder head to crankcase fixing, bolt	M10	4+ 90°+90°+90°			●	●		
Cylinder head to crankcase fixing, bolt	M10	5+ 90°+90°+90°					●	
Cylinder head to crankcase fixing, bolt	M10	6,5+ 90°+90°+90°						●
Engine support to crankcase fixing, bolt	M10	5				●		
	M10×1,25	7	●	●	●			
	M8	2,5		●				
Camshaft cap fixing, bolt and nut	M8	1,9					●	
	M7	1,5	●		●	●		●
Tappet cover to cylinder head fixing, bolt	M6	0,9	●		●	●		●
Inlet manifold to cylinder head fixing, nut	M8	2,5	●		●		●	●
		3		●				
Exhaust manifold to cylinder head fixing, nut	M8	2,5	●		●	●	●	●
		3		●				
Flywheel to crankshaft fixing, bolt	M6	0,9	●		●	●		
Bearing caps fixing, bolt	M8	2+40°	●					
	M8	2+60°				●		●
	M10	2,5+50°					●	
	M9×1	2,5+60°			●			

DESCRIPTION	Thread size	Tightening torques daNm	ENGINE TYPE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Engine flywheel fixing, bolt	M10	8,3		●				
	M12×1,25	16	●		●	●		●
	M12×1,25	14,2					●	
Crankshaft gear fixing, bolt (*)	M16 left	36	●		●	●		●
Auxiliary pulley to crankshaft gear fixing, bolt	M8	2,5	●					●
		3,2			●			
Gear to camshaft fixing, bolt (inlet and/or exhaust)	M12	12	●	●	●	●	●	●
Butterfly casing to inlet manifold fixing, bolt	M6	0,9	●					
Accelerator bracket to inlet manifold fixing, bolt	M6	0,9	●					
Sensors to cylinder block/crankcase and cylinder head fixing, bolt	M6	0,9	●		●	●		●
Detonation sensor to cylinder block/crankcase fixing, bolt	M8	2,5	●		●	●		
Coils support to cylinder head fixing, bolt	M6	0,9	●					
Connector mounting bracket to inlet manifold and coils support fixing, bolt	M6	0,9	●					
Oil pump to crankcase fixing, bolt	M6	0,9	●		●	●		●
	M8	2,5		●				
Oil dipstick fixing, bolt and nut	M6	0,9	●			●		●
Water pump fixing, bolt	M8	2,5	●	●	●	●	●	●
Water inlet pipe to cylinder head fixing, bolt	M6	0,9	●		●	●		
	M8	2,5	●	●				
	M10	5				●		
Thermostat to cylinder head fixing, bolt	M8	2,5	●	●	●	●	●	●
Air conditioning compressor support to crankcase fixing, bolt	M10×1,25	5	●		●			
Alternator mounting to crankcase fixing, bolt	M8	2,5	●					
	M10×1,25	7	●					
	M10×1,25	5		●				

(*) The bolt should not be lubricated

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DESCRIPTION	Thread size	Tightening torques daNm	ENGINE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Cover and bracket to water pump casing fixing, bolt	M8	2,3						
Water pump to cylinder head fixing, nut with flange	M8	2	●		●	●		●
Oil pump drive shaft driven gear fixing, bolt	M10×1,25	8		●				
Thermostat to cylinder head fixing, nut	M8	2	●	●	●	●	●	●
Driven gear to oil pump drive gear fixing, bolt	M10×1,25 left	7				●		
Butterfly casing to inlet manifold fixing, bolt	M8	2,5	●			●		
Ante-chamber fixing, ring nut	M32×1,5	11,8					●	●
Injection pump fixing, nut for stud	M8	2,5					●	
Injection pump fixing, bolt	M8	2,5					●	●
Flexible mounting to water pump casing fixing, nut	M12×1,25	8					●	
Injection pump drive gear fixing, nut	M12×1,25	4,9					●	
	M14×1,5	5						●
Reaction bracket to oil filter support and injection pump fixing, bolt	M8	2,9					●	
Injection pump mounting to crankcase and inlet manifold fixing, bolt	M8	2,5						●
Oil filter and injection pump mounting fixing, upper bolt or nut	M12×1,25	9,8					●	
Oil filter and injection pump mounting fixing, lower bolt	M10×1,25	7,1					●	
Complete injector	M24×2	5,5					●	●
Heater plugs	M12×1,25	1,5					●	
Fuel supply pipe on injection pump and on injector, nuts	M12×1,25	2,9					●	

DESCRIPTION	Thread size	Tightening torques daNm	ENGINE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Union on injection pump	M12×1,5	3,2					●	
Oil filter mounting union	M20×1,5	5					●	
Alternator to bracket fixing, bolt	M10×1,25	4,3					●	
Alternator to mounting fixing, bolt	M12×1,25	8,5		●				
	M10×1,25	5	●					
Alternator to mounting fixing, nut	M12×1,25	6					●	
Alternator mounting to crankcase fixing, bolt	M10×1,25	5	●	●	●	●		
Alternator mounting fixing, nut	M10×1,25	4,3					●	
Alternator to mounting fixing, nut	M12×1,25	7	●		●			●
Turbocharger to exhaust union fixing, nut	M8	2,5						●
Bolt for bracket strengthening exhaust manifold complete with turbocharger to crankcase	M10×1,25	4						●
Turbocharger to exhaust manifold fixing, nut	M8	2,5						●
Power steering pump to support fixing, bolt	M8	2,5	●	●	●			●
Pulley to power steering pump fixing, bolt	M8	2,5	●		●			●
Power steering pump to support fixing, nut	M10×1,25	4,8		●				
Power steering pump after tensioning belt fixing, bolt	M10×1,25	4,8		●				
Air conditioner to support fixing, bolt with flange	M10×1,5	5	●		●	●		●
Reaction bracket to support fixing, bolt with flange	M10×1,5	5	●		●	●		●

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DESCRIPTION	Thread size	Tightening torques daNm	ENGINE 1370 12V	1581 16V	1747 16V	1998 20V	1929 D	1910 TD
Reaction bracket to air conditioner fixing, bolt with flange	M8	2,5	●		●	●		●
Drive shaft bracket to oil sump fixing, bolt	M8	2	●		●	●		●
Drive shaft to crankcase connecting support fixing, bolt	M10×1,25	4,9	●		●	●		●
E.G.R. valve to exhaust manifold fixing, nut	M8	2,5						●
Pipe to E.G.R. valve fixing, bolt	M8	2,5						●
Engine oil pressure sender unit	M14×1,5	3	●		●	●		●
Engine oil pressure switch	M14×1,5	3,2	●	●	●	●	●	●
Thermal switch for pollution control	M14×1,5	1,5			●	●		
		3						●
Engine coolant temperature sender unit	M16×1,5 tapered	3,4					●	
	M14×1,5	3	●	●	●	●		●
Engine coolant temperature sender unit for injection electrical components	M12×1,5	2,5	●					
	M14×1,5	3			●	●		●
Air pressure switch	M12×1,5	3						●
Spark plugs	M14×1,25	2,5	●		●	●		
		3,7		●				

00.

DESCRIPTION	Thread size	Tightening torquesio daNm

ENGINE EXHAUST

Front section of exhaust pipe with differential side bracket fixing, bolt	M8	1,8

POWER UNIT MOUNTING

Bracket, differential side, to gearbox fixing, bolt (1370)	M12×1,25	9
Bracket, differential side and engine side, to gearbox, fixing bolt (1370)	M10×1,25	4,5
Mounting, engine side, to engine support, fixing nut (1998)	M12×1,25	8
Support, differential side, to gearbox, fixing, bolt	M12×1,25	8,5
Engine to bodyshell fixing, bolt with flange	M8	3,2
Differential support to gearbox fixing, nut	M12×1,25	8
Bracket, differential side, to gearbox fixing, bolt (1929 D-1910 TD)	M10×1,25	5
Support to gearbox fixing, bolt with flange (1370)	M10×1,25	5
Connecting rod support to bodyshell fixing, bolt with flat tapered washer (1747-1998)	M8	3,8 2,8
Reaction rod to bracket and engine support fixing, bolt (1747-1998)	M10×1,25	5
Mounting, engine side, to support fixing, bolt (1581)	M12×1,25	8
Mounting to engine oil sump, differential side fixing, bolt (1747-1998)	M12×1,25	8
Counter-pulley to support, differential side fixing, bolt (1747-1998)	M12×1,25	8
Flexible mounting to differential cross member fixing, bolt	M8	3,8
Bracket, gearbox side, to gearbox fixing, bolt (1581-1747-1998-1929D-1910TD)	M10×1,25	5

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DESCRIPTION	Thread size	Tightening torque daNm

PEDALS

Brake pedal and clutch pedal to pedals fixing, self-locking nut with polyammide ring for hinging bolt	M8	3
Complete support for brake pedal and clutch pedal to body-work fixing, nut with border	M8	1,5
Pedals to dashboard fixing, bolt with flange	M8	2,6

EXTERNAL GEARBOX CONTROLS

Gear lever support to floor panel fixing, bolt	M6	0,74
Lower gear selection and engagement rod to gear lever fixing, bolt	M8	2,8
Intermediate idler fixing pin, nut	M8	1,5
Heads to levers fixing, nut	M8	1,5
Idler selector to gearbox fixing, nut for bolt	M8	1,5
Reverse gear pipe to gearbox fixing, bolt	M8	1,5
Spherical tubes to selector lever fixing, nut	M8	1
Reaction bracket to gearbox fixing, bolt	M8	2,5

GEARBOX AND DIFFERENTIAL

Gear control lever spring fixing, nut	M14×1,4	3
Plate to gearbox casing fixing, bolt	M8	2,5
Gearbox casing cover and plate fixing, bolt	M8	2,5
Cover on gearbox casing fixing, bolt	M8	2,5
Gearbox casing to bell housing fixing, bolt	M6	1
	M8	2

DESCRIPTION	Thread size	Tightening torques
		daNm
Reverse shaft fixing, bolt	M8	3,4
Ring nut for main and lay shaft fixing 5th speed gear	M20×1,5	11,8
Gear selector forks fixing, bolt	M6	1,8
Lever to gear selector and engagement control shaft fixing, bolt	M8	2,5
Reverse control lever support fixing, bolt	M6	1
Bush for gear control shaft fixing, bolt	M6	1
Front axle reduction ring gear fixing, bolt	M10×1,25	8,8
Flange retaining differential casing to gearbox casing fixing, bolt	M10×1,25	4,9
	M8	2,5
Speedometer mounting fixing, bolt	M6	1,2
Tapered, threaded gearbox oil drain plug	M22×1,5	4,6
Tapered, threaded gearbox oil filler plug	M22×1,5	4,6
Right differential shaft support fixing, bolt	M6	1
Tapered threaded plug for 1st- 2nd speed rod housing in gear-box casing	M18×1,5	2
Gear selector lever support fixing, bolt	M8	1,5
Switch for reversing light	M14×1,25	3

POWER ASSISTED STEERING

Power steering box to chassis fixing, bolt	M10×1,25	7
Power steering bracket fixing, nut	M6	0,4

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DESCRIPTION	Thread size	Tightening torque daNm
Power steering bracket fixing, bolt	M8	1,5
Power steering bracket fixing, bolt	M6	1,5
Power steering bracket fixing, nut	M8	1,5
Filler for return union from power steering to reservoir	M12×1,5	2
Filler for oil supply union from pump to power steering, on power steering	M14×1,5	3
Air Bag control unit fixing, bolt	M6	0,8
Air Bag module to steering wheel fixing, bolt	M6	0,8
Passenger module to dashboard cross member fixing, bolt	M6	0,7

FRONT SUSPENSION

Front cross member to bodyshell front fixing, bolt with wide flange	M12×1,25	10,8
Front cross member to bodyshell rear fixing, bolt with normal flange for nut	M10×1,25	8
Bolt with flat and tapered washer for fixing front and rear external U bolts securing track control arm to cross member	M10×1,25	6,9
Bolt with flat and tapered washer fixing and rear internal U bolt securing track control arm to cross member	M10×1,25	6,9
Upper shock absorber to mounting fixing, flanged nut	M12×1,25	10
Upper shock absorber mounting to bodyshell fixing, bolt with wide flange	M8	4
Shock absorber to steering knuckle fixing, nut	M10×1,25	7
Track control arm to steering knuckle fixing, nut for bolt	M10×1,25	7
U bolt supporting anti-roll bar to cross member fixing, bolt with flat and tapered unlosable washer	M8	4

DESCRIPTION	Thread size	Tightening torques daNm
Ends of anti-roll bar to connecting rod fixing, nut	M10×1,25	7
Connecting rod to front suspension arm fixing, nut	M10×1,25	3,1
Front wheel hub to joint fixing, nut	M22×1,5	24
	M24×1,5	28
Wheel bolts/nuts	M12×1,25	8,6

REAR SUSPENSION

DESCRIPTION	Thread size	Tightening torques daNm
Front flexible mounting to rear frame and bodyshell fixing, bolt with wide flange	M12×1,25	10,8
Rear flexible mounting to bodyshell fixing, bolt with wide flange	M12×1,25	10,8
Rear suspension track control arm to frame fixing, nut for bolt	M16×1,5	15
Lower shock absorber to suspension fixing, nut for bolt	M12×1,25	8,8
Upper shock absorber to mounting fixing, bolt	M10×1,25	6
Rear hub stub axle fixing, nut	M22×1,5	28
Anti-roll bar to rear suspension arm fixing, bolt	M10×1,25	5,6
U bolts supporting anti-roll bar to rear suspension arm fixing, bolt	M8	2,8
Wheel bolts/nuts	M12×1,25	8,6
Lever to track control arm fixing, nut for bolt	M8	1,5

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DESCRIPTION	Thread size	Tightening torques daNm

BODYWORK

Luggage compartment retaining hook fixing, bolt	M8	2
Side door lock fixing, bolt with tapered washer	M6	0,75
Rear door fixed hinge fixing, bolt	M10×1,25	4,5
Front bumper fixing, bolt with flange	M8	2

Lubrication service

The engine oil should be changed, on petrol engines, every 20,000 km or, irrespective of the mileage, every 12 months and for diesel engines every 10,000 km.
The oil filter should be replaced at the same time as the oil is changed.

For the correct and optimum operation of the engine, it is advisable to use the type of oil recommended in the tableon page 8.

If the vehicle is constantly subjected to heavy usage conditions (mainly town driving, journies in dusty areas, constant mountain driving, towing a trailer or caravan, particulary harsh climatic conditions, constant motorway driving at high speed etc.) the "Lubrication service" should be carried out at more frequent intervals. In the above mentioned conditions it is also advisable to carry out the "Planned maintenance prorgramme" and the "Intermediate checks" at more frequent intervals.

	INTERVALS IN THOUSANDS OF KM				
PLANNED MAINTENANCE OPERATIONS	**20**	**40**	**60**	**80**	**100**
Check condition and wear of tyres	☆	☆	☆	☆	☆
Check condition and wear of front brake pads	☆	☆	☆	☆	☆
Check condition and wear of rear brake discs (only for 1998 20v)		☆		☆	
Check condition and wear of rear brake linings (drum brakes)			☆		
Visually inspect condition of exterior bodywork and underbody protection	☆	☆	☆	☆	☆
Check condition of pipes (exhaust, fuel system, braking system)	☆	☆	☆	☆	☆
Check condition of rubber elements, boots, hoses, etc	☆	☆	☆	☆	☆
Check condition of various drive belts	☆		☆		☆
Check and adjust clutch pedal height (excluding version with hydraulic operation)		☆		☆	
Check anti-evaporation system			☆		
Check and adjust tappet clearance (only for diesel engines)	☆		☆		☆
Check exhaust gas emissions (petrol engines, using CO tester)	☆	☆	☆	☆	☆
Check crankcase ventilation system					☆
Replace fuel filter (petrol engines)		☆		☆	
Replace fuel filter (diesel engines)	☆	☆	☆	☆	☆
Sostituzione cartuccia filtro aria (motori benzina)		☆		☆	
Replace air filter cartridge (diesel engines)	☆	☆	☆	☆	☆
Top up fluid levels (engine coolant, braking system, windscreen washer, power assisted steering, hydraulically operated clutch)	☆	☆	☆	☆	☆
Check gearbox differential oil level			☆		
Replace gearbox differential oil					☆
Replace pollen filter	☆	☆	☆	☆	☆
Replace engine coolant			☆		
Change automatic gearbox oil and (filter)		☆		☆	

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PLANNED MAINTENANCE OPERATIONS

	INTERVALS IN THOUSANDS OF KM				
	20	40	60	80	100
Replace spark plugs, check high tension leads		☆		☆	
Replace brake fluid			☆		
Check injection/ignition system (petrol engines, using autodiagnostic socket)		☆		☆	
Change engine oil and oil filter (every 10,000 Km for diesel engines)	☆	☆	☆	☆	☆

Additional operations

In addition to what is laid down in the "Planned maintenace" programme, the following checks should also be carried out:

Every 500 km or before long journies check	- engine oil level - engine coolant level - brake fluid level/hydraulic clutch operation - power steering fluid level - pressure and condition of tyres - windscreen washer fluid level
Every 500 km check (only for diesel engines)	- bleed condesnation water from fuel filter
Replace every 2 years	- engine coolant - brake/clutch fluid
Replace every 120,000 km	- timing belt

Engine 1370 12v

Engine 1581 16v

Engine 1747 16v

Engine 1929 Diesel

Engine 1998 20v

Removing-Refitting

Engine 1370 12v removing-refitting

Engine 1581 16v removing-refitting

Engine 1747 16v removing-refitting

Engine 1929 Diesel removing-refitting

Engine 1998 20v removing-refitting

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BOSCH MONOMOTRONIC SPI INTEGRATED INJECTION-IGNITION SYSTEM

Introduction

The BOSCH MONOMOTRONIC SPI control system is an integrated system and thus governs engine injection and ignition by means of a single electronic control unit.

This is an S.P.I. system, in other words only one injector controls fuel injection point and pulse duration upstream of the throttle and the instant when a spark is triggered in the combustion chamber of each cylinder (advance angle).

The MONOMOTRONIC engine control system works on the basis of engine load information determined by throttle angle/rpm (α/n). In other words, fuel requirements and advance settings are calculated on the basis of throttle opening angle of throttle and engine rpm.

This system is equipped with a LAMBDA probe. The system corrects injection pulse constant according to whether the lambda probe indicates a rich or lean mixture. A closed-loop control system is therefore set up.

SYSTEM OPERATING STRATEGIES

The management software resident in the ECU memory comprises a set of strategies. Each of these controls a specific system control function.

Each strategy uses the various inputs listed above to process a set of parameters, using data maps saved in specific areas of the ECU. The resulting data output is used to control system actuators, in other words the devices used to operate the engine.
The management strategies control the moment of ignition and temperature/pressure of intake air at different engine speeds in order to ensure even engine runnind regardless of changes in environmental conditions and applied loads. They must also control and manage injection so that the stoichiometric ratio (air/fuel) is maintained within optimal levels.

System management strategies are essentially as follows:

1. injection management;
2. ignition management;
3. engine idle control;
4. fuel vapour recirculation management;
5. controlling knock;
6. heating/ventilation system management;
7. system self-adaption;
8. Fiat CODE lock management;
9. test management.

INJECTION MANAGEMENT

The ECU receives information on rpm (n) and throttle valve opening (alpha) and is then able to identify base pulse constant (ti) within a specific map.

Under various different engine service conditions, injector opening times are optimised by correcting times (in accordance with changing conditions) of: coolant temperature (1), air temperature (2) and signal received from lambda probe (3). Injection is synchronous at all times, i.e. timed to coincide with the moment of ignition.

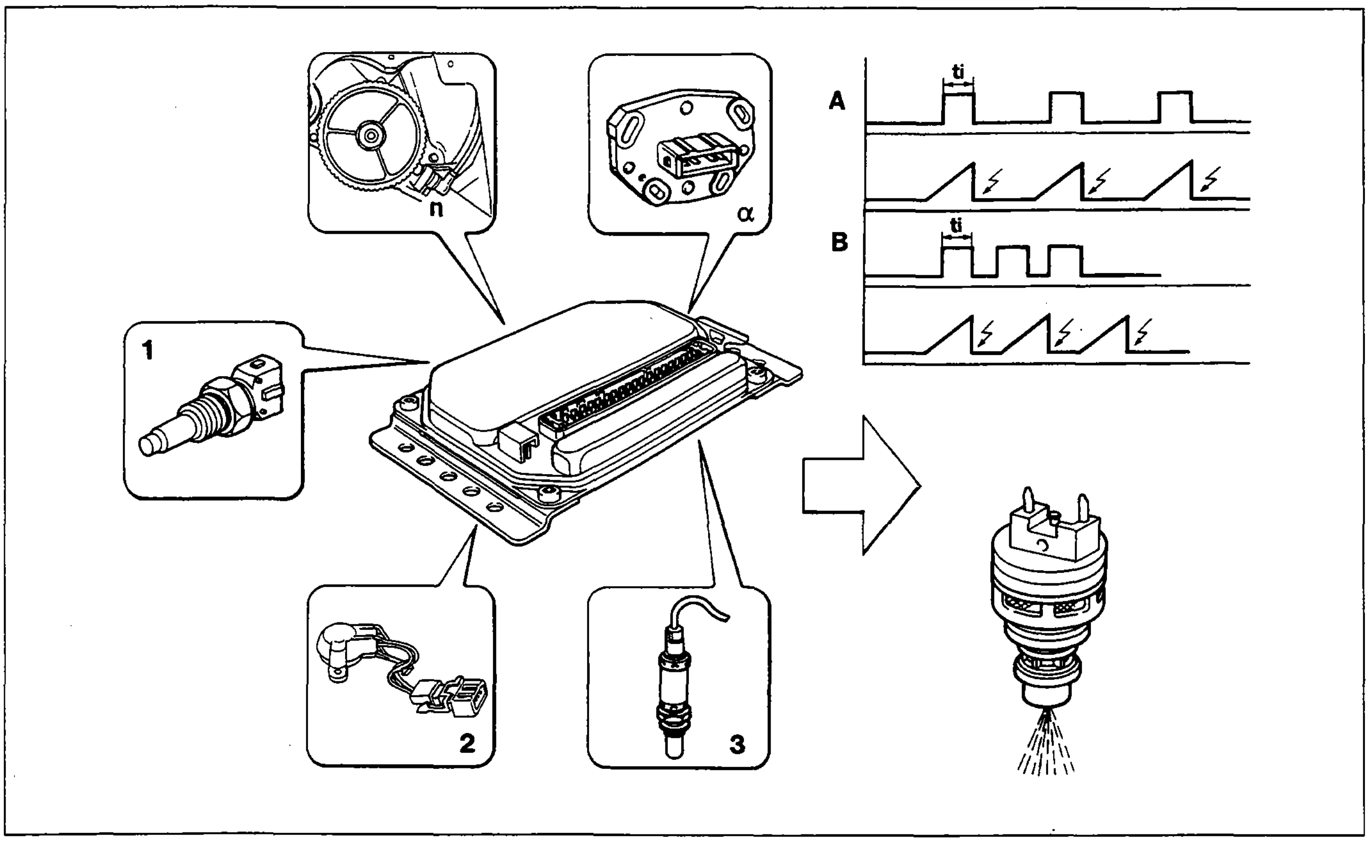
The ECU uses specially selected maps to keep fuel mixture concentration close to stoichiometric levels (14.7 parts air to 1 part petrol).

To maintain this ratio constant, **the ECU uses two different modes for the control of injector opening.**

The first mode is **synchronous operation, where the injector is opened whenever a high tension pulse is sent to the spark plugs** (graph A).

The second control mode is **asynchronous operation, where the ECU controls injector opening regardless of the number of high tension pulses sent to the spark plugs** (graph B).

This occurs because under certain conditions (with base pulse constants too short, ≥ 1.4 milliseconds) mechcanical inertia characteristics (hysteresis) of the injector do not permit proper opening and closure. For this reason, a specific strategy must be adopted to suit mechanical injector properties.



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Controlling supply to fuel pump

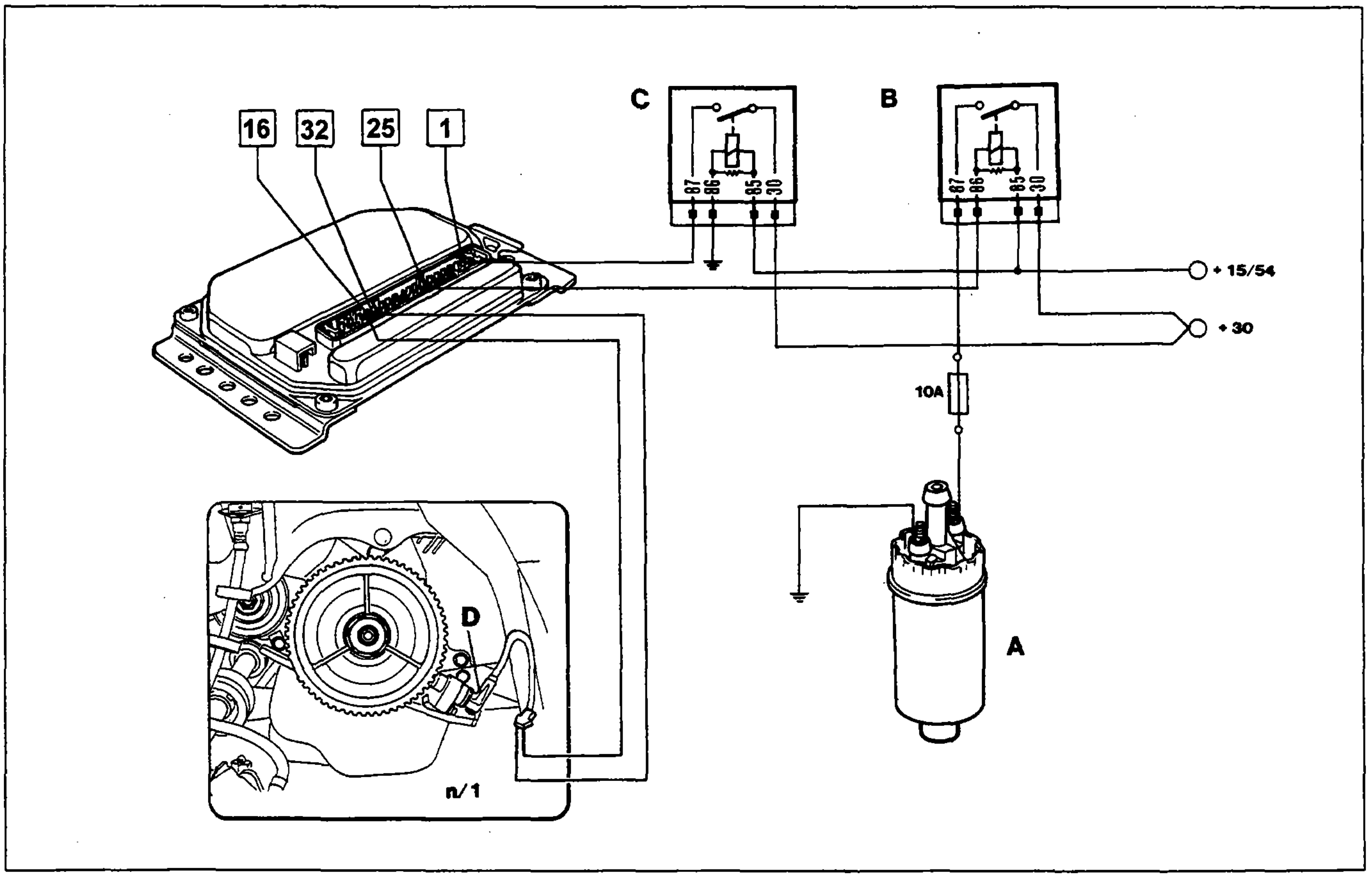
Control of fuel pump (A) is through the ECU which is responsible for turning on pump, by means of relay (B), during start-up and normal engine operation.

With ignition switch in MAR position (15/54), power is supplied simultaneously to pump relay (B) and main relay (C), which closes to provide power to the ECU (terminal 1).

A special circuit in the ECU earths pump relay (B) through terminal (25), which in turn supplies fuel pump (A) with power through a 10 A fuse. The pump puts the fuel system under pressure for about 1 - 2 seconds.

When the engine is started up, an rpm signal from rpm and TDC sensor (D) reaches terminals (16 and 32) of the ECU. After about 1 second, relay (B) is activated and the pump thus stops (for safety reasons) even with the ignition switch in MAR position.
If battery voltage drops below rated level (e.g. during cold starting), the fuel feed pressure tends to drop.

To overcome this drawback, the ECU increases injection time proportionally in accordance with a correction factor to ensure accurate fuel metering at all times.



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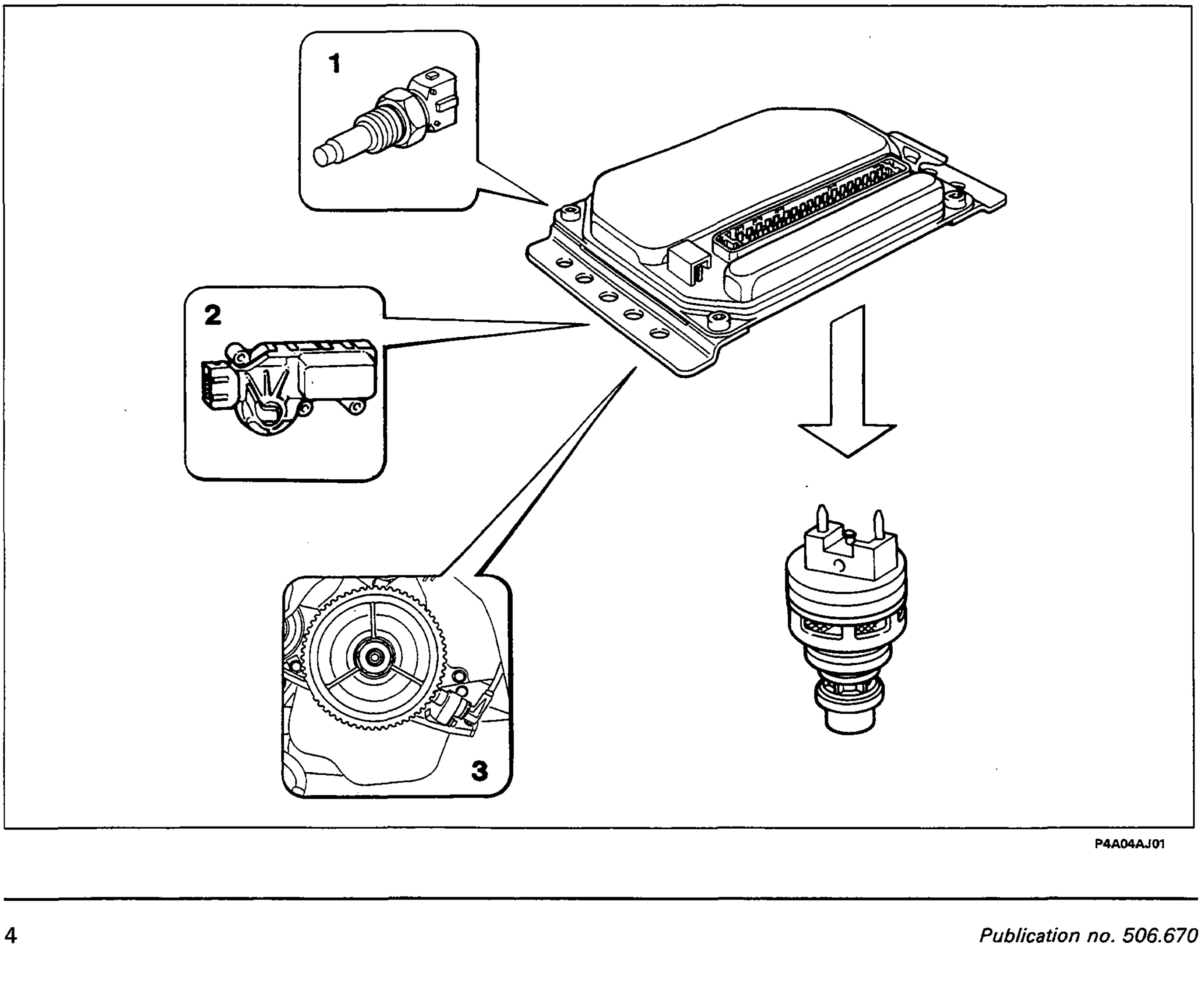
Starting

With the ignition key in MAR position, the ECU activates the electric pump for a few moments and obtains data from the various sensors.
According to information from coolant temperature sensor, the ECU commands throttle valve opening via direct current motor.**The control unit recognises the start-up phase when the rpm value reading from sensor (3) exceeds 30/min.**
At very low temperatures, base pulse constants increase: the injector stays open longer and a richer mixture is formed.
At very high temperatures, pulse constants are reduced to move closer to a stoichiometric ratio.
The control unit also contains an anti-flood function controlled by an internal timer that gradually reduces mixture enrichment when the engine fails to start for some reason.
During the stage following start-up, base pulse constants (ti) selected by the control unit are enriched by a function that varies according to coolant temperature and is cancelled with time.
This constant does not remain the same throughout the activation period but is reduced gradually (by a timer in the control unit)
During engine warm-up a further untimed coolant temperature-dependent enrichment takes place in addition to the enrichment that occurs after starting:
This enrichment falls gradually in inverse proportion to engine temperature.



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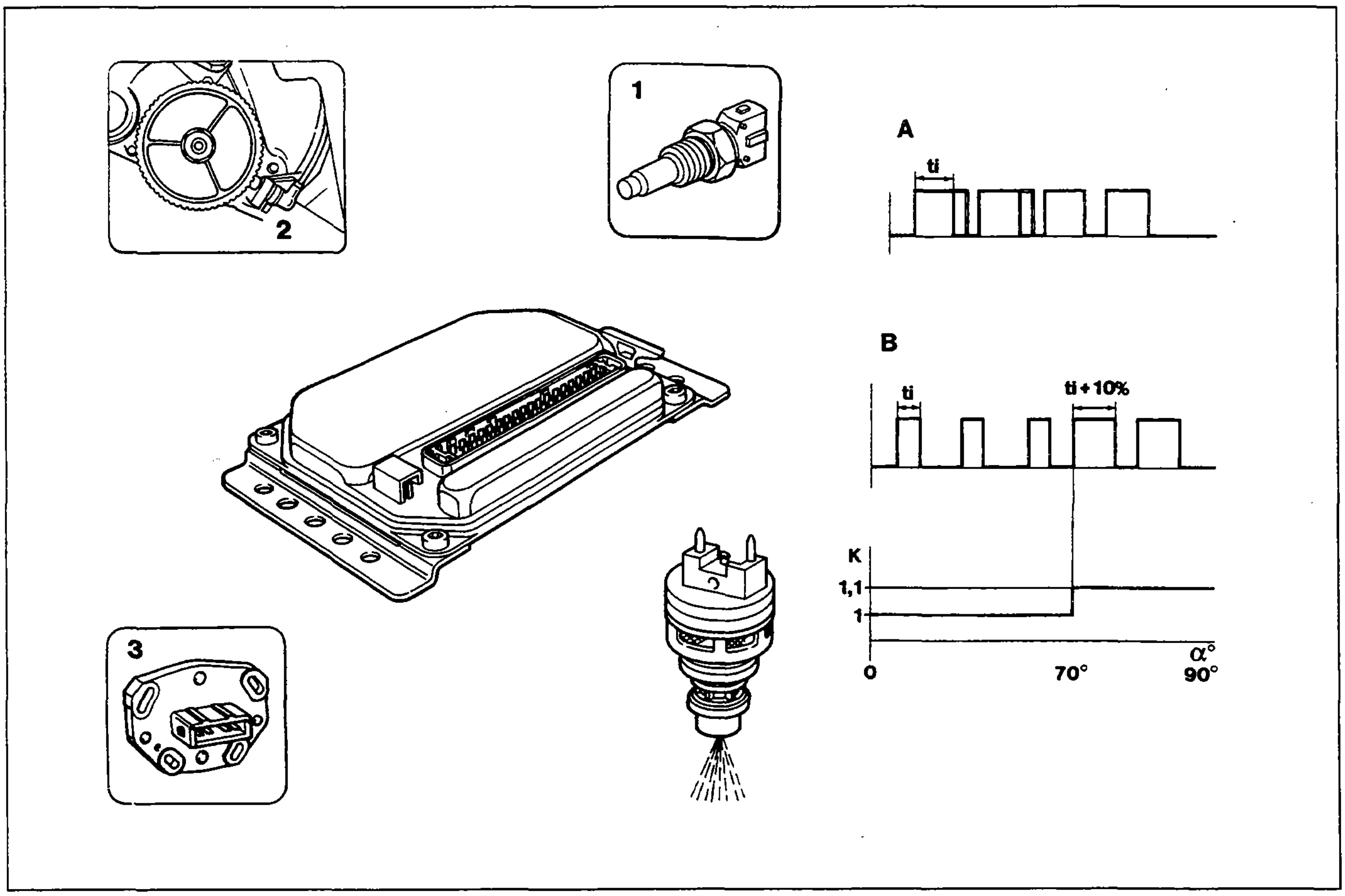
Acceleration and full power

During acceleration, the electronic control unit brings about enrichment of the mixture concentration (graph A) as a function of signals from the coolant temperature sensor (1), rpm sensor (2) and throttle valve angular position sensor (3).

When the engine is working at full power, base pulse constnants (ti) are increased by a factor (K) according to opening angle (α) of throttle valve (3).

When the butterfly valve opening angle exceeds 70° (graph B), fuel power enrichment comes into operation and increases base pulse constant by about 10%.

When rpm exceeds 6000/min, the control unit restricts maximum rpm (suppressing injection pulses by cutting off the fuel supply).



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Over-run and cut-off

During over-run, the mixture must be made more lean to reduce fuel consumption and polluting emission levels (HC + CO).

To achieve this aim, the control unit contains a function known as fuel CUT-OFF that is dependent upon the closure of contact (1) in the idle control motor at a given coolant temperature and rpm.

The first two conditions necessary for activating the CUT-OFF function are:

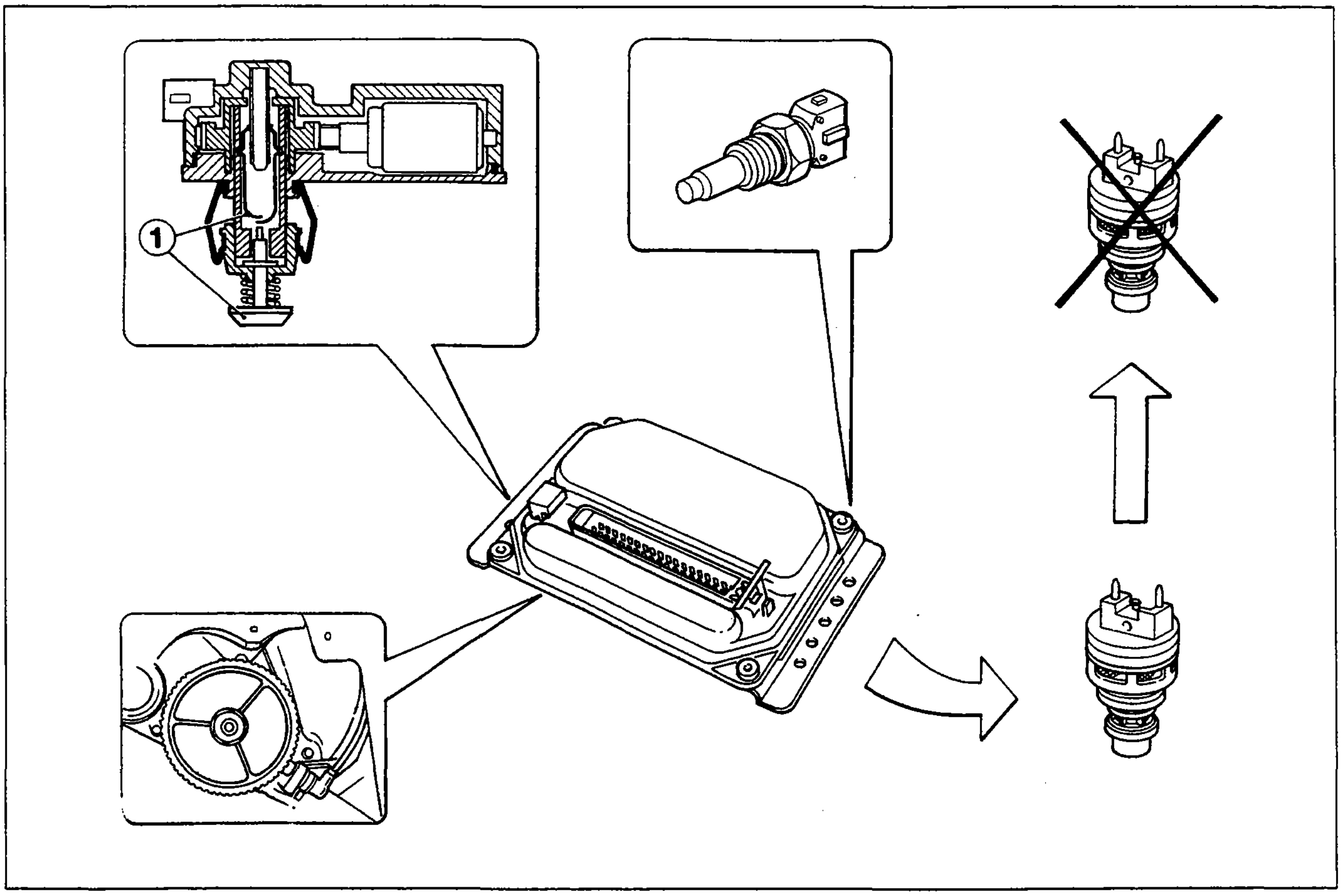
- coolant temperature in excess of 40° C,
- engine rpm in excess of 1800/min.

If the above over-run conditions exist, idle contact (1 - throttle closed) earths terminal 3 of the control unit, which cuts off fuel injection via terminal 21.

In addition to fuel cut-off, the control unit activates a specific ignition curve with "over-run" advance settings.

Fuel injection cut-off and specific advance curves remain in operation until the engine reaches a speed of 1500/min. Below this speed, injection pulses are activated to prevent the engine stalling.

When injection is restored, the control unit implements a fuel enrichment strategy in order to re-form the fuel film on the manifold and thus optimise engine efficiency.



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Lambda adjustment

The LAMBDA probe controls mixture concentration by measuring the residual oxygen content of exhaust emissions.

Because the ceramic is not active below 300° C, the LAMBDA probe is heated electrically by a resistance (inside the probe) that is continually supplied by a locked positive and protected by a 10 A fuse.

This heating is necessary during cold starts to maintain sensor efficiency if the engine idles for long periods.

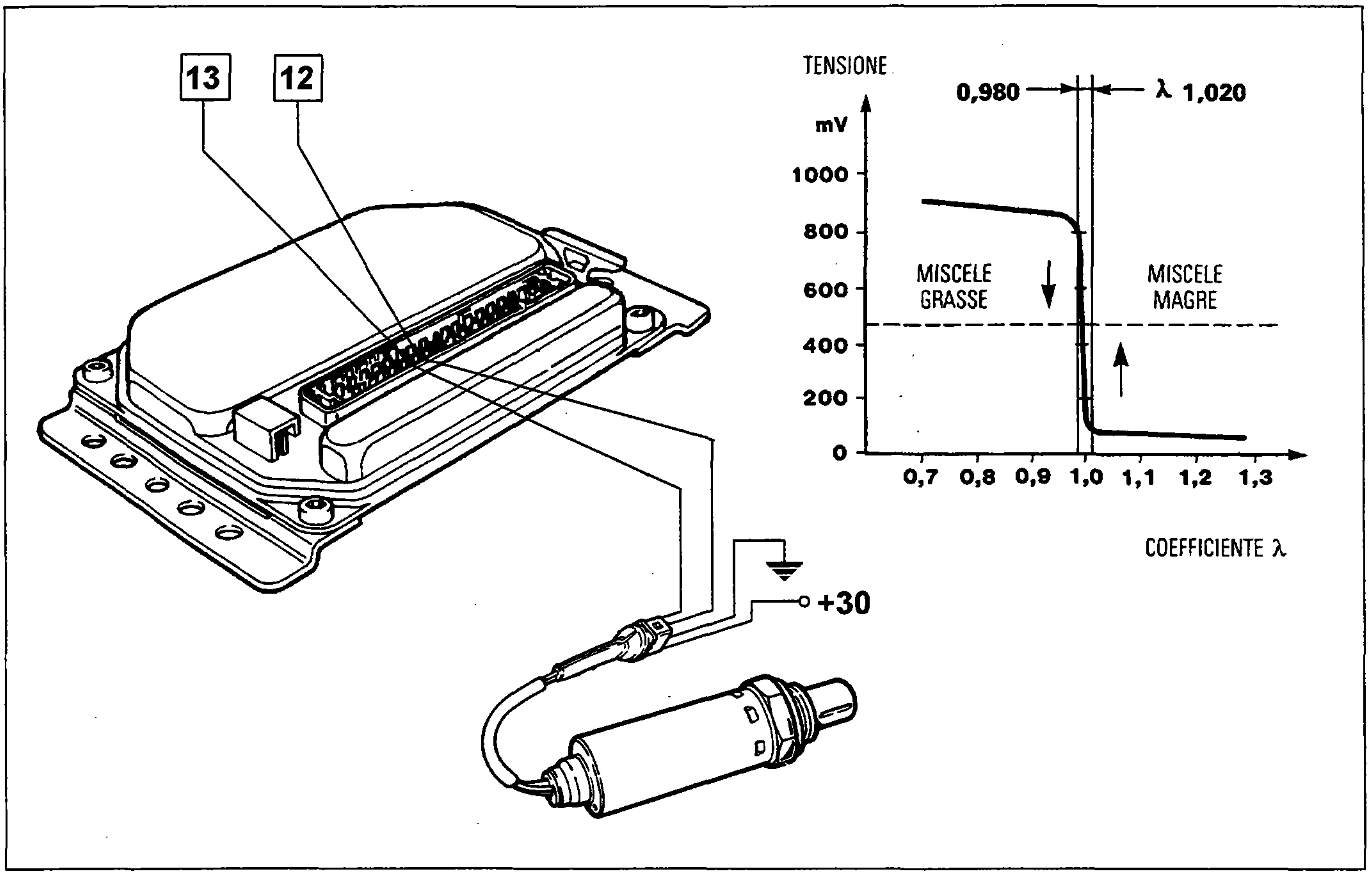
With temperatures in excess of 300° C, the ceramic becomes a conductor of oxygen ions. If the percentages of oxygen present on either side of the sensor differ, a voltage difference is set up across the two end poles.

The LAMBDA probe sends a voltage difference signal to the control unit through terminals (12) and (13).

LAMBDA probe measurements of exhaust gas composition allow the control unit to correct the mixture concentration continually on-line (leaner/richer) in order to maintain it close to a stoichiometric ratio. Efficient catalytic converter operation and low exhaust gas toxicity are dependent on an exact mixture composition.

During the above stages, injection pulse changes made by the control unit on the basis of the LAMBDA probe signal are excluded because they would be at odds with the required driving conditions; the engine thus operates in OPEN LOOP.

With both LAMBDA probe and control unit circuit working properly, the percentages of polluting exhaust gases are self-regulated by the system without the possibiilty of external regulation.



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10.

IGNITION MANAGEMENT

The ignition system is solid-state distribution type. In other words, moving parts are eliminated by doing away with a high tension distributor (case-brush-cap).

Coil (B) is fitted with four high tension outlets connected directly to the spark plugs. Their operation is managed entirely by control unit (A).

The control unit contains (in addition to fuel metering control parameters) a memory map (C) containing a set of optimal advance angles that can be used by the engine according to service conditions: engine load (α) and rpm (n).

The mapped values are obtained experimentally on a bench taking into account power, fuel consumption and polluting emissions.

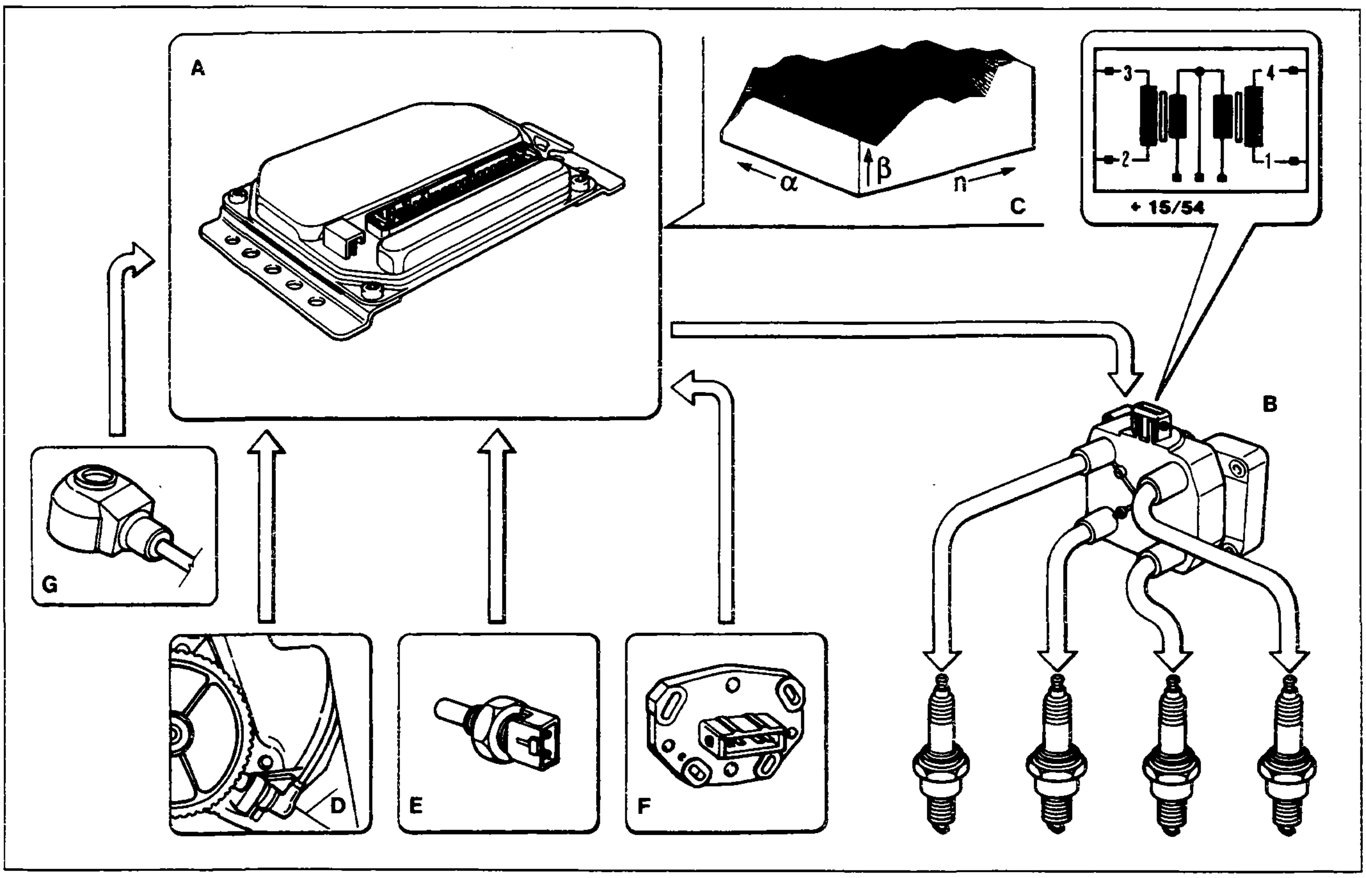
The control unit selects the appropriate advance value according to the memory maps, rpm (D), coolant temperature (E) and engine load (F), knock (G) and governs the ignition unit power module accordingly.

The control unit contains three different base advance angle maps to cater for changing engine service conditions:

- full load, settings mapped according to rpm and engine load.
- partial load, settings again mapped according to rpm and engine load.
- idling, where settings are mapped according to rpm.

The full load and partial load advance angle may also be subject to further corrections on the basis of engine temperature and air temperature. The idle advance angle is corrected only on the basis of engine temperature (non-constant value is about 7°).

The control unit contains an algorithm that computes the advance on the basis of rpm and battery voltage at which current begins to flow into the coil primary winding.



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The ignition coil consists of two primary windings connected to control unit (A) via terminals 34 and 35 supplied by battery voltage, and two high tension secondary windings whose outputs are connected directly to the spark plugs of cylinders 1-4 and 3-2.

The two spark plug pairs are supplied with high voltage whenever current is cut off in the primary winding by the power module. The high tension solid state distribution exploits the different pressure conditions existing simultaneously in cylinder pairs 1-4 and 3-2.
In practice, if an air/fuel mixture is present, the compression phase of one cylinder corresponds to the exhaust phase of the other.

If, under these conditions, the voltages required to set off a spark between the electrodes of a spark plug are examined, it may be noted that the voltage is very high during the compression stage (10 - 15 kV), but extremely low during the exhaust stage (in the order of 500 V).

Two sparks therefore cross the secondary circuit of each coil. One of these generates about 500 V and is in essence a wasted spark because it is triggered in the cylinder in exhaust phase, the other generates 10 - 15 or more kV in the cylinder in compression-exhaust stage in order to burn the air fuel mixture in the cylinder.

ENGINE IDLE CONTROL

The main aim of this strategy is to maintain engine speed at around the mapped setting (warm engine: 850 rpm): the position assumed by the actuator is dependent on engine conditions/rpm and vehicle speed.

Start-up stage

When the key is inserted, the actuator takes up a position dependent on engine temperature and battery voltage (open-loop position).

Warming-up stage

The rpm is mainly corrected on the basis of coolant temperature.

With the engine warm, idle management is dependent upon the signal from the rpm sensor. The ECU introduces sustained idle when external loads are activated.

Over-run

When the accelerator is released when the car is not idling, the ECU governs the actuator (step motor) by measn of special delivery curve (dash-pot curve), i.e. delays the return of the plunger to its housing to bring about a reduction in engine braking effect.

FUEL VAPOUR RECIRCULATION MANAGEMENT

Fuel vapours (legally recognised pollutants) are directed to an active carbon filter and then on to the engine where they are burnt. This is achieved by means of a solenoid controlled by the ECU only when engine load conditions are appropriate for permitting effective combustion without operation being impaired. The ECU compensates for the extra fuel by reducing fuel flow to the injectors.

CONTROLLING KNOCK

This function detects the presence of knock by processing a signal from a knock sensor. The ECU continually compares signals from the sensor with threshold values, which are in turn continually updated to take into account background noise levels and engine age.

The ECU is therefore able to detect the presence of knock (or incipient knock) and reduce the ignition advance until the effect disappears. The advance is then gradually restored to baseline levels.

When the car is accelerating, a higher threshold is used in order to take into account the increased engine noise under these conditions. The knock control strategy is also equipped with a self-adaptive facility which memorises advance reductions which are repeated regularly. In this way, the maps are adapted to the different conditions the engine encounters.

HEATING/VENTILATION SYSTEM MANAGEMENT

When the air conditioner comes on, the compressor takes up power from the engine which tends to stall when idling. To avoid this problem, the ECU adjusts air flow to the new power requirements by driving the relevant actuator (adjustment also takes place when the car is running in order to maintain optimum driveability). Another system function is to cut off the power supply to the compressor temporarily in the case of high power demands on the engine (powerful acceleration).

SYSTEM SELF-ADAPTION

The ECU comprises a self-adaptive function which recognises changes occurring in the engine due to settling and wear (this applies to the components and the engine itself).
Such changes are memorised in the form of changes to the baseline maps and serve the purpose of adapting system function to gradual changes in the engine and its components as the engine grows older.
This function also compensates for inevitable differences between original parts and new parts (due to production tolerances. Maximum performance is therefore achieved for all vehicles without the need for specific adjustment and test operations.
Self-adaptive parameters are lost if the ECU is disconnected.

FIAT CODE IGNITION LOCK FUNCTION MANAGEMENT

The system features an ignition lock function. This is implemented through a special FIAT CODE control unit able to dialogue with the engine control unit, and an electronic key with a specific sender unit designed for sending an identification code.
Once the key has been turned to STOP, the FIAT CODE system de-activates the engine control unit completely.
When the key is turned to MAR, the following operations take place in sequence:

1. the engine control unit (whose memory contains a secret code) sends the FIAT CODE a request demanding that a secret code be sent to de-activate the function lock:
2. the FIAT CODE control unit responds by sending the secret code only after receiving a recognition code sent by the ignition key;
3. recognition of the secret code allows the engine control unit lock to be de-activated and normal operation to proceed.

NOTE *When the FIAT CODE anti-theft system is present, it is extremely inadvisable to test the vehicle using another engine control unit. In this case, the FIAT CODE control unit would transfer the recognition code (unknown) to the test control unit, which would thus be rendered completely unserviceable on other vehicles.*

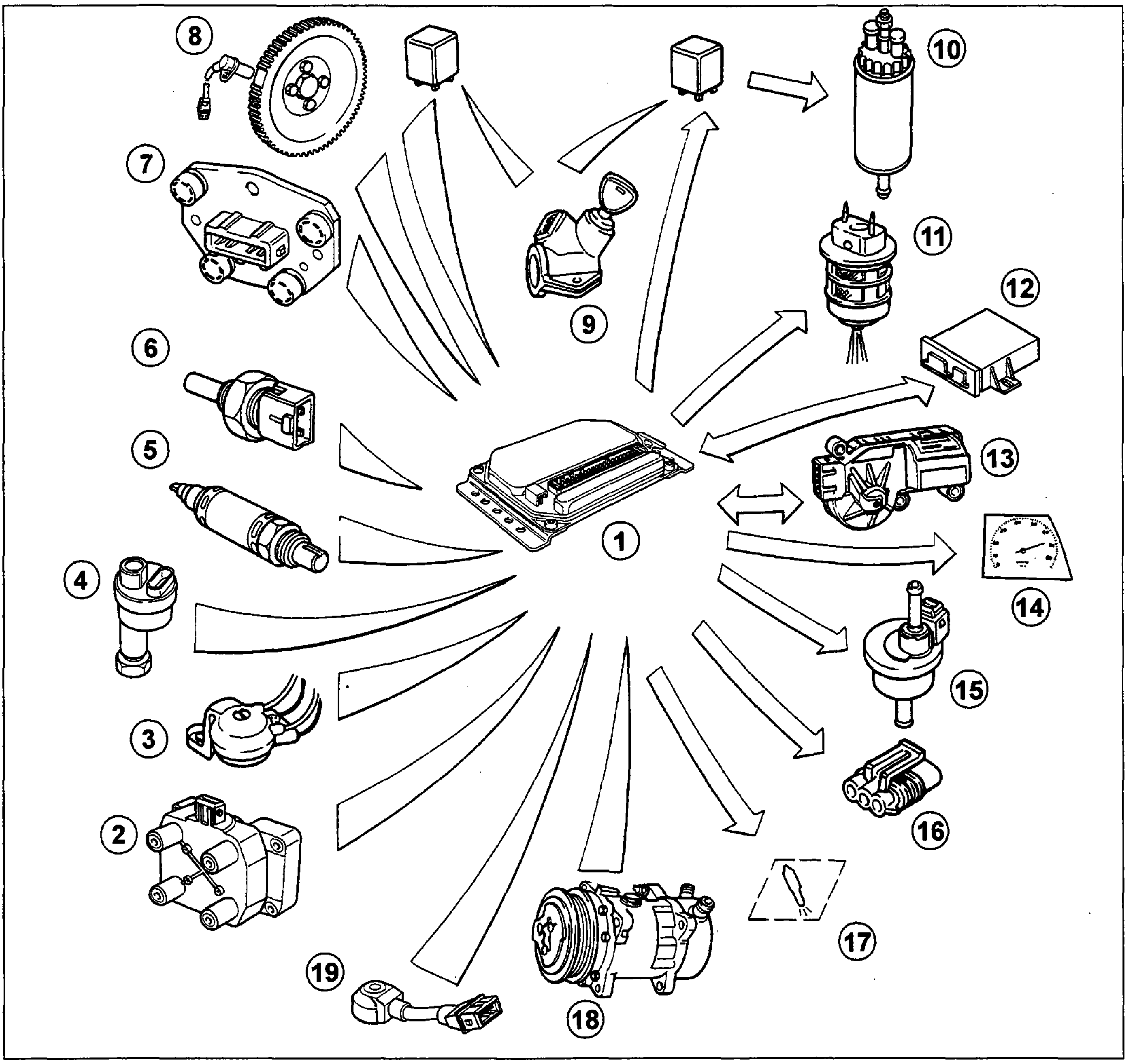
TEST MANAGEMENT

Full injection-ignition system electronic testing can be achieved by connecting a FIAT/LANCIA TESTER to the test socket.

The system is also equipped with a self-diagnostic function which recognises, memorises and indicates any faults.

If sensors or actuators are found to be faulty, signal reconstruction strategies are immediately activated (recovery) so that the engine is able to operate at an acceptable level without affecting function. The car can then be driven to a service point for the necessary repairs.

DIAGRAM SHOWING INPUT/OUTPUT BETWEEN ECU AND SENSORS/ACTUATORS OF THE BOSCH MONOMOTRONIC SPI INJECTION-IGNITION SYSTEM

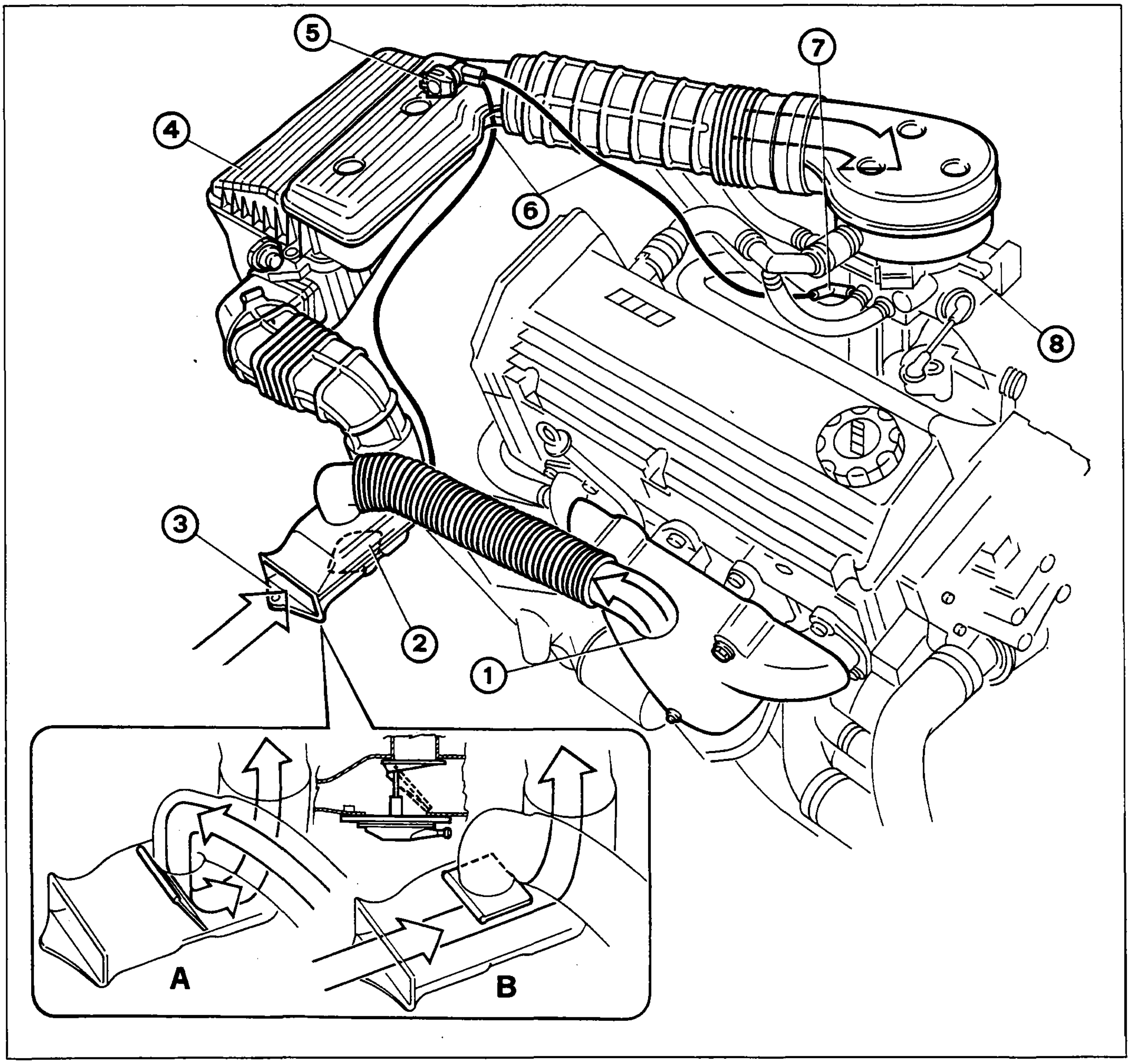


P4A11AJ01

Key to components

1. Electronic control unit
2. Coil
3. Air temperature sensor
4. Speedometer sensor
5. Lambda probe
6. Coolant sensor
7. Throttle position sensor
8. Rpm and TDC sensor
9. Ignition switch
10. Electric fuel pump
11. Injector
12. FIAT CODE control unit
13. Engine idle speed actuator
14. Rev counter
15. Fuel vapour cut-off solenoid
16. Diagnostic socket
17. Injection warning light
18. Air conditioner compressor
19. Knock sensor

AIR INTAKE CIRCUIT DIAGRAM

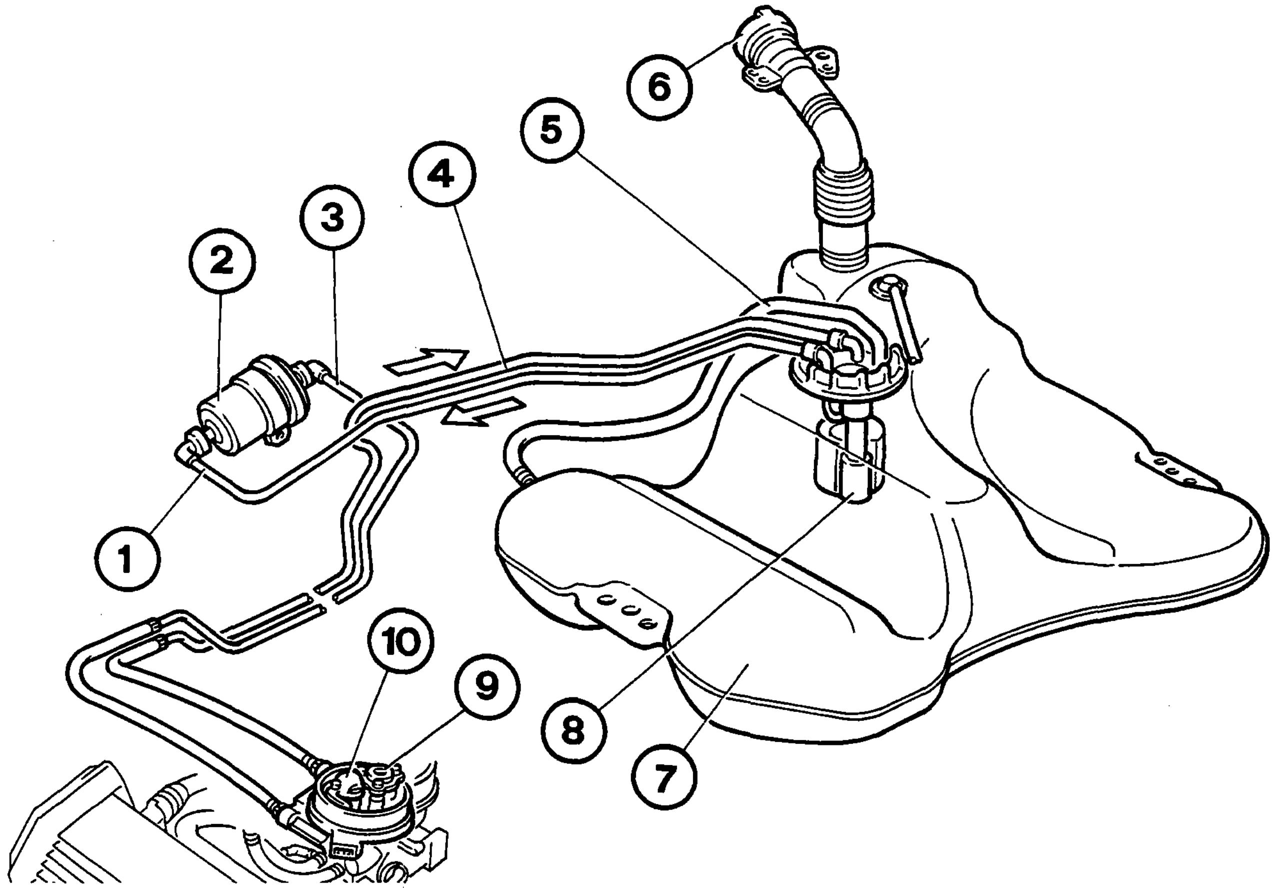


P4A12AJ01

1. Warm air intake on exhaust manifold
2. Actuator for warm/cold air deflector
3. Cold air intake fitting
4. Air cleaner
5. Thermostatic valve
6. Vacuum ducts
7. Vacuum socket
8. Throttle case

The air intake circuits comprises various components which ensure sufficient air is carried to the engine under different service conditions.
The intake of warm or cold air is selected by deflector (2) which may or may not be affected by the vacuum in the intake manifold according to position of thermostatic valve (5).
More specifically, when intake air temperature exceeds 9°C, thermostatic valve (5) stays closed and does not allow the vacuum to reach actuator (2) (position B).
Viceversa, when intake air temperature drops below 9°C, the thermostatic valve (5) opens to allow a vacuum through to actuator (2) (position A).

FUEL SUPPLY CIRCUIT DIAGRAM



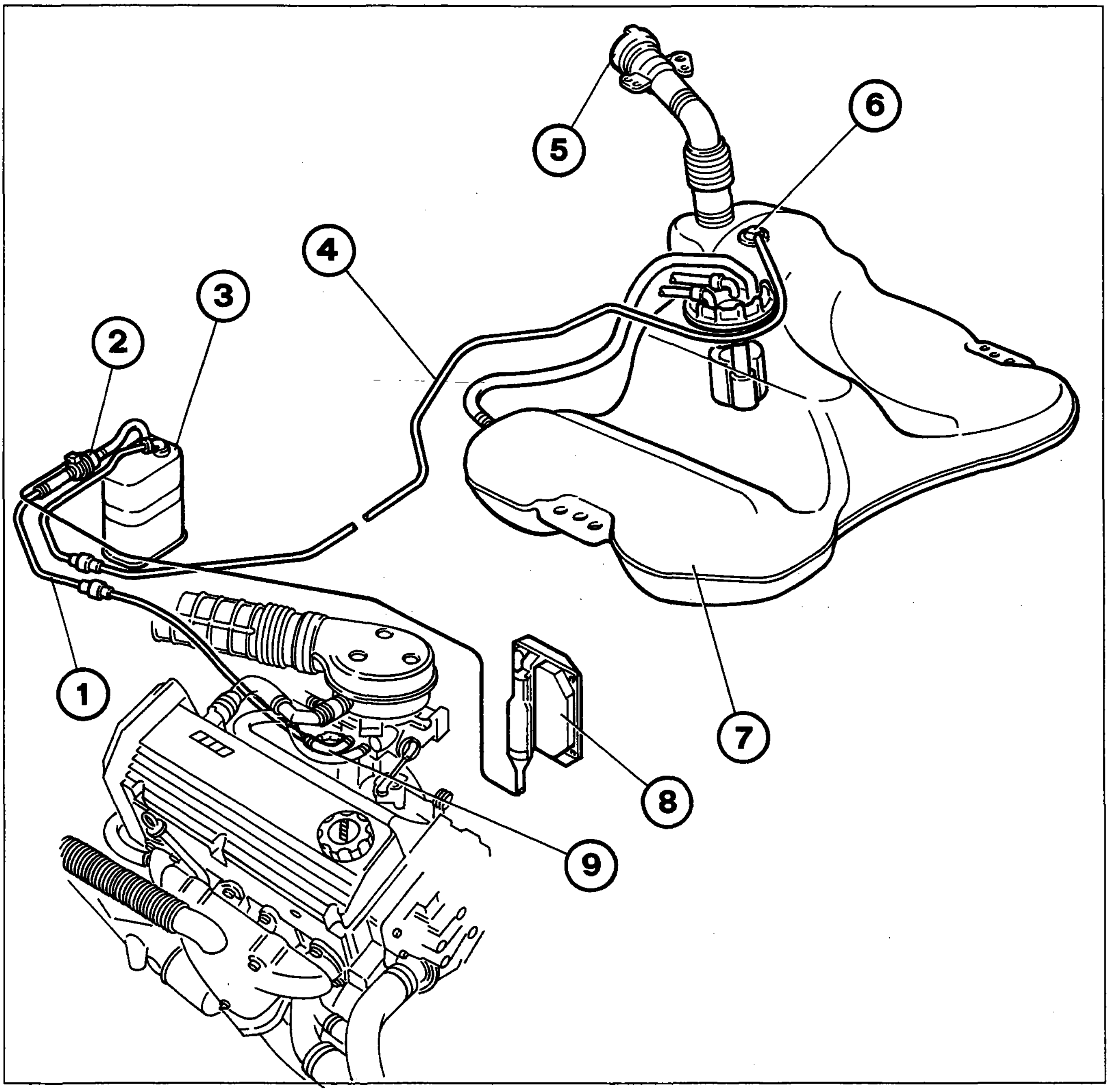
P4A13AJ01

1. Delivery line from tank to filter
2. Fuel filter
3. Delivery line from filter to injector
4. Return line
5. Vent pipe
6. Union with vent and pressure relief valve
7. Tank
8. Electric pump
9. Pressure regulator
10. Injector

NOTE *Due to the specific shape of the tank, when fuel is added, an air lock may build up at the bottom which could prevent complete filling. Pipe (6) allows air to flow from the lower part so that the tank can be filled completely.*

10.

FUEL EVAPORATION CONTROL CIRCUIT DIAGRAM

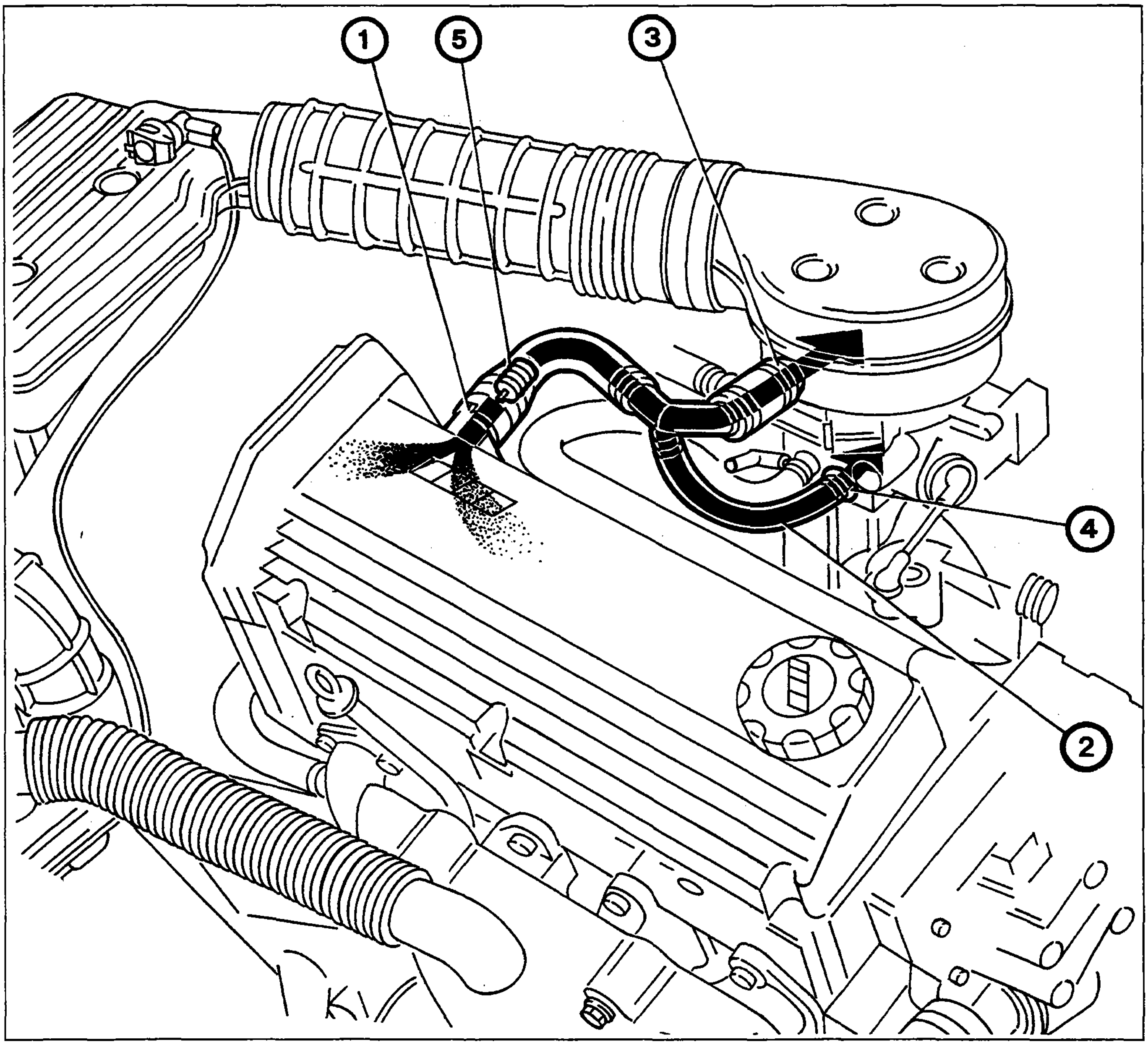


P4A14AJ01

The fuel evaporation system prevents fuel vapour, mainly comprising lighter hydrocarbon fractions formed in the tank, to escape into the atmosphere.

1. Pipe carrying fuel vapour to butterfly valve case
2. Fuel vapour cut-off solenoid
3. Carbon filter
4. Pipe carrying fuel vapour from tank to carbon filter
5. Safety and ventilation valve
6. Multifunction valve
7. Tank
8. Injection-ignition ECU
9. Fuel vapour intake fitting in intake manifold

BLOW-BY GAS RECIRCULATION DIAGRAM



P4A15AJ01

The system controls emission, from the engine block, of vent gases made up of air-fuel mixtures, burnt gases which leak through piston rings and lubricant oil vapours by recirculating them to the intake.

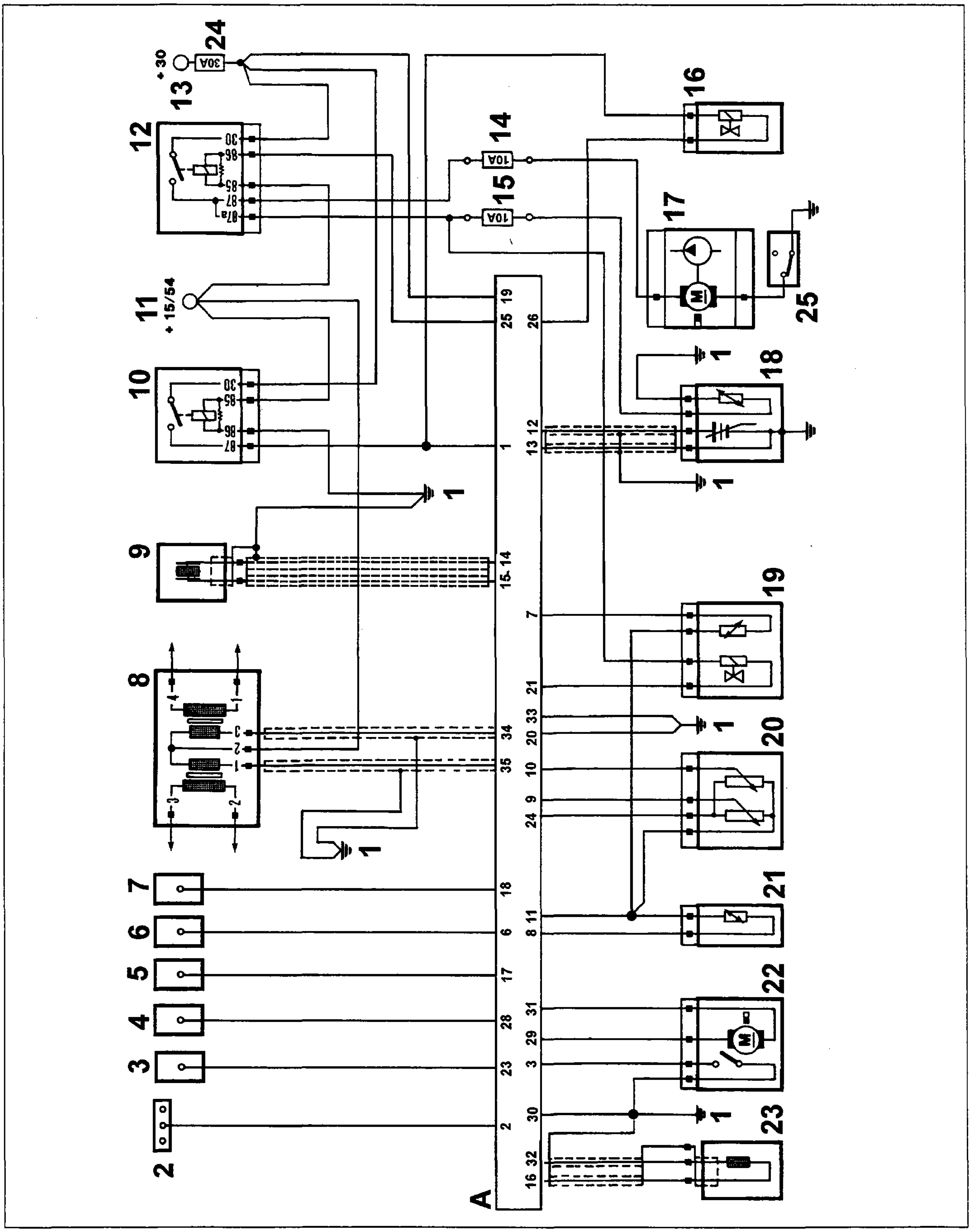
Gases emerge from outlet (1), which contains a flame trap (5) designed to prevent combustion caused by flame flashing back from the butterfly valve case.

With the accelerator throttle open, gases are taken in upstream of the throttle through intake (3) located on the air shroud to the butterfly valve case.

With the throttle closed (engine idling), the vacuum in the intake manifold takes up gas (in limited quantities) directly through the pipe (2) and calibrated hole (4).

10.

INJECTION-IGNITION SYSTEM WIRING DIAGRAM

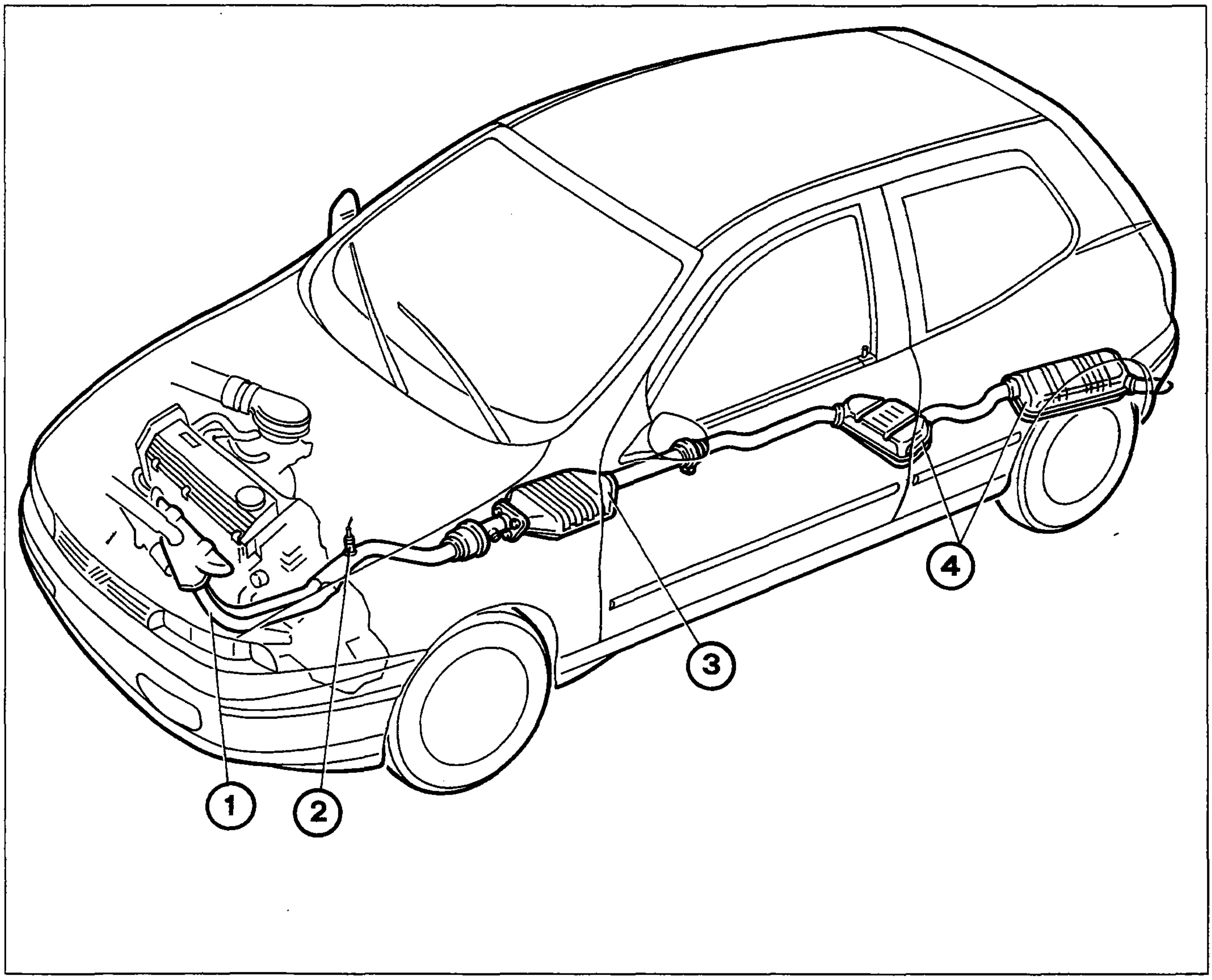


P4A16AJ01

Key to components in injection-ignition system wiring diagram

A. I.e. electronic control unit.
1. Earth
2. Diagnostic socket
3. Air conditioning system connection
4. System warning light
5. Rev counter
6. FIAT CODE control unit
7. Speedometer signal
8. Ignition coil
9. Knock sensor
10. I.e. system supply relay.
11. Ignition switch
12. Fuel pump and lambda probe relay
13. Battery positive (+30)
14. 10A fuse for fuel pump
15. 10A fuse for lambda probe heating coil
16. Fuel vapour cut-off solenoid
17. Electric fuel pump
18. Hot Lambda probe
19. Injector and intake air temperature sensor
20. Throttle valve position sensor
21. Coolant temperature sensor
22. Engine idle speed actuator
23. Rpm and TDC sensor
24. 30A master fuse for injection-ignition system
25. Inertia switch

ENGINE EXHAUST ASSEMBLY DIAGRAM

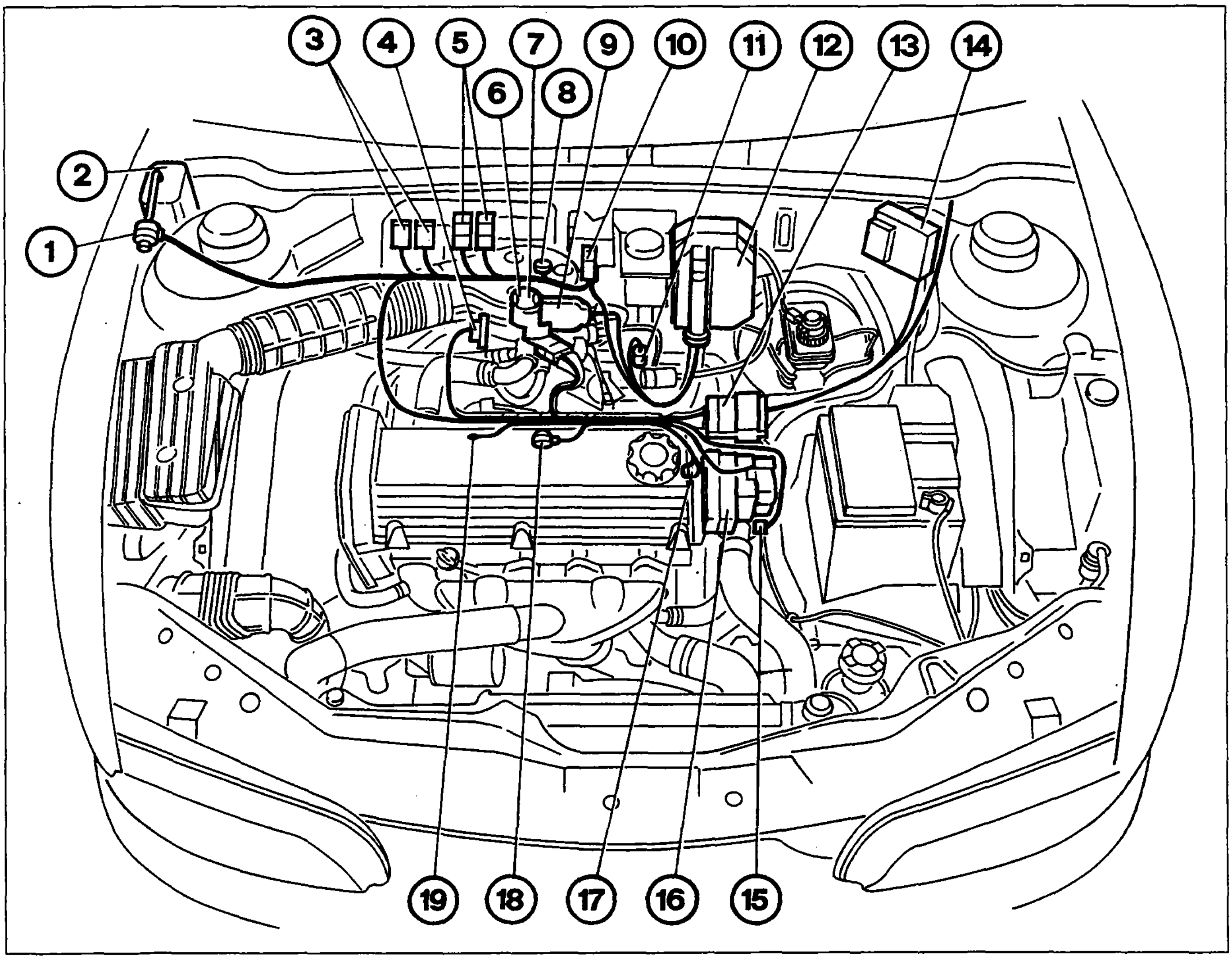


P4A18AJ01

Key

1. Exhaust manifold
2. Lambda probe
3. Catalytic converter
4. Silencers

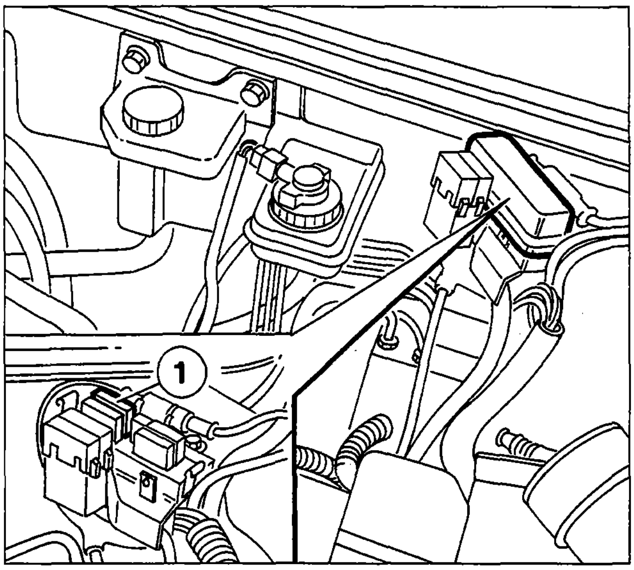
LOCATION OF INJECTION-IGNITION SYSTEM COMPONENTS IN ENGINE BAY



P4A19AJ01

Key to components

1. Fuel vapour cut-off solenoid
2. Carbon filter
3. 10A fuse for pump and injection-ignition system
4. Throttle position sensor
5. Pump and injection-ignition system relays
6. Injector
7. Air temperature sensor
8. Fuel pressure regulator
9. Engine idle speed actuator
10. Diagnostic socket
11. Lambda probe
12. Injection-ignition ECU
13. Joint between injection lead and front lead
14. General 30A system fuse
15. Coolant temperature sensor
16. Ignition coil
17. Rpm and TDC sensor
18. Knock sensor
19. Earth

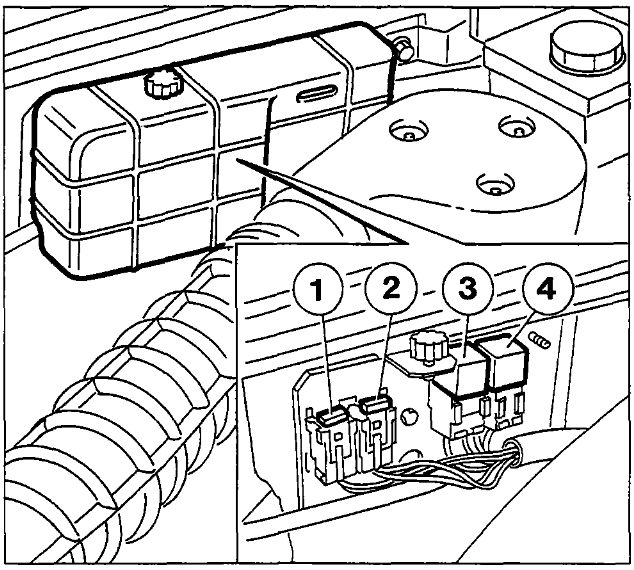


P4A23CJ01

INJECTION SYSTEM FUSES AND RELAYS

General system protection fuse

The general fuse (EFI-30A) protecting the injection-ignition system (1) is housed inside a container; to gain access to the fuse, undo side clips and lift lid.



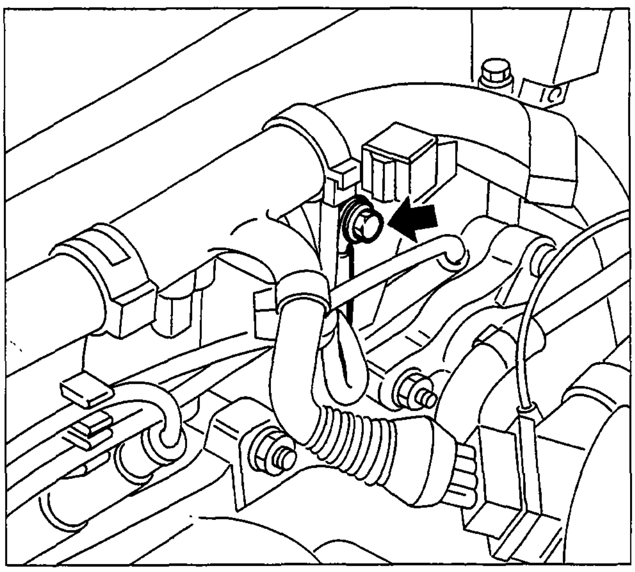
P4A20AJ02

Fuses and relays

The following components are housed on a bracket located against the rear wall of the engine bay:

1. 10A fuse for fuel pump
2. 10A injection-ignition system fuse
3. Injection-ignition system relay
4. Fuel pump relay

Unscrew ring nut and remove cover to gain access to the above components.



P4A20AJ03

EARTH POINT

The earth of the injection-ignition system is fixed at the right rear of the engine, close to the first cylinder spark plug.

COMPONENTS OF INJECTION-IGNITION SYSTEM

The injection-ignition system consists mainly of wiring, an electronic control unit (i.e. ECU) and the following sensors and actuators:

Sensors
- Speedometer sensor
- Rpm and TDC sensor.
- Knock sensor
- Coolant temperature sensor
- Throttle position sensor
- Intake air temperature sensor
- Lambda probe sensor

Actuators
- Engine idle speed actuator
- Fuel vapour cut-off solenoid
- Electric fuel pump
- Injector
- Ignition coil
- Spark plugs

INJECTION-IGNITION SYSTEM WIRING

The various system components are connected by a single wiring system fitted with connectors of various types. These are grouped in special ducts fitted to the engine (prewiring).

INJECTION-IGNITION ECU (0.261.203.868)

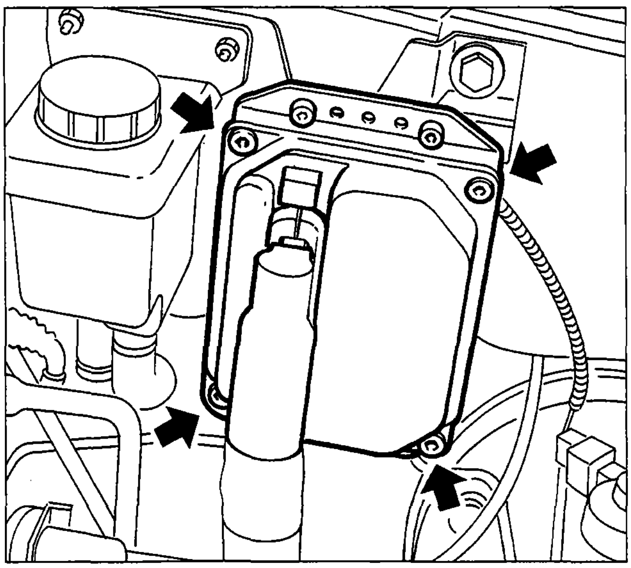
The ECU analyses data on engine service conditions transmitted by the sensors. Input signals from peripheral sensors are processes and injector/ignition timing pulses are governed with the aid of programmed typical curves.

The ECU is connected to the system by means of a 35 pin connector and protected by false polarities and circuit-breakers.

The ECU is able to detect when sensors are not working efficiently and replace incorrect or missing data with data taken from certain areas of its memory in order to ensure engine operation even under emergency conditions. It is also equipped with a full SELF-DIAGNOSTIC strategy for both input and output sensors. It also contains a special memory able to record any faults received during testing.

When a Fiat/Lancia TESTER is connected to the system it is therefore possible to test or display any errors stored in the memory.

Another important feature of the ECU is self-adaption. This function allows the system to recognise various changes (ranging from atmospheric changes to changes due to component wear) which could impair efficient engine operation and adjust to them by implementing appropriate strategies.



P4A21AJ01

Removing-refitting control unit

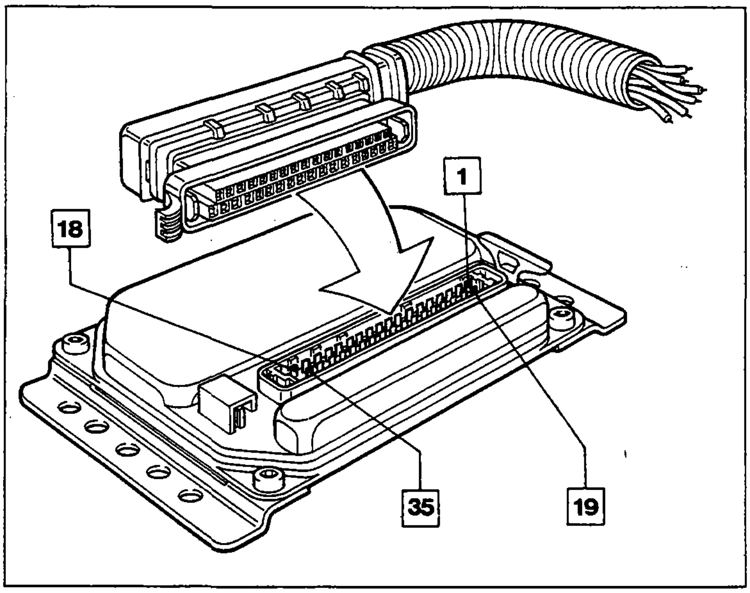
Disconnect electrical connection. Undo retaining nuts and remove ECU.

It is absolutely prohibited to exchange injection control units between different vehicles in order to check their efficiency.

Before replacing an ECU as a result of testing, ensure it is really faulty because when a new ECU is activated, the secret Fiat CODE system code is memorised and this makes the unit completely unusable on other vehicles.

10.

IDENTIFYING CONNECTIONS ON CONTROL UNIT (PIN-OUT)



P4A22AJ01

1. I.e. system supply relay.
2. Diagnostic socket
3. Engine idle speed actuator
4. Not connected
5. Not connected
6. FIAT CODE control unit
7. Intake air temperature sensor
8. Coolant temperature sensor
9. Throttle position sensor
10. Throttle position sensor
11. Power source for coolant temperature sensor, throttle position sensor and intake air temperature sensor
12. Lambda probe
13. Lambda probe
14. Knock sensor
15. Knock sensor
16. Rpm and TDC sensor
17. Rev counter signal
18. Speedometer sensor
19. Power supply (+30)
20. Engine earth
21. Injector
22. Not connected
23. Air conditioning system connection
24. Throttle position sensor
25. Fuel pump and lambda probe relay
26. Fuel vapour cut-off solenoid
27. Not connected
28. Injection system failure warning light
29. Engine idle speed actuator
30. Engine earth
31. Engine idle speed actuator
32. RPM and TDC sensor
33. Engine earth
34. Ignition coil
35. Ignition coil

RPM AND TDC SENSOR (0.281.002.102)

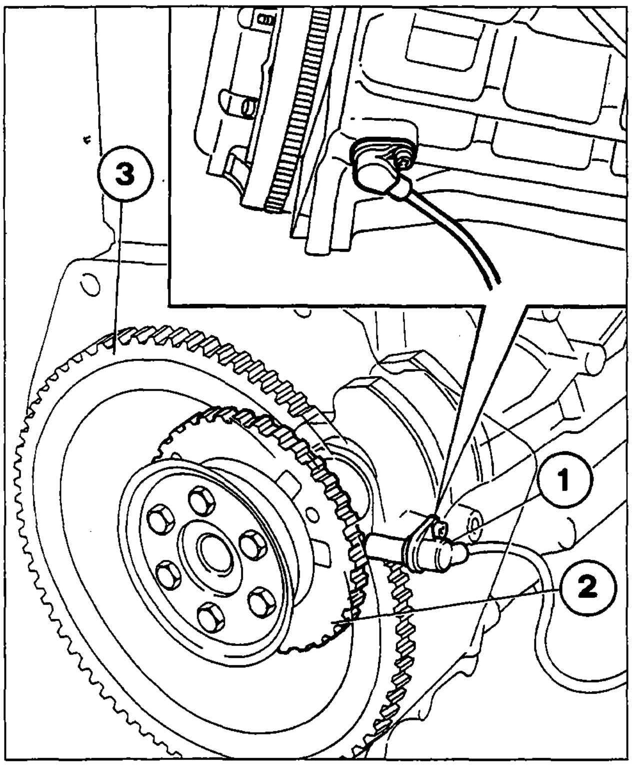
The sensor responsible for measuring rpm and TDC is inductive, in other words it works by means of changes in a magnetic field generated by teeth passing in front of a toothed pulley (phonic wheel) situated inside the engine block. The sensor is thus fastened to the engine block and it is no longer necessary to check and adjust gap or angular position.

The passage of teeth in front of the sensor alter the gap between pulley and sensor. The dispersed flow alters as a result to set up an alternating voltage with amplitude dependent on rpm.

The phonic wheel consists of 58 teeth plus a space equivalent to the gap left by two missing teeth.

The reference point defined by the gap left by two missing teeth is used as a basis for recording synchronism point (TDC).

Refer to Fuel System section for the 1581 16v engine for a more detailed description of sensor operation.



P4A23AJ01

1. Rpm sensor
2. Toothed pulley
3. Engine flywheel

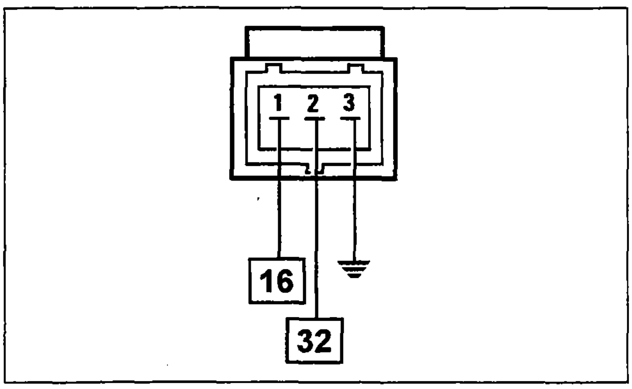
Removing-refitting

Position vehicle on a lift, then work from below the vehicle and proceed as follows:

- Disconnect electrical connection;
- unscrew screw retaining sensor and withdraw from housing.

Wiring connector

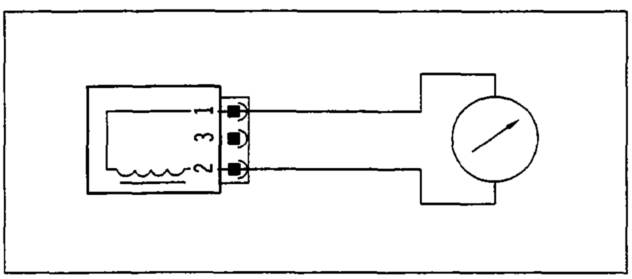
The sensor is connected to the ECU (pin 16 e 32) by means of twisted wires covered by an earthed interference-proof shielded sheath.



P4A23AJ02

NOTE *The numbers in boxes indicate the corresponding control unit pins.*

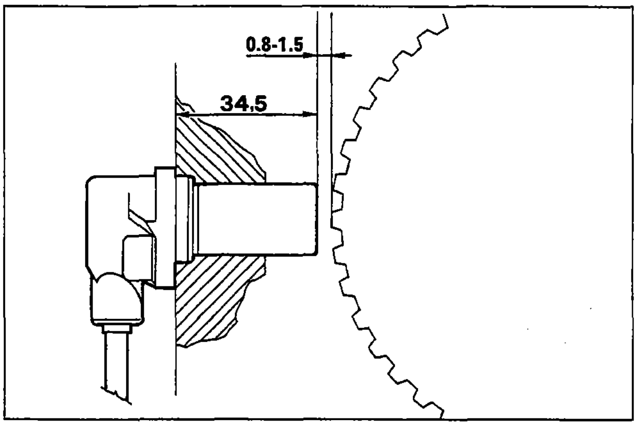
Checking resistance



P4A23AJ03

Sensor resistance may be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

Resistance: 774-946 ohm at 20°C



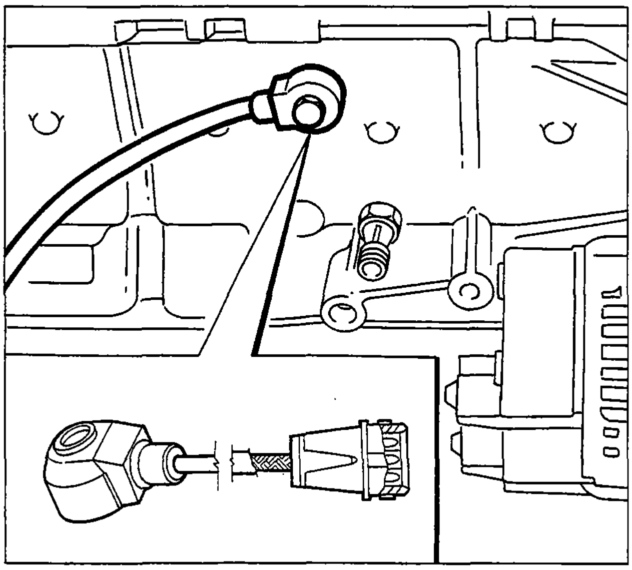
P4A24AJ01

Be sure to take the measurement at right angles to the phonic wheel and at the point of a tooth, not a depression.

Checking gap

Because the rpm and TDC sensor is secured directly to the engine block, gap and angular position do not require adjustment. If a fault is suspected, the gap can be checked as follows:

- remove the rpm and TDC sensor;
- check that the distance between the sensor contact surface and phonic wheel tooth corresponds to the sum of sensor probe length (34.5 mm) and gap (0.8 - 1.5 mm).


P4A24AJ02

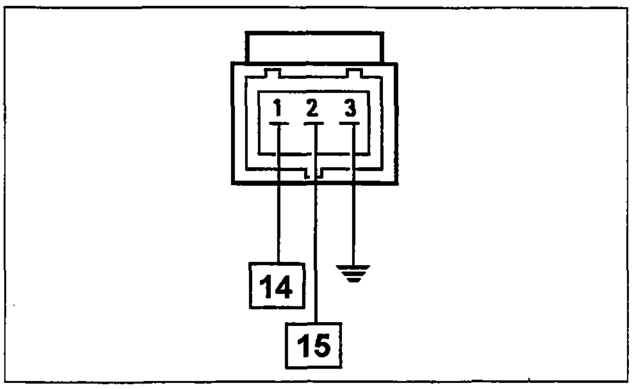
KNOCK SENSOR (0.261.231.007)

The knock sensor is located on the rear of then engine block, between cylinders 2 and 3.

Refer to the fuel system section for the 1998 20V engine for a more detailed description of operation.

Recovery

Ignition advance delay: 8° - 9° according to engine speed.
Knock control deactivation
If the fault relates to the sensor interface circuit, the ECU assumes an ignition advance delay of 10°.



P4A24AJ03

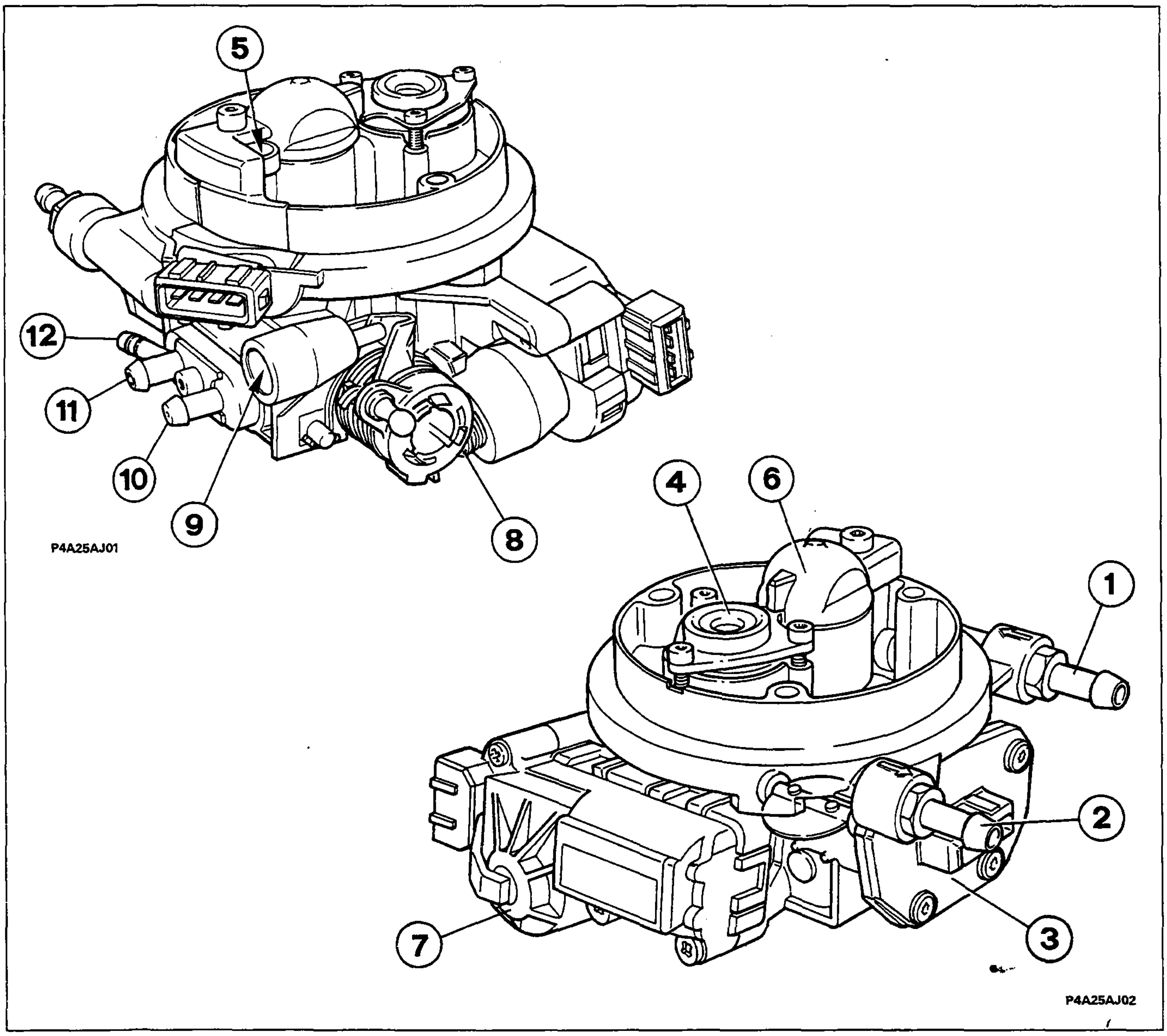
Wiring connector

The numbers in boxes indicate the corresponding control unit pins.

THROTTLE CASE (0.438.201.523)

All the components of the aluminium butterfly valve case or injector turret are highly miniaturised and the unit is extremely compact. Most system sensors and actuators are fitted to this unit:

1. Fuel intake fitting
2. Fuel return fitting
3. Accelerator throttle position sensor (potentiometer)
4. Fuel pressure regulator
5. Intake air temperature sensor
4. Injector
7. Director current motor for idle speed control
8. Throttle closed recognition microswitch incorporated in motor (7)
9. Throttle position adjustment screw (do not touch)
10. Crankcase oil vapour recirculation fitting (BLOW-BY)
11. Fitting for intake of fuel vapour from carbon filter through cut-off valve
12. Fitting for thermal valve control vacuum on air cleaner



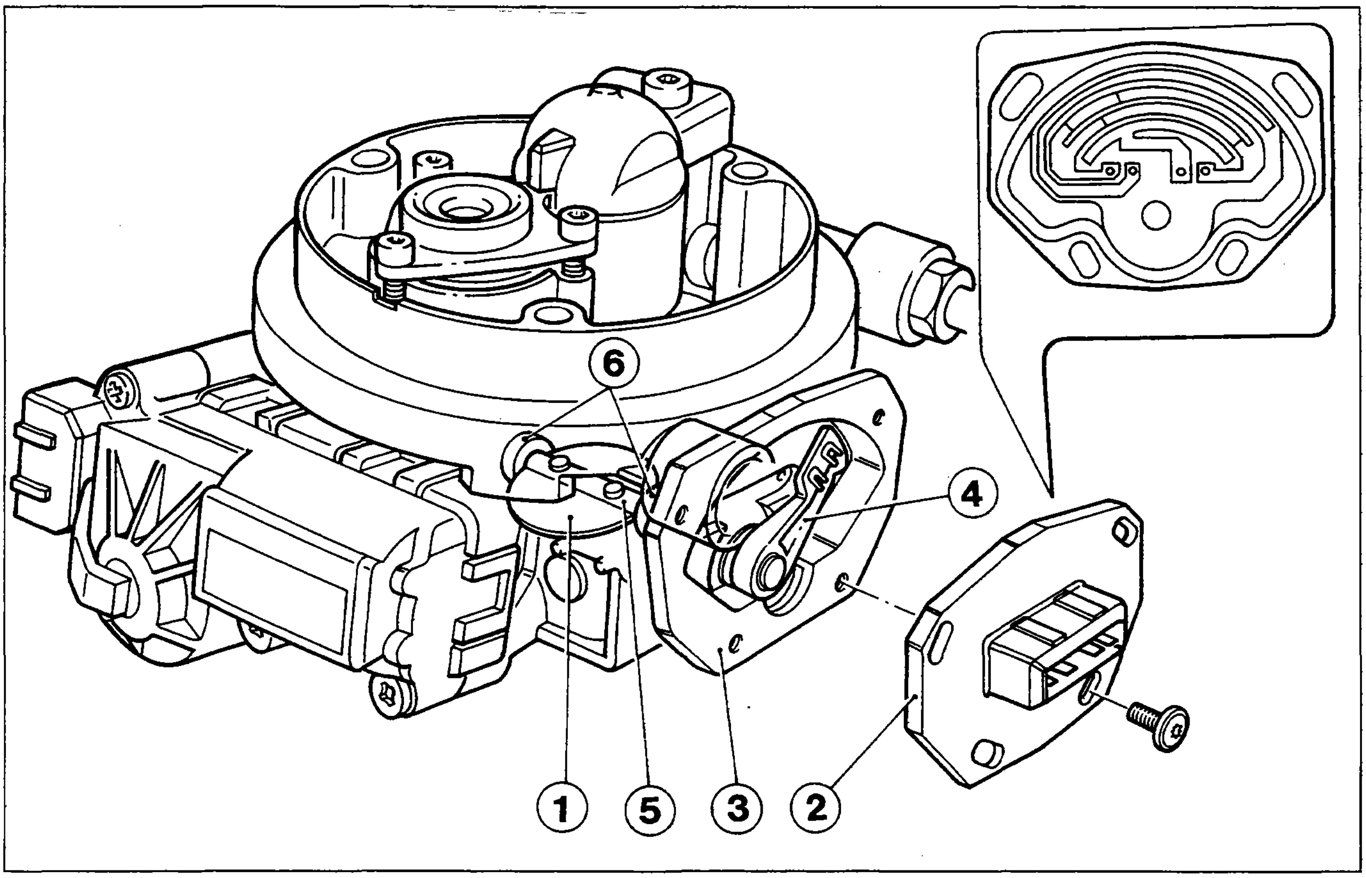
Throttle angular opening sensor

The angular position signal (α) from throttle (1) plays a fundemental role in determining base pulse constant.

This signal is recorded by a dual-race potentiometer (2) fitted to butterfly valve case by means of a brush with two double rows (4) integral with the throttle valve spindle (5).

The throttle sprindle is fitted on two ball bearings (6) to prevent binding or errors when measuring angle α.

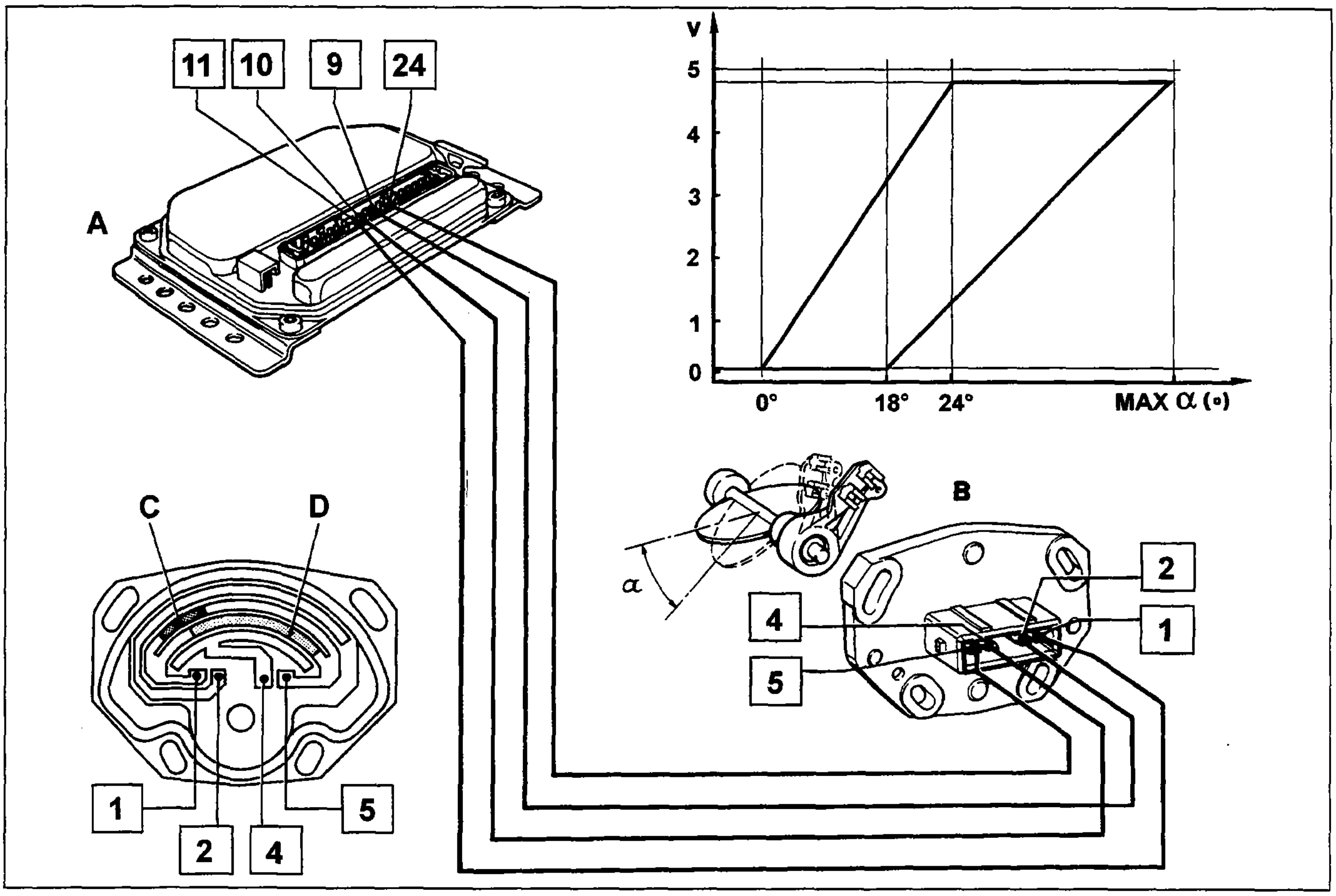
The position of potentiometer (2) is adjusted in relation to the butterfly valve in the factory and should never be removed for any reason. Replace butterfly valve case assemby if found to be faulty.



P4A26AJ01

The ECU (A - see figure overleaf), supplies terminal 5 of the throttle angular opening sensor (B) with a stabilised reference voltage of 5 V (constant) through terminal 24.

A voltage signal measured on the first race (C) is sent to terminal 9 of the ECU from terminal 2 of the potentiometer. This is proportional to the positions taken up by the throttle during the first 24° (0° - 24°) of opening.



P4A27AJ01

The signal therefore assumes a value close to 0 Volt when the throttle is completely closed, and a value close to 5 Volt for an opening of 24° in relation to rest position.

The throttle opening range from 0° - 24° corresponds to tend reference points in the ECU map (α). These represent the ten main positions taken up by the throttle valve. In this way, the ECU may recognise small angular changes in the order of 2°25'.

This high degree of sensitivity allows the ECU to select base pulse constant from the specific maps with greater precision under critical engine service conditions, i.e. when idling and under partial load.

From 18° of throttle opening up to full opening (about 90°), a signal is produced by terminal 4 of potentiometer (B), i.e. terminal of second race (D).

This signal is sent to terminal 10 of the ECU and relates to engine service conditions at medium and full loads.

The field of the second race is divided into ECU maps α with lower resolution than the first race, i.e. into 5 points corresponding to angular throttle changes of about 13°. The entire opening range of the throttle valve therefore corresponds to 15 significant points or openings (alpha). These are identified by the ECU by means of two potentiometer races.

With throttle valve opening angles between 18° and 24°, both voltage signals present simultaneously at terminals 2 and 4, first and second race respectively, should respect a certain ratio.

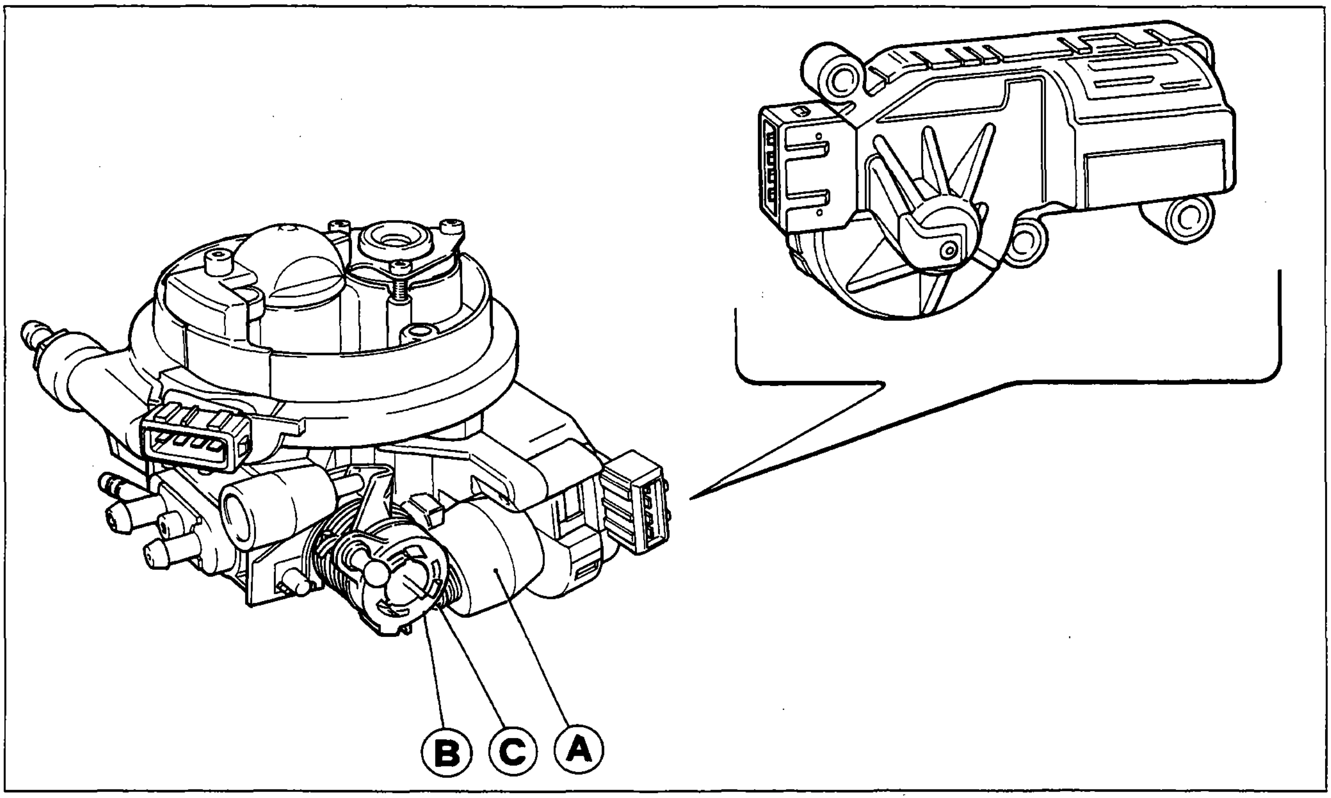
Under the above conditions, the ECU runs a plausibility check to test signals from the first race (C - minimum/partial load) are perfectly synchronised with those of the second (D - medium/full load).

Terminal 1 of the potentiometer is earthed through terminal 11 of the ECU.

Recovery
The potentiometer emergency/safety function is activated when faults prevent the ECU from measuring the actual throttle openng angle (α).

- when race 1 of the potentiometer is faulty, predefined safety injection times and ignition advances are set. The idle regulation motor is set to an emergency position.
- when race 2 is faulty, only a safety injection time and a safety ignition time are set.
- when synchronisation is faulty, the last data item saved is set as the offset between both races.

Direct current motor for idle speed control
Idling rpm level is adjusted automatically by the ECU through a 12 V direct current electric motor (A). This acts directly on linkage (B) of the throttle control valve through a reduction system.
The throttle opening motor incorporates a microswitch (C), which is closed when the accelerator pedal is at rest (released).
Contact closure activates the two-fold CUT-OFF function during over-run and automatic idle adjustment.



P4A28AJ01

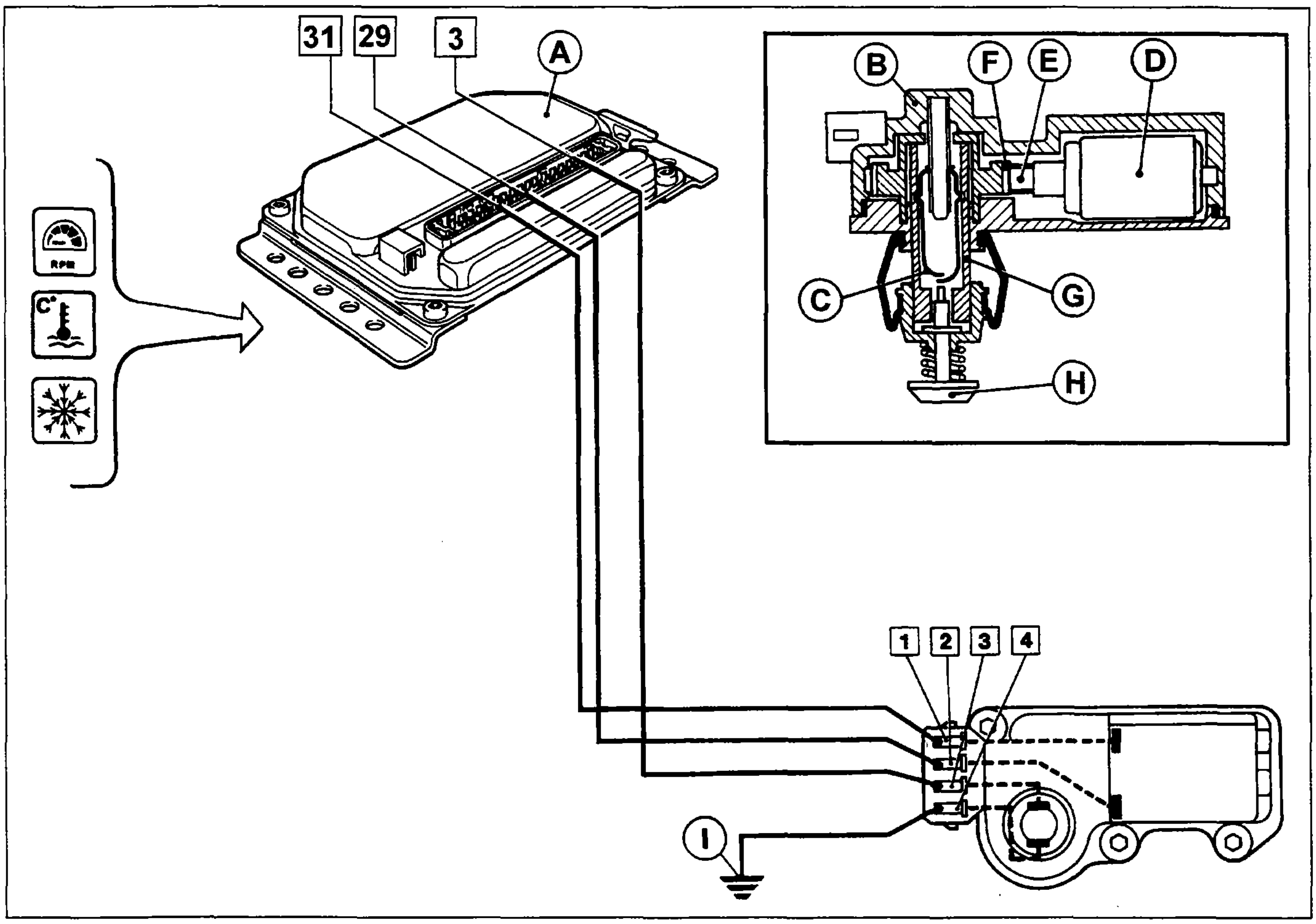
Injection pulses are restored after a period of CUT-OFF and idle speed regulation is activated by the ECU (A see figure overleaf), mainly on the basis of rpm and coolant temperature.
The electronic system is also able to take into account other parameters, namely: engine in start-up or or warm-up mode, air conditioner activated.
The idle control function is activated by closure of contact (C see figure overleaf) which connects terminal 3 of the ECU to earth through terminals 3 and 4 of the connector of motor (B) at point (I).
Whenever necessary, the ECU supplies regulation motor (D) through terminals 29 and 31 so that the throttle valve opens and closes to correct idle speed.
An electronic switch inside the ECU reverses motor polarity in order to produce two directions of rotation (clockwise and anticlockwise).

When motor (D) is activated, the reduction unit is set in rotation. This consists of a worm screw (E) and helical gear (F).

The helical gear contains a worm screw which microswitch case (G) moves along in both directions so that the case can move in and out according to wheel rotation direction.

At the end of its travel, plunger (H) acting on throttle valve linkage can bring about a maximum opening of about 18°.

If a fault has been established, the idle control motor can be obtained as an individual part.



P4A29AJ01

Recovery

In the case of an error on the idle contact (short circuit or circuit open) the ECU implements one of two strategies according to time of recognition:

- recognition (circuit open) when key is positioned on MAR, no recovery value obtained (ignored);
- recognition (short circuit or circuit open) with key set to MAR, the ECU drives the d.c. motor to a safety position (throttle in idling position).

In the case of an error on the motor (locked or defective, drive stage broken or defective), revealed by a comparison between drive value and actual position under actual idling contact conditions, the ECU activates an rpm limitation, which ranges from 1400 to 2000 rpm.

Injector

The injector performs the function of nebulizing the fuel necessary for forming the fuel mixture. It is made out of stainless steel for more effective resistance to any impurities present in the fuel. It is connected in a central position on the injector turret above the butterfly valve.

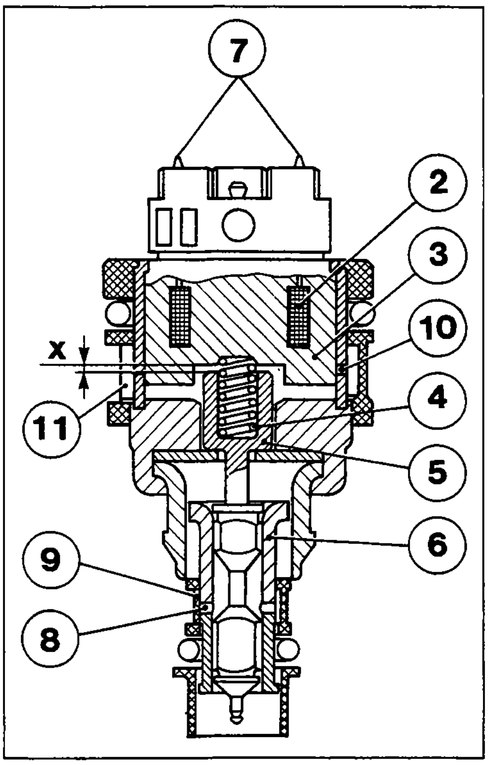
It consists of an outer case (1) containing coil (2) with a ferromagnetic core (3) and spring (4), which performs the task of holding plunger (5) closed against the seat on bcase (6). The assembly is completed by other parts: electrical contacts (7), fuel intake channel (8) with filter (9), fuel outlet channel (10) and filter (11).

Control pulses from the ECU reach the injector through electrical contacts (7) to set up a magnetic field about core (3) through winding (2). Plunger (5) then lifts from its seat to overcome the load of counter-spring (4) and bring about injector opening.

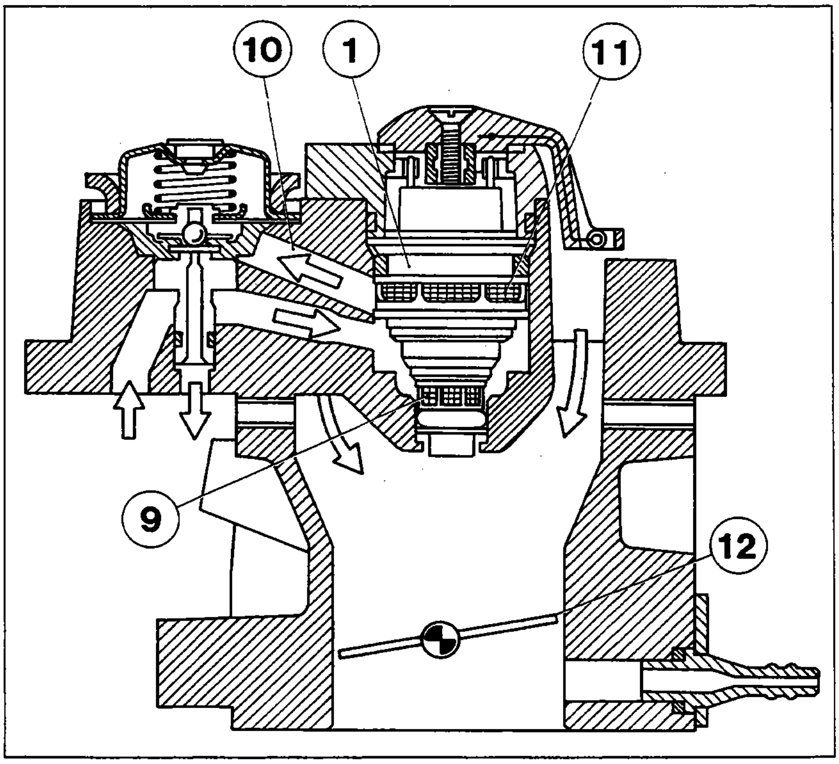
Plunger height is 0.06 mm (height **x**); If physical fuel properties are constant, the amount injected depends solely on injector opening time (injection time), which is established by the ECU according to engine service conditions.

The fuel jet leaves the injector at a pressure of about 1 bar, is immediately nebulized to form a cone of 30° - 90° and injected upstream of the accelerator throttle. Injector control is synchronous, i.e. one injection per ignition command.

A hole (12) on the accelerator throttle is designed to optimise mixture distribution within the intake manifold while the engine is warming up.

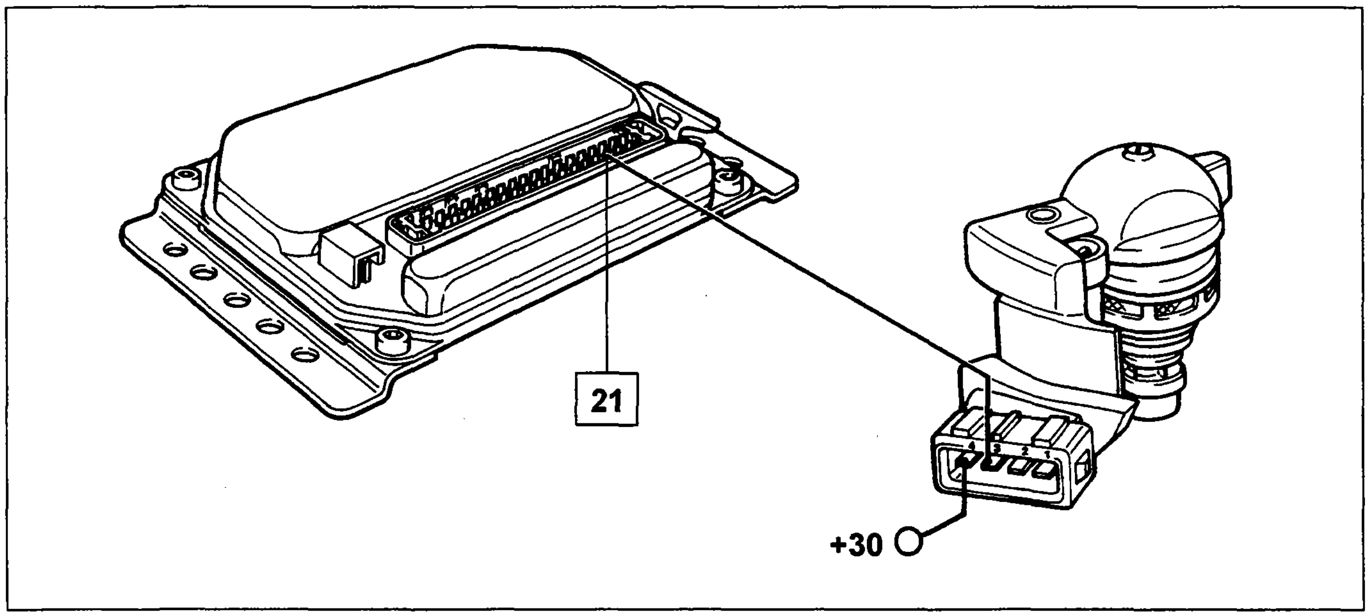


P4A30AJ01



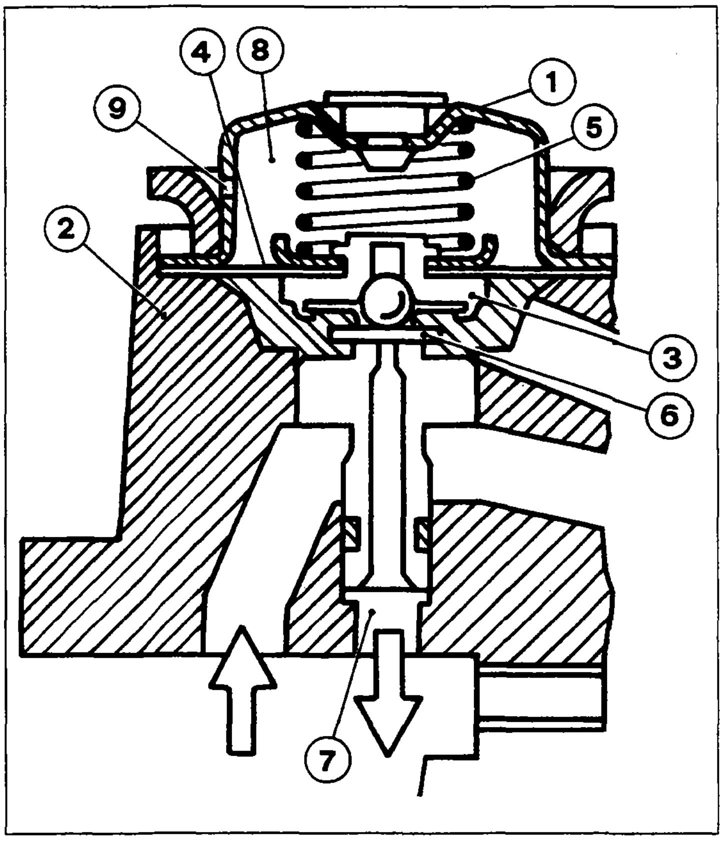
P4A30AJ02

A positive injector supply current is supplied through the fuel pump relay; the circuit is earthed in the control unit via terminal 21.



P4A31AJ01

Fuel pressure regulator



P4A31AJ02

The mechanical diaphragm regulator (1) is fitted in the injector turret (2).

The function of the fuel pressure regulator is to maintain fuel feed pressure to the injector at a level of about 1 bar.

Fuel under pressure from the electric pump reaches hydraulic chamber (3) of the pressure regulator.

If pressure on membrane (4) exceeds a level of 1 bar, it overcomes the load on counter-spring (5), and moves plate (6) to allow fuel to flow out through a channel (7) in the tank.

Hole (9) in the top chamber (8) of the regulator brings chamber 8 into communication with the outside so that a vacuum does not build up inside the chamber.

When the engine stops, fuel feed is also shut off. The pump check valve and injector close. In this way, feed pressure is maintained for a certain period in the hydraulic section.

This form of operation prevents the formation of vapour bubbles as a result of fuel in the system being heated by the engine to ensure trouble-free starting at all times.

Intake air temperature sensor

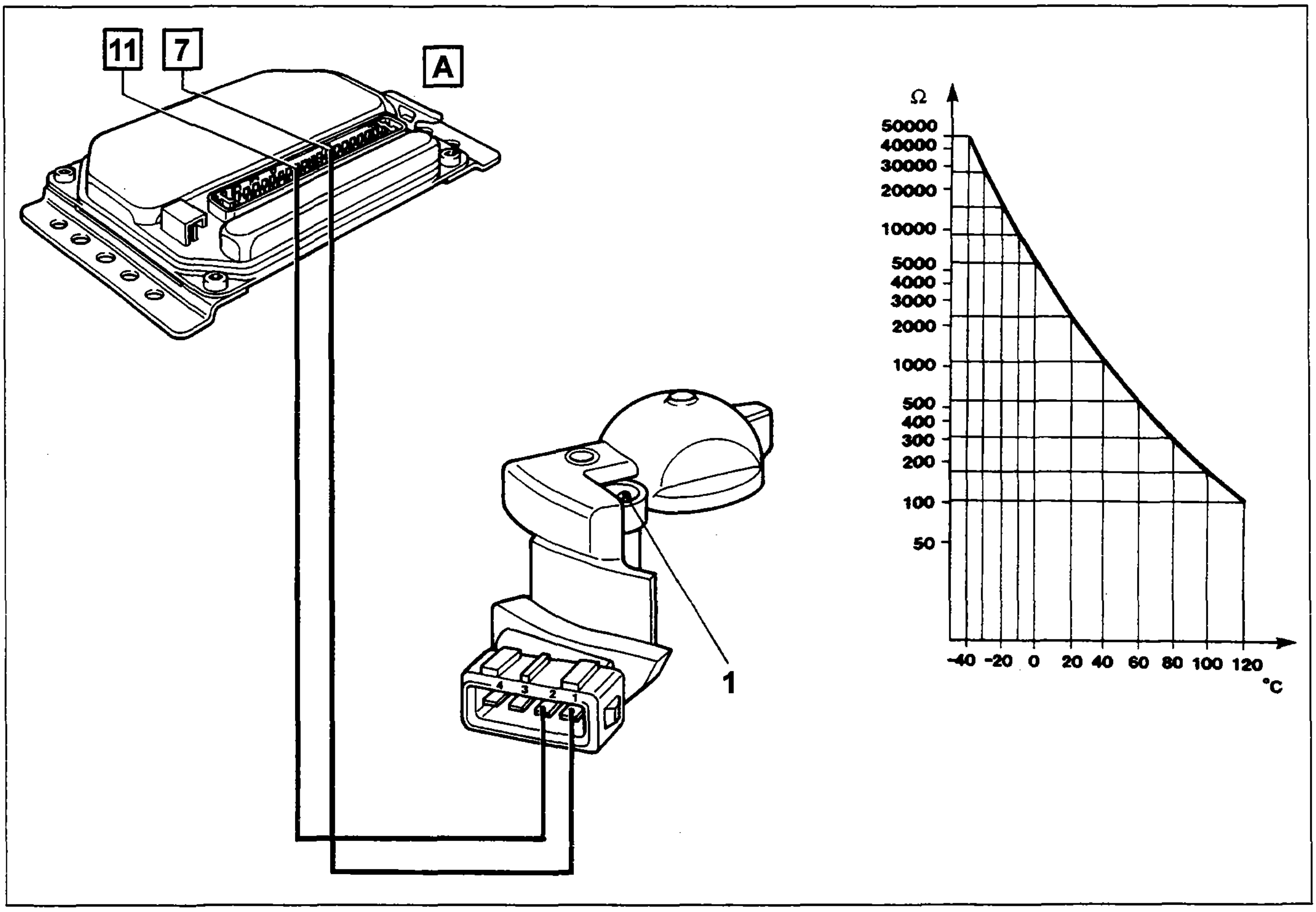
Intake air temperature is measured by temperature sensor (B) located on the butterfly valve case.

This sensor consists of a plastic case on which is located the reactive element (1), which consists of a resistance (N.T.C.) that varies in inverse proportion to temperature.

If temperature is between 15° C - 30° C, resistance is 3.3 - 1.5 kΩ. If temperature is about 80° C, the resistance is 0.280 - 0.360 Ω.

Terminal 13 of the ECU (A) supplies terminal 1 of sensor (B); the circuit is earthed from terminal 2 of the sensor to terminal 27 of the ECU.

When the sensor is disconnected, the ECU supplies a voltage of 5 V. With the sensor connected, the supply voltage alters according to temperature (internal sensor resistance).



P4A32AJ01

Recovery

When the air temperature sensor is short-circuited (d.c.) or circuitis open (a.c.), the ECU receives implausible signals, i.e.:

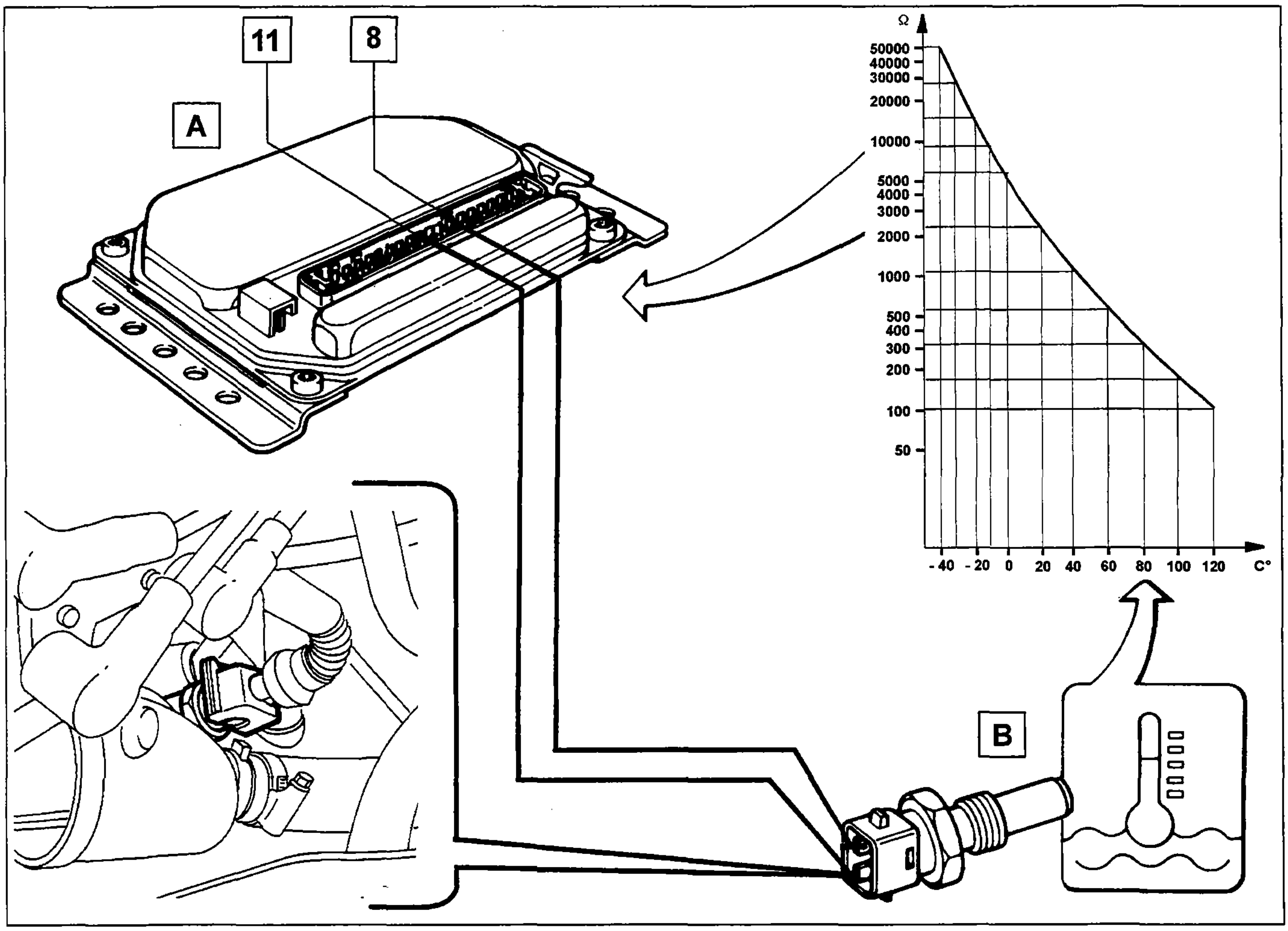
- d.c. sensor: air temperature > 128° C
- a.c. sensor: air temperature < -50° C

In these cases, the ECU implements a Recovery strategy which takes an air temperature of 20° C as a reference.

COOLANT TEMPERATURE SENSOR (0.280.130.026)

The coolant termperature sensor (B) consists of a variable N.T.C. resistance. It is fitted on the thermostat case and works in a similar way to the intake air temperature sensor.

Terminal 8 of ECU (A) supplies sensor (B). The circuit is earthed through the sensor terminal to terminal 11 of the ECU.



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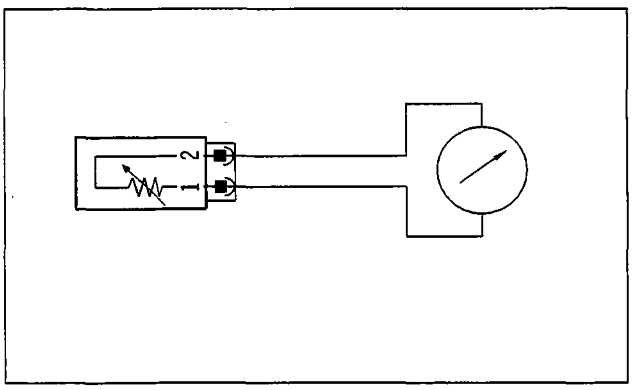


P4A33AJ02

Checking resistance

The graph in the figure shows the sensor resistance curve, which may be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

Removing-refitting

Disconnct the electrical connection and remove the sensor.

Tightening torque 2.4 daNm.

Recovery

- with coolant temperature sensor disconnected, short circuited (d.c.) or with circuit open (a.c.), implausible signals reach the ECU, i.e.:
- d.c.: coolant temperature > 96.5 °C
- a.c.: coolant temperature < 96.5 °C
- false contact: when temperature drops occur between two successive temperature samples and the deviation is too great.
- implausible signal: with coolant temperature < +60° C, and engine running, sensor output signal does not change.

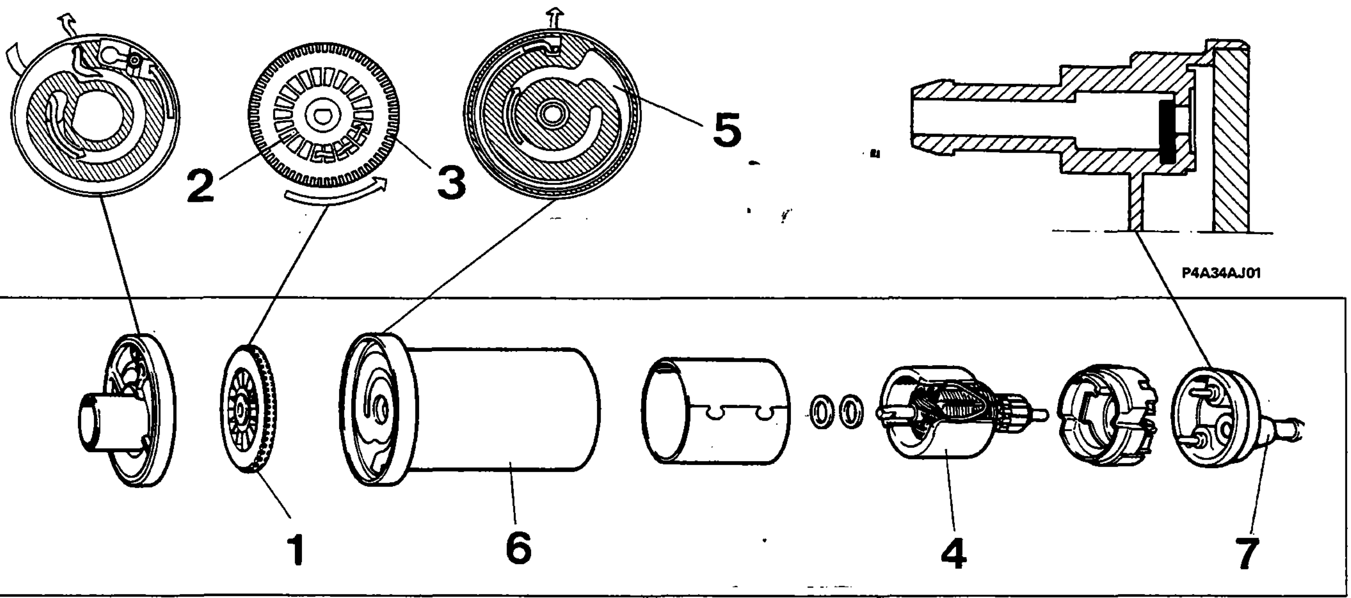
If the ECU records one or more signals as above, the RECOVERY strategy is implemented:

- with air temperature < 24° C, the ECU considers coolant temperature to be equal to air temperature for about 4 minutes. After this, coolant temperature is assumed to be 100° C;
- with air temperature ⩾ 24° C, the ECU considers coolant temperature to be 100° C.

ELECTRIC FUEL PUMP (0.580.453.514)

The fuel pump, submerged in the tank, is a two-stage turbo pump and integral with the fuel level gauge assembly.
The pump is designed to work with a 12 V supply, at a nominal pressure of 1.1 ± 0.1 bar providing an output of 100 litres/hour.

The advantages of low pressure turbo pumps compared to high pressure pumps (2.5 bar), are: small size, reduced weights and low noise levels.



P4A34AJ02

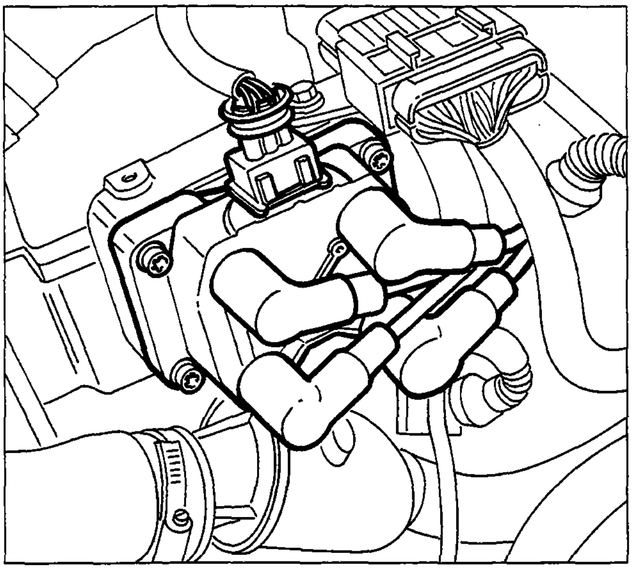
The electric pump contains an impeller (1) that turns two sets of blades: an inner set (2) with lateral profile and an outer set (3) with peripheral profile.
When field coil (4) turns, fuel is taken into the first stage with lateral profile. It then flows through a channel in intake disc (5) to the second stage where it picks up speed and is sent on to the injector turret through outlet case (6) and antireflux valve (7).

The electric pump is supplied by the electronic control unit via a relay and 10A fuse.

NOTE *Refer to fuel system section for the 1581 16V for location and removal-refitting procedure.*

FUEL FILTER (A.450.024.262)

The fuel filter is fitted under the floor pan, along the fuel delivery line. Refer to fuel system section in 1581 16V manual for location and removal-refitting procedure.



P4A35AJ01

IGNITION COIL (0.221.503.407)

The closed magnetic loop coil is fastened to the left hand side of the cylinder head cover.

1. HT socket for cylinder no. 1 spark plug
2. HT socket for cylinder no. 2 spark plug
3. HT socket for cylinder no. 3 spark plug
4. HT socket for cylinder no. 4 spark plug
5. LT socket for ECU connection

Checking winding resistance

Primary circuit (A cylinders 2-3, B cylinders 1-4)

Bring the terminals of an ohmmeter into contact with positive strip (central pin) and negative strip (pin 1 for circuit A and pin 2 for circuit B) respectively.

The primary circuit resistance reading on the guage should be between 0.45 and 0.55 ohm at 23 °C.

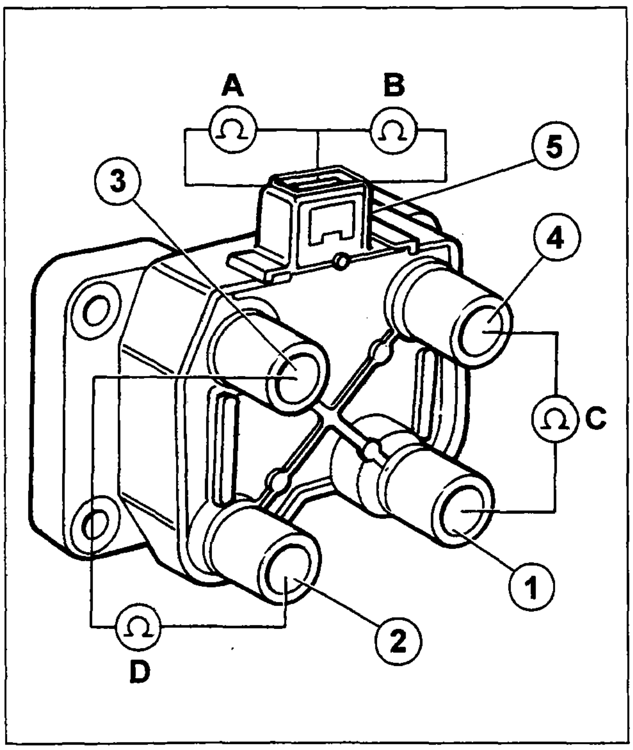
Secondary circuit (C cylinders 1-4, D cylinders 2-3)

Bring the terminals of an ohhmeter into contact between the two high tension outlet terminals

The secondary circuit resistance reading on the gauge should be between 12000 and 14600 ohm at 23 °C.

Removing refitting

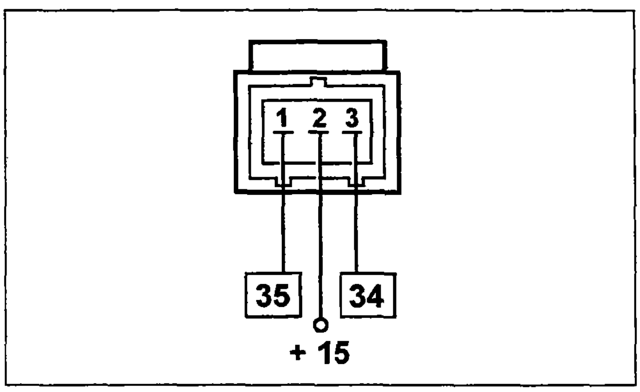
Disconnect HT and LT connections, then unscrew retaining screws and remove the coil.



P4A35AJ02

Connector wiring

NOTE *The numbers in boxes indicate the corresponding control unit pins.*



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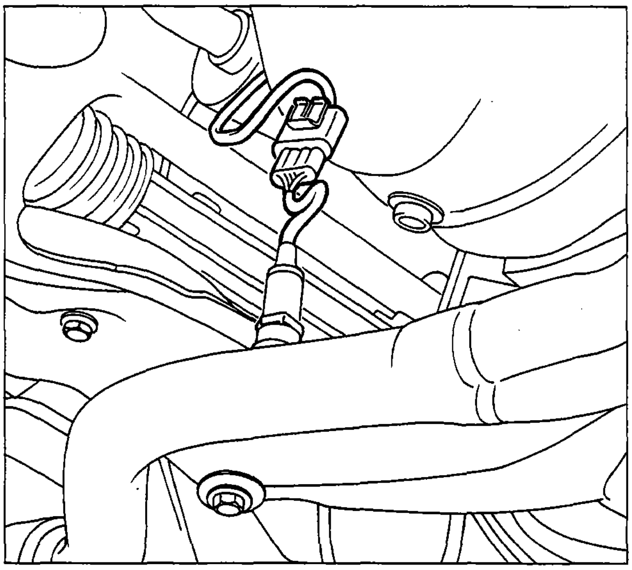


P4A004B02

LAMBDA PROBE (0.258.003.466)

The vehicle is fitted with a four channel hot lambda probe which measures exhaust gas oxygen content. Refer to Fuel System section in the 1581 16V manual for a full description of the lambda probe

The probe may be swiftly put out of service by the presence of even slight amounts of lead in the fuel.

Removing-refitting

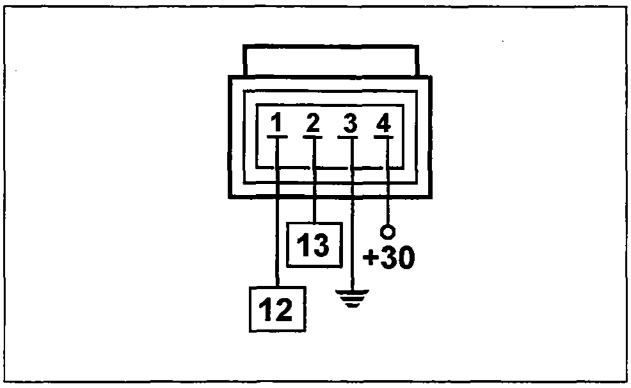
- Place the vehicle on a lift.
- Disconnect battery negative lead.
- Raise the vehicle
- Disconnect electrical connection
- Remove the lambda probe from its seat.
- When tightening, do not force the component or it could be irreparably damaged.

If fitting a new lambda probe, spread threaded part with anti-seize graphite grease (e.g. Bosch VS 14016- FT).

Tightening torque 5 - 6 daNm

Wiring connector

The numbers in boxes indicate the corresponding control unit pins.

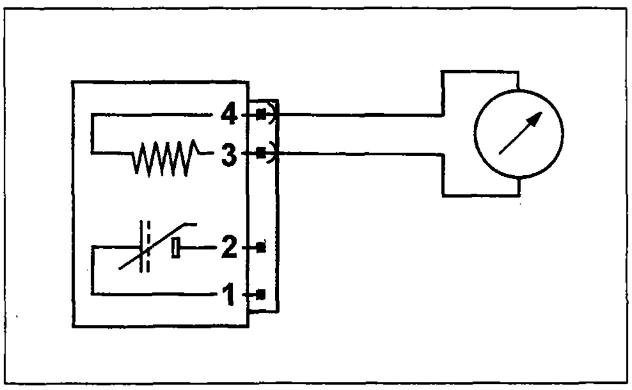


P4A36AJ02

Checking resistance

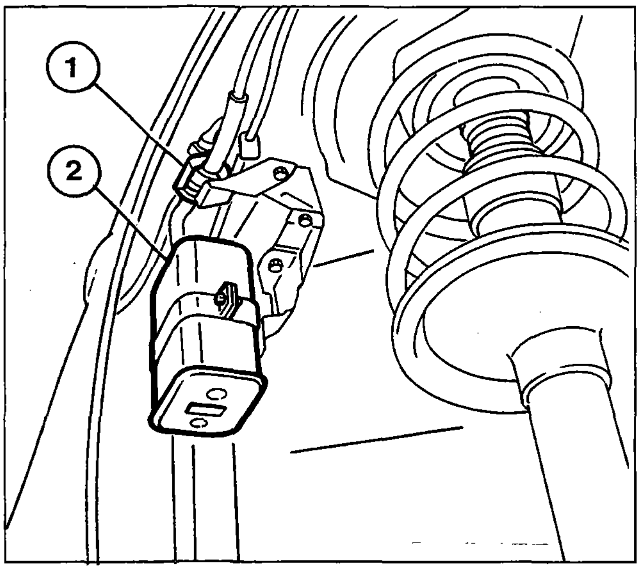
Probe heater resistance may be measured by disconnecting connector and connecting an ohmmeter as shown in the figure.

Resistance: 4.5 ± 0.5 ohm at 20 °C



P4A36FJ01

CARBON FILTER AND FUEL VAPOUR CUT-OFF SOLENOID



P4A36FJ02

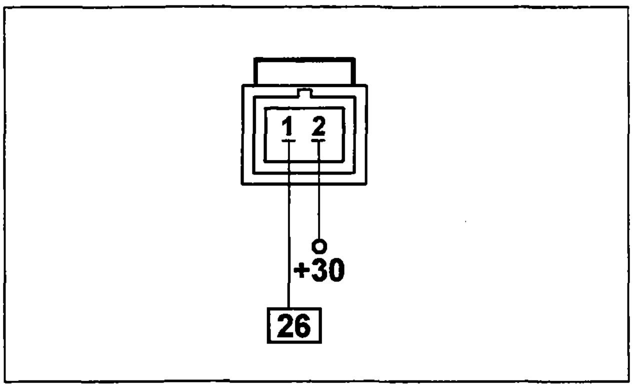
The carbon filter and solenoid are located in the right hand wheel arch compartment.

For a description of the carbon filter refer to Fuel System section of the 1581 16V manual.

For a description of the fuel vapour cut-off solenoid and removal-refitting procedures for filter and cut-off solenoid, refer to Fuel System section of 1998 20V manual.

1. Vapour cut-off solenoid
2. Carbon filter

Vapour cut-off solenoid (0.280.142.300)

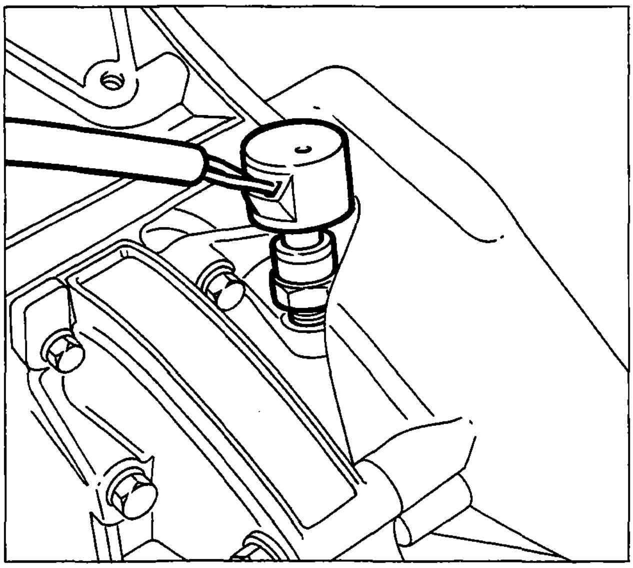


P4A37AJ02

Wiring connector

NOTE *The numbers in boxes indicate the corresponding control unit pins.*

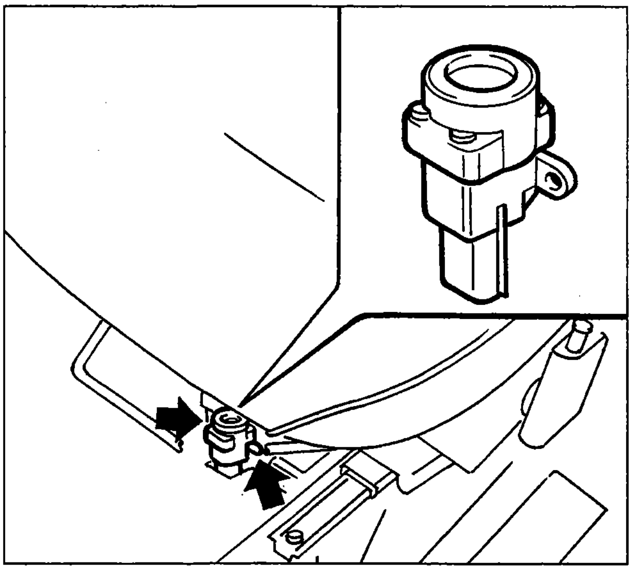
SPEEDOMETER SENSOR



P4A37AJ03

The speedometer sensor (vehicle speed sensor) consists of a Hall-effect sensor located on the differential output.
The sensor sends the ECU a signal, whose frequency alters according to vehicle speed.

The ECU uses this information for more effective idle adjustment actuator management.



P4A48CJ02

INERTIA SWITCH

The vehicle is equipped with an inertia switch located inside the passenger compartment beneath the driver's seat.

This sensor reduces the possibility of fire (caused by fuel emerging from the injection system) by de-activating the fuel feed pump.

For a full description and removal-refitting procedure, refer to Fuel System section of the 1581 16V manual.

After even an apparently light collision, if a smell of petrol is noted or fuel leaks are seen, do not activate the switch again until the fault has been found and corrected in order to avoid the risk of fire.

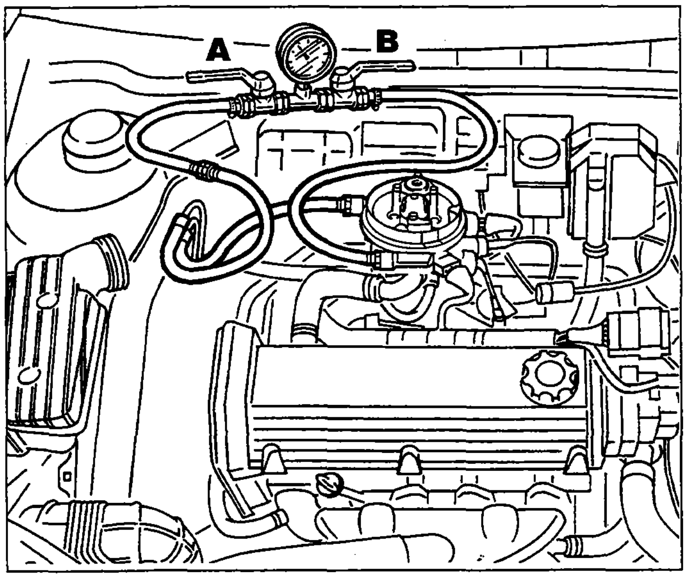
MULTIFUNCTION VALVE AND SAFETY AND VENTILATION VALVE

These valves belong to the evaporation control and fuel vapour recirculation system. For a description of operation, refer to Fuel System section of the 1581 16V manual.

CHECKS, ADJUSTMENTS AND REPAIRS TO BOSCH MONOMOTRONIC SYSTEM

OBSERVE THE FOLLOWING PRECAUTIONS WHEN WORKING ON VEHICLES WITH BOSCH MONOMOTRONIC INJECTION-IGNITION SYSTEMS:

- *never start the engine when the electrical terminals are poorly connected or loose on the battery poles;*
- *never use a quick battery charger to start the engine;*
- *never disconnect the battery from the car circuit with the engine running;*
- *when charging the battery quickly, first disconnect the battery from the vehicle circuit;*
- *if the vehicle is placed in a drying oven after painting at a temperature of more than 80° C, first remove the injection/ignition ECU;*
- *never connect or disconnect the ECU multiple connector with the ignition key in MARCIA position;*
- *always disconnect battery negative lead before carrying out electrical welding on vehicle.*
- *Note that the memory of this system is active at all times (memory on stand-by), and contains all learnt self-adaptive parameters. Because all this information would be lost if the battery were disconnected, this operation should only be carried out when absolutely essential.*



P4A39AJ01

CHECKING FUEL SUPPLY CIRCUIT

Test 1

Check **fuel regulation pressure** as follows:

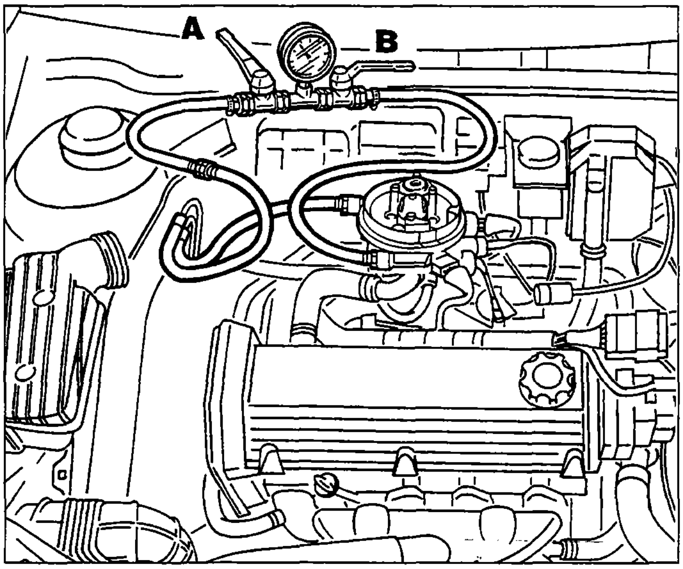
- Disconnect fuel delivery line to injector turret (from fuel filter) from inlet duct;
- Interpose pressure gauge 1895890000 between the disconnected pipe end and the fuel manifold with cocks (A) and (B) open.
- Activate fuel pump with engine off.

The last operation is carried out by selecting "fuel pump" test on a Fiat/Lancia tester.

Under these conditions, the pressure gauge reading should stabilise at 1.1 ± 0.1 bars.

If pressure is insufficient, carry out the test 2.

10.



P4A40AJ01

Test 2

Testing maximum fuel feed pressure (or pump efficiency)

Same connections as previous test.

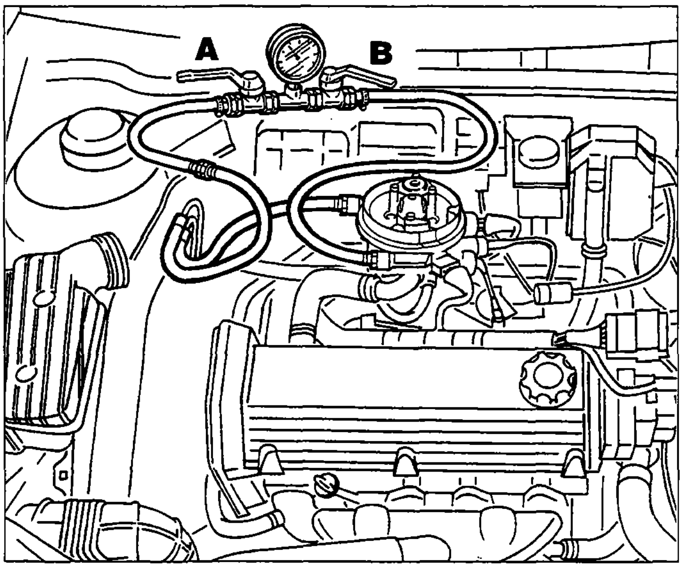
- Close fuel cock lever (A);
- operate the pump with the engine off, as described previously: pressure should not exceed 5 bar (pump pressure relief valve setting). Otherwise, replace the pump because it is defective.

If pressure measured in test 1 (see previous page) exceeds 1.1 ± 0.1 bar proceed as follows:

- disconnect fuel return pipe (at point (1) for connection to rigid fuel return line to pump) and place in a container suitable for collecting the fuel.
- operate the fuel pump with engine idling, then take pressure reading off pressure gauge:

a) if it reaches 1.1 ± 0.1 bar replace the fuel return pipe to the tank because it is blocked or kinked;

b) if it exceeds 1.1 ± 0.1 bar replace the pressure regulator because it is defective.



P4A40AJ02

Test 3

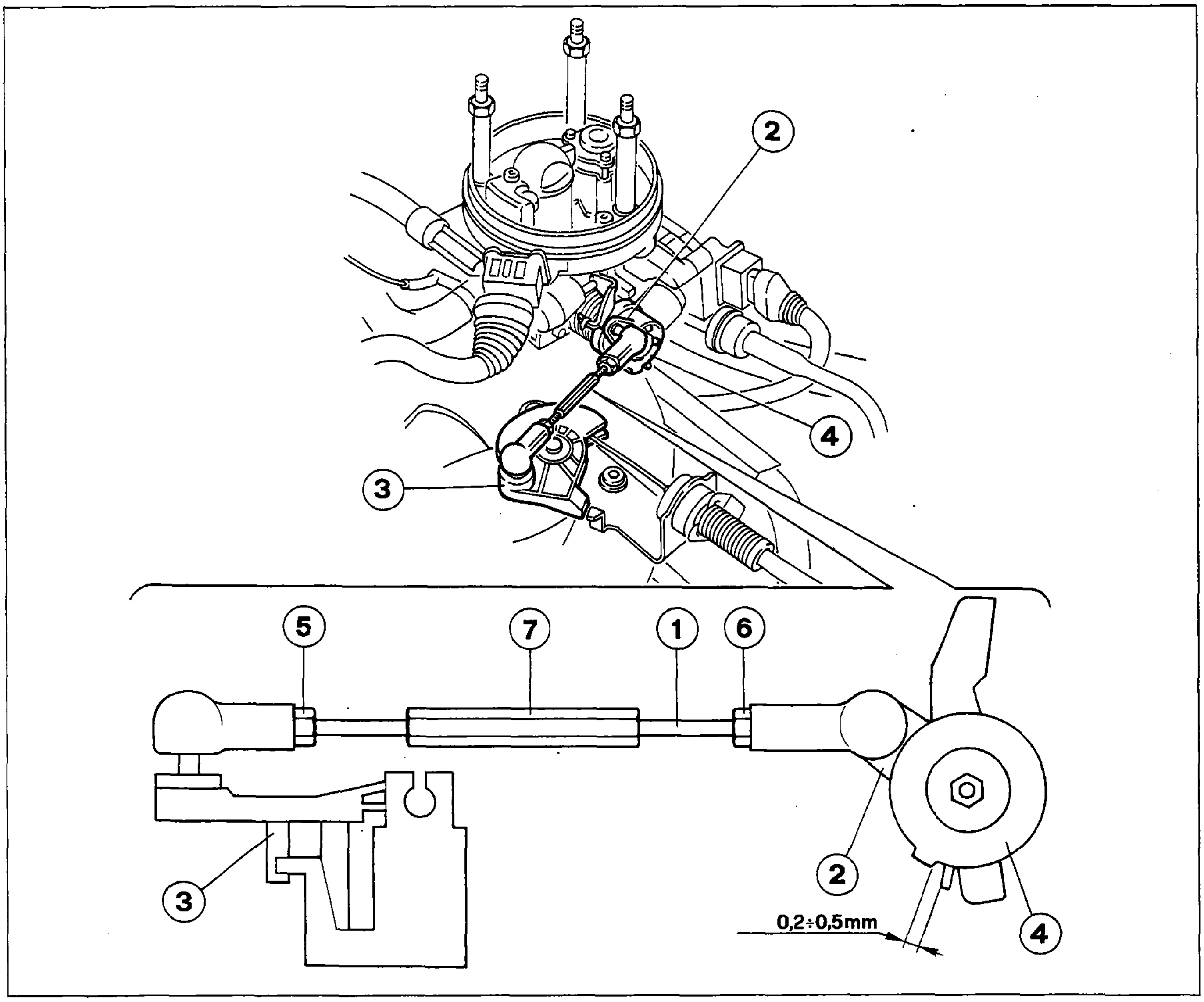
Checking injector seal

To check for drips from the injectors, connect as described in first test (regulation pressure check) and then operate the pump with the engine off. When the regulation pressure is reached, close control lever B so that fuel pressure and injection pressure is the same.

Then:
- turn off the pump;
- see whether pressure remains constant for 60 seconds after stabilising (i.e. dropping slightly).
- After supplying the pump with the engine off, look to see whether any of the injectors or connection sections are dripping.

Replace any dripping injectors and/or repair the defective seal in the leaking joint.

ADJUSTING BUTTERFLY VALVE OPENING CONTROL



P4A41AJ01

The butterfly valve opening linkage must be adjusted properly for the Monomotronic injection system to work properly.

Check that block (3) is fully home with link (1) disconnected from lever (2). **Under these conditions the accelerator control cable should never be taut or excessively slack so that accelerator pedal free travel is taken up.** If pedal shows free travel, adjust accelerator control cable nut and lock-nut.

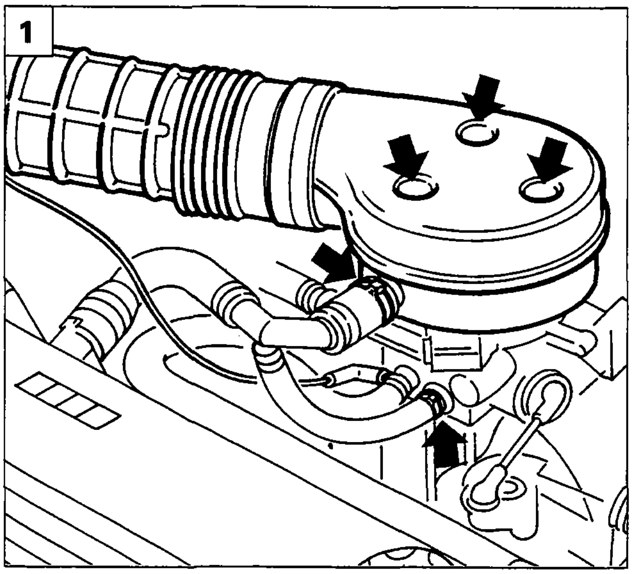
Connect link (1) to head of lever (2) and warm up engine.

With accelerator pedal released (butterfly valve closed) check clearance between levers (2) and (4) is 0.2 - 0.5 mm.

If the above clearance is not as specified, loosen nuts (5) and (6) and tighten/loosen gauge (7) on link (1).

After adjustment, check that butterfly valve is fully open with accelerator pedal pressed fully down.

10.



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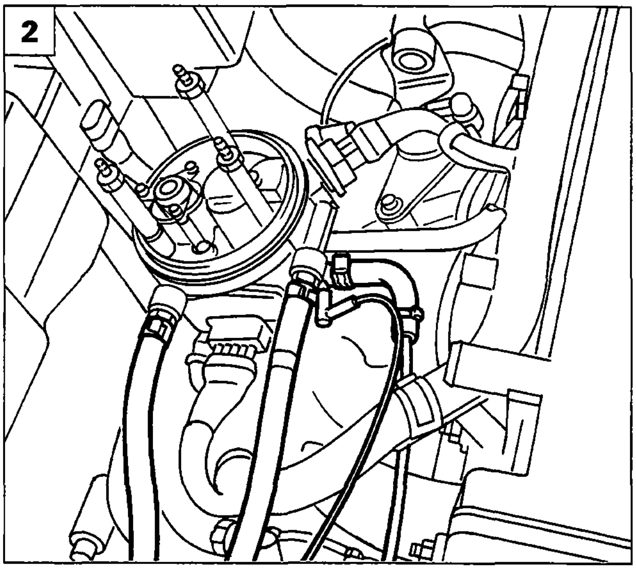
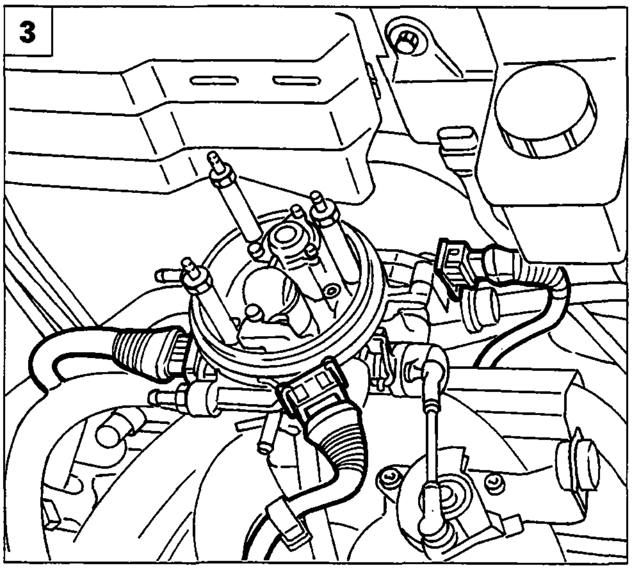


P4A18AX01

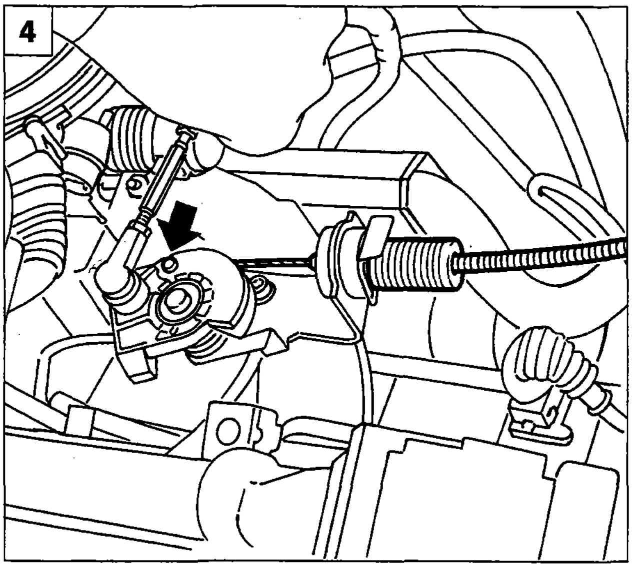


P4A19AX04

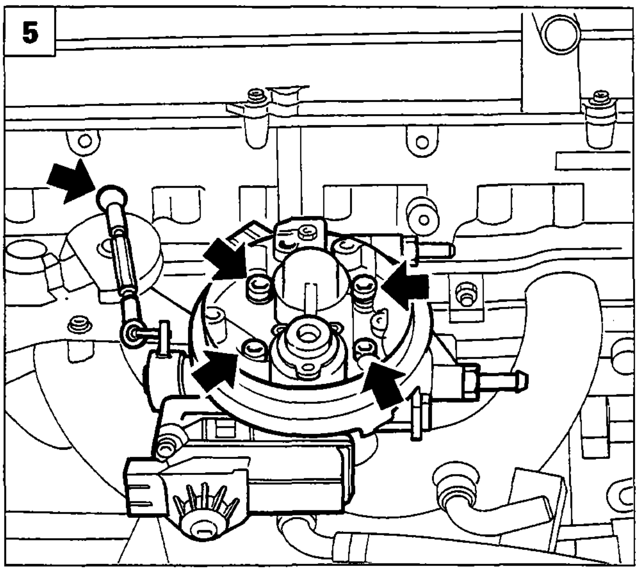
REMOVING-REFITTING BUTTERFLY VALVE CASE

1. Disconnect the air shroud and blow-by gas recirculation lines by unfastening at the points indicated.
2. Disconnect fuel lines, evaporation control line and vacuum duct
3. Disconnect electrical connections

4-5 Release accelerator link by unscrewing the screws indicated and remove the butterfly valve case.



P4A18AX03



P4A42AJ02

CHECKING ENGINE IDLE SPEED

If engine speed is not 850 ± 50 rpm, because the injection-ignition system is self-regulating, no adjustment can be carried out. It is therefore necessary to check that the accelerator linkage is properly adjusted and then search for the fault through full diagnosis using a Fiat/Lancia Tester.

CHECKING LEVELS OF POLLUTING EMISSIONS

The Monomotronic system is self-adaptive and thus constantly monitors idle speed and CO levels. Therefore there is no need for manual adjustment (adjustment screws are no longer fitted). However, checking exhaust contents downstream of the catalytic converter can provide useful information about the injection-ignition system condition, engine and catalytic converter parameters

Checking CO and HC levels when idling

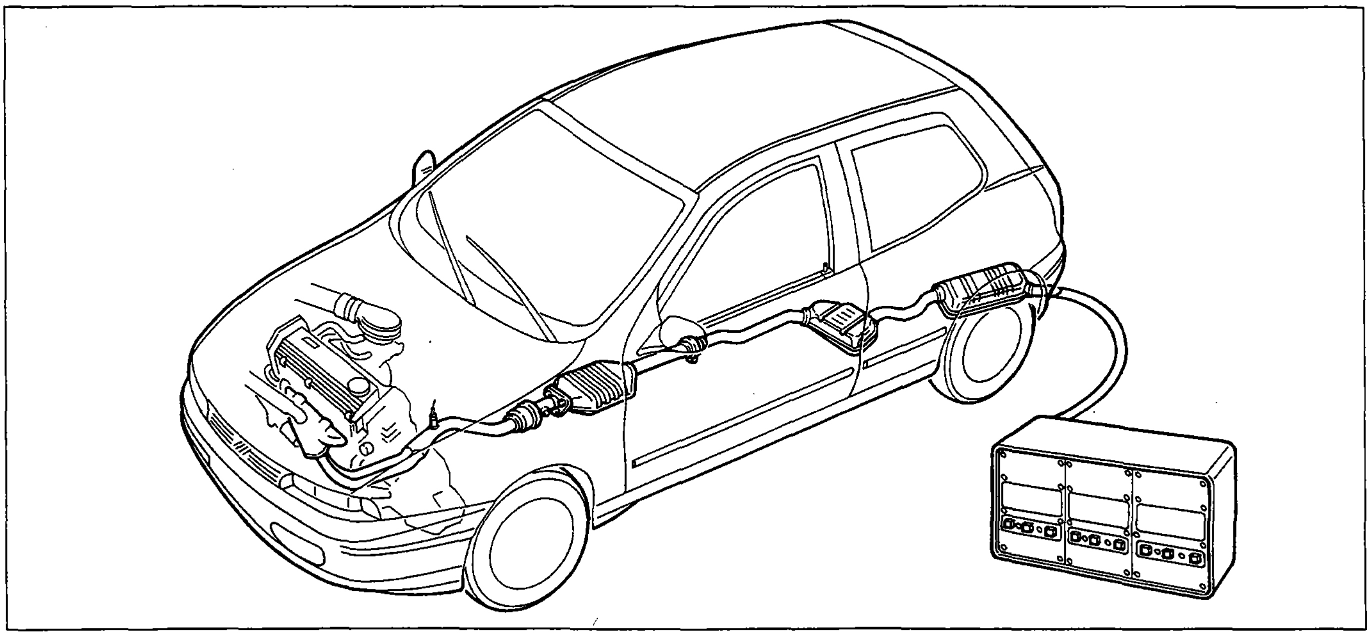
Measure levels of carbon monoxide (CO) and unburnt hydrocarbons (HC) with the catalytic converter hot (300 - 350 °C) (it is advisable to push the car engine on the road for about 5-10 minutes to ensure that the catalytic converter reaches service temperature), Then fit the probe of a suitably calibrated tester to at least 30 cm as indicated in the figure.

If the shape of the exhaust tail pape will not allow the probe to be fully inserted, add an extension pipe designed to ensure a seal in the joint area.

1. Check that CO and HC levels are as specified in the table;
2. If CO level is not as specified, check that:
   - Lambda probe is working properly, with the aid of a Fiat/Lancia Tester;
   - for air leaks in the area surrounding the lambda probe seat
   - the injection and ignition system **(particularly for spark plug wear).**
3. If HC level is not as specified, the engine is not properly tuned or the catalytic converter is not efficient.

CO (%)	HC (p.p.m.)	CO_2 (%)
$\leqslant$ 0.35	$\leqslant$ 90	$\geqslant$ 13

Summary table showing emission level tolerances downstream of converter



P4A43AJ01

10.

DIAGNOSIS

Full system diagnosis can be carried out by means of active diagnosis using a Fiat/Lancia Tester

If a sensor fault is recorded, the ECU replaces the input from the faulty sensor with information from its memory **(recovery)** to allow the engine to continue running. When a fault is recorded, it is saved permanently and the sensor excluded from the system until the signal is again compatible.

The same procedure is applied if the fault affects an actuator or an actuator control port. When a fault is recorded and the signal replaced by a recovery input, the fault is indicated by a warning light coming on on the control panel.

The ECU is able to manage the following parameters in the case of failure: idle adjustment actuator, coolant temperature sensor, butterfly valve position sensor, air temperature sensor and knock sensor. If required by an operator, anomalies may be read off the ECU using a Fiat/Lancia Tester.

Recording faults

This is carried out while running the basic function used to manage the sensor/actuator.

Memorising error and structure of error memory

Errors are memorised in the ECU in the order in which they occur in the RAM. Location and a frequency counter are memorised for each one.

Defect classification

If a defect is recognised for the first time and the error status persists for the recognition time, the defect is memorised as "permanent". If this defect then disappears, it is memorised as "intermittent". If it reappears, it again becomes "permanent".

Classification of a fault as "permanent" activates recovery functions: when the fault disappears, normal reading or activation function is restored.

Some fault types are classified as "important", i.e. significant as far as emission control regulations are concerned. A warning light comes on on the control panel when these faults occur.

Frequency counter

A frequency counter is allocated to each error to determine the moment at which a fault no longer present was memorised. When the fault is first detected, the frequency counter memorises a value of 10. If the fault disappears it is memorised as intermittent and the counter is decreased whenever the car is started without the fault reappearing; if the counter reaches 0, the fault is deleted automatically from the memory.

If the fault reappears after the counter has been reduced, the counter is always reset to 10 (or remains unchanged if alredy greater than 10).

Fault notification

A warning light comes on when a defect is saved as "present" and "important".

The delay between recording of the fault and the warning light coming on is 2.5 secondi; the delay between the fault disappearing from the memory and the warning light going off is 0 seconds.

The warning light comes on whenever the ignition key is turned to MAR. The warning light goes off after 4 seconds unless "important" faults are present.

Deleting errors

When the frequency counter reaches 0, the fault and associated parameters are deleted.

The entire error memory is cleared immediately in the following cases:
- by means of a "clear error memory" command sent by the tester;
- by interrupting ECU supply (by disconnecting the battery or ECU connector).

Diagnosis using Fiat/Lancia tester

Connect the Fiat/Lancia Tester (F.L.T.) to a socket beside the ECU.

Information is exchanged between ECU and Tester via a two-way serial line (line K) using standard Bosch communication Protocol.

The Tester is able to perform the following functions:

- Error display;
- Engine parameter display;
- Active diagnosis

List of errors

RPM sensor	Incorrect signal (circuit open) Loss of synchronism (implausible signal)
Throttle potentiometer	Race 1 defective - Race 2 defective - Synchronisation error between races
Air temperature sensor	A.C.-D.C.
Coolant temperature sensor	A.C.-D.C.- False contact - Implausible signal
Lambda probe	A.C.-D.C.- Limit reached for lambda reconstruction and self-adaptive factor
Idle speed actuator	A.C.-D.C.
Control unit	ECU memory anomalies indicated
Detonation sensor	A.C.-D.C.
Fiat CODE	Code not recognised or not received

Displayed parameters

Engine rpm
Injection time
Inlet air temperature
Coolant temperature
Throttle valve opening angle (race 1 angle, race 2 angle, standard angle and relationship between races)
Lambda probe (status, reconstruction value, self-adaptive value and probe signal activated)
Fiat CODE (status byte)

Active diagnosis

The Fiat/Lancia Tester can be used to run the following tests:
- Injector
- Fuel vapour cut-off solenoid
- Rev counter
- Idle speed actuator
- Error deletion.

Recovery

In the event of sensor malfunction, the ECU replaces the value transmitted by the sensor with a 'Recovery' value. This is stored in the ECU for use in the case of certain faults or may be reconstructed approximately on the basis of other available information, thus allowing the vehicle to be driven to a service centre.

The value is also relayed to the Fiat/Lancia tester, and therefore it should be noted, when diagnosing, that in the event of a malfunction, the Fiat/Lancia tester indicates an error in the affected sensor and displays the recovery value.

Permanent memory

The control unit has a permanent memory, which keeps a record of the error even after its cause has been eliminated, or after the key has been turned to STOP; and a temporary, volatile memory (RAM), which loses error details as soon as the underlying cause has been removed.

This will allow more effective identification of occasional errors.

Before completing tests on «permanent» memory content, delete using a Fiat/Lancia Tester in Active diagnosis mode.

Otherwise, when reconnected, the tester will still display errors from a previous diagnosis.

Disconnecting the control unit from the system, even for a long period, does not delete the "permanent" memory.

page

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M.MARELLI-WEBER I.A.W.-1AF.13 INTEGRATED INJECTION-IGNITION SYSTEM

Introduction

The I.A.W.-1AF.13 system (I.A.W.-1AF.23 for versions with automatic transmission) The Hitachi system fitted to the 1581 i.e. 16v engine belongs to the category of digital electronic ignition systems with static advance and timing, integrated with a phased, multipoint, intermittent electronic fuel injection system.
This system therefore adopts a single ECU, single wiring system and a set of sensors common to both systems.
Its function is therefore to inject an exact quantity of fuel into the engine intake duct upstream of the intake valves in order to obtain the correct mixture concentration.

The I.A.W.-1AF.13 system ensures efficient operation and optimisation of performance and fuel consumption. Harmful emission levels are reduced through real time response to the various engine operating conditions.

The system may be divided schematically into the following subsystems:

- Electric/electronic circuit
- Air intake circuit
- Fuel feed circuit
- Emission control devices

The system is able to monitor the following parameters by means of dedicated sensors:

1. instantaneous engine rpm;
2. position of each piston pair in relation to TDC of cylinder 1;
3. intake air temperature;
4. throttle valve angular position;
5. coolant temperature;
c. actual mixture concentration (by means of lambda probe signal);
7. intake manifold pressure;
8. vehicle speed;
9. battery voltage;
10. air conditioner compressor activation (if fitted).

This data, generally analogue, is converted into digital signals by analogue/digital (A/D) converters so that it may be used by the ECU.
Note that this I.A.W.-IAF.13 injection-ignition sytem does not require adjustment because it is self-adjusting and self-adaptive.

SYSTEM OPERATING STRATEGIES

The management software resident in the ECU memory comprises a set of strategies. Each of these controls a specific system control function.

Each strategy uses the various inputs listed above to process a set of parameters, using data maps saved in specific areas of the ECU. The resulting data output is used to control system actuators, in other words the devices used to operate the engine, namely:

1. injectors;
2. ignition coils;
3. solenoids of various types;
4. electric fuel pump;
5. engine idle speed actuator;
6. control relays.

The management strategies must not only control the moment of ignition and intake air temperature/-pressure at various engine speeds in order to allow the engine to work properly as environmental parameters change, but also control and manage injection in order to maintain an optimal stoichiometric ratio (air/fuel) at all times.

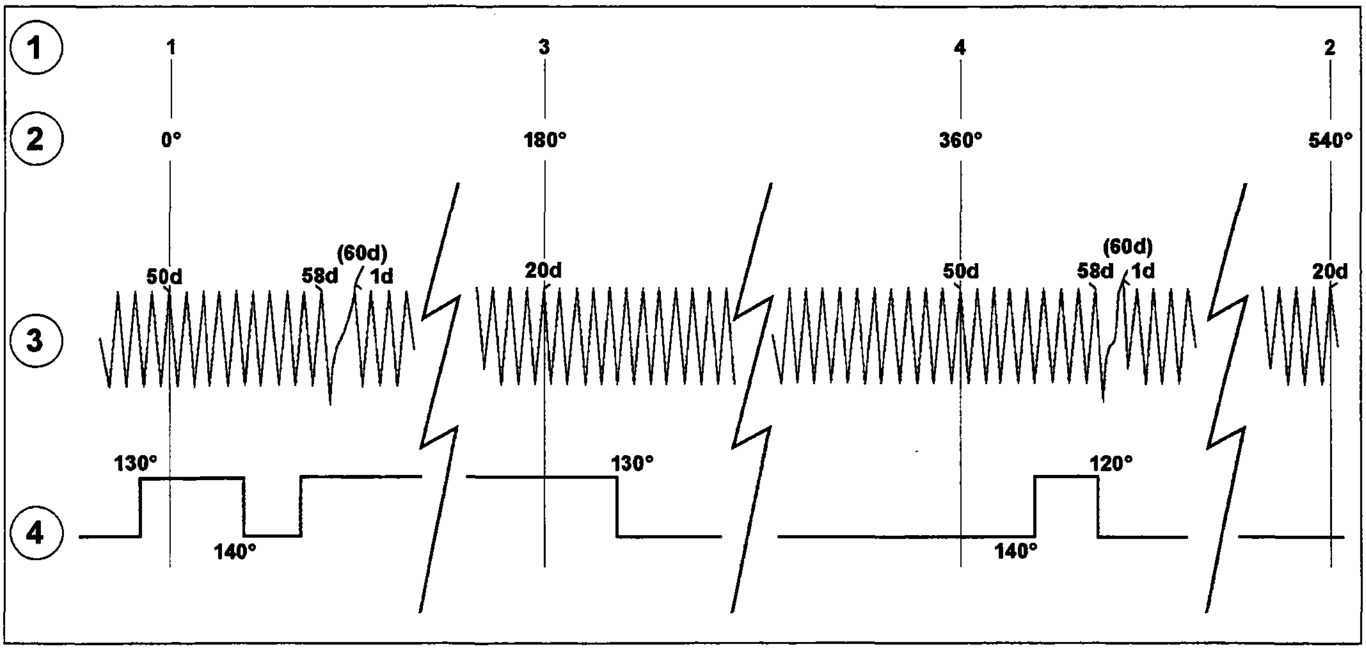
System management strategies are essentially as follows:
-signal management;
-injection management;
-Fiat CODE ignition lock function management);
-ignition management;
-engine idle control;
-fuel vapour recirculation management;
-test management
-heating/ventilation system management

SIGNAL MANAGEMENT

Upon starting, the ECU identifies injection and ignition timing, because these parameters are essential to ensure subsequent successful implementation of all strategies.
Timing is identified by interpreting a series of signals from an rpm sensor located on the crankshaft pulley and a timing sensor located on the camshaft pulley, intake side.

NOTE *The term "signal framework" denotes the set of signals produced by a sensor on the crankshaft and a sensor on the camshaft. Because these are located in specific reciprocal positions, they provide the ECU with a synchronised sequence of signals that the ECU is able to identify.*

The signal framework is produced as follows:
- phonic wheel on the crankshaft pulley, equipped with (60-2) 58 teeth and an angular gap of 18° (equivalent to two missing teeth) for TDC recognition.
- wheel on camshaft pulley, intake side, comprises two long slots and one short slot, with width and arrangement designed to provide the signal indicated in the figure.



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1. Cylinder TDC
2. Crankshaft angles
3. Crankshaft phonic wheel signal (rpm sensor)
4. Camshaft wheel signal (engine timing sensor)

NOTE *Numbers allocated to signals indicate crankshaft angles ahead of subsequent TDC.*

INJECTION MANAGEMENT

The ignition management strategies are designed to provide the engine with the correct amount of fuel at the right time in accordance with engine service conditions.

The Marelli I.A.W.-IAF.13 injection-ignition system uses an indirect measurement system known as «SPEED DENSITY - LAMBDA», i.e. angular speed of rotation, intake air density, retro-active concentration check.

In practice this system uses ENGINE SPEED (revs per minute) and AIR DENSITY (pressure and temperature) to measure the amount of air taken in by the engine.

The amount of air taken in by each cylinder upon each engine stroke depends on intake air density and also on standard displacement and volumetric efficiency.

Air density is taken to be the density of air taken in by the engine and calculated as a function of absolute pressure and temperature - both measured in the inlet manifold.

Volumetric efficiency is a parameter relating to the cylinder filling coefficient. It is calculated on the basis of experimental tests carried out on the engine throughout its service range and then memorized in the ECU.

Once the amount of air taken in has been established, the system must provide sufficient fuel to make up the required fuel mixture concentration.

The injection trigger pulse or time at which fuel delivery begins is mapped in a control unit and alters according to engine speed and intake manifold pressure. In practice, the the ECU performs calculations in order to control sequential, phased opening of the four injectors, one per cylinder for the length of time strictly necessary to form an air-fuel mixture as close as possible to a stoichiometric ratio.

Fuel is injected directly into the manifold close to the intake valves at a differential pressure of some 3 bar.

Speed (no. of revolutions per minute) and air density (pressure and temperature) are used to measure intake air quantity, which is used in turn to calculate the amount of fuel needed to achieve the required mixture proportions. The other sensors in the system (coolant temperature, throttle valve position, battery voltage, etc.) allow the ECU to correct the baseline strategy for each specific engine service condition.

This specification is fitted with a catalytic converter to abate polluting emissions. In order to keep this working efficiently, the air-fuel ratio must be maintained at near stoichiometric levels.

A stoichiometric ratio is achieved by using a hot lambda probe. This probe continually monitors the amount of oxygen in the exhaust gas and then informs the ECU. This unit in turn uses mapped data to correct the fuel air mixture on-line if proportions are no longer stoichiometric.

Idle speed, exhaust gas CO level and butterfly valve sensor position are not adjusted on this system.

Control of mixture concentration (retro-active control)

NOTE *Mixture ratio is defined and indicated by the Greek letter α (alfa) as follows:*

$$\alpha = \frac{\textbf{quantity of air taken in by engine}}{\textbf{quantity of fuel injected}}$$

10.

Stoichiometric ratio is defined and indicated by the symbolα st as follows

$$\alpha\ st = \frac{\textbf{theoretical quantity of air required to burn all the fuel injected}}{\textbf{quantity of fuel injected}}$$

Mixture concentration is defined and indicated by the Greek letterλ as the ratio::

$$\lambda = \frac{\textbf{quantity of air taken in by engine}}{\textbf{theoretical quantity of air required to burn all the fuel injected}}$$

Thus we easily find that α/α st = λ.

Stoichiometric ratio depends on fuel type. For unleaded fuels in current use, this figure is 14.7 - 14.8, which corresponds to lambda = 1. (a ratio of 14.8:1 means that 14.8 parts of air are required to burn 1 part of fuel).

The mixture is termed rich (or heavy) when the quantity if air is less than the stoichiometric level. In this case, lambda equals$\leq$ 1;

the mixture is termed lean (or light) when the quantity of air exceeds the stoichiometric level. In this case, lambda equals$\geq$1;

The strategy is designed to correct base pulse constants so that mixture concentration oscillates continually and at a high rate between 0.98 and 1.02.

This oscillation rate varies according to engine load and speed. It is in the order of tens of Hertz.

NOTE

1 Hz = 1 oscillation per second

Under conditions of:

- cut-off,
- throttle opening greater than 70%
- engine temperature less than 25 °C

the strategy is de-activated.

Self-adaptability

The control unit features a self-adaptive function able to memorise deviations between basic maps and corrections imposed by the lambda probe that occur persistently during operation. Such deviations (due to system and engine component ageing) are saved permanently so that system operation can be adapted to gradual changes in engine and components with regard to original specifications.

The strategy is de-activated while the carbon filter flushing solenoid is open. If the ECU is replaced, carry out a road test to enable the engine to warm up and the ECU autoadaptive strategy to come into play (particularly important when idling at a standstill).

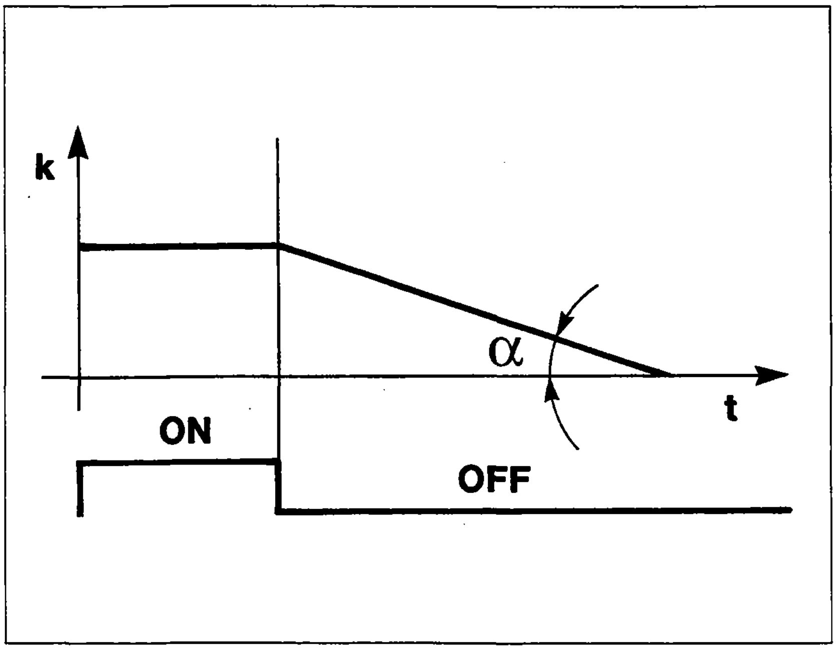
Starting and post-starting

During start-up, engine phase cannot be identified and phased injection cannot therefore be implemented.

An initial simultaneous injection is carried out during the first few engine revolutions (full group) because the considerable fluctuations in rotation speed do not permit injection time to be calculated correctly. Only subsequently does injection becomes phased.

The base pulse constant is increased by a certain factor throughout the period when the engine is cranked by the starter motor.

Once start-up has taken place, the factor is gradually reduced to zero within a given time period, which is in inverse proportion to engine temperature.



P4A05CJ01

k : enrichment factor

t : time

α : decrease proportional to engine temperature

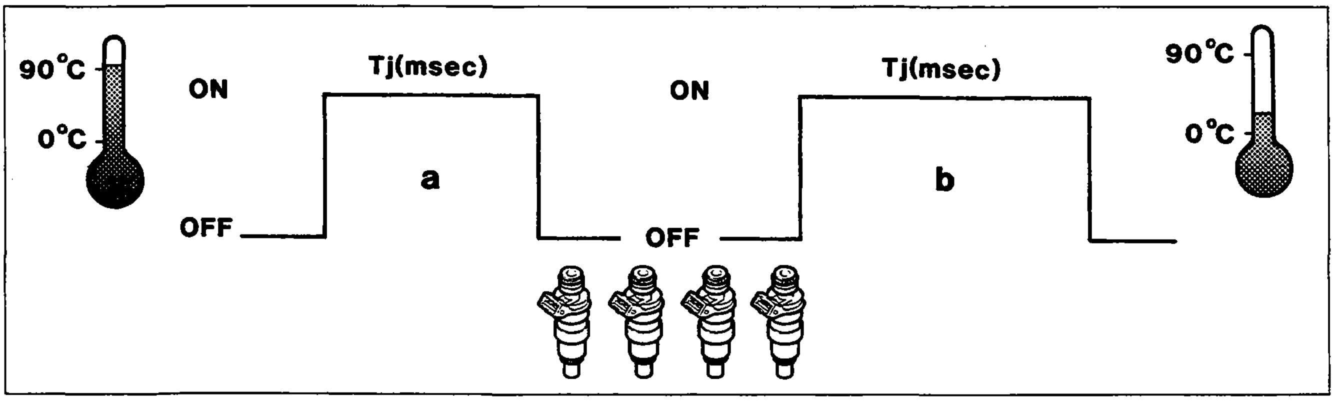
ON: engine cranked

OFF: engine running

Cold operation

Under these conditions, the mixture becomes naturally leaner due to reduced evaporation and heavy fuel condensation on the intake manifold internal walls. The greater viscosity of the lubrication oil also brings about an increase in the rolling resistance of internal engine components which also serves to exacerbate matters.

The electronic control unit recognises this condition and corrects injection time on the basis of the coolant temperature signal.



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As a result:

- At very low temperatures the injector stays open longer Tj) graph (b) for a low air fuel ratio (rich mixtures);

- As engine temperature increases, injector opening time becomes shorter (tj) graph (a) and the air/fuel ratio becomes correspondingly higher (lean mixture).

While the engine is warming up, the ECU also governs a step motor which is responsible for calculating the amount of air necessary to ensure the engine does not stall.

Rpm is decreased as the temperature rises until the rated level is reached (850 ± 30 Rpm) when the engine is warm. The ECU governs the step motor to maintain idle speed constant even if electrical and mechanical loads vary.

Full-load

Under full load conditions, base pulse constant must be increased to obtain maximum engine power output.

The ECU detects a full load condition as a result of parameters supplied by the throttle position and absolute pressure sensors.

On the basis of this information, the ECU implements the appropriate correction strategy by increasing base pulse constant.

Over-run

Two strategies are superimposed during this stage:

1. Transitory negative strategy to reduce the amount of fuel required by the engine (lower emissions).

   This stage is recognized by the ECU when the potentiometer signal changes from a higher voltage level to a lower value.

2. A dash-pot strategy to lessen changes in torque delivery (lower engine brake).
   This strategy is implemented when the potentiometer signal indicates that the throttle is closed and rpm is high. The step motor gradually decreases the flow of air through the by-pass.

Connection to automatic transmission

The ECU adjusts engine idle speed on the basis of the load input when the selector lever is moved to a given position and transmits information to the automatic transmission ECU on engine coolant temperature (pin 5) and throttle valve position (pin 44).

Barometric correction

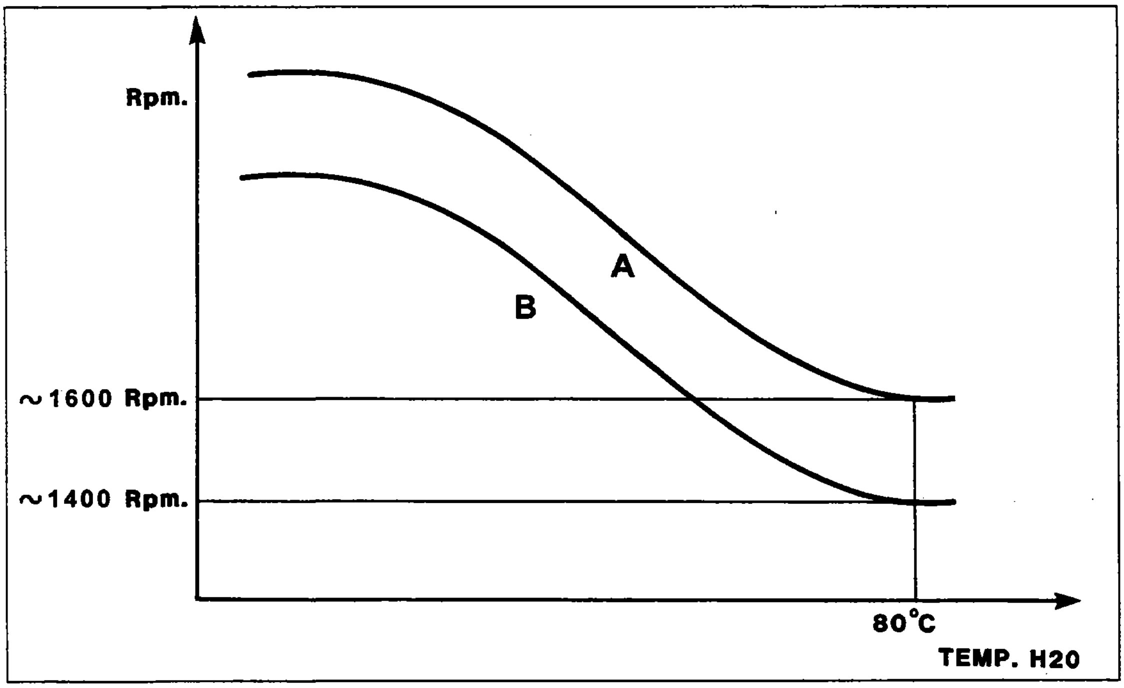
Atmospheric pressure varies with altitude to bring about changes in volumetric efficiency of sufficient entity to require a correction to baseline concentration (injection time).

Injection time is corrected according to changes in altitude and updated automatically by the ECU whenever the engine is started up and under certain conditions of throttle position and rpm (dynamic adjustment of barometric correction)

Cut-off

The fuel cut-off strategy is activated when the ECU recognises that the throttle is in closed position (throttle potentiometer signal) and engine speed exceeds 2000 rpm. The ECU activates cut-off only when engine temperature exceeds 0° C.

The fuel supply is restored when the throttle is no longer closed.



P4A07CJ01

A. entering cut-off
B. leaving cut-off

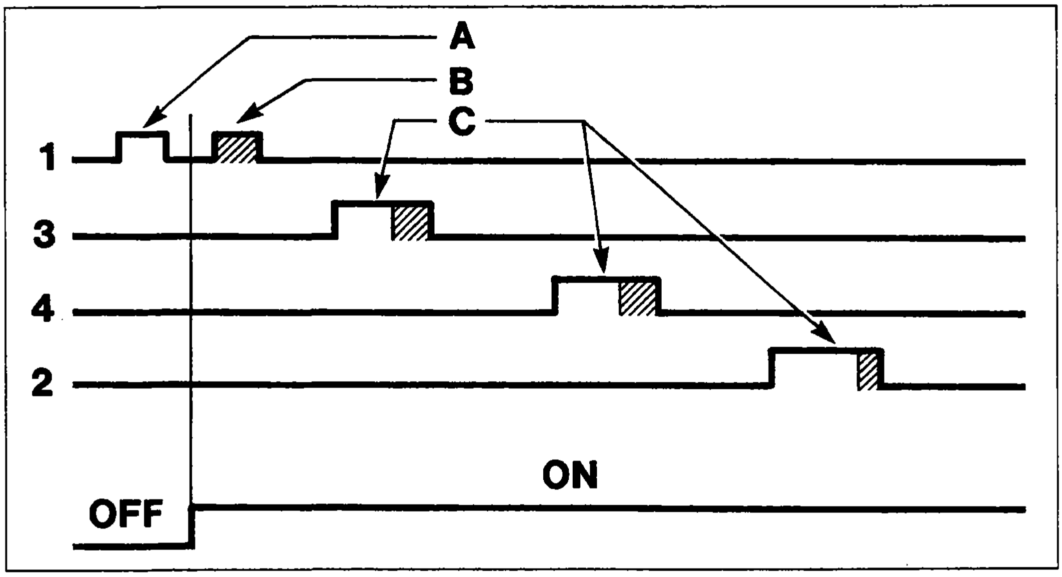
Acceleration

During this stage, the ECU increases the amount of fuel required by the engine (to achieve maximum torque) on the basis of signals from the following sensors:

- throttle potentiometer; - absolute pressure sensor; - rpm and TDC sensor.

The base pulse constant is multiplied by a factor according to coolant temperature and accelerator throttle opening speed.

If an abrupt change in injection time is calculated when the injector is already closed, the ECU reopens the injector (extra pulse), in order to make the concentration up to the required level as quickly as possible. Subsequent injections are automatically increased as described previously.



P4A07CJ02

A. normal injection time
B. injector re-opening (extra pulse)
C. injection time including enrichment
OFF. engine under steady-state conditions
ON. engine under transient conditions

Protection against excess rpm

When engine rpm exceeds an upper threshold of 6900 rpm imposed by the manufacturer, engine operating conditions are critical.

When the ECU recognises that this threshold rpm level has been exceeded, it reduces injector control time.

When rpm drops to non-critical levels, control is restored.

Electric fuel pump drive

The fuel pump is governed by the ECU through a dual relay.
The pump stops when:

- engine rpm drops below 50 rpm;
- starting does not occur with key in «Marcia» position (timed enablement).
- if the inertia switch is activated.

Injector control

Injectors are controlled in sequential, phased manner. During start-up, however, all injectors are initially all controlled in parallel (full-group).

Injector control timing varies according to engine speed and intake air pressure in order to improve cylinder filling because this makes for better fuel economy, good handling and lower emission levels.

FIAT CODE IGNITION LOCK FUNCTION MANAGEMENT

The system features an anti-theft function. This is implemented through a special FIAT CODE control unit able to dialogue with the engine control unit, and an electronic key with a specific sender unit designed for sending an identification code.

Once the key has been turned to STOP, the FIAT CODE system de-activates the engine control unit completely.

When the key is turned to MAR, the following operations take place in sequence:

1 - the engine control unit (whose memory contains a secret code) sends the FIAT CODE a request demanding that a secret code be sent to de-activate the function lock:

2 - the FIAT CODE control unit responds by sending the secret code only after receiving a recognition code sent by the ignition key;

3 - recognition of the secret code allows the engine control unit lock to be de-activated and normal operation to proceed.

NOTE *When the FIAT CODE anti-theft system is present, it is extremely inadvisable to test the vehicle using another engine control unit. In this case, the FIAT CODE control unit would transfer the recognition code (unknown) to the test control unit, which would thus be rendered completely unserviceable on other vehicles.*

IGNITION MANAGEMENT

The ignition circuit is static inductive discharge type, i.e. a high tension distributor with power modules located inside the injection-ignition control unit.

The system comprises two high tension twin outlet coils combined in a single container and connected directly to the spark plugs.

The primary winding of each coil is connected to the power relay (i.e. supplied by battery voltage) and pins of the ECU for connection to earth.

Once the start-up stage is over, the I.A.W. - 1AF -13 ECU implements a base pulse constant taken from a specific map in accordance with the following input parameters:

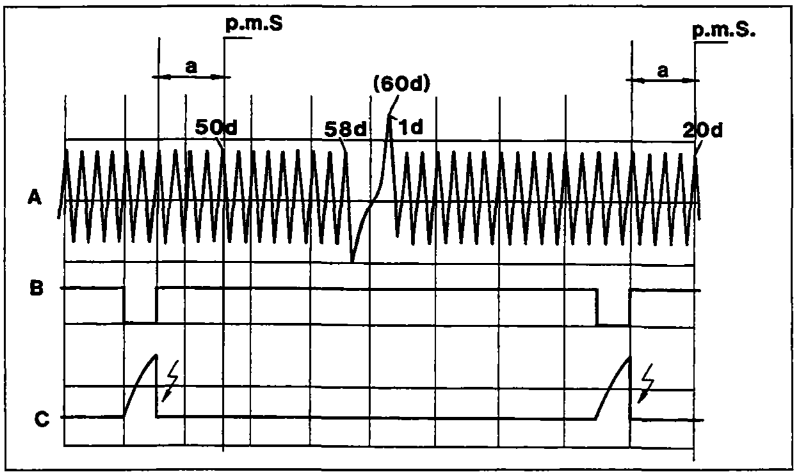
- engine rotating speed (rpm),
- absolute pressure reading (mmhg) obtained in intake manifold.

This advance setting is corrected according to temperature.

The advance angle is also subject to correction under the following conditions:

- during start-up;
- during transitory stages of acceleration and over-run.
- during cut-off.
- when rpm is excessive.

For the ignition system to work efficiently, the ECU must recognise signal configuration (3).



P4A09CJ01

A. Rpm sensor signal
B. Power control
C. Current running through coil primary winding
a. Ignition advance with reference to cylinder TDC

The gap or change in signal generated by the lack of two teeth on the phonic wheel, more specifically between the 58th and 1st tooth (known also as the synchronism tooth) which occurs each time the crankshaft pulley turns is a reference signal which allows the ECU recognition 114° in advance of TDC of piston pair 1-4 in correspondence to falling front of 20th tooth.

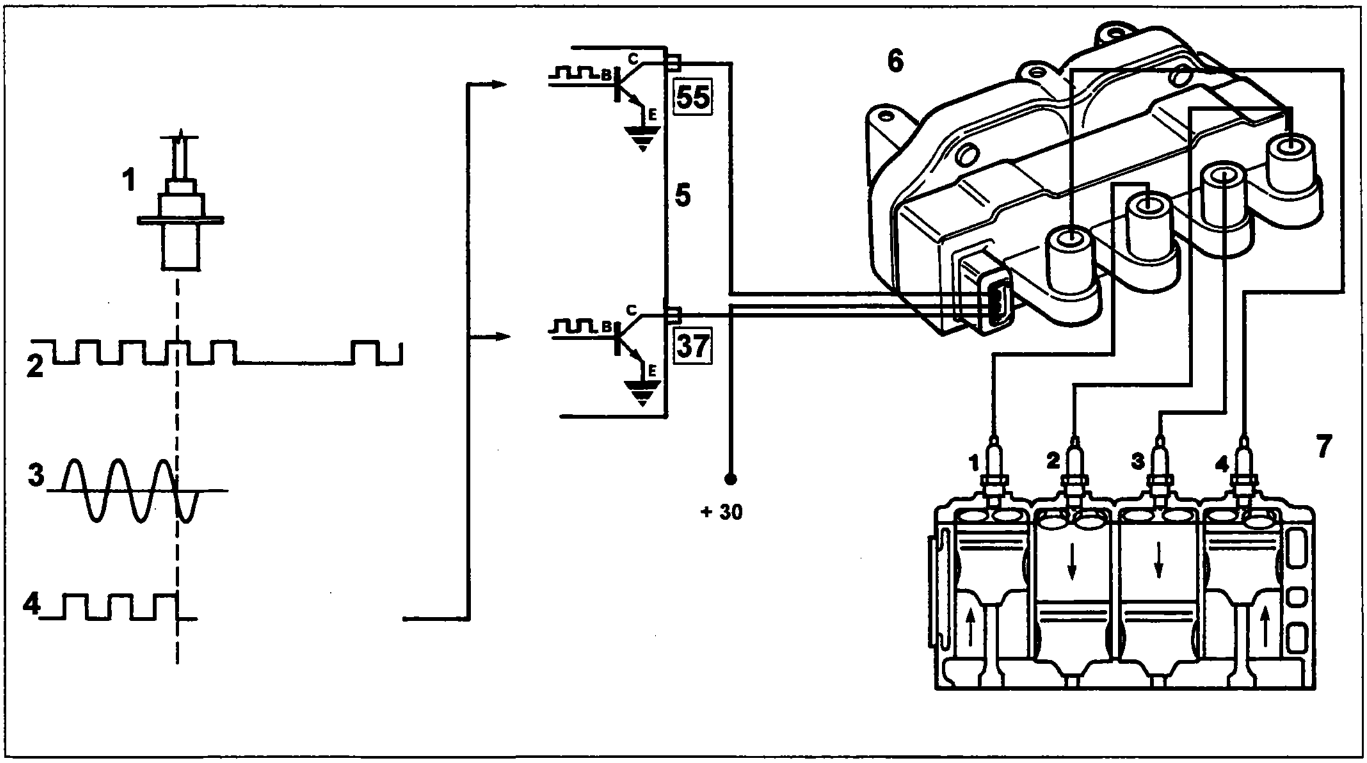
Once the ECU (see following page) has received the correct T.D.C. signal configuration, it establishes the point at which conduction (supply) to primary circuits of coils (6) begins and makes internal power module (5) conductive.

10.

The rising side of signal (graph B in figure on previous page) therefore represents a moment within which alternative primary winding conduction could take place. This point can be established only by the control unit power module. The conduction time the H.T. coil needs in order to store sufficient energy is also defined by DWELL management strategies. This depends on the time taken by the current to reach about 6A in the coil primary winding and also on the calculation algorithm run by the microprocessor which uses factors saved in a special memory, obviously based on engine rpm

With reference to the figure on the previous page, the falling side of the signal, (B) conduction end point (or current drop to zero), is a categorical order to cut-off the current flowing in the primary winding and represents the ignition advance point (a) processed by the computer (advance - (a) - varies according to rpm).

The control unit (ECU) then controls spark advance in the different cylinders in relation to top dead centre and conduction time necessary for the coil to store energy by controlling the two power stages (corresponding to ECU pins 55 and 37). These in turn permit current to flow through primary windings of coils (6) for long enough to ensure the specified 6A current rating.



P4A10CJ01

Ignition operating diagram

1. RPM and TDC sensor.
2. Phonic wheel.
3. Signal pattern taken from phonic wheel (60-2) teeth.

   TDCs correspond to teeth 20 and 50.
4. Succession of rectangular square wave signals of constant amplitude
5. Ignition power module (inside control unit).
6. Ignition coils.
7. Spark plugs

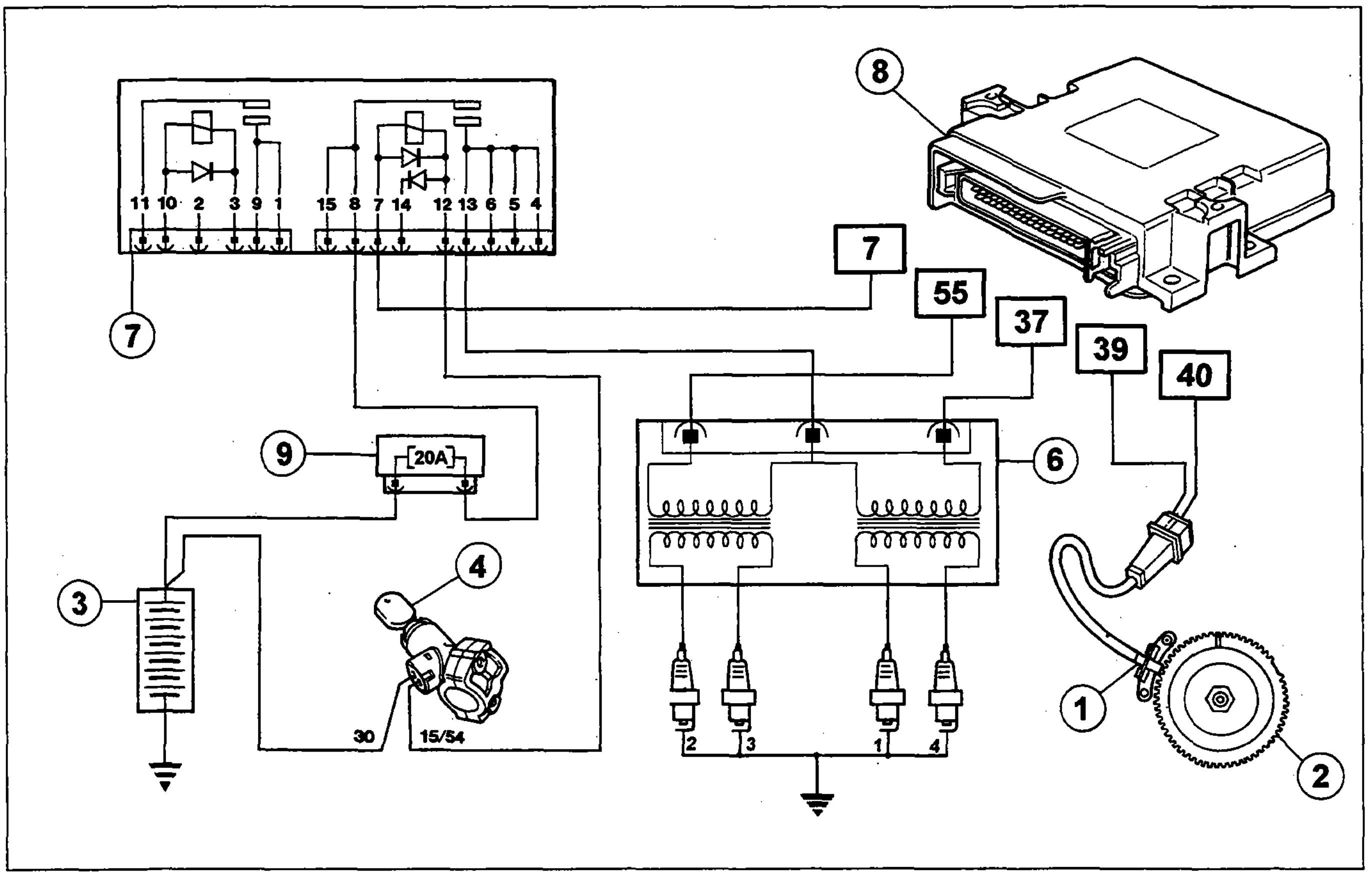
NOTE *The numbers in boxes indicate the corresponding control unit pins*

At the moment when the ECU de-activates one of the two power stages, current flow is cut off. This generates a voltage by induction (up to 30kV without loads) in the secondary winding.

When the voltage required for triggering an arc between the spark plug electrodes is examined, we note that voltage is high in the cylinder undergoing compression (about 10kV) while it is reduced (about 5kV) in the cylinder undergoing exhaust.

High tension distribution is static, i.e. takes place without a rotary brush and cap. This system effectively does away with a distributor. This gives the system a considerable advantage because it is known that brush and cap insulation properties play an important role. Any loss of insulation to earth may impair ignition: particularly during winter or periods of heavy rain.

The spark plugs of cylinders 1-4 and 2-3 are connected directly (in pairs) by means of high tension leads to coil secondary winding terminals and may be considered to be connected in series, because the cylinder head joins them all. This solution is also known as a "lost spark" system because the energy built up by the coil discharges almost exclusively on the electrodes of the spark plug located in the cylinder under compression to allow mixture ignition. The other spark is obviously unused because the cylinder does not contain mixture for ignition - solely exhaust gas ready for venting.



P4A11CJ01

1. Rpm and TDC sensor
2. Crankshaft pulley with phonic wheel
3. Battery
4. Ignition switch
5. Spark plugs
6. Ignition coils
7. Dual relay
8. Injection-ignition ECU
9. Injection-ignition system fuse

ENGINE IDLE CONTROL

The main aim of this strategy is to maintain engine speed at around the mapped setting (warm engine: 850 rpm): the position assumed by the actuator is dependent on engine conditions/rpm and vehicle speed.

Start-up stage

When the key is inserted, the actuator takes up a position dependent on engine temperature and battery voltage (open-loop position).

Warming-up stage

The rpm is mainly corrected on the basis of coolant temperature.

With the engine warm, idle management is dependent upon the signal from the rpm sensor. The ECU introduces sustained idle when external loads are activated.

Deceleration stage

When the accelerator is released when the car is not idling, the ECU governs the actuator (step motor) by measn of special delivery curve (dash-pot curve), i.e. delays the return of the plunger to its housing to bring about a reduction in engine braking effect.

FUEL VAPOUR RECIRCULATION MANAGEMENT

The strategy controls vapour cut-off solenoid position as follows:

- during start-up, the solenoid remains closed to prevent fuel vapours enriching the mixture excessively. This condition persists until coolant temperature reaches 65° C;

- with the engine warm, the ECU sends the solenoid a square wave signal (duty-cycle control) which modulates opening.

In this way, the ECU controls the amount of fuel vapour directed to the intake, thus avoiding substantial changes in mixture concentration.

Under the following operation conditions:

- throttle valve closed
- speed less than 1500 rpm
- intake manifold pressure less than a lower threshold calculated by the ECU in accordance with rpm level

solenoid control is inhibited with the same closure position maintained. This makes engine operation more efficient.

TEST MANAGEMENT

Full injection-ignition system electronic testing can be achieved by connecting a FIAT/LANCIA TESTER to the test socket.

The system is also equipped with a self-diagnostic function which recognises, memorises and indicates any faults.

If sensors or actuators are found to be faulty, signal reconstruction strategies are immediately activated (recovery) so that the engine is able to operate at an acceptable level without affecting function. The car can then be driven to a service point for the necessary repairs.

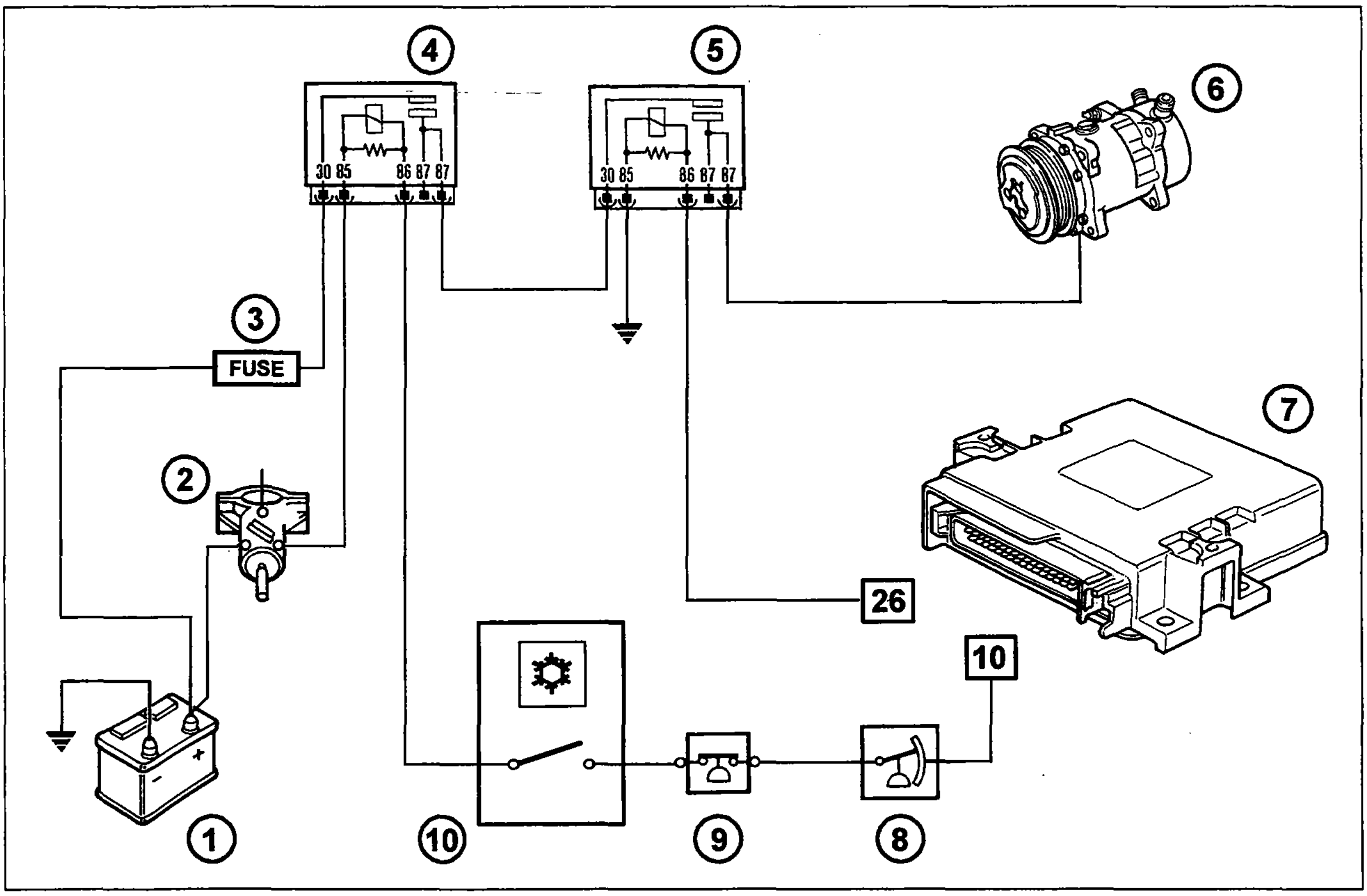
HEATING/VENTILATION SYSTEM MANAGEMENT

Rpm decreases when the air conditioner is turned on because the system compressor takes up power.

This involves a drop in rpm, which is particularly evident during idling.

To overcome this drawback, when the ECU is informed of air conditioner activation (pin 10) ahead of compressor activation (pin 26), it increases the speed by adjusting the air flow by means of the step motor.

When a power requirement is identified (throttle position higher than a given threshold) the ECU inhibits air conditioner operation for a memorized time interval.

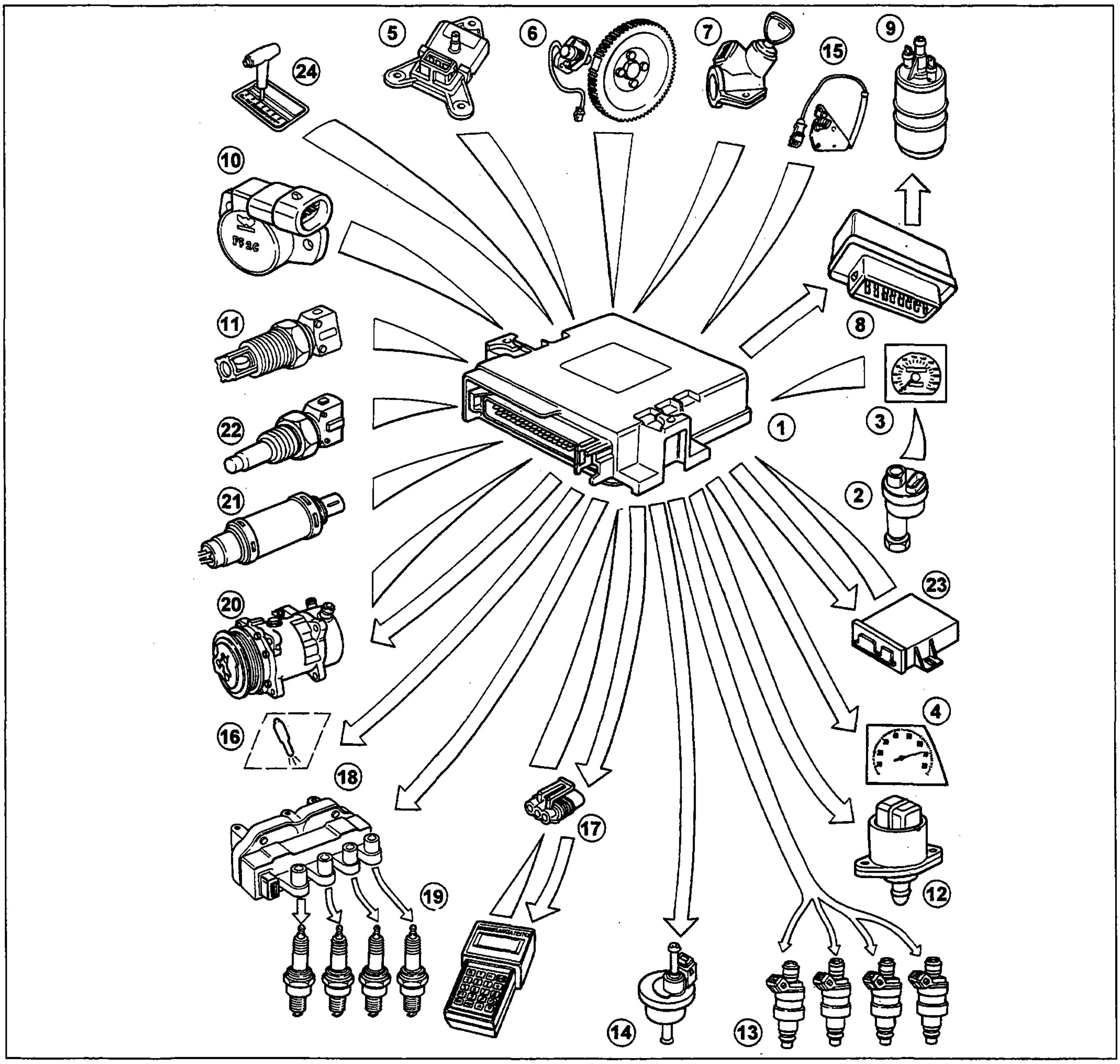


P4A13CJ01

1. Battery
2. Ignition switch
3. Fuse
4. Air conditioning system enablement relay
5. Compressor electromagnetic coupling supply relay
6. Compressor
7. Electronic injection-ignition control unit
8. Three stage pressure switch
9. Defrosting sensor
10. Air conditioner activation switch

10.

DIAGRAM SHOWING INPUT/OUTPUT BETWEEN INJECTION-IGNITION SYSTEM ECU AND SENSORS/ACTUATORS

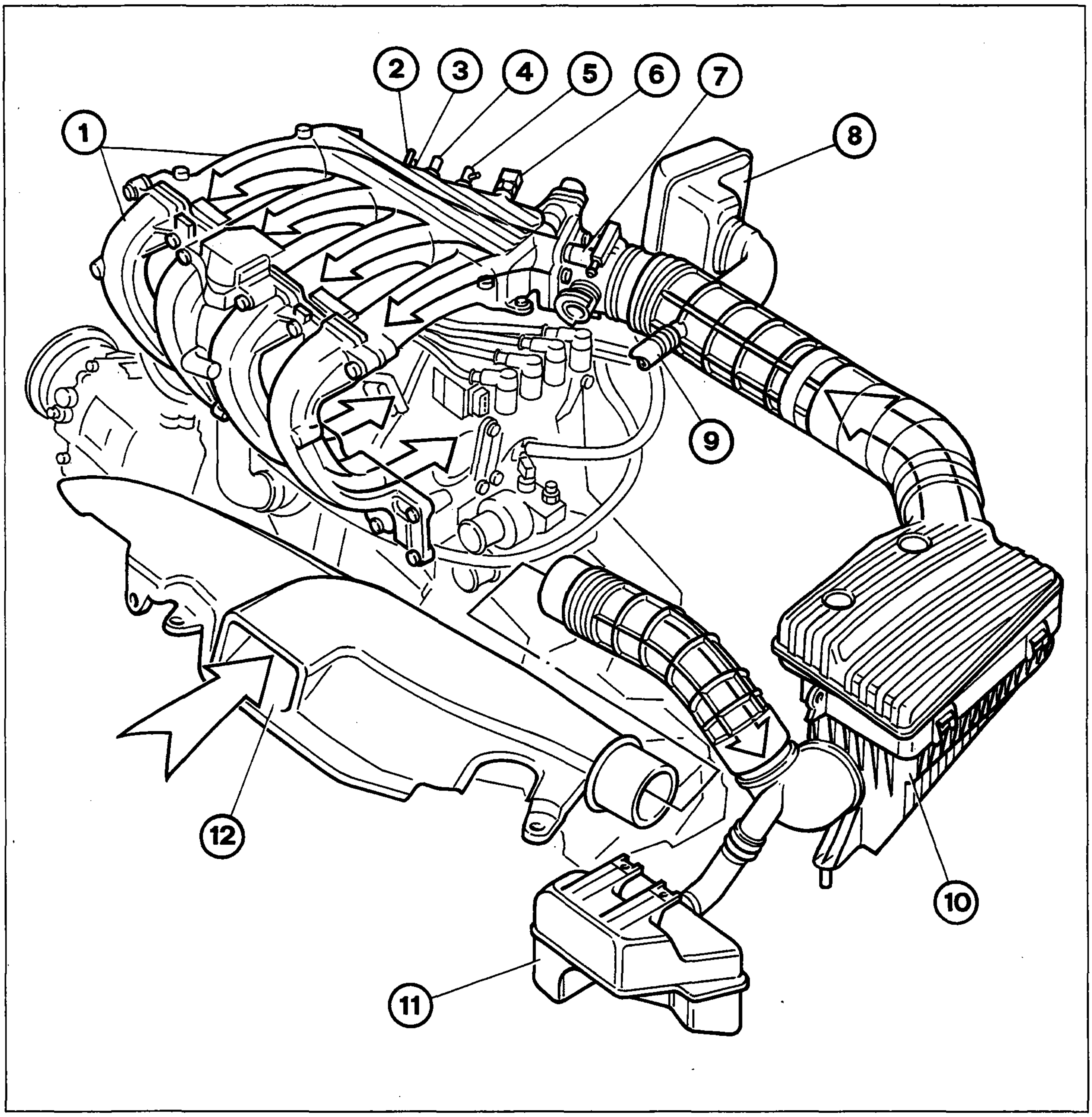


P4A14CJ01

Key to components

1. Electronic control unit
2. Speedometer sensor
3. Speedometer/mileometer
4. Rev counter
5. Absolute pressure sensor
6. Rpm and TDC sensor
7. Ignition switch
8. Dual relay
9. Electric fuel pump
10. Throttle position sensor
11. Air temperature sensor
12. Engine idle speed actuator
13. Injectors
14. Fuel vapour cut-off solenoid
15. Timing sensor
16. Injection warning light
17. Diagnostic socket
18. Coils
19. Spark plugs
20. Air conditioner compressor
21. Lambda probe
22. Coolant temperature sensor
23. FIAT CODE control unit
24. Automatic transmission

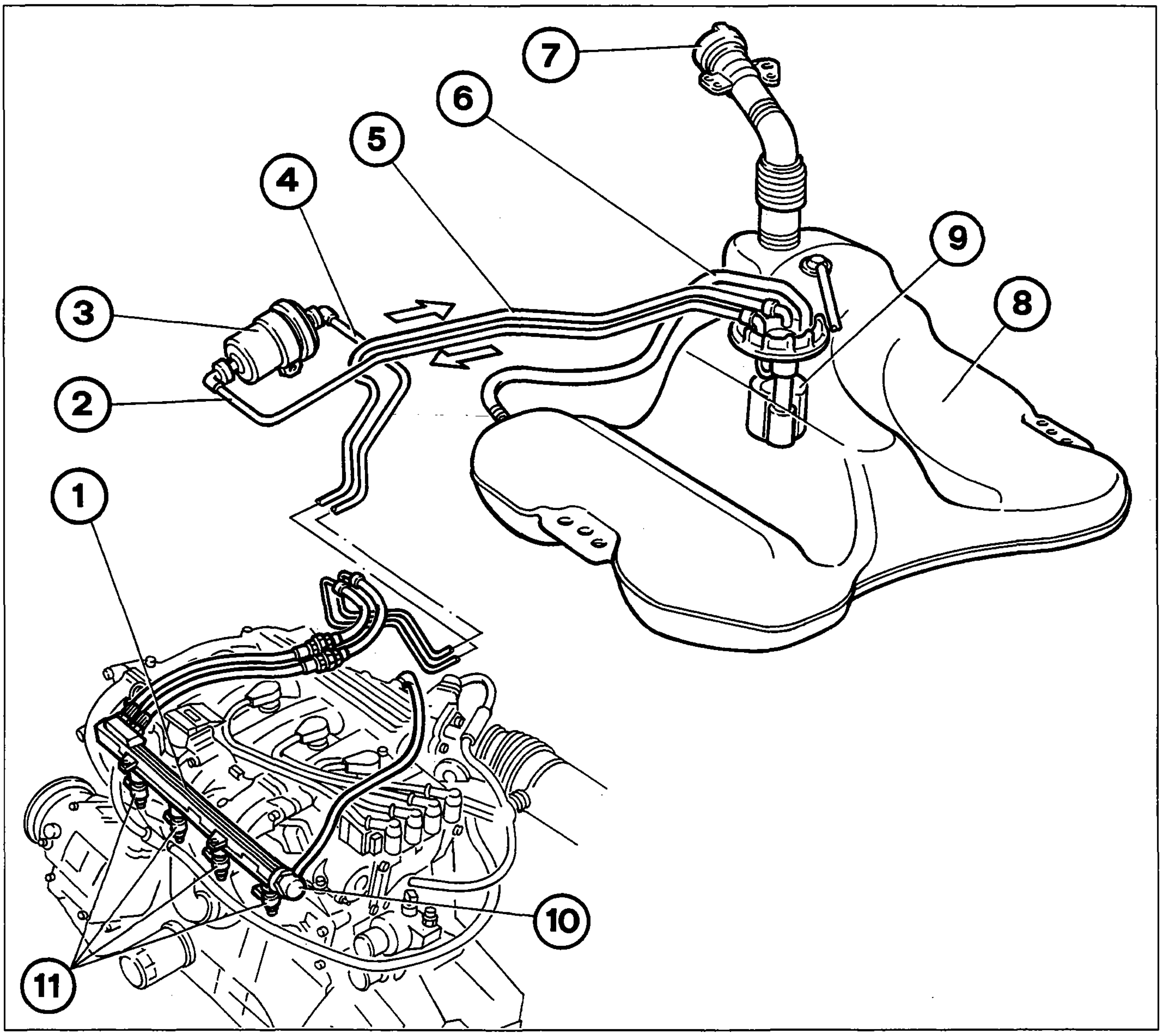
AIR INTAKE CIRCUIT MANAGEMENT



1. Inlet manifold
2. Evaporation control system socket
3. Socket for absolute pressure sensor
4. Socket for servo brake
5. Socket for fuel pressure regulator
6. Air temperature sensor
7. Throttle case
8. Upper resonator
9. Gas uptake from crankcase
10. Air cleaner
11. Lower resonator
12. Inlet fitting

10.

FUEL SUPPLY CIRCUIT DIAGRAM

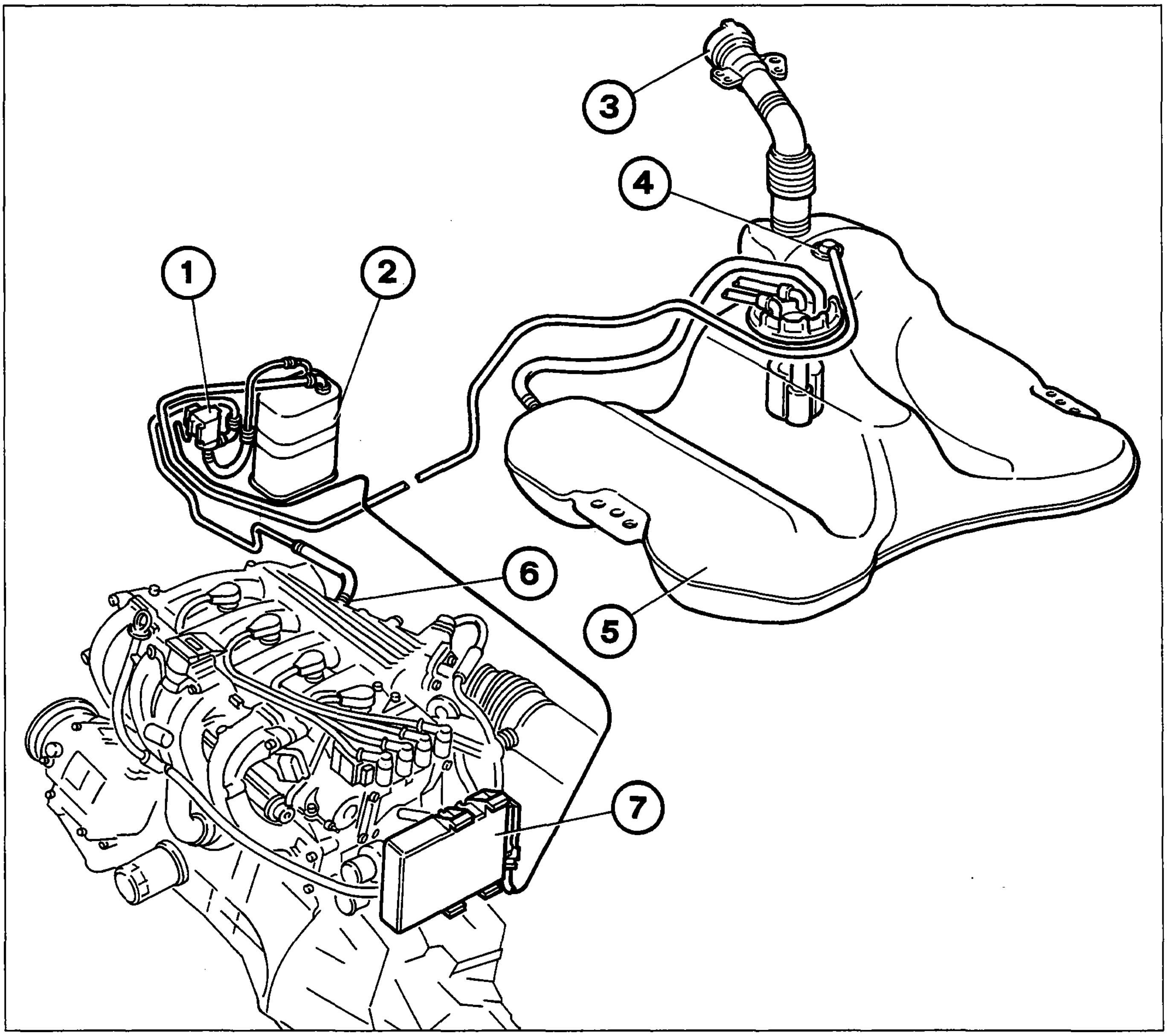


P4A16CJ01

1. Fuel supply manifold
2. Delivery line from tank to filter
3. Fuel filter
4. Delivery line from filter to injectors
5. Return line
6. Vent pipe
7. Union with vent and pressure relief valve
8. Tank
9. Fuel pump
10. Pressure regulator
11. Injectors

NOTE *Due to the specific shape of the tank, when fuel is added, an air lock may build up at the bottom which could prevent complete filling. Pipe (6) allows air to flow from the lower part so that the tank can be filled completely.*

FUEL EVAPORATION CONTROL CIRCUIT DIAGRAM



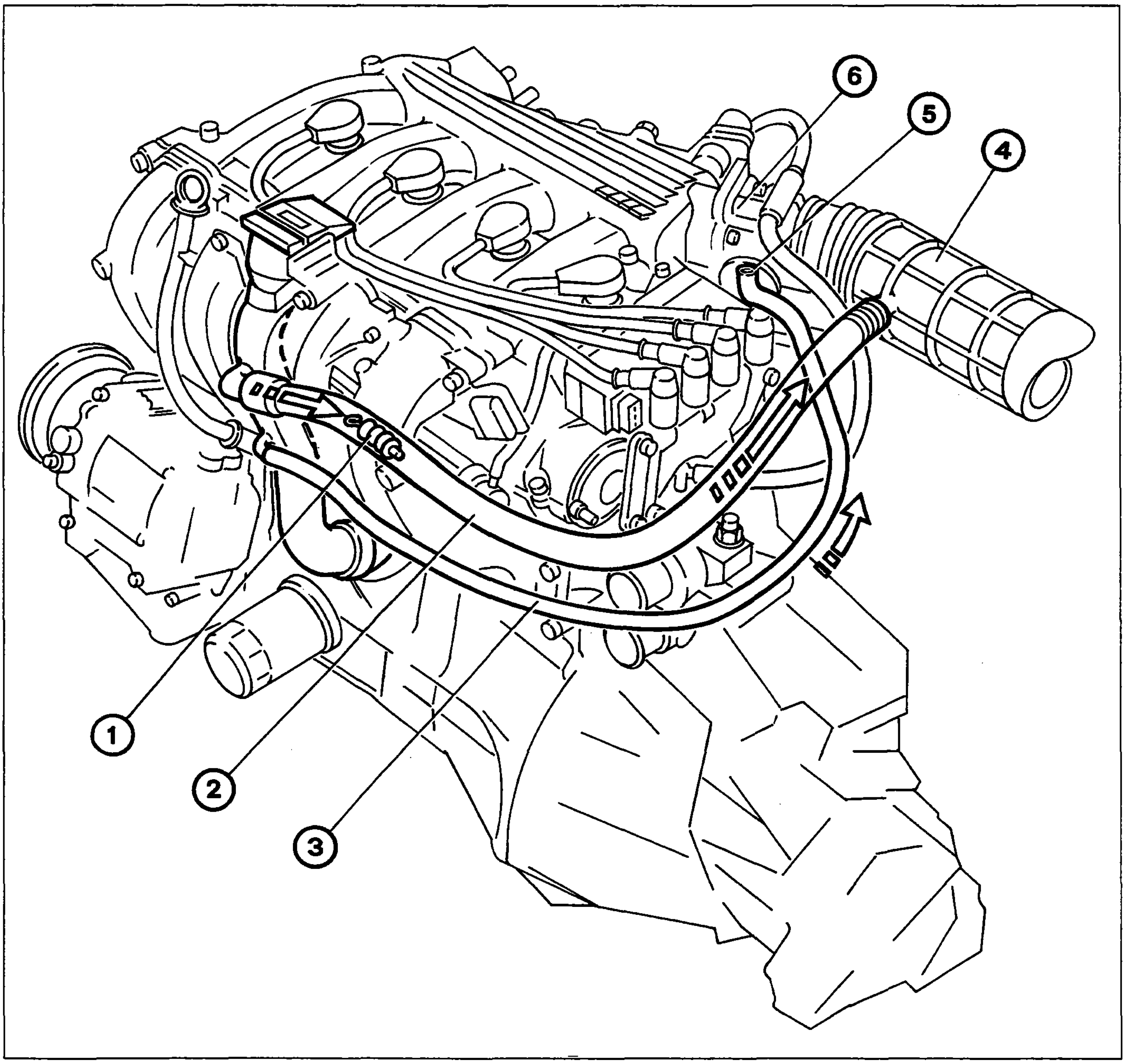
P4A17CJ01

The fuel evaporation system prevents fuel vapour, mainly comprising lighter hydrocarbon fractions formed in the tank, to escape into the atmosphere.

1. Fuel vapour cut-off valve
2. Active carbon trap filter
3. Safety and ventilation valve
4. Multifunction valve
5. Reservoir
6. Fuel vapour intake fitting in intake manifold
7. Injection-ignition ECU

10.

BLOW-BY GAS RECIRCULATION DIAGRAM



P4A18CJ01

The system controls emission, from the engine block, of vent gases made up of air-fuel mixtures, burnt gases which leak through piston rings and lubricant oil vapours by recirculating them to the intake.

With the accelerator throttle open, vent gases from the engine block reach the sleeve connecting the air cleaner-butterfly valve case (4) through pipe (2). This contains a flame trap (1) which prevents combustion caused by flame flashing back from the butterfly valve case (6).

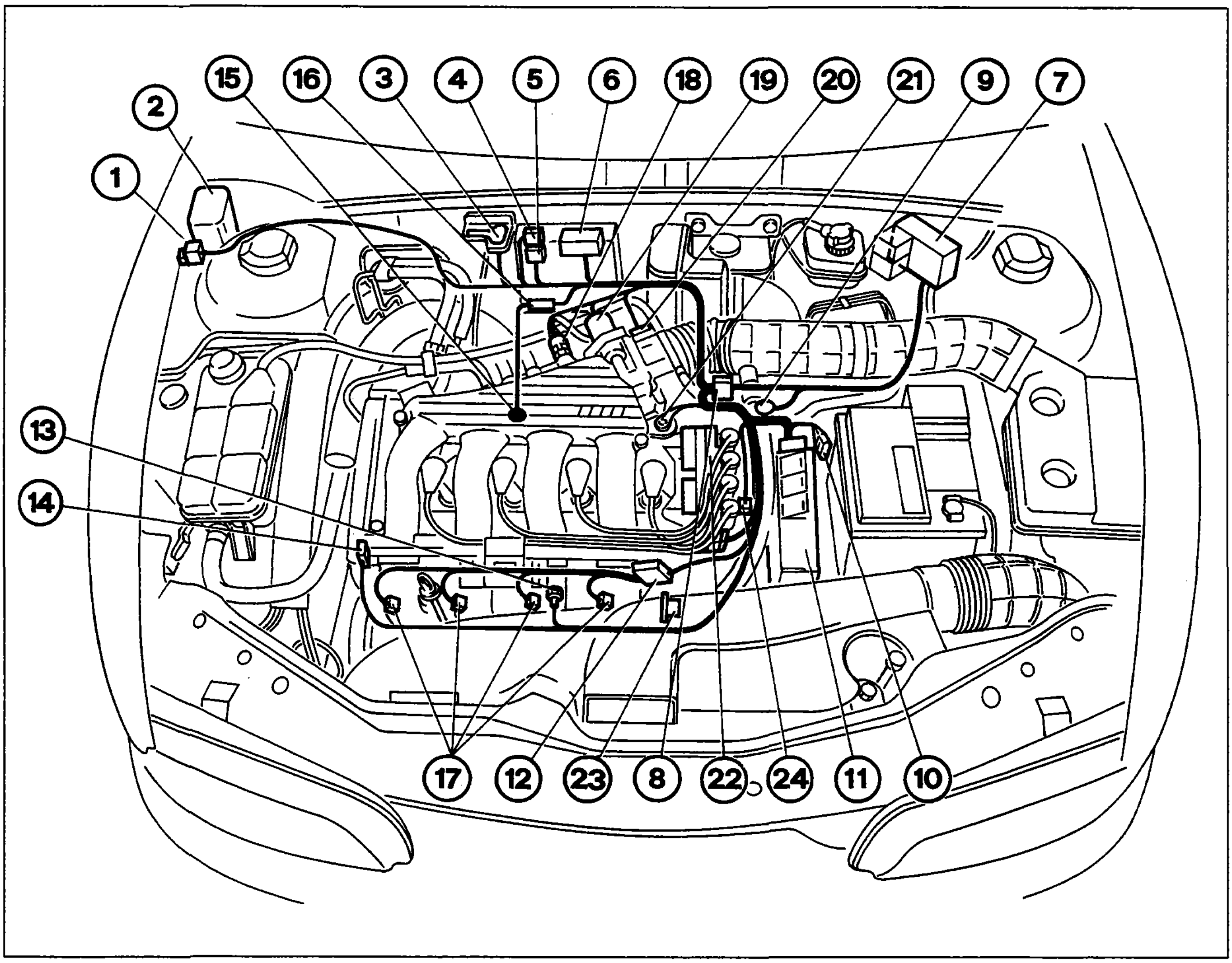
With the throttle closed (engine idling), the vacuum in the intake manifold takes up gas (in limited quantities) directly through the pipe (3) and calibrated hole (6).

Key to components in injection-ignition system wiring diagram

1. General 40A fuse for users beneath ignition switch
2. General 30A fuse for injection-ignition system
3. Ignition switch
4. 20A fuse for components supplied through dual relay (electric pump, lambda probe, injectors and fuel vapour cut-off solenoid)
5. 5A fuse for injection-ignition ECU
6. Dual relay
7. Lambda probe
8. Inertia switch
9. Electric fuel pump
10. Rev counter
11. Ignition coils
12. Spark plugs
13. Earth on body shell
14. Fuel vapour cut-off solenoid
15. Earth on engine
16. Injectors
17. System warning light
18. Automatic transmission ECU
19. FIAT CODE control unit
20. Speedometer signal
21. Air conditioner compressor
22. Three stage pressure switch
23. Engine idle speed actuator
24. Timing sensor
25. Throttle valve position sensor
26. Absolute pressure sensor
27. Coolant temperature sensor
28. Air temperature sensor
29. Rpm and TDC sensor
30. Diagnostic socket

10.

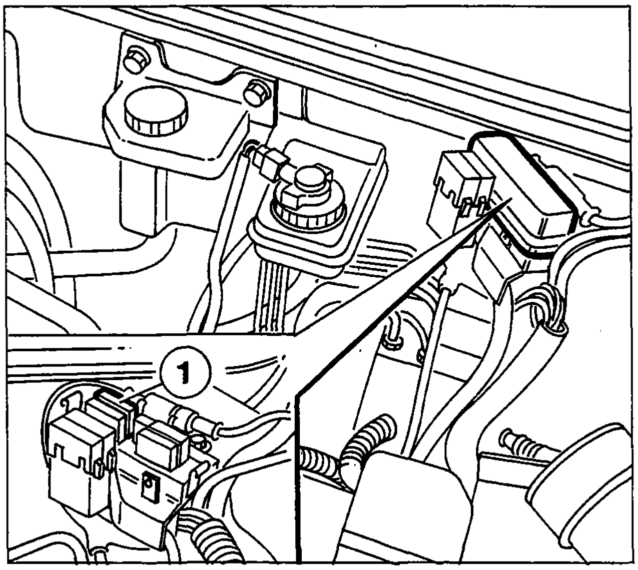
LOCATION OF INJECTION-IGNITION SYSTEM COMPONENTS IN ENGINE BAY



P4A22CJ01

Key to components

1. Fuel vapour cut-off solenoid
2. Carbon filter
3. Absolute pressure sensor
4. 5A fuse for injection-ignition ECU
5. 20A fuse for components supplied through dual relay (electric pump, lambda probe, injectors and fuel vapour solenoid)
6. Dual relay
7. General 30A system fuse
8. Injection lead coupling with front lead
9. Vehicle speed sensor
10. Diagnostic socket
11. Injection-ignition ECU
12. Injector lead coupling
13. Rpm and TDC sensor
14. Timing sensor
15. Lambda probe
16. Lambda probe coupling
17. Injectors
18. Air temperature sensor
19. Engine idle speed actuator
20. Throttle position sensor
21. Earth
22. Ignition coils
23. Fuel pressure regulator
24. Coolant temperature sensor

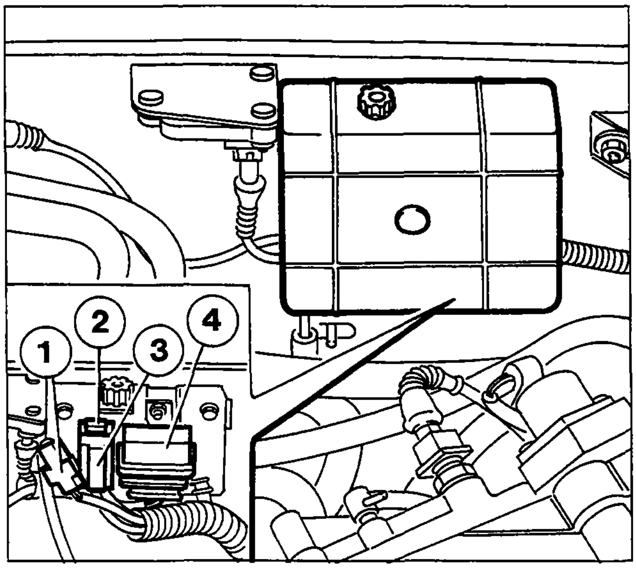


P4A23CJ01

INJECTION SYSTEM FUSES AND RELAYS

General system protection fuse

The general fuse (EFI-30A) protecting the injection-ignition system (1) is housed inside a container; to gain access to the fuse, undo side clips and lift lid.



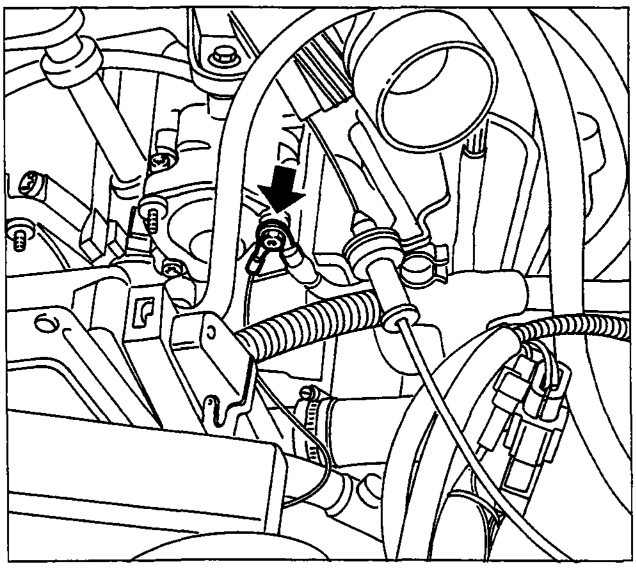
P4A23CJ02

Fuses and relays

The following components are housed on a bracket located against the rear wall of the engine bay:

1. Lambda probe lead junction
2. 5A ECU fuse
3. 20A fuse for components supplied through dual relay (electric pump, lambda probe, injectors and fuel vapour cut-off solenoid)
4. Dual relay

Unscrew ring nut and remove cover to gain access to the above components.



P4A23CJ03

EARTH POINTS

The earth of the injection-ignition system and earth of the electronic control unit are both fixed to the left hand side of the engine, close to the exhaust valves cover.

NOTE *The air cleaner-butterfly valve case connecting sleee and ignition coils are not shown in the figure alongside in order to illustrate the position of the earth points more clearly. No components require removal in order to gain access to the earths.*

COMPONENTS OF INJECTION-IGNITION SYSTEM

The injection-ignition system consists mainly of wiring, an electronic control unit (ECU) and the following sensors and actuators:

Sensors

- -Rpm and TDC sensor
- -Timing sensor
- -Throttle position sensor
- -Coolant temperature sensor
- -Intake air temperature sensor
- -Absolute pressure sensor
- -Vehicle speed sensor
- -Lambda probe

Actuators

- -Engine idle speed actuator
- -Electric fuel pump
- -Fuel vapour cut-off valve
- -Injectors
- -Ignition coils
- -Dual relay

INJECTION-IGNITION SYSTEM WIRING

The various system components are connected by a single wiring system fitted with connectors of various types. These are grouped in special ducts fitted to the engine (prewiring).

INJECTION-IGNITION ECU

The I.A.W. -1AF.13 (I.A.W. -1AF.23 for vehicles with automatic transmission) injection-ignition system ECU adopted is specific to this version.

It consists of hybrid thick film circuits connected to the electrical system by a 55 pin multiple connector.

The ECU's task is to process signals from the various sensors through the application of software algorithms and control the actuators in order to achieve optimal engine performance.

Essential features of the electronic control unit are as follows:

a. Data acquisition and coding section

This consists of a set of electronic components designed to receive data in the form of analogue electrical signals. Inside, the signals are converted into digital signals, processed and stored.

b. Microprocessor

This electronic component is responsible for computing and managing acquired data. It is thus a true computer and its main tasks include: consulting memories, comparing data input with sample data, managing actuator control circuits.

c. ROM memory (Read Only Memory-memoria di sola lettura)

This contains all programs necessary for microprocessor operation. Because the unit is programmed permanently prior to installation, data may be read but not modified.

The ROM memory is conservative; commands are saved even when the battery leads are disconnected.

d. RAM memory (Random Access Memory)

The RAM memory is a transitional memory where data can be read and saved.

This memory is actually used to save input data temporarily so that they are available for processing and also to memorize signals for coding operating anomalies that may occur within sensors, actuators or ECU functions.

The RAM memory is divided into sections: the first volatile part, for data memorization, is enabled with ignition key in MARCIA position and deleted in STOP position.

The second non-volatile part, (RAM STAND-BY) saves engine parameters and adapts them in time. In other words, the ECU uses the Lambda probe signal to modify and store an injection time correction factor that influences mixture concentration; this ECU is therefore defined SELF-ADAPTIVE.

These values require a continual supply from the battery in order to be maintained (memory in STAND-BY). If the battery, dual relay or terminals are disconnected, the parameters are zeroed. Normal vehicle use resets the adaptation process and new parameters are memorized.

The presence of a non volatile memory allows data relating to system anomalies to be saved even if the battery is disconnected and anomalies to be indicated even once they have been absent for 5 consecutive start-ups (one start-up +20' engine operation).

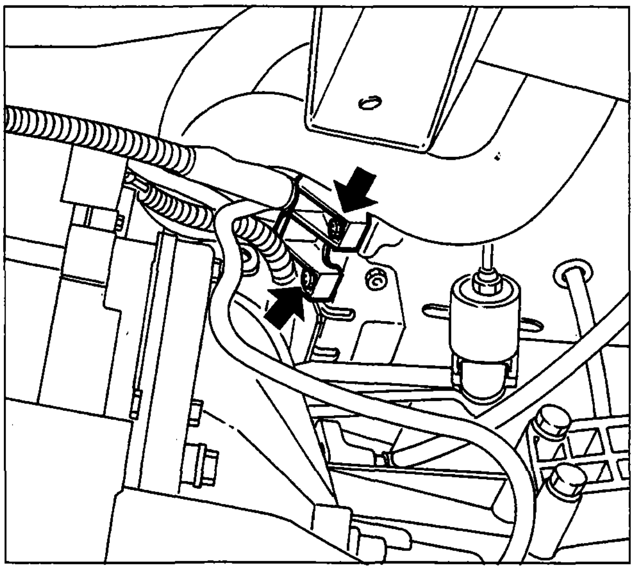
e. EEPROM memory (Electrical Erasable Programmable Read Only Memory)

This is a special type of memory that can be deleted electrically and reprogrammed again and again. One of its functions is to receive from the RAM STAND-BY recordings of anomalies that have arisen during engine operation and send these through the diagnostic socket to a Fiat-Lancia Tester. A Fiat-Lancia Tester must be used in active diagnosis in order to delete the anomalies.

f. Drivers (final power stages for actuator control)

These circuits are driven directly by the microprocessor and the relevant integrated circuit. They are used to supply actuators such as: injectors, step motor for idle control, carbon filter flushing valve, fuel pump relay, ignition coil main relay.

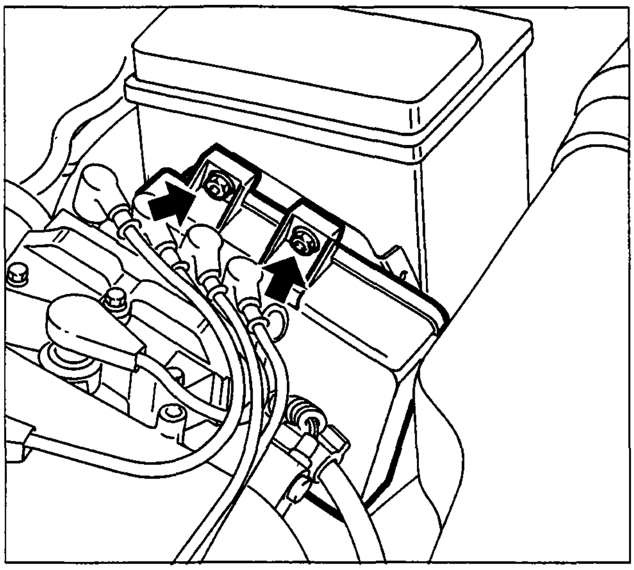
10.



P4A26CJ01

Removing-refitting

Position the vehicle on a lift and unscrew the lower retaining bolts.

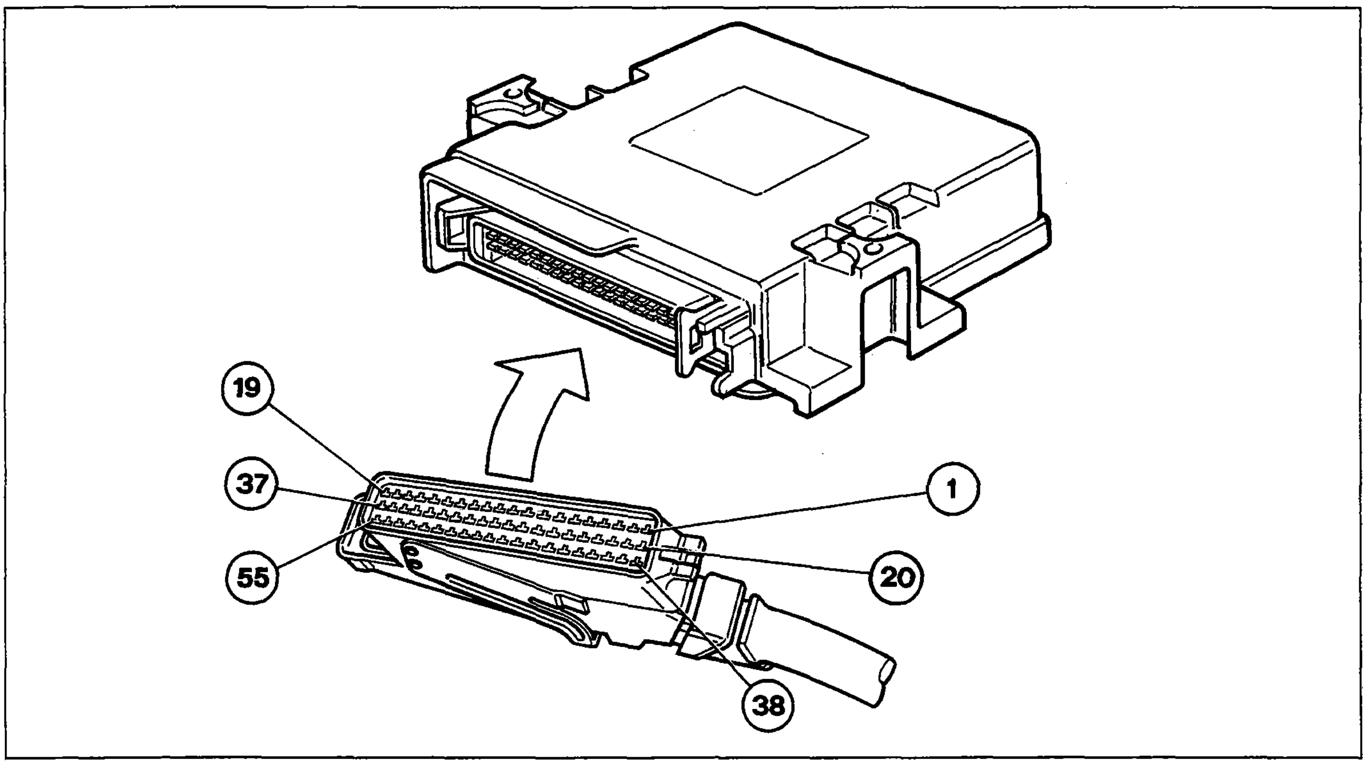


P4A26CJ02

Disconnect electrical connection and the earth connection. Unscrew upper retaining bolts and remove the control unit.

It is absolutely prohibited to exchange injection control units between different vehicles in order to check their efficiency.

Before replacing an ECU as a result of testing, ensure it is really faulty because when a new ECU is activated, the secret Fiat CODE system code is memorised and this makes the unit completely unusable on other vehicles.

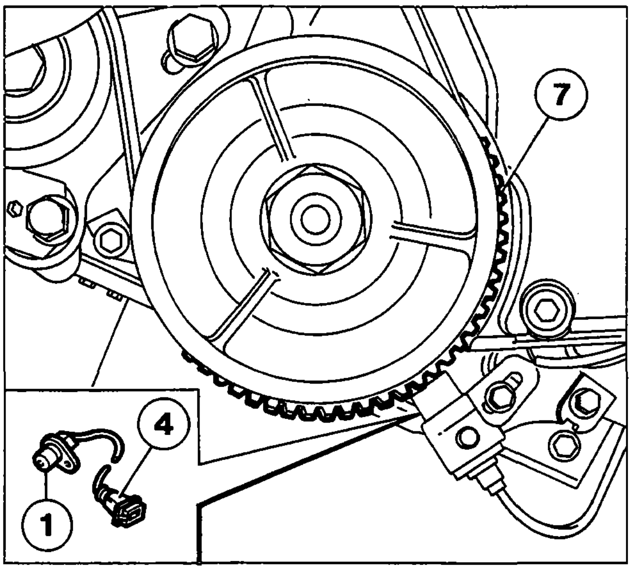


P4A27CJ01

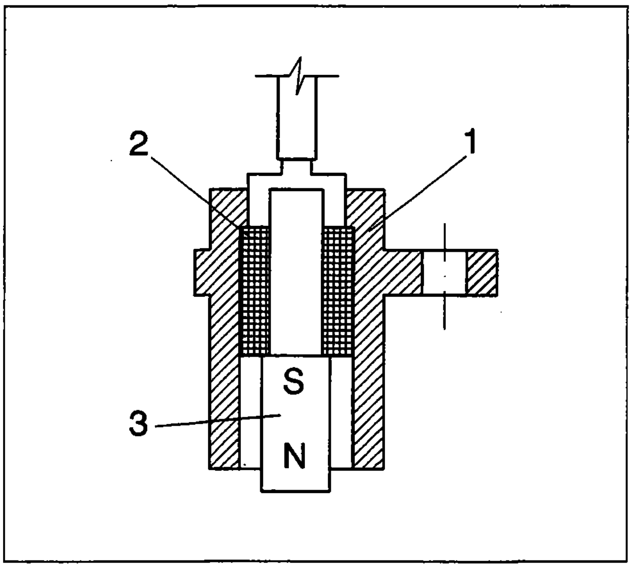
Identifying connections on control unit (pin-out)

1. Cylinder no. 3 injector
2. Cylinder no. 1 injector
3. Engine idle speed actuator (stage 2)
4. Lambda probe earth
5. Automatic transmission ECU (coolant temperature signal)
6. N. C.
7. Dual relay (activate sect. B)
8. N. C.
9. IE system failure warning light.
10. 3-stage pressure switch
11. Timing sensor signal
12. Diagnostic socket (line L)
13. Power supply (+15/54)
14. Absolute pressure sensor signal
15. N. C.
16. Throttle valve position and timing sensor power supply
17. Electronic earth
18. N. C.
19. N. C.
20. Engine idle speed actuator (stage 2)
21. Engine idle speed actuator (stage 2)
22. Lambda probe signal
23. Throttle valve position sensor signal
24. Fuel vapour solenoid
25. N. C.
26. Air conditioner compressor
27. N. C.
28. Speedometer signal
29. Intake air temperature sensor
30. Rpm and TDC sensor earth
31. Diagnostic socket (K line)
32. Automatic transmission ECU (transmission ratio change)
33. N. C.
34. Absolute pressure sensor power supply
35. Power supply (+30)
36. Earth on engine
37. Ignition coil (cylinders 1-4)
38. Cylinder no. 4 injector
39. Cylinder no. 2 injector
40. Engine idle speed actuator (stage 1)
41. N. C.
42. Rev counter output
43. N. C.
44. Automatic transmission ECU (throttle valve angle)
45. N. C.
46. N. C.
47. Coolant temperature sensor signal
48. FIAT CODE control unit
49. Rpm and TDC sensor signal
50. Automatic transmission ECU (neutral/-drive signal)
51. N. C.
52. Dual relay (activate sect. A)
53. Throttle valve position and timing sensor earth
54. Earth on engine
55. Ignition coils (cylinders 2-3)

10.



P4A28CJ01



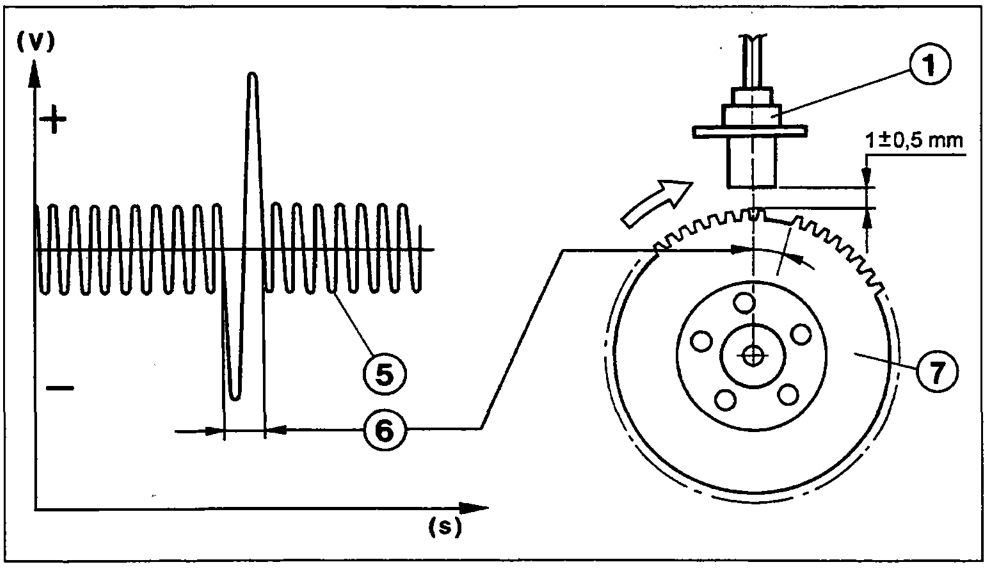
P4A28CJ02

RPM AND TDC SENSOR (Jeager CVM01)

RPM and crankshaft angular position reference (TDC indicator) sensor (1) is secured to the engine block facing phonic wheel (7) located on the crankshaft pulley.

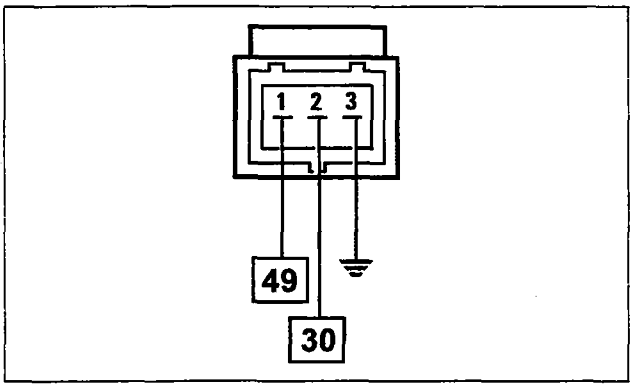
Principle of operation

This consists of a tubular case containing a permanent magnet (3) and an electrical coil (2).The magnetic flux set up by magnet (3) undergoes fluctuations due to changes in the gap as the teeth pass in front of the phonic wheel.
These magnetic flux changes set up an electromotive force in coil (2). An alternating positive (teeth facing sensor) and negative (gap facing sensor) voltage is set up at coil terminals. The sensor output voltage peak value depends on the gap beteween sensor and phonic wheel teeth if all other factors are equal.
Two of the sixty teeth on the phonic wheel are removed to create a reference gap. Gear pitch therefore corresponds to an angle of 6° (360° divided by 60 teeth). The synchronism point is recognised at the end of the first tooth following the space left by the two missing teeth. When this gap passes beneath the sensor, engine piston pair 1-4 is located at 114° before TDC.



P4A28CJ03

1. Sensor
2. Winding
3. Permanent magnet
4. Sensor connector
5. Output signal
6. Signal corresonding to the two missing teeth
7. Crankshaft pulley with phonic wheel

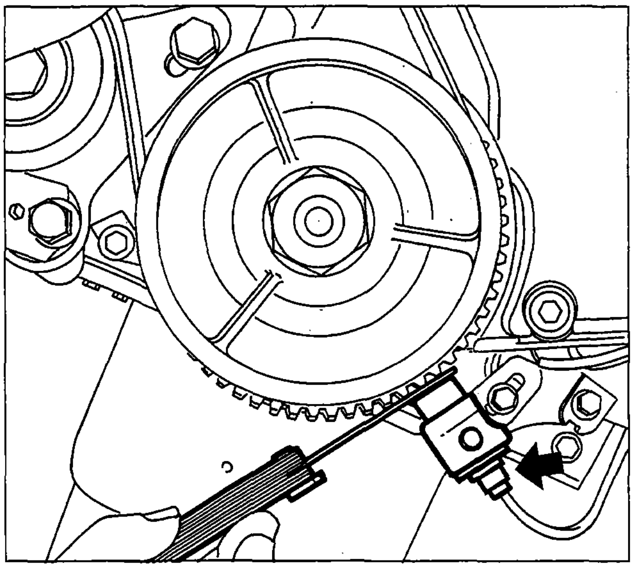


P4A29CJ01

Wiring connector

The sensor is connected to the ECU (pin 30 and 49) by means of twisted wires covered by a shielded, interference-proof sheath connected to earth.

NOTE *The numbers in boxes indicate the corresponding control unit pins.*



P4A29CJ02

Removing-refitting

Disconnect electrical connection.

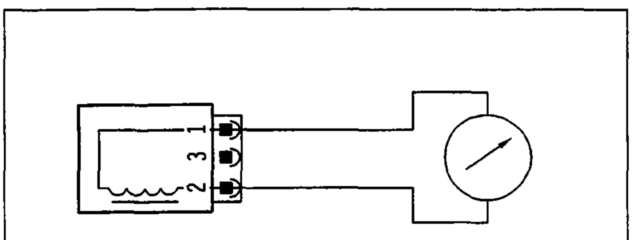
Unscrew the screw indicated and remove the sensor.

Checking gap

Check gap between sensor and phonic wheel teeth.

Gap: 0.5 - 1.5 mm

NOTE *Whenever repairs to the rpm and TDC sensor mount are necessary (e.g. gap not as specified, sensor not aligned etc.), the sensor must be positioned and aligned with the mount as described in the engine service manual (publication no. 504.589/20).*



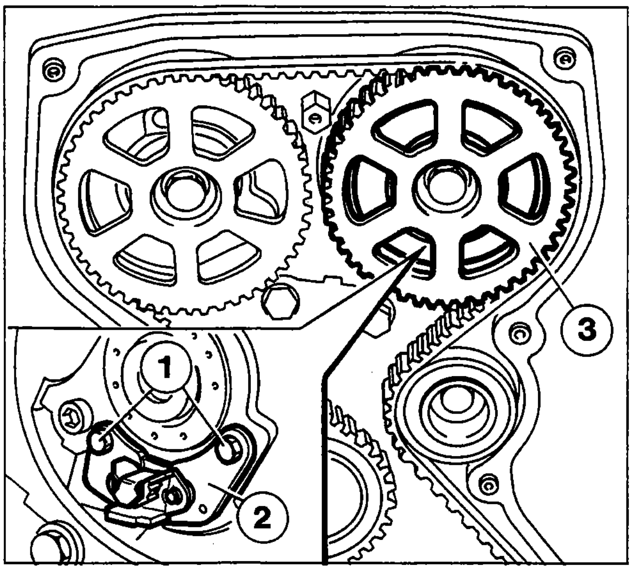
P4A29CJ03

Checking resistance

Sensor resistance may be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

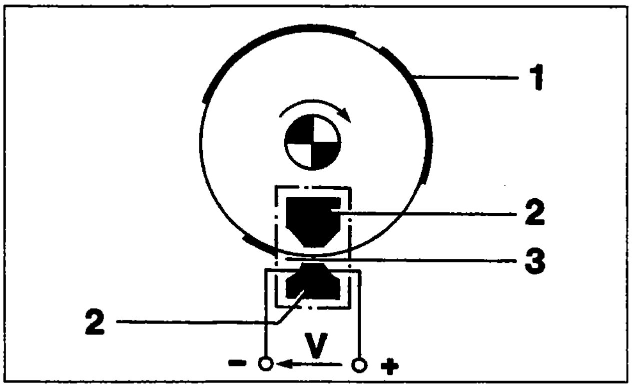
Resistance 575 - 750 ohm at 20 °C

10.



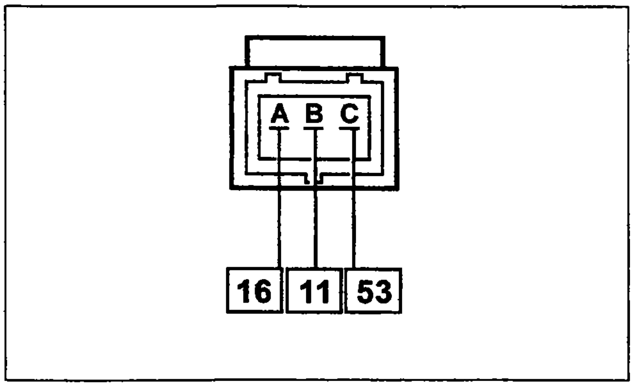
P4A30CJ01

NOTE *Sensor angular position may not be adjusted in any way.*



P4A30CJ02

1. Deflector
2. Magnetic material
3. Gap



P4A30CJ03

Wiring connector

The numbers in boxes indicate the corresponding control unit pins

TIMING SENSOR (SFA 200)

The I.A.W.-1AF.13 system adopts a phased, sequential injection system. In other words, fuel is injected into each cylinder in sequence during the intake phase.

To achieve this, the ECU uses a timing signal together with the rpm and TDC signal to determine the point of injection.

This signal is generated by a Hall sensor fitted on the exhaust camshaft pulley.

Principle of operation

A semi-conducting layer with current flowing through it is placed in a normal magnetic field (force lines at right angles to current direction). A potential difference known as a HALL voltage is set up at its terminals.

If current intensity remains constant, the voltage generated depends solely on the intensity of the magnetic field; magnetic field intensity need therefore only vary periodically to set up a modulated electrical signal with frequency proportional to the speed with which the magnetic field changes.

To achieve this change, the sensor is crossed by a metal ring (internal part of pulley) with an opening. The moving metal part of the ring covers the sensor and blocks the magnetic field to produce a low output signal. The sensor generates a high signal when aligned with the opening, i.e. with magnetic field present.

The alternation of signals is therefore dependent on the succession of openings (see chapter on "signal management").

Removing-refitting

To gain access to the timing sensor, remove the intake side camshaft pulley (3) (refer to engine service manual, publication no. 504.589/20).

Disconnect electrical connection of sensor.

Unscrew both screws (1) and remove timing sensor (2) with retaining plate.

BUTTERFLY VALVE CASE (54 CFA 26)

The butterfly valve case is responsible for metering the quantity of air supplied to the engine (and thus controlling engine power output) according to accelerator position determined by the driver.

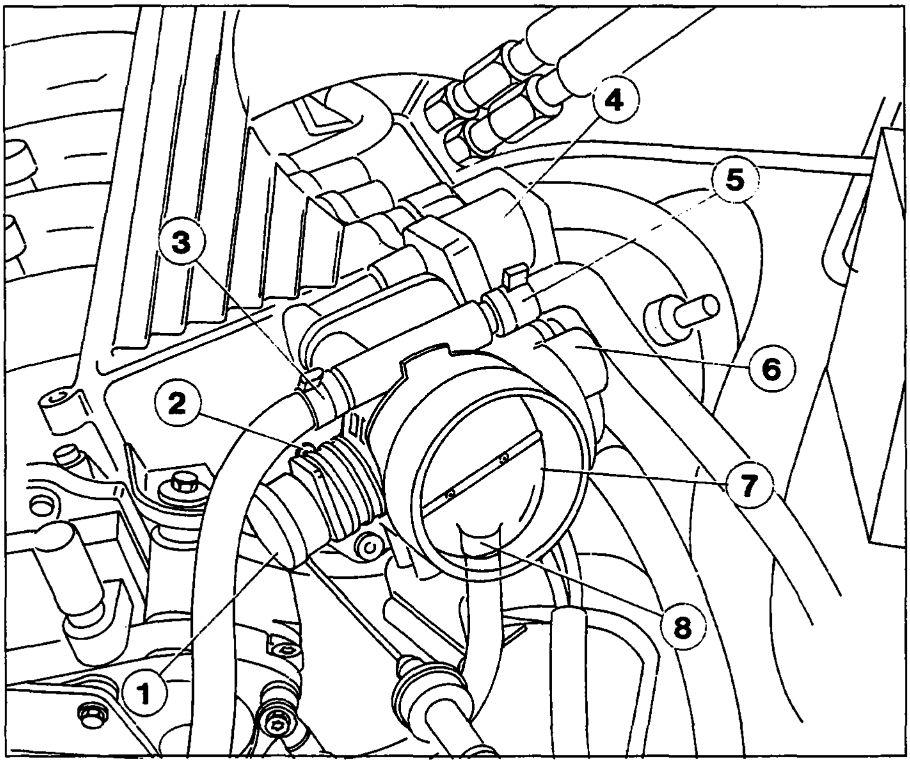
The butterfly valve case is fastened to the intake manifold by four screws. The throttle is opened by a linkage with configuration designed to open the throttle by a small amount when the pedal is hardly pressed (provided pedal travel remains the same) and open it by large amounts when the pedal is pressed down further.

With the pedal fully released (engine in over-run or idling), the additional air required is supplied by an engine idle adjustment solenoid. Under these conditions, the throttle opening lever comes into contact with an anti-bind screw, which prevents the throttle becoming locked in closed position.

To prevent the build-up of ice around the throttle and the hole leading to the PCV valve, the butterfly valve case is heated by directing a small amount of coolant from the engine thermostat around a chamber inside the case.

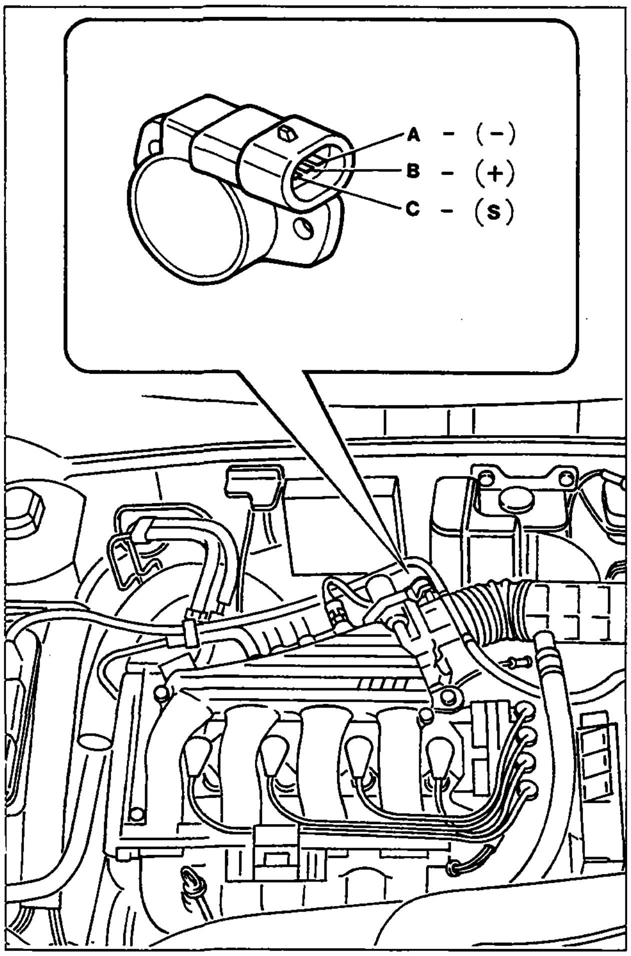
The oil vapour recirculation system PCV valve and throttle position sensor are also fitted on the butterfly valve case.

The anti-bind screw is set by flushing in the factory and should never be tampered with.



P4A31CJ01

1. Throttle linkage
2. Butterfly valve adjustment and antibind screw (do not touch)
3. Attachment for engine coolant delivery hose
4. Engine idle speed actuator
5. Attachment for engine coolant return hose
6. Throttle position sensor
7. Throttle valve
8. Attachment for engine block vapour recirculation and recovery line



P4A32CJ01

THROTTLE VALVE POSITION SENSOR (WEBER PF-1C)

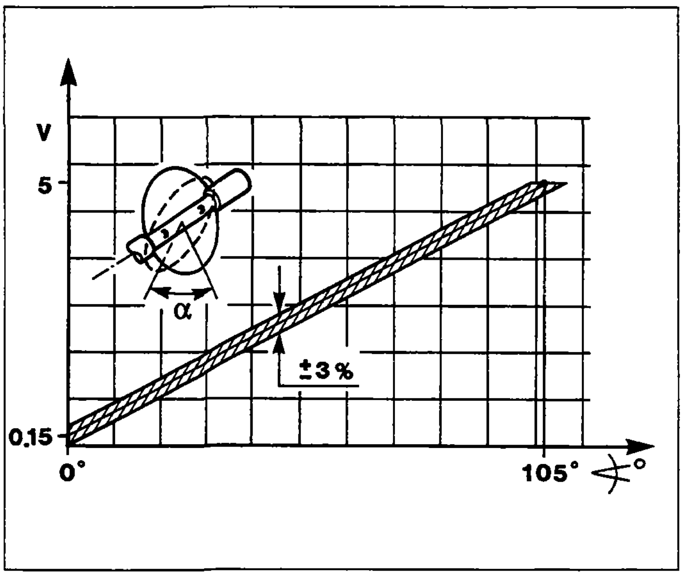
This takes the form of a potentiometer whose mobile part is controlled by the butterfly valve spindle.

The potentiometer is fitted inside a plastic container equipped with two tabs containing two UNSLOTTED holes. These anchor the sensor and ensure it is positioned correctly in relation to the throttle valve. A three-pin socket (ABC) on the container provides an electrical connection with the injection-ignition ECU.

During operation, the ECU supplies the potentiometer at a voltage of 5 Volt. The parameter measured is throttle position from idle to full opening for injection control management.

The ECU recognises throttle valve opening status on the basis of outlet voltage and corrects mixture concentration accordingly.
When the throttle is closed, an electric voltage signal is sent to the ECU, which recognises idle and cut-off status (discerning between them on the basis of rpm level).

The following graph indicates the voltage level supplied by the sensor as a function of throttle opening angle.



P4A32CJ02

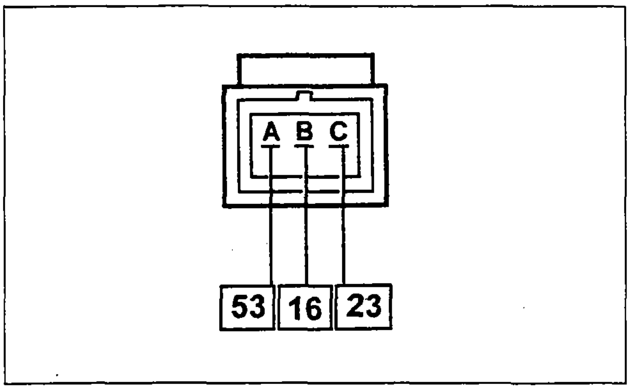
The potentiometer is single-ramp: its main specifications are as follows:

Effective electrical angle: 90° ± 2°

Mechanical angle: 105° ± 4°

Total mechanical travel: 110° ± 8°

Temperature service range: –30°C ÷ +125°C



P4A33CJ04

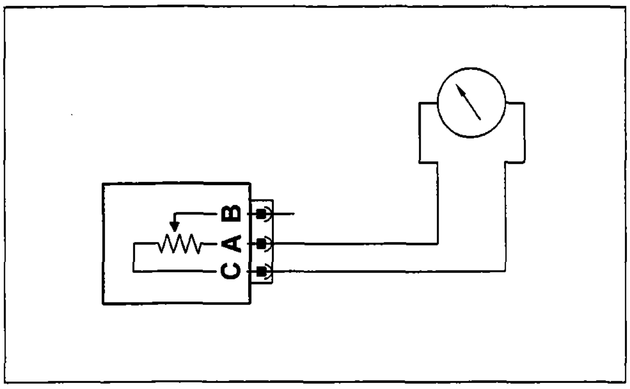
Wiring connector

The numbers in squares indicate the corresponding control unit pins.

Checking resistance

The sensor's resistance can be measured by connecting an ohmmeter between pins A and C of the sensor.

Resistance: 0 - 1200 ohm ± 20% at 23 °C



P4A33CJ02

Recovery

A value is assumed which is calculated in accordance with the pressure present in the inlet manifold; if the pressure sensor is also faulty, a throttle aperture angle of about 50° is established as a fixed value.

The strategies of gradual reduction of rpm at idling speed (dashpot) are inhibited.

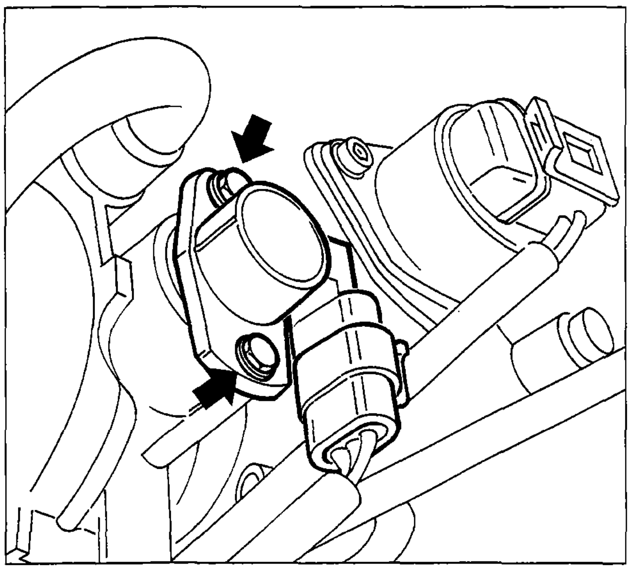
Self-adaptivity of idle speed is inhibited.

Self-adaptivity of the mixture strength is inhibited.

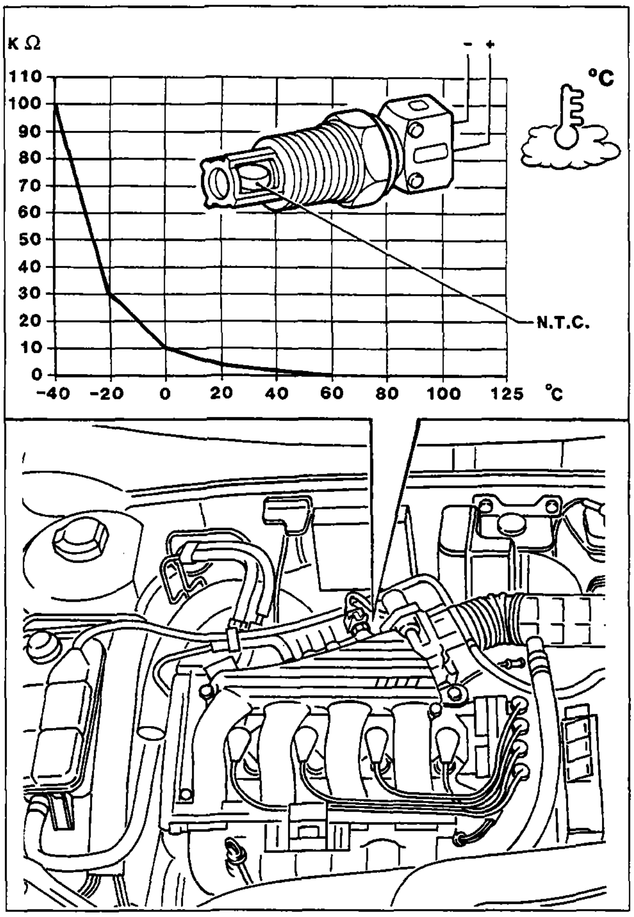
Removing-refitting

Undo the two bolts and remove the sensor.

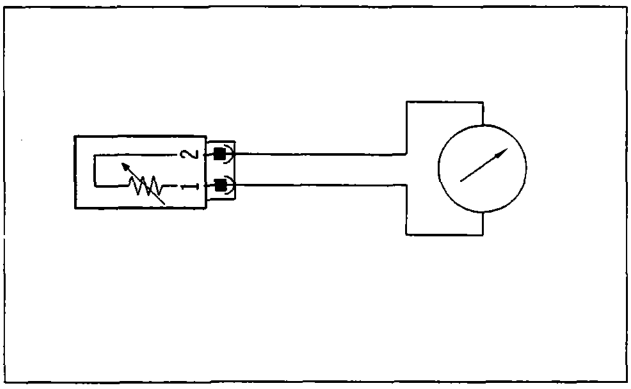
NOTE *The sensor is secured to the throttle body by means of two lugs in which there are two non-slotted holes; it is therefore not necessary to make any adjustment to its angle position as the control unit itself, by means of appropriate self-adaptive algorithms, recognizes the fully closed or fully open position of the throttle.*


P4A33CJ03

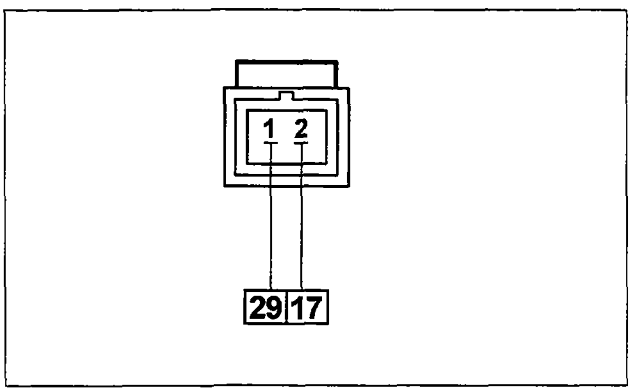
NOTE *Whenever the potentiometer bolts are slackened or removed, they must be replaced as the thread is coated with a thin layer of Loctite which ensures only once that they lock.*



P4A34CJ01



P4A34CJ02



P4A34CJ03

INTAKE AIR TEMPERATURE SENSOR (Jaeger ATS-04)

The sensor is installed on the inlet port.

It consists of a brass body, from which a plastic cage emerges. This protects the actual resistive element, which is an NTC ("Negative Temperature Coefficient") thermistor; the electrical resistance of the sensor decreases as the temperature increases.

Depending on the temperature of the air drawn in by the manifold, the NTC thermistor varies its resistance in accordance with the diagram in the figure.

The reference voltage for the air sensor is 5V; as this circuit is designed as a voltage divider, this voltage is shared between a resistor present in the electronic control unit and the air sensor's N.T.C. resistor. The electronic control unit is thus able to assess the variations in the sensor's resistance via changes in the voltage, and thus obtain infromation concerning the intake air temperature.

Together with the absolute pressure information, this information is used by the electronic control unit to establish the "AIR DENSITY" which is essential information for ascertaining the quantity of air drawn in by the engine, in accordance with which the computer will have to work out the injection time, i.e. the exact quantity of petrol to be delivered.

Checking resistance

The diagram shows the trend of the sensor's characteristic curve, which can be measured by disconnecting the connector and connecting an ohmmeter to the sensor's terminals.

Removing-refitting

Disconnect the electrical connection and remove the sensor screwed in the inlet port.

Tightening torque: 2.4 daNm

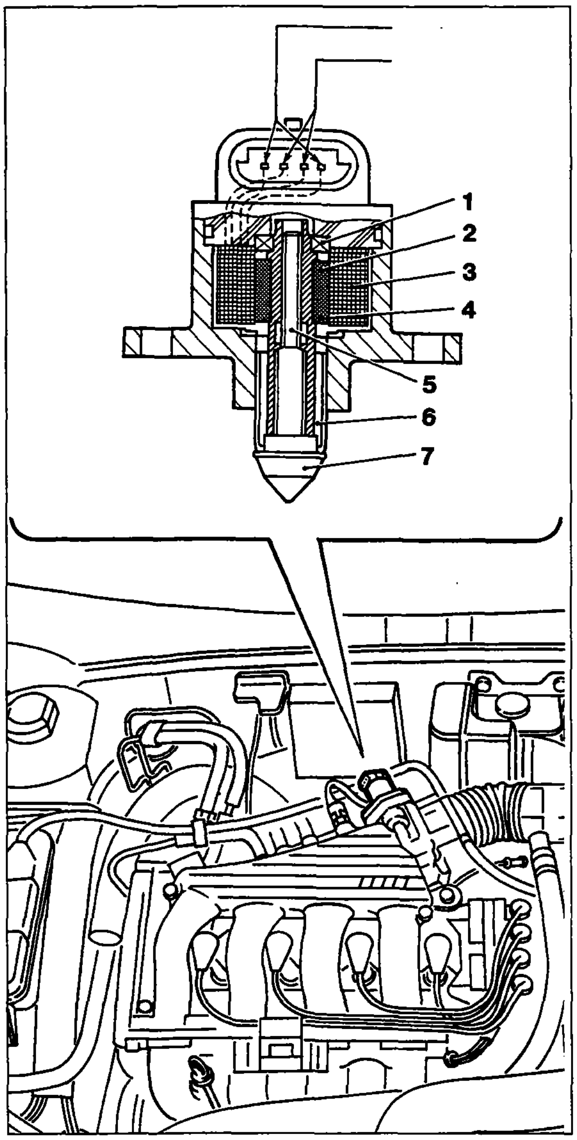
Recovery

An air T = 54°C is assumed.

Self-adaptivity during idling is inhibited.

Wiring connector

The numbers in squares indicate the corresponding control unit pins.



P4A35CJ01

ENGINE IDLE SPEED ACTUATOR (step motor) (WEBER B02)

1. Bearing
2. Lead screw
3. Coils
4. Magnets
5. Screw
6. Anti-rotation grooves
7. Plunger

The actuator is fitted to the butterfly valve case and consists of:

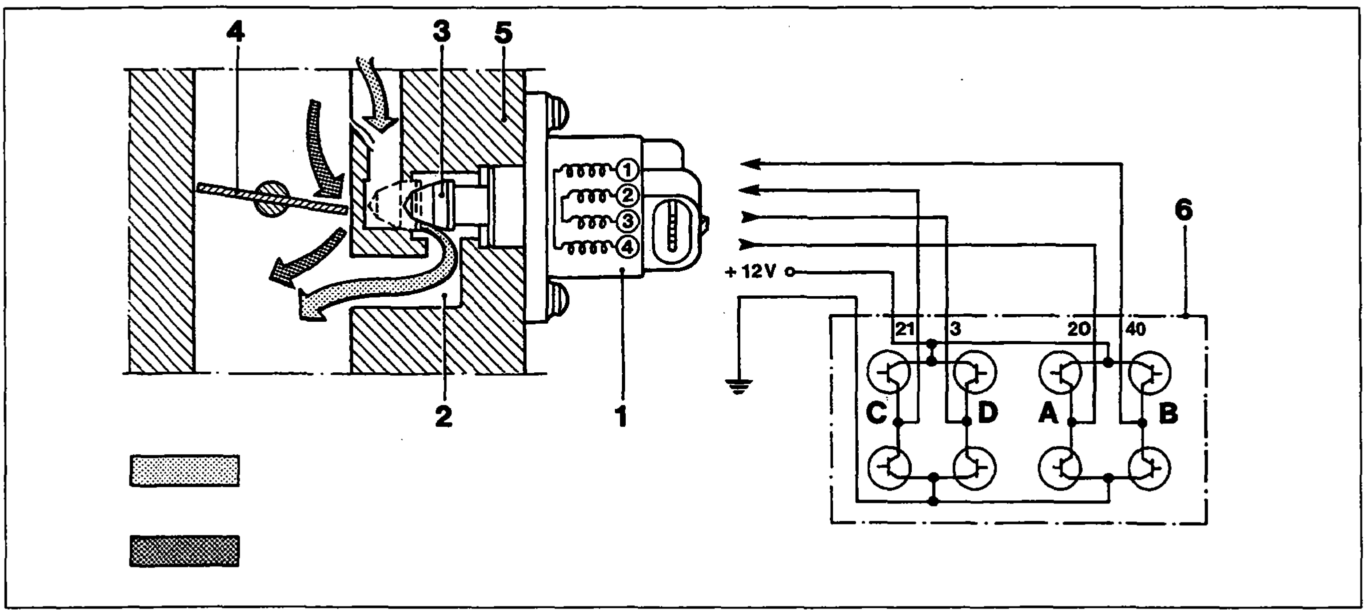
- An electric step motor with two windings in the stator and a rotor that contains a certain number of permanent magnet pairs.
- A worm and screw reduction unit that converts rotatory motion into linear motion.

In order to idle, i.e. with throttle (4) fully closed, the engine needs a certain amount of air (Qo) and fuel to overcome internal friction and maintain rpm levels.

To the quantity of air Qo that leaks through the closed butterfly valve (4) during idling, an additional quantity of air Q must be added to allow the engine to maintain rpm levels constant, particularly during warm up and when electrical users or external loads are activated (air conditioner, automatic transmission, etc).

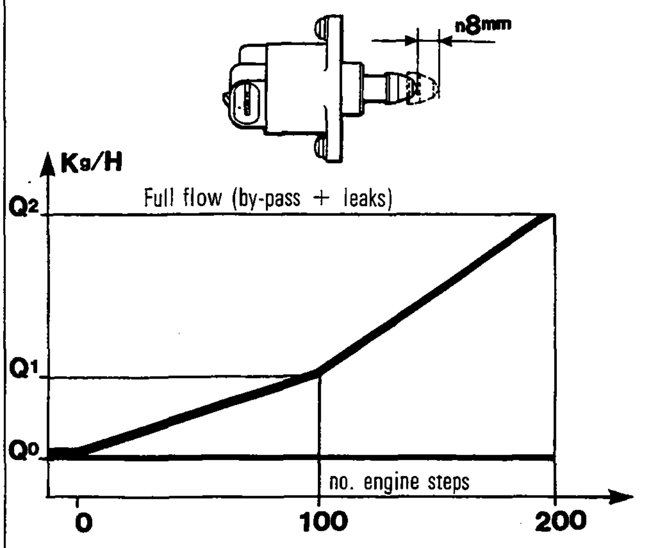
To achieve this result, the system uses a step motor (1) fastened to butterfly valve case (5) controlled by ECU (6) which moves a rod fitted with a plunger (3) during operation. This alters the cross-section of by-pass duct (2) and thus the amount of air (Qo + Q) taken in by the engine.

In order to govern this type of action, the ECU uses angular engine speed and coolant temperature input from the relevant sensors.



P4A35CJ02

10.



Air flow graph step no.

P4A36CJ01

The electric step motor features extremely high accuracy and resolution (about 20 rpm). Pulses sent from the ECU to the engine are converted from rotary motion into straight-line motion (about 0.04 mm/step) through a worm and screw mechanism. This operates a plunger which in turn moves to alter the by-pass duct cross-section.

The constant idle air flow Qo arises as a result of leakage through the butterfly valve. This is regulated during production and protected by a cap. Maximum flow Q2 arises when the plunger is fully retracted (about 200 steps corresponding to 8 mm). Between these two levels, air flow follows the graph shown alongside.

Motor strategy

The number of working steps is dependent upon engine conditions:
- Start-up stage
  When the key is inserted, the ECU controls step motor position according to engine coolant temperature and battery voltage.
- Warming-up stage
  Rpm levels are corrected according to engine coolan temperature.
- With engine warm:
  Idle control is dependent on a signal from the rpm sensor. When external users are activated, the ECU governs sustained idle.
- Over-run:
  The ECU recognises over-run status from the throttle potentiometer position.
  It controls step motor position by means of the idle flow law (DASH-POT laws). In other words, it slows the return of pluger (3) to its seat so that a quantity of air by-passing hole (2) reaches the engine and reduces levels of pollutants in the exhaust gas.

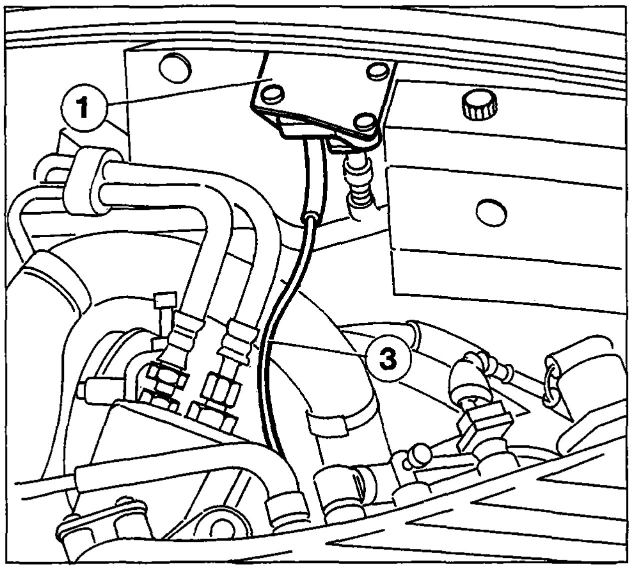
Recovery

Actuator operation disenabled and self-adaption of idling fuel mixture level blocked.

Removing-refitting engine idle control actuator (step motor)
- disconnect battery negative terminal;
- unscrew both retaining screws and withdraw the actuator;
- check condition of thoroid seal and remove any impurities from the case seat;
- refit the actuator, checking that the plunger fits easily without forcing. To do this, fit the actuator and replace screws but do not tighten. Operate the step motor using a Fiat-Lancia/Tester until it has moved through its entire travel. Tighten screws only after checking plunger is correctly aligned in its seat and electrical connector is positioned correctly.

NOTE *It is advisable to leave the battery negative terminal disconnected for about 20 minutes. Provided the above procedure is carried out as described, the ECU will position the idle speed actuator correctly the first time the engine is started up.*
Fit new step motor retaining screws whenever they are loosened or removed because the threads are covered with a light layer of loctyte, which guaranteeds a seal only once.

Tightening torque of step motor screws 0.36 - 0.44 da Nm.



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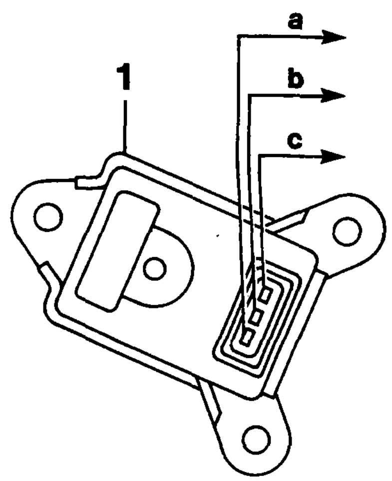
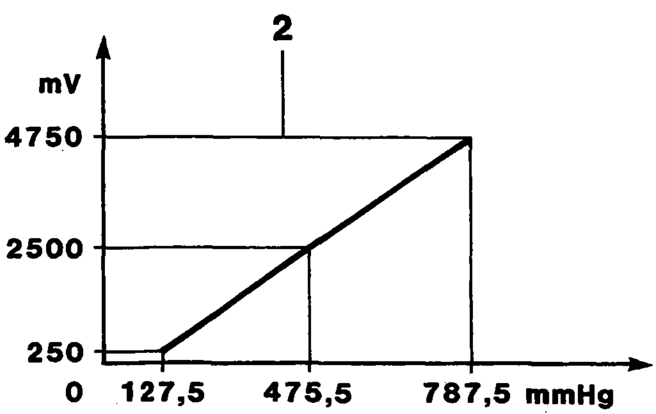


P4A37CJ02



P4A37CJ04

ABSOLUTE PRESSURE SENSOR WEBER PRT 03

The sensitive element is enclosed within a plastic container (1) and consists of a Wheatstone sridge screen printed to a very fine circular ceramic plate (diaphragm) fitted to the underside of a ring mount.

The diaphragm separates two chambers: a vacuum is set up in the bottom sealed chamber while the top chamber communicates with the intake manifold indirectly through a rubber pipe (3).

When the engine is off, the diaphragm bends according to atmospheric pressure level. Exact information on altitude is therefore provided when the key is inserted.

When running, the engine sets up a vacuum that gives rise to a mechanical effect on the sensor diaphragm, which bends to alter the resistance level.

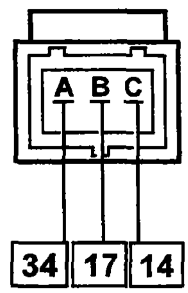
Because the electrical supply is maintained constant (5 V) by the control unit, when the resistance is altered, the output voltage changes in proportion to the vacuum in the intake manifold.

Recovery

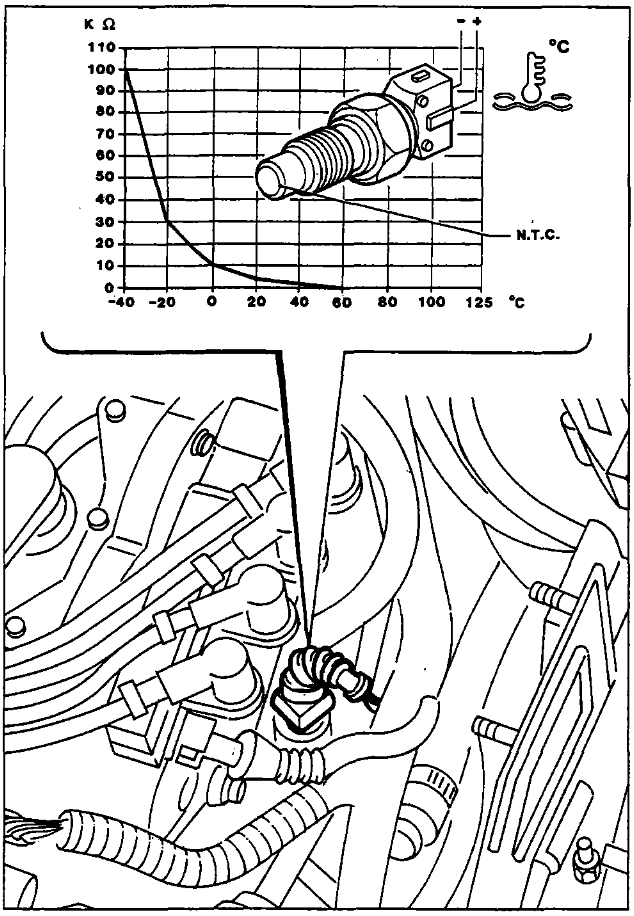
The pressure is calculated according to throttle angle and rpm level.
If the butterfly valve position sensor is faulty, a fixed calibration value is assigned.
Mixture self-adaption is inhibited.
Lambda probe test is inhibited.

Wiring connector

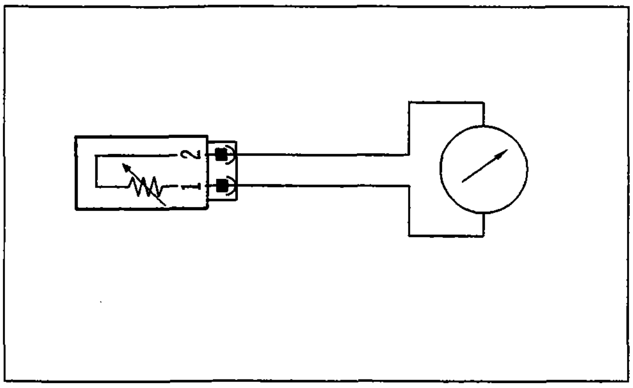
The numbers in boxes indicate the corresponding control unit pins



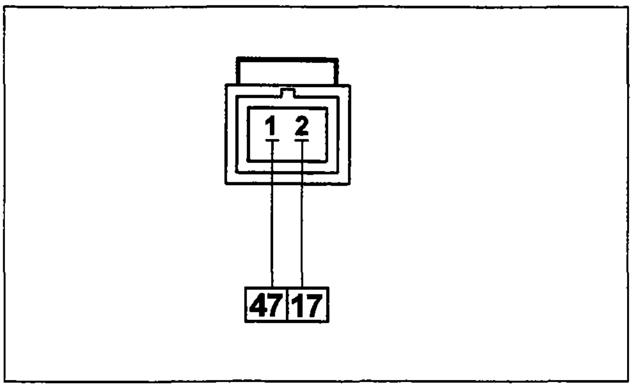
P4A37CJ03



P4A38CJ01



P4A34CJ02



P4A38CJ03

COOLANT TEMPERATURE SENSOR (Jeager 401930.01)

The sensor is fitted to the thermostat case. It consists of a brass case, which protects the actual resistance element: an NTC thermistor (standing for Negative Temperature Coefficient because sensor electrical resistance decreases in inverse proportion to temperature).

The reference voltage is 5V; since this circuit is designed as a voltage divider, the voltage is distributed between a resistance present in the ECU and the sensor N.T.C. resistance. The ECU is therefore able at any moment to assess sensor resistance changes through voltage changes and thus obtain information on intake air temperature.

Recovery

The last reading is adopted. If the temperature does not correspond to steady state levels, this is gradually increased with time following start-up and corrected on the basis of intake air temperature.

Mixture concentration self-adaption is inhibited.

Idle self-adaption is inhibited.

Checking resistance

The graph plots sensor resistance values. These may be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

Removing-refitting

Disconnect electrical connection and remove the sensor

Before refitting apply MR/B anaerobic sealant to the tapered threads.

Tightening torque 2.4 daNm.

Wiring connector

The numbers in boxes indicate the corresponding control unit pins

ELECTRIC FUEL PUMP (Walbro-Marwal MSS071)

The pump is housed inside the fuel tank in a holder, together with the fuel level indicator. It is fitted with a mesh filter on the pump intake.

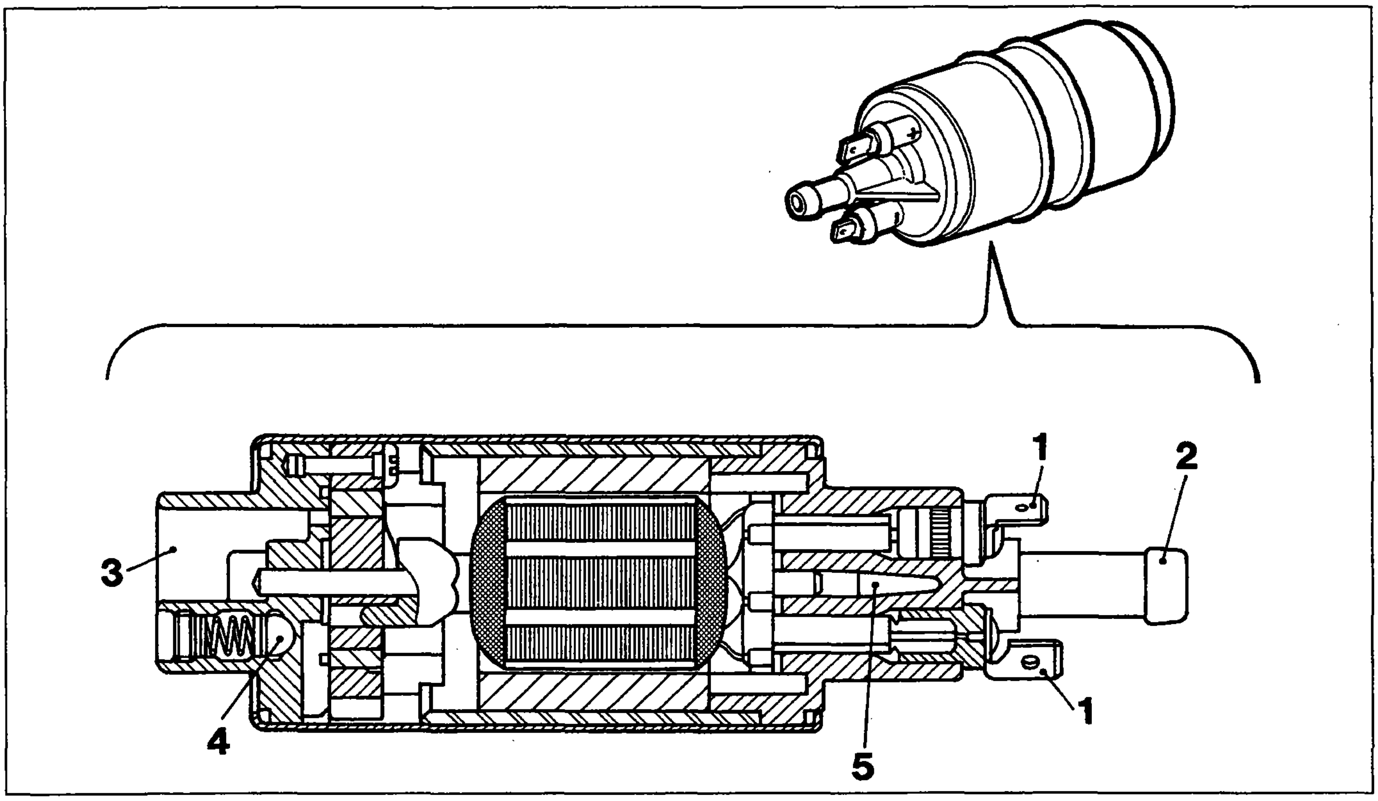
The pump is volumetric type and designed to work with unleaded fuel.The rotor is turned by an electric d.c. motor supplied at battery voltage directly through the dual relay, controlled in turn by the ECU.

The motor is submerged in the fuel in order to clean and cool the brushes and commutator.

The pump is fitted with a pressure relief valve, which short-circuits delivery to intake if inlet circuit pressure exceeds 5 bar. This prevents the electric motor overheating.

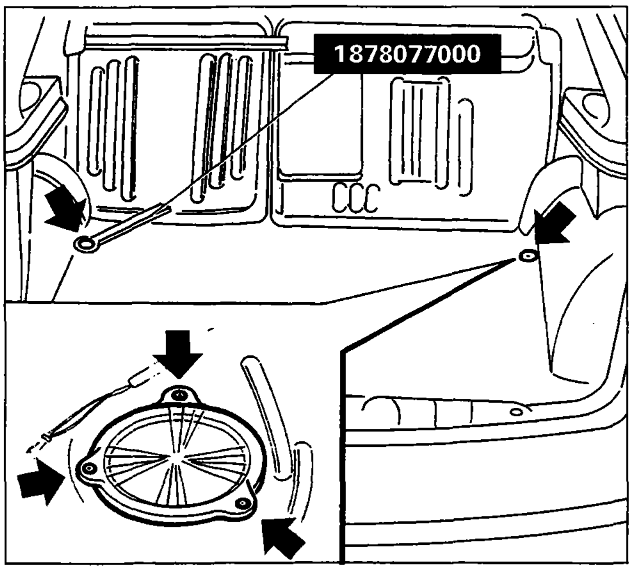
A check valve fitted in the delivery line prevents the entire fuel circuit emptying when the pump is not working.

Rated pump output varies according to angular rotor speed and hence supply voltage: it is about 140 l/h at a voltage of 12 V.



P4A39CJ01

1. Electrical connectors
2. Delivery port
3. Inlet port
4. Pressure relief valve
5. Check valve



P4A40CJ01

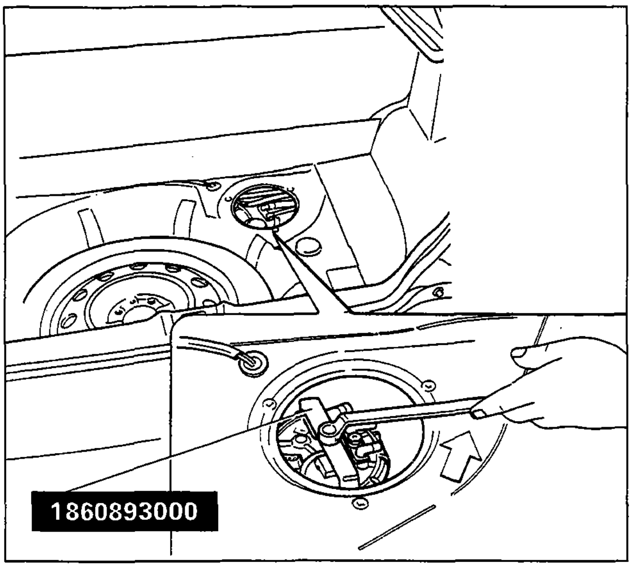
Removing-refitting electric fuel pump

The pump is located in the tank: proceed as follows to remove:

Undo retaining buttons indicated using tool 1878077000.

Lift load compartment mat.

Remove dust cover.



P4A40CJ02

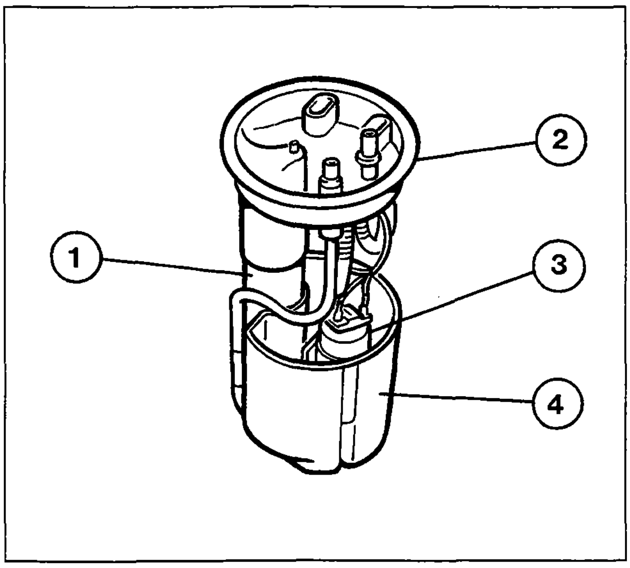
Disconnect electrical connections from pump and from fuel level sending unit.

Disconnect fuel lines (inlet, outlet and breather).

Unscrew lock-ring retaining pump to tank using tool 1860893000 and a box wrench.

Remove fuel pump assembly.

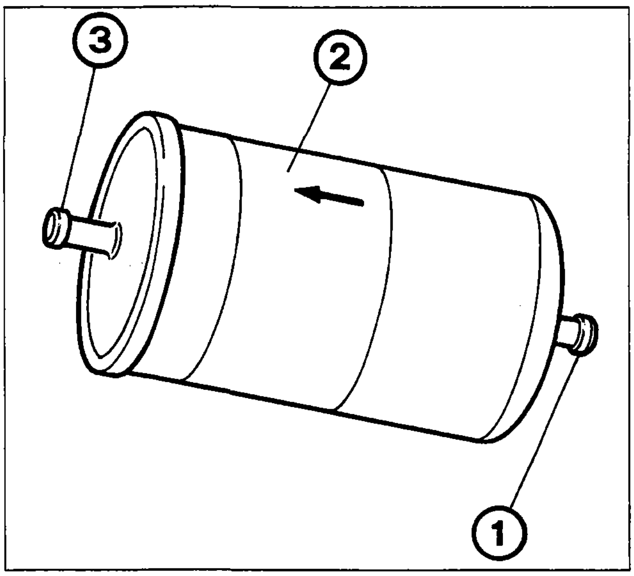
When refitting, electrical connections and fuel lines cannot be fitted the wrong way round because the respective terminals are of different diameter.



P4A40CJ03

Components of fuel pump assembly

1. Fuel level gauge
2. Retaining plate
3. Electric pump
4. Reservoir with mesh prefilter



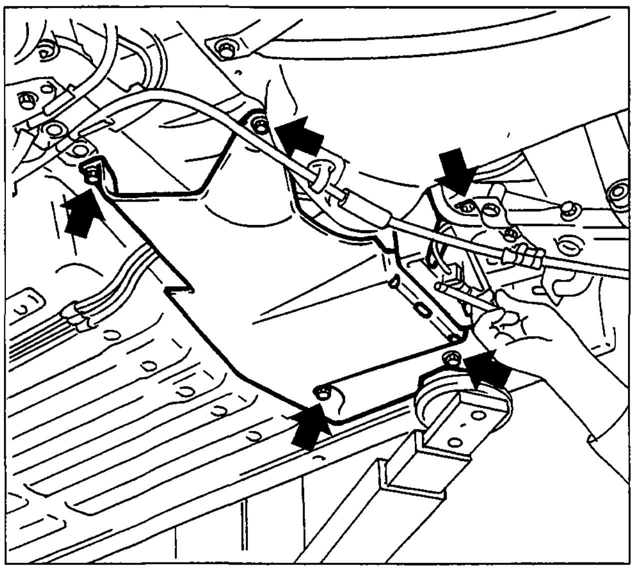
P4A41CJ01

FUEL FILTER
(Bosch A 450.024.262)

The filter is inserted in the fuel delivery pipe; it consists of a steel plate casing and an internal polyurethane mounting on which an element with high-filtration capacity is wound.

NOTE *On the outer casing, there is an arrow which indicates the direction of fuel flow and so correct assembly.*

1. Fuel inlet
2. Arrow position
3. Fuel outlet

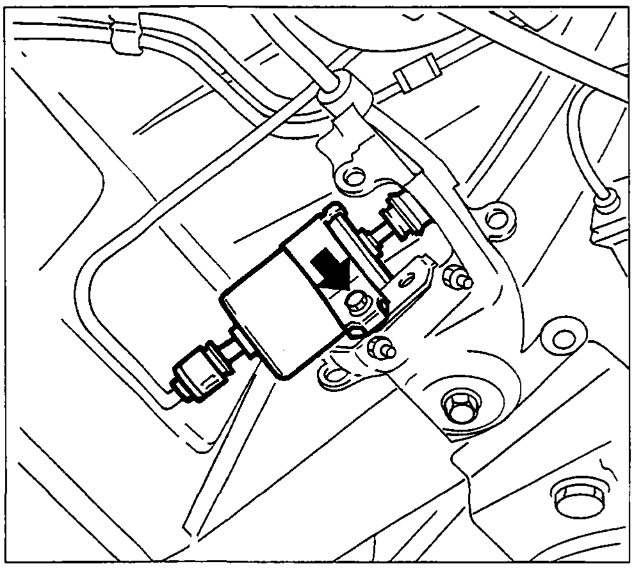

P4A41CJ02

Removing-refitting

To remove the fuel filter, proceed as follows:

Raise the vehicle.

Undo the bolts indicated and remove the protective cover.

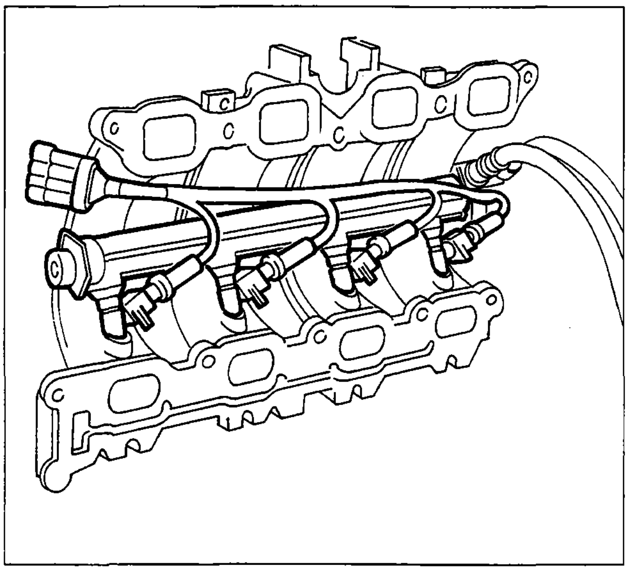

P4A41CJ03

Disconnect the fuel inlet and outlet quick-fit connectors from the filter, collecting in a suitable container the fuel which leaks during the operation.

Undo the bolt and remove the filter.

The fuel filter must be replaced every 40000 km.
After replacing the filter, start the engine and check that there are no fuel leaks from the connections.

10.



P4A42CJ01

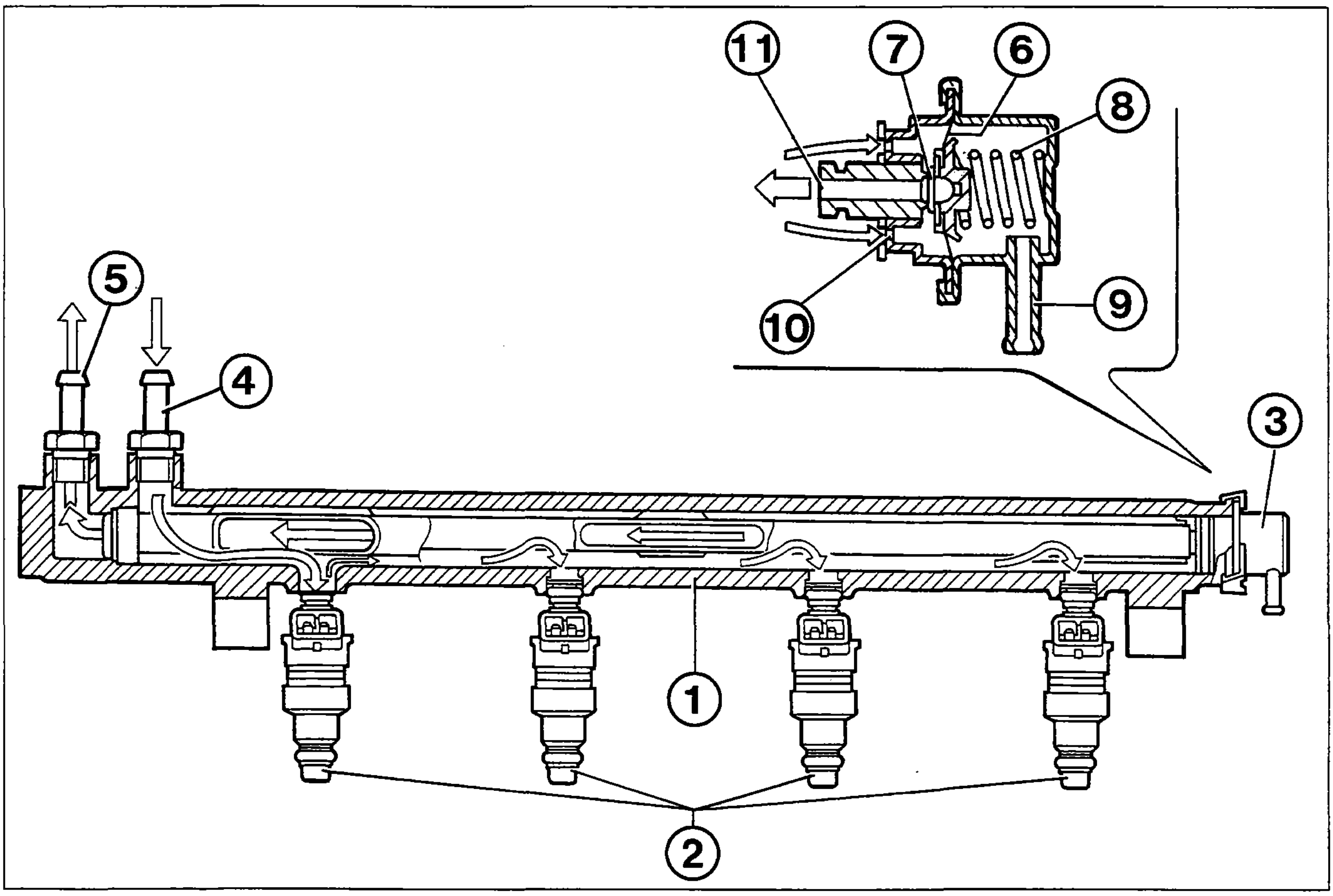
FUEL MANIFOLD (CB 104)

The fuel manifold is secured to the inside of the inlet manifold, and its function is to send fuel to the fuel injectors.

The fuel manifold consists of an aluminium casting and it incorporates the seats for the fuel injectors and pressure regulator.

The fuel inlet comprises an attachment with tapered sealing screw.

The fuel is recirculated by means of a pipe contained in the manifold and connected at one end to the regulator, and at the other end to the external fuel return pipe to the tank.



P4A42CJ02

1. Fuel manifold
2. Fuel injectors
3. Pressure regulator
4. Fuel inlet connection
5. Connection for fuel return to tank
6. Diaphragm
7. Backflow valve
8. Adjustment spring
9. Vacuum connection
10. Fuel inlet
11. Fuel return

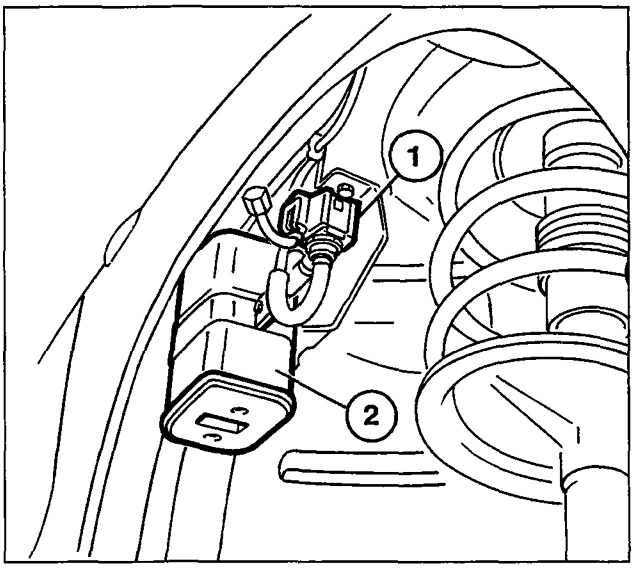
FUEL PRESSURE REGULATOR (RPM 40)

This differential diaphragm device is set to a pressure of 3.00 ± 0.05 bar in the factory.

Pressurised fuel from the pump exercises thrust on reflux valve (7) countered by calibrated spring (8). When pressure setting is exceeded, reflux valve opens and excess fuel returns to the tank in order to stabilise pressure in the circuit. The vacuum in the intake manifold (acting also on injector nozzle) acts on regulator diaphragm through intake (9) in order to reduce the load on the calibration spring.

The pressure differential between the fuel and the injector's surroundings (intake manifold) is therefore maintained constant under all engine service conditions. The injector flow (for a given supply voltage) thus depends solely on injection time established by the ECU.

NOTE *The ECU assumes pressure as a fixed parameter. The regulator should never therefore be tampered with; otherwise the mixture concentration specified for the engine will be altered.*



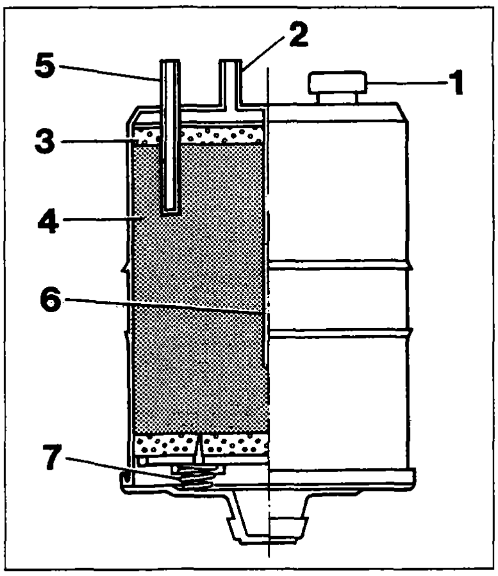
P4A43CJ01

CARBON FILTER AND FUEL VAPOUR CUT-OFF VALVE

These components form part of the fuel evaporation control and vapour recovery system. They are located in the right wheel arch compartment and can be reached by removing the rear part of the right front wheel arch compartment trim.

1. Fuel vapour cut-off solenoid

2. Carbon filter



P4A43CJ02

Carbon filter

This consists of carbon granules (4) that trap fuel vapour entering intake (5).

Warm flushing air enters intake (1), through paper filter (3) and flows over the carbon granules to remove fuel vapours and carry them toward the outlet (2) and then on toward the cut-off valve.

Air entering through intake (5) may also be pulled back by a vacuum in the tank, when it serves to ventilate the tank. Partition (6) ensures that the flushing air flows over all the carbon granules and promotes the release of fuel vapour toward the inlet manifold.

Two springs (7) allow the mass of granules to expand when the pressure increases.

Fuel vapour cut-off solenoid (Siemens EC1)

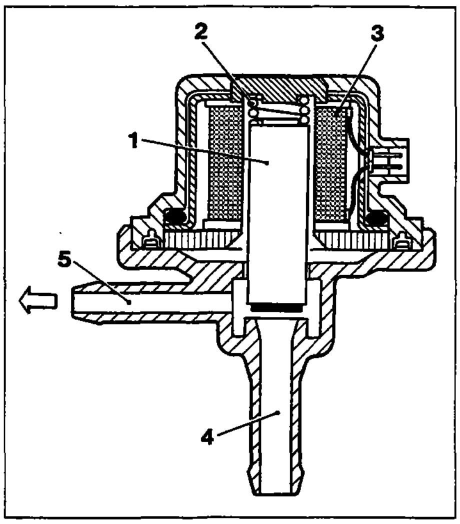
The function of this valve is to control the quantity of fuel taken up by the active carbon filter and directed to the intake manifold (via the injection-ignition control unit).

The valve is closed when de-activated to prevent fuel vapours enriching the mixture excessively.

The injection-ignition control unit controls operation as follows:

- during start-up, the solenoid remains closed to prevent fuel vapour from enriching the mixture excessively. This condition persists until the coolant temperature reaches a pre-established threshold.

- with engine warm, the ECU sends the solenoid a square wave signal, which modulates opening in accordance with the signal empty/full pattern.
  In this way, the ECU controls the quantity of fuel vapour sent to the intake to prevent significant changes in mixture concentration.



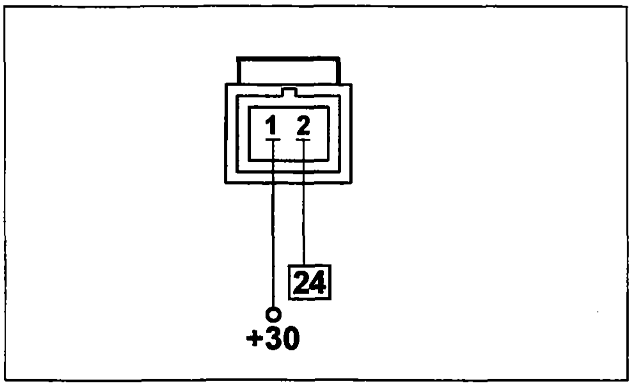
P4A44CJ01

Under the service conditions listed below:
- throttle in idle position
- speed less than 1500 rpm
- intake manifold pressure less than a limit setting computed by the ECU according to rpm level

solenoid activation is inhibited to maintain the unit closed in order to improve engine operation.

Longitudinal section through fuel vapour cut-off valve

1. Valve core.
2. Reaction spring.
3. Magnetic winding.
4. Pipe connected to air intake manifold
5. Pipe connected to active carbon filter.



P4A44CJ02

Wiring connector

The numbers in boxes indicate the corresponding control unit pins

Recovery

Mixture self-adaption is inhibited.

Mixture concentration test is inhibited.

Lambda probe test is inhibited.

MULTIFUNCTION VALVE (SIRIO 0175.00)

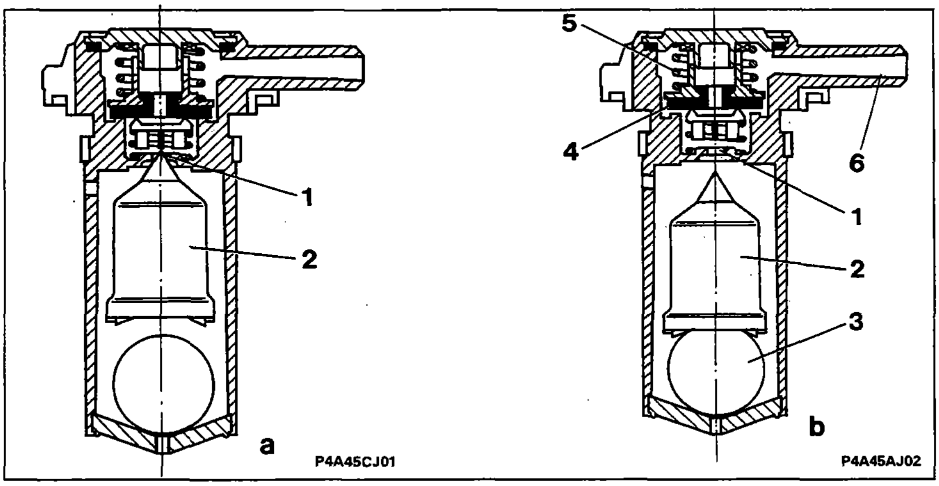
This valve performs the following functions:

- prevents fuel flowing out when tank is over-filled or in case the vehicle overturns in an accident;

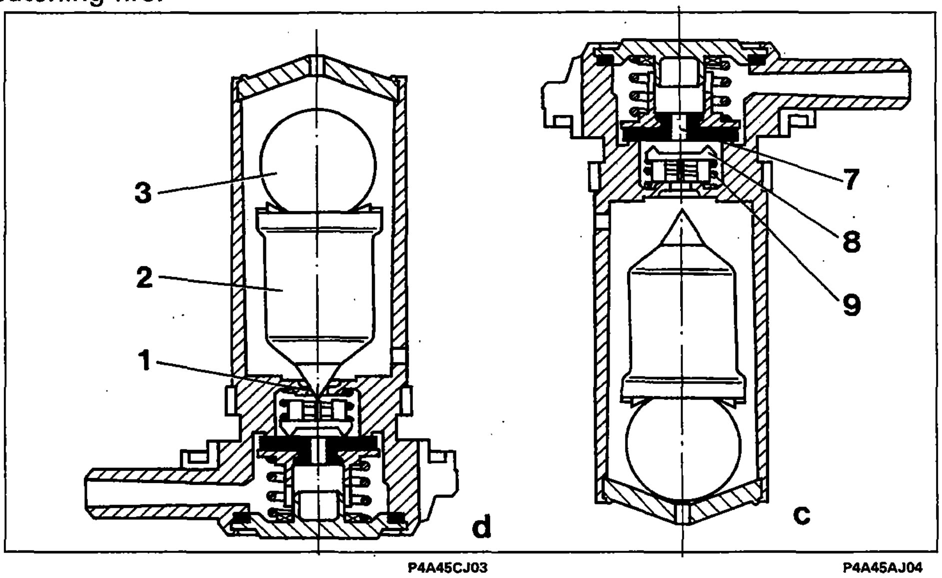
- vents fuel vapours from tank to the active carbon trap filter;
- ventilates the tank if a vacuum builds up inside.

This valve consists of: a float (2); a heavy ball (3); a plate (4), pushed against valve case of spring (5) and plate (8), pushed against plate (4) of spring (9). Multifunctional valve operation may be summarised as follows and depends on fuel tank level:

a. if the tank is full float (2) blocks hole (1) to prevent liquid fuel from reaching active carbon filter and hence damage to the filter;
b. the tank fuel level drops, float (2) is lowered and rests upon ball (3) to open hole (1). When the pressure exercised by fuel vapours on plate (4) overcomes load of spring (5), a ring opening between plate and valve case opens to allow fuel vapours to emerge from the duct (6) and reach the active carbon filter.



c. if the drop in tank fuel level is sufficient to set up a vacuum, this acts on plate (8) and overcomes load of spring (9) so that this moves down to allow tank ventilation through hole (7).
d. if the vehicle overturns, however full the tank, the weight of ball (3) acts on float (2) to push the float against hole (1) and prevent a dangerous flow of fuel to the intake manifold with the attendant risk of the vehicle catching fire.



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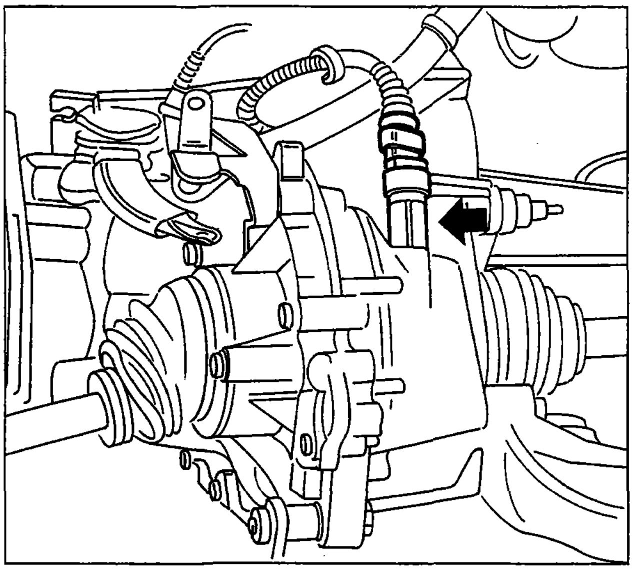


P4A46CJ01

VEHICLE SPEED SENSOR

SWF B451
BORLETTI TGK
SO.GE.MI.

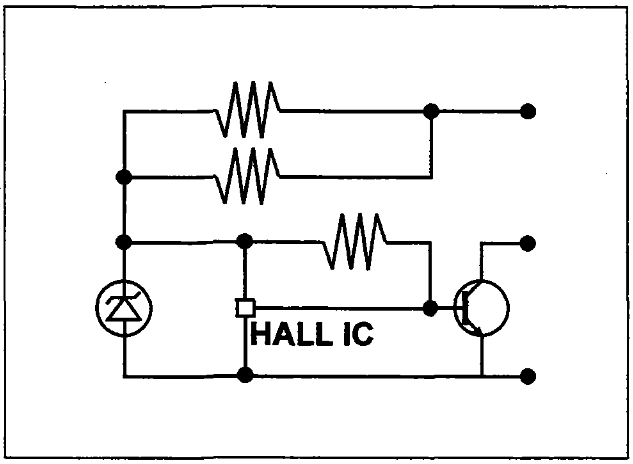
The sensor is located on the differential output, near the left half-axle joint. It sends information on vehicle speed to the control unit: the signal is also used to operate the speedometer.

The sensor operates on the principle of the Hall effect (see section on "engine timing sensor") and transmits 16 pulses/revolution. Vehicle speed can therefore be calculated from pulse frequency.

Removing - refitting

Disconnect electrical connection and remove the sensor.

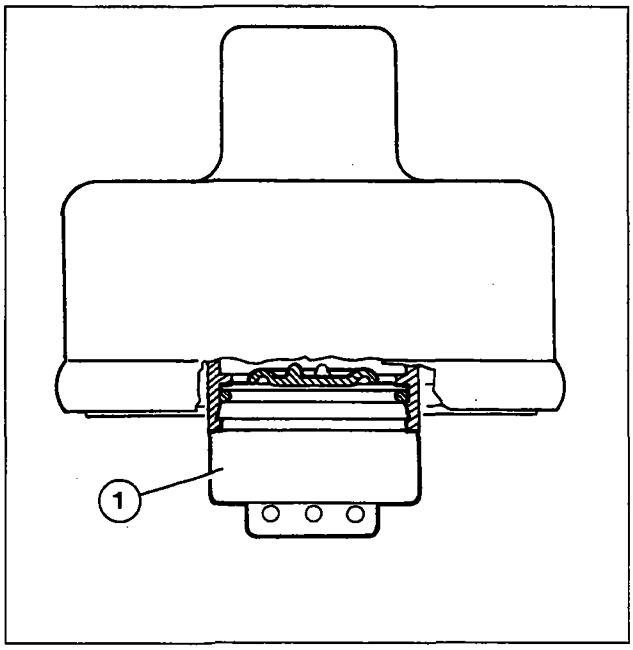
Tightening torque 0.8 daNm



P4A46CJ02

Wiring diagram

SAFETY AND VENTILATION VALVE



P4A46CJ03

This valve is located in the fuel filler cap and performs the following functions according to the pressure level in the tank:

- When the pressure inside the tank exceeds 0.13 - 0.18 bar, excess fuel vapours are vented to the outside (pressure-relief function).
- If, on the other hand, a vacuum builds up inside the tank, equivalent to 0.020 - 0.030 bar, air is taken into the tank (ventilation function).

INJECTORS (WEBER IWP 001)

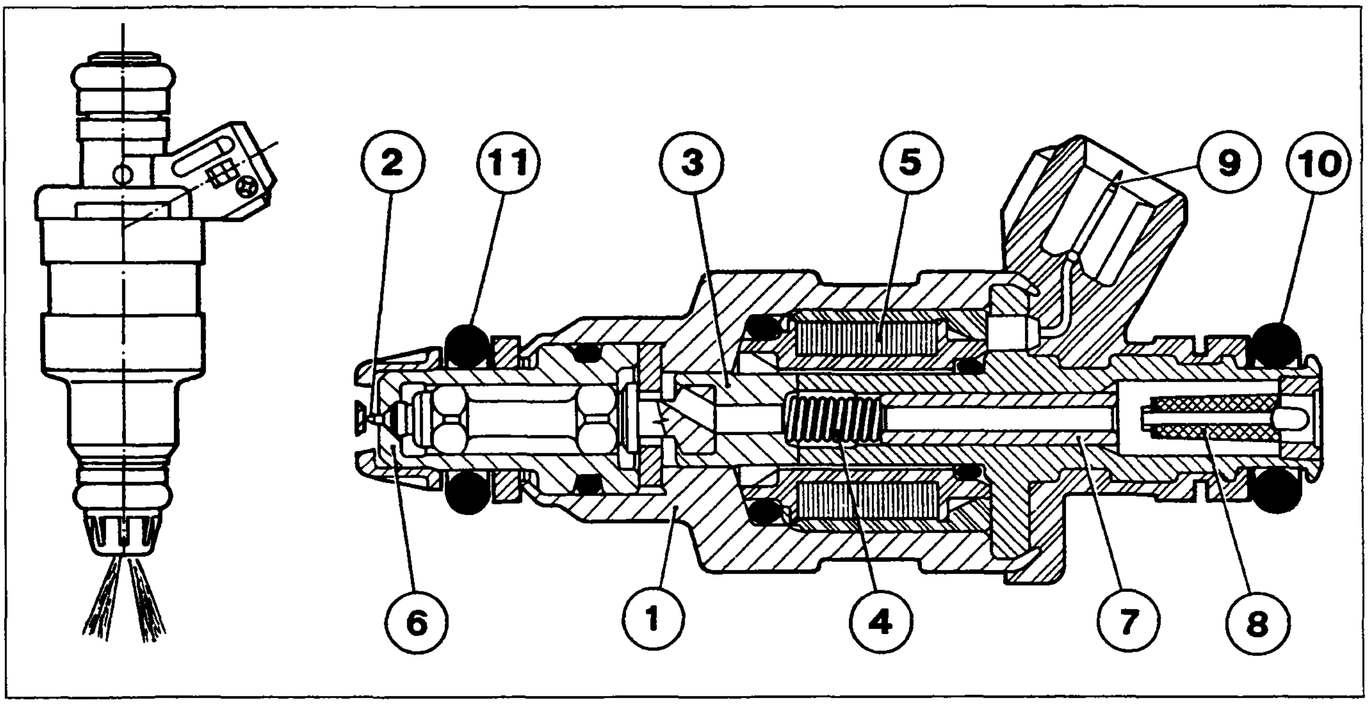
The twin jet injectors are used specifically on engines with four valves per cylinder because they allow the jets to be directed against the two intake valves.

The fuel jet leaves the injector nozzle with a pressure differential of 3 bars and nebulises immediately to form two cones.

Injector control is «sequential, staged», i.e all four injectors are controlled in accordance with the cylinder intake sequence. The supply to each cylinder may begin during the expansion stage up to a time when intake has already begun.

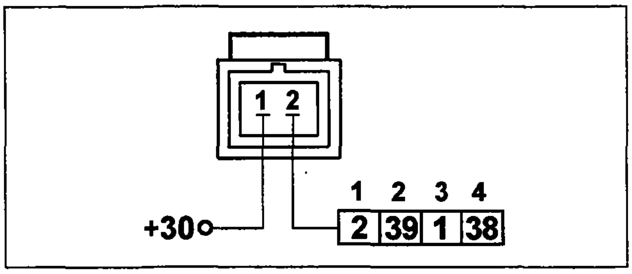
The fuel manifold presses against the injectors to fasten them into the seats on the intake ducts. They are also anchored to the fuel manifold by means of «safety clips». Two rubber rings (10) and (11) ensure a seal to the intake duct and fuel manifold.

The injectors are top-feed type and supplied with fuel from the rear of the case, which houses coil (5) connected to electrical connector (9).



P4A47CJ01

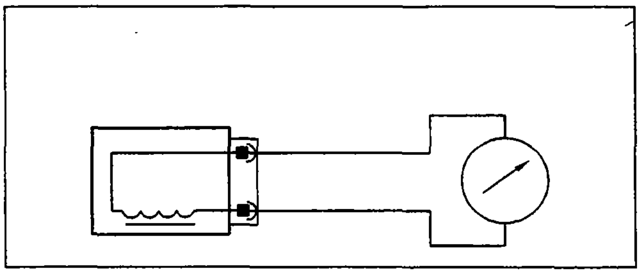
Wiring connector



P4A47CJ02

NOTE *The numbers in boxes indicate ECU pin no. in order of cylinder number.*

Checking resistance



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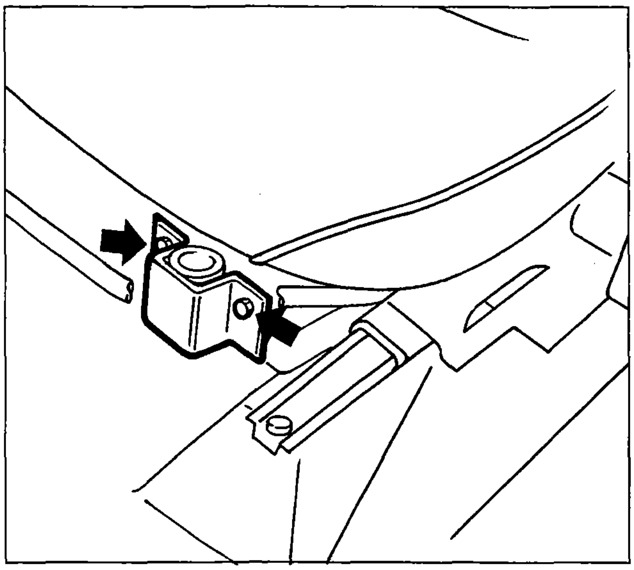
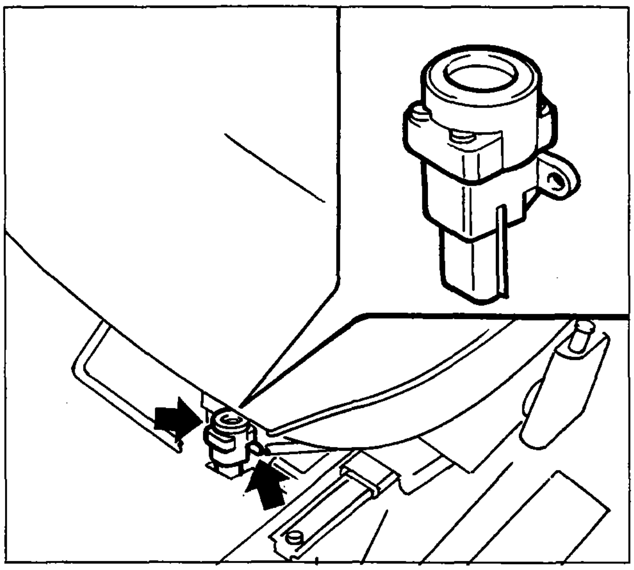
Injector resistance may be measured by disconnecting the connector and connecting an ohmmeter as shown in the figure.

Resistance value 16.2 ohm

INERTIA SAFETY SWITCH



P4A48CJ01



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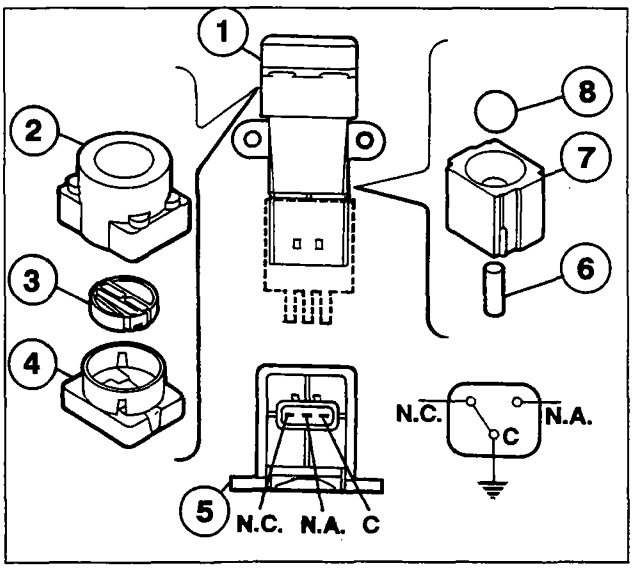

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The vehicle is equipped with an inertia switch located inside the passenger compartment beneath the driver's seat.

This sensor reduces the possibility of fire (caused by fuel emerging from the injection system) by de-activating the fuel feed pump.

The switch consists of a steel ball fitted inside a tapered housing. It is held in position through the attractive force of an permanent magnet.
The ball is released from the magnetic force in the case of violent impact, when it opens the normally closed (NC) electrical circuit to cut off the fuel pump earth connection and thus the fuel supply to the injection system.

To restore the pump earth connection, push the seat back and press the switch until it clicks on.

Removing-refitting

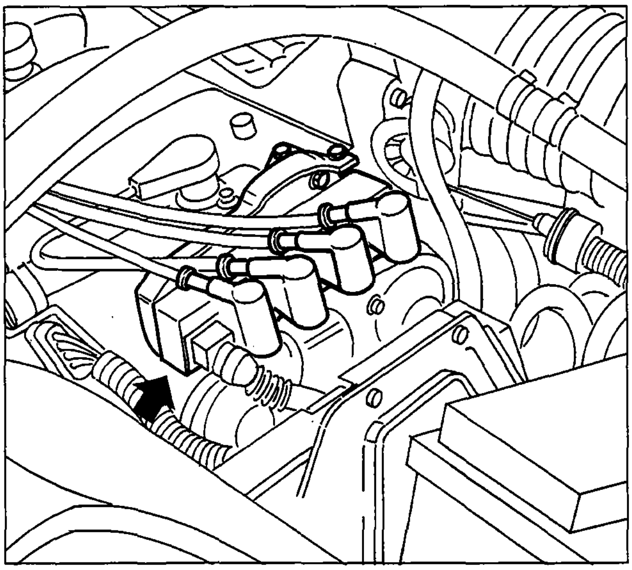
1. Move driver's seat back fully, unscrew the bolts indicated and remove the plastic protection.
2. Unscrew the bolts indicated, disconnect electrical connection and remove the switch.

After even an apparently light collision, if a smell of petrol is noted or fuel leaks are seen, do not activate the switch again until the fault has been found and corrected in order to avoid the risk of fire.

Inertia switch components

1. Inertia switch assembly
2. Sheath
3. Button
4. Upper end
5. Fitting end
6. Permanent magnet
7. Permanent magnet seat
8. Steel ball

C= Common terminal
N.C. Normally closed
N.A. Normally open

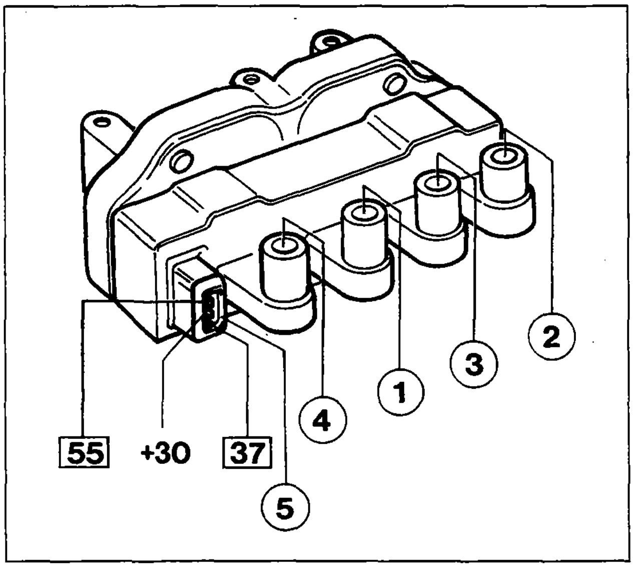


P4A49CJ01

IGNITION COILS (Marelli Bae 920A)

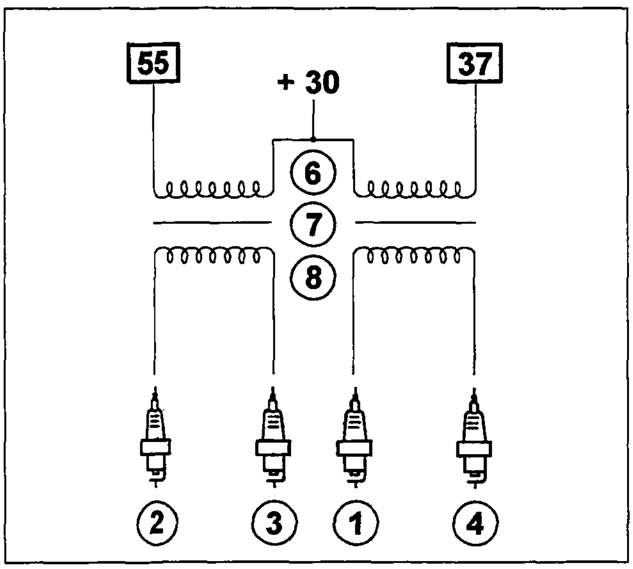
The coils are fastened by means of a bracket to the camshaft covers and are closed magnetic loop type. They are formed from a layered pack, whose central core (broken by a narrow gap) carries both windings.

The windings are placed in a moulded plastic container embedded in epoxy resin, which gives them exceptional dielectric properties. Because the primary winding is so close to the magnetic core, little magnetic flux is lost and coupling with the secondary winding is maximised.



P4A49CJ02

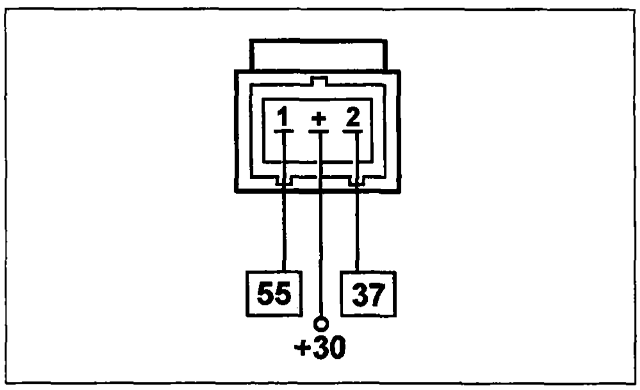
1. HT socket for cylinder no. 1 spark plug
2. HT socket for cylinder no. 2 spark plug
3. HT socket for cylinder no. 3 spark plug
4. HT socket for cylinder no. 4 spark plug
5. LT socket for ECU connection
6. Primary circuit
7. Gap
8. Secondary circuit



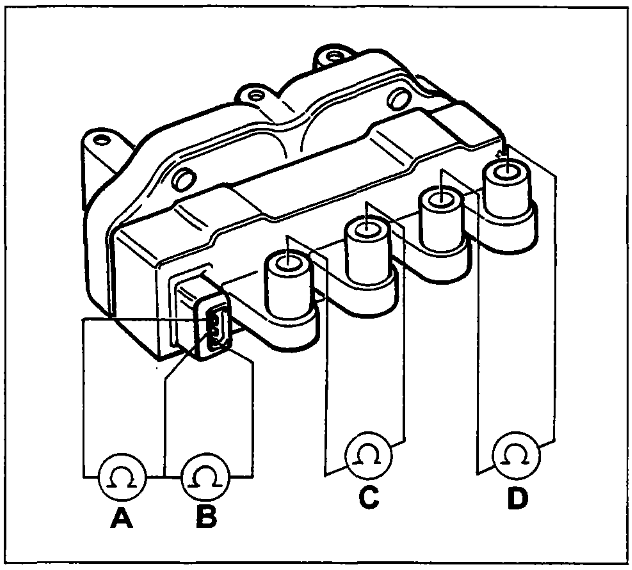
P4A49CJ03

Wiring connector

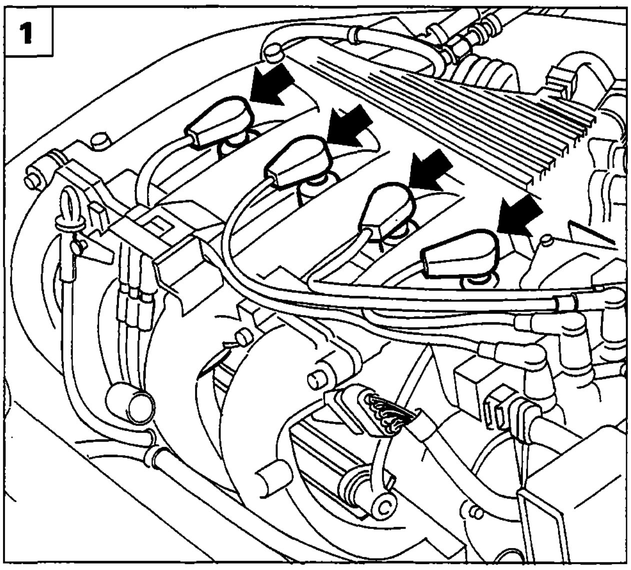
NOTE *The numbers in boxes indicate the corresponding control unit pins.*



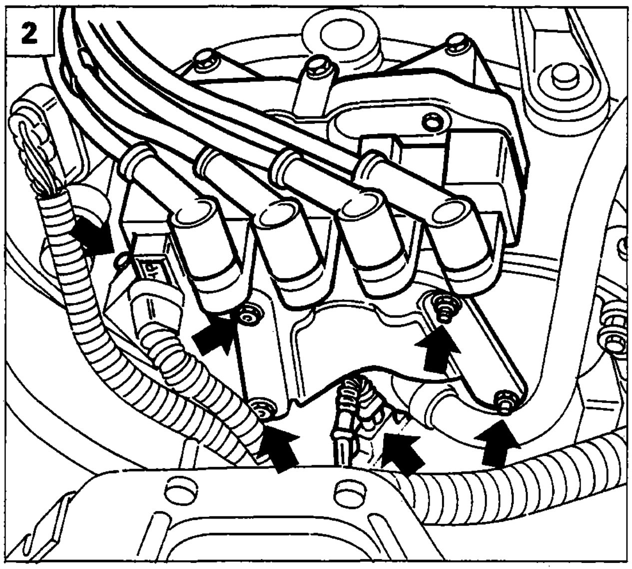
P4A49CJ04



P4A50CJ01



P4A50CJ02



P4A50CJ03

Checking winding resistance

Primary circuit (A cylinders 2-3, B cylinders 1-4)

Bring the probes of an ohmmeter into contact with the postive strip (central pin) and the negative strip (pin 1 for circuit A and pin 2 for circuit B).

The primary circuit resistance reading on the guage should be between 0.55 and 0.61 ohm at 23 °C.

Secondary circuit (C cylinders 1-4, D cylinders 2-3)

Bring the probes of an ohmmeter into contact between the two high tension outlet terminals.

The secondary winding resistance reading on the gauge must be between 8645 and 9555 ohm at 23 °C.

Recovery

Inhibition of injectors for cylinders in which ingnition is not taking place.

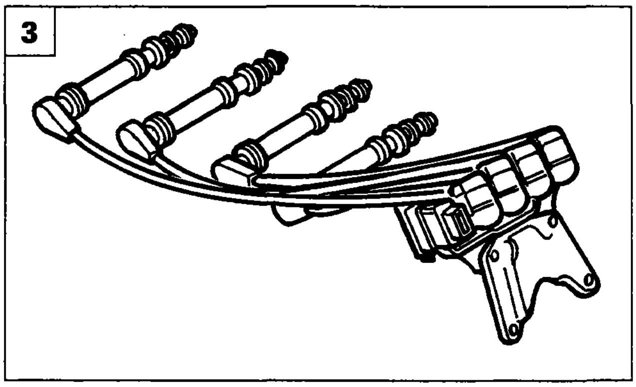
Open-loop concentration control

Current command is de-activated when battery d.c. is applied in order to try again later.

If circuit is broken, or GND under d.c., charge time assumed to be dependent upon battery voltage.

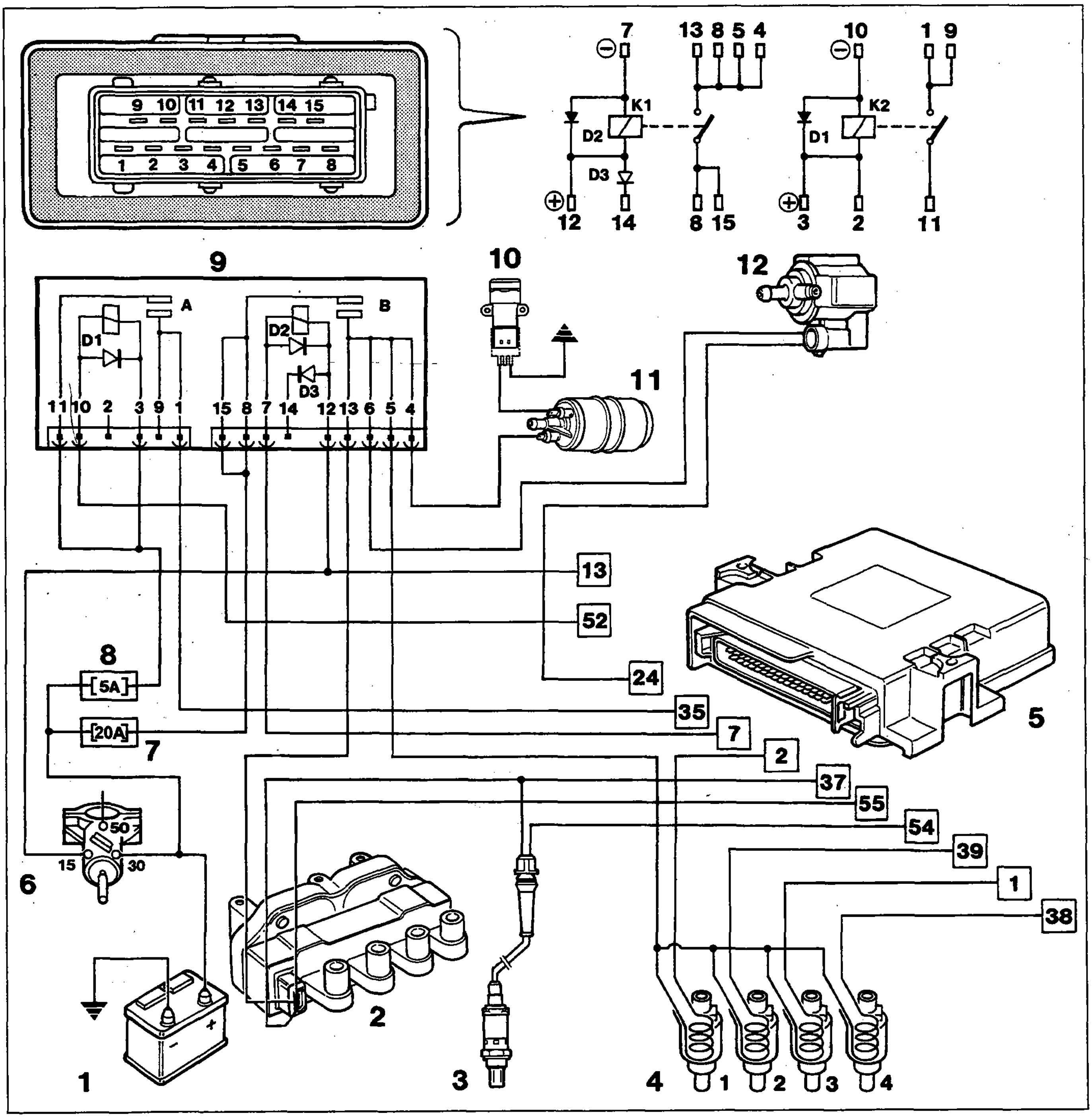
Removing refitting

1. Disconnect HT leads from spark plugs.
2. Disconnect electrical connections from the coils and the coolant temperature sensor; unscrew the nuts indicated and remove the coil/HT lead/support bracket assembly.
3. Disconnect the mount bracket and HT leads from the coils.



P4A50CJ04

DUAL RELAY (NDRS 240103)



P4A51CJ01

1. Battery
2. Ignition coils
3. Lambda probe
4. Injectors
5. Electronic control unit
6. Ignition switch
7. 20A system fuse
8. 5A control unit fuse
9. Dual relay (A-Control unit B-Electric fuel pump)
10. Inertia safety switch
11. Electric fuel pump
12. Fuel vapour cut-off solenoid

10.

A dual relay specifically for automotive applications ensures the battery voltage reaches the system. This electrical device consists of a single container containing two special normally open relays whose task is to supply the electronic control unit (section A, control unit supply) and main injection-ignition power circuits (pump, coils etc.) (section B).

When ignition key is in MAR position "Services 15/54", excitation winding of relay (9) on pin 12 and ECU on pin 13 are activated.

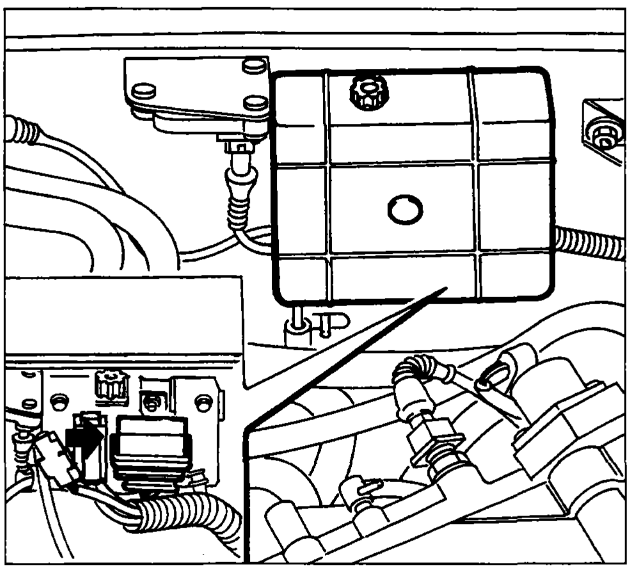
As soon as ECU (5) receives voltage at pin 13 through pin 52 (internal earth), it enables closure of power contacts of relay A (ECU POWER SUPPLY section) to ensure the battary is supplied at pin 35 through fuse (8); it then enables closure of power contacts of relay B in order to earth pin 7 and ensure a power supply to pump (11) and the other sensors and actuators making up the injection system.

The fuel pump must be activated before starting up the engine to ensure that the fuel system is already under a pressure of 3 ± 0.5 bar.If starting does not not take place with the ignition key in MAR position, the electronic control unit (5) deactivates section of relay (9) pin 7 (pump-components) and automatically stops the pump (11). Timed enablement lasts about 10 sec.

For safety reasons, the ECU (5) activates a control strategy for pump (11) based on engine rpm. In practice, the ECU (5) deactivates section of relay (9) pin 7 in order to cut off supply to the pump (11) when engine rpm drops below a minimum memorised threshold, if the engine stalls with the ignition on or if the start-up code is not recognised by the Fiat CODE system.

When the ignition key is returned to STOP position, the electronic control unit maintains section A of the dual relay excited for about 90 seconds before cutting off its power supply (time taken to transfer data from RAM STAND-BY memory to the EEPROM.

NOTE *Diodes D1 and D2 reduce voltage surges in the respective relays. Diode D3 acts against the voltage from the low alternator charge warning light.*



P4A52CJ01

Removing-refitting

The dual relay is fitted on a bracket against the rear wall of the engine bay. Proceed as follows to remove-refit:

Remove the protective cover.
Disconnect electrical connection and remove the dual relay.

LAMBDA PROBE (NTK 0ZA112-A1)

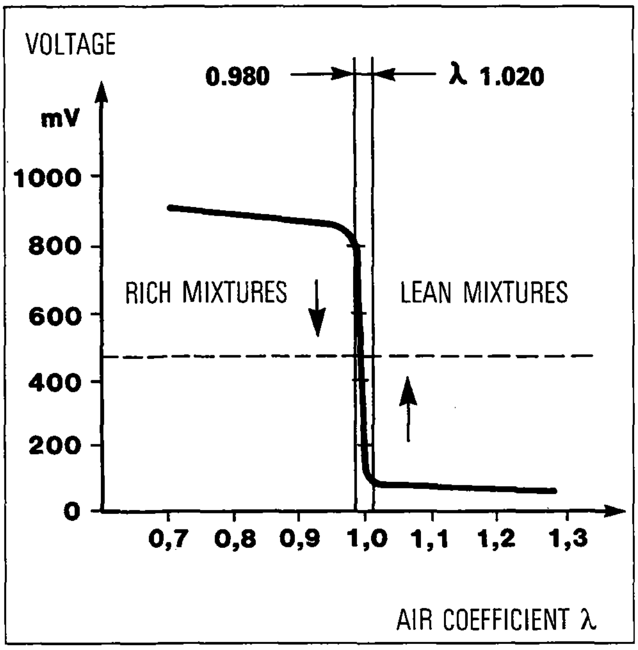
This sensor measures exhaust gas oxygen content.

The sensor output signal is sent to the electronic control unit to adjust the air-fuel mixture in order to maintain the ratio as close as possible to stoichiometric levels.

To obtain an optimum mixture, the quantity of fuel injected must be as close as possible to a theoretical quantity that could be fully burnt for a given amount of air taken in by the engine.

In this case, Lambda factor (λ) is said to be equal to 1;in fact:

$$\lambda = \frac{\text{INTAKE AIR QUANTITY}}{\text{THEORETICAL QUANTITY OF AIR NECESSARY TO BURN ALL THE FUEL INJECTED}}$$



P4A53CJ01

$\lambda = 1$ Ideal mixture
CO levels are within legal limits

$\lambda \geqslant 1$ Lean mixture
Excess air; CO levels tend to be low

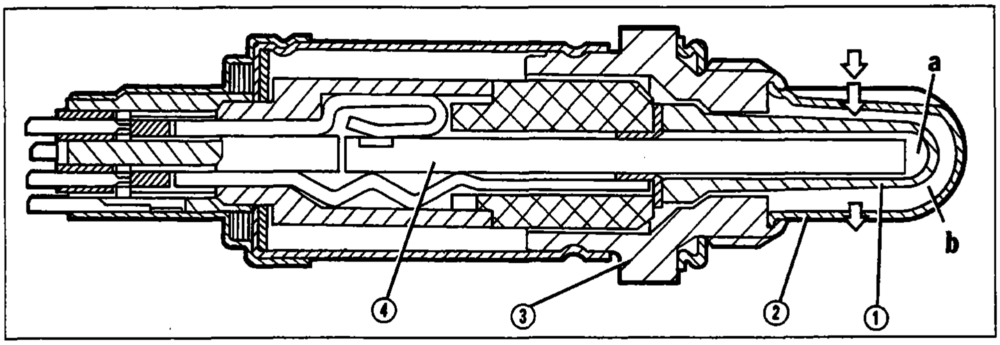
$\lambda \leqslant 1$ Rich mixture
Lack of air; CO levels tend to be high

NOTE *While the coefficient λ expresses an excess or lack of air supplied to the engine in relation to the theoretical required level, the air-fuel mixture is a ratio between these two substances that react chemically when combined. The stoichiometric proportions depend on fuel type used: this ratio is 14.7-14.8 for present-day engines, which means they require 14.7 parts of air to burn 1 part of petrol fully.*

The probe is fastened upstream of the converter.

It consists of a ceramic case (1) made up of a zirconium dioxide base covered by a light layer of platinum. It is sealed at one end, enclosed in protective pipe (2), and housed in metal case (3) that provides further protection and permits installation to the exhaust manifold. The outer part (B) of the ceramic case is exposed to the exhaust gas flow while inner part (A) communicates with the outside air.

The probe works on the principle that when the temperature exceeds 300 °C, the ceramic material used begins to conduct oxygen ions. Under these conditions, if the levels of oxygen at both ends (a and b) of the probe are different, a voltage variation is set up between the two ends. This signal notifies the ECU that the oxygen residues in the exhaust gas are not in proportions that will ensure lean burning of harmful residues.



P4A54CJ01

a. Electrode (+) in contact with outside air

b. Electrode (-) in contact with exhaust gas

1. Ceramic case
2. Protective pipe
3. Metal case
4. Electrical resistant

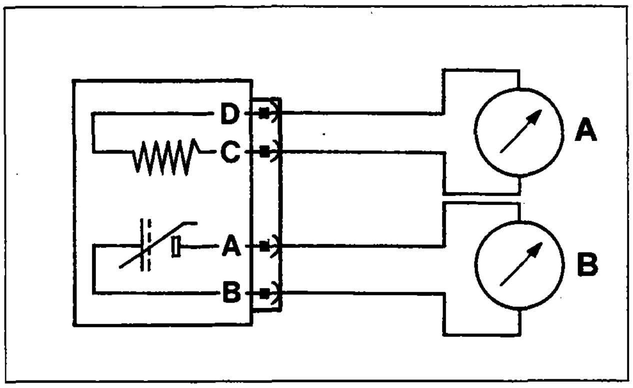
When the probe supplies a low voltage level (less than 200 mV) the ECU recognises that the mixture is lean (lambda » 1) and takes steps to increase the amount of fuel injected. When the probe supplies a high voltage level (greater than 800 mV) the control unti recognises that the mixture is rich (lambda « 1) and decreases the quantity of fuel injected.

The lambda probe therefore alters injection times to ensure that the engine operates with a lambda factor continually fluctuating between 0.980 and 1.020.

Below 300 °C the ceramic material is not active and the probe does not send usable signals. A special circuit in the control unit blocks loop mixture regulation while the probe is warming up.

To ensure service temperature is reached quickly, the probe is equipped with electrical resistance (4) supplied by the battery

The probe may be swiftly put out of service by even slight traces of lead in the fuel. Operation should be checked at 45,000 and 90,000 km in accordance with the programmed maintenance plan.



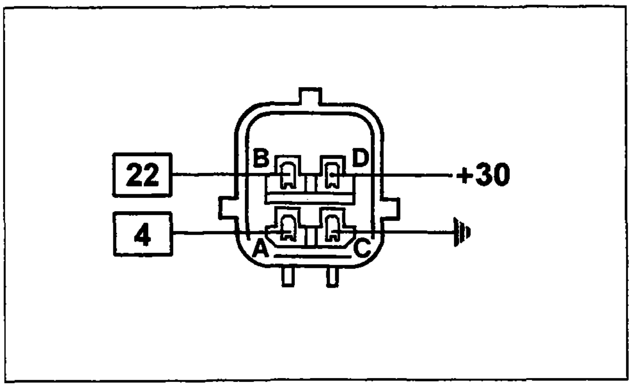
P4A54CJ02

Checking resistance

The heater and probe resistance may be measured by disconnecting the connector and connecting an ohmmeter as indicated in the figure.

Heater resistance (A) = 4.3 - 4.7 ohm

Probe resistance (B) = 5000 ohm (max)



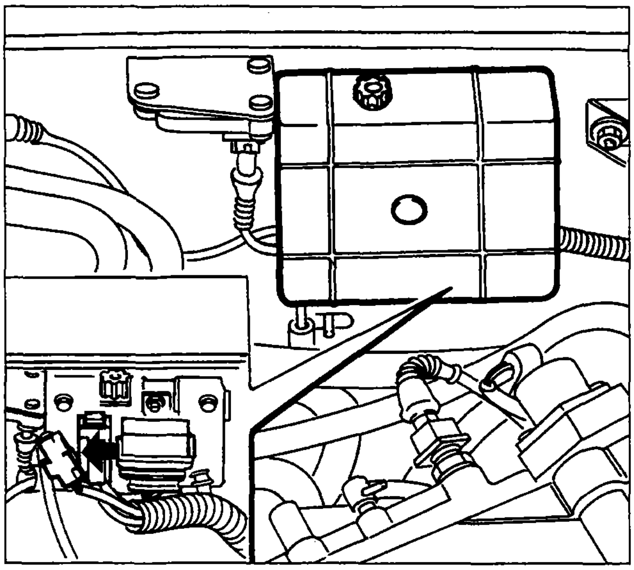
P4A54CJ03

Recovery

Lambda data are ignored (open loop).

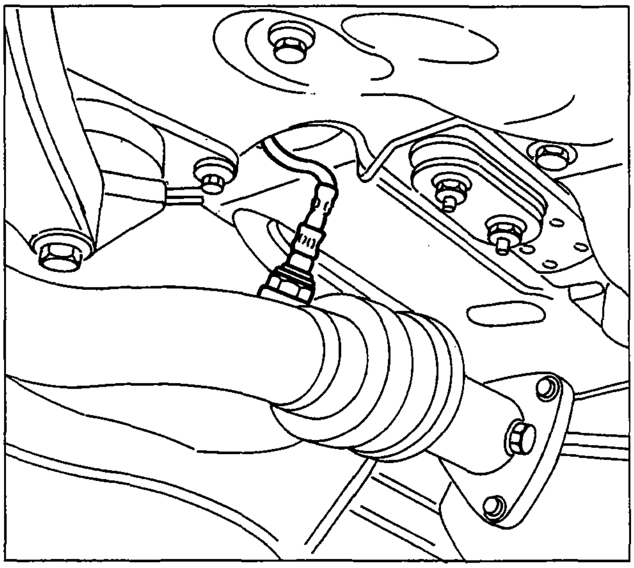
Wiring connector

The numbers in boxes indicate the corresponding control unit pins.


P4A55CJ01

REMOVING - REFITTING LAMBDA PROBE

- Position vehicle on lift
- Disconnect battery negative lead
- Disconnect electrical connection located against the rear wall of the engine bay and protected by a cover.


P4A55CJ02

Remove the lambda probe from its seat on the exhaust pipe.

When refitting, spread the threaded part with ANTISEIZE MATERI-A-BORON NITRIDE N.G.K. grease from SPARK PLUG CO-LTD.

Tightening torque 3.5 - 4.5 daNm

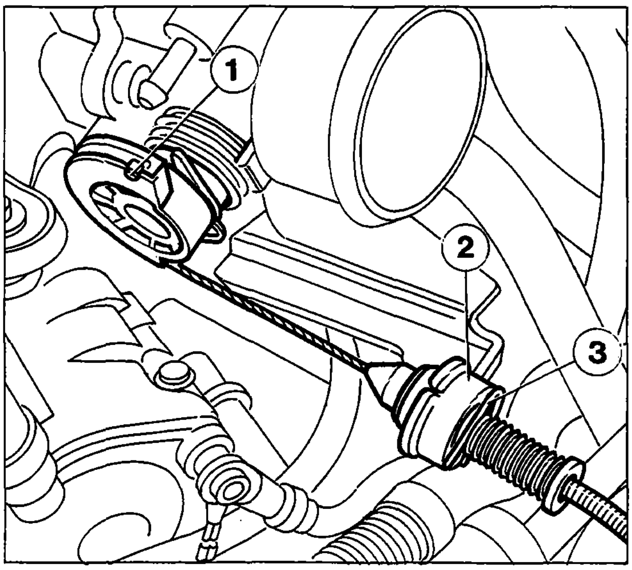
10.

CHECKS, ADJUSTMENTS AND REPAIRS TO I.A.W. INJECTION-IGNITION SYSTEM.

OBSERVE THE FOLLOWING PRECAUTIONS WHEN WORKING ON VEHICLES WITH IAW INJECTION-IGNITION SYSTEMS:

- *never start the engine when the electrical terminals are poorly connected or loose on the battery poles;*
- *never use a quick battery charger to start the engine;*
- *never disconnect the battery from the car circuit with the engine running;*
- *when charging the battery quickly, first disconnect the battery from the vehicle circuit;*
- *if the vehicle is placed in a drying oven after painting at a temperature of more than 80° C, first remove the injection/ignition ECU;*
- *never connect or disconnect the ECU multiple connector with the ignition key in MARCIA position;*
- *always disconnect battery negative lead before carrying out electrical welding on vehicle.*

Note that the memory of this system is active at all times (memory on stand-by), and contains all learnt self-adaptive parameters. Because all this information would be lost if the battery were disconnected, this operation should only be carried out when absolutely essential.

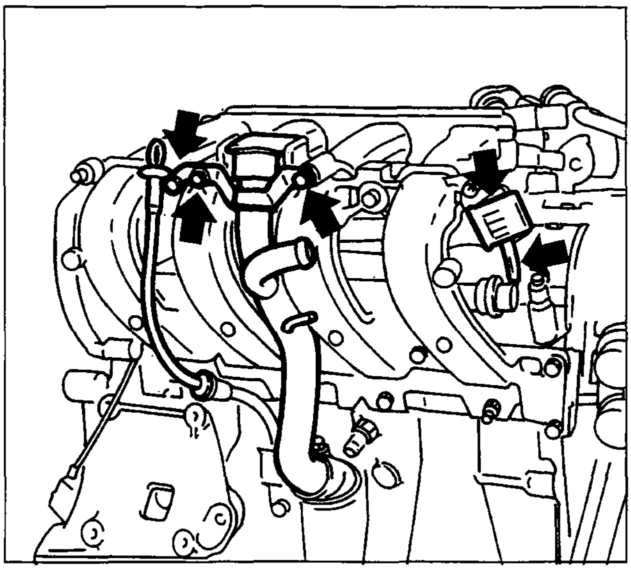


P4A56CJ01

ADJUSTING THROTTLE CABLE

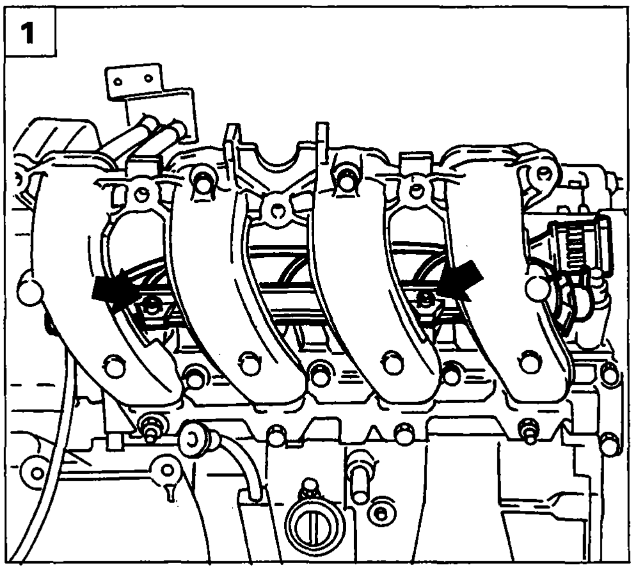
The accelerator cable is adjusted by moving clip (3) along the grooves on bush (2).

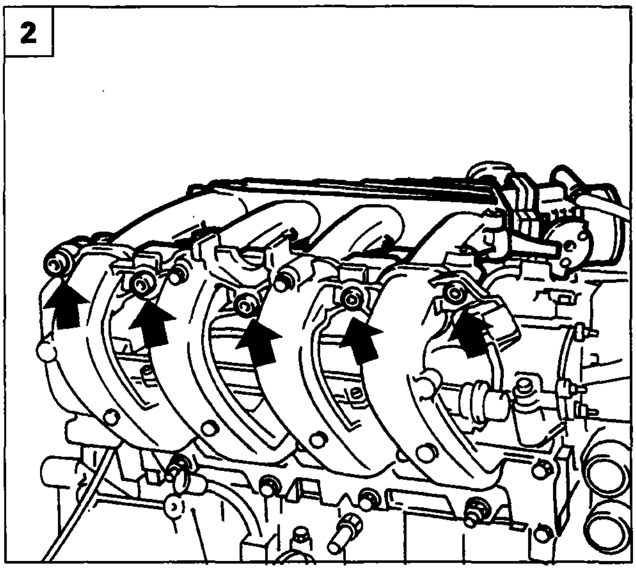
Position the clip so that head (1) of the accelerator cable fits freely into the slot without altering idle speed.

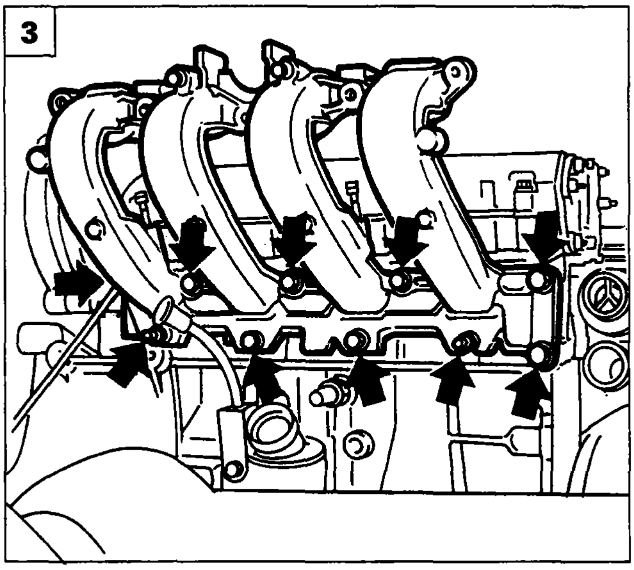

P4A56CJ02

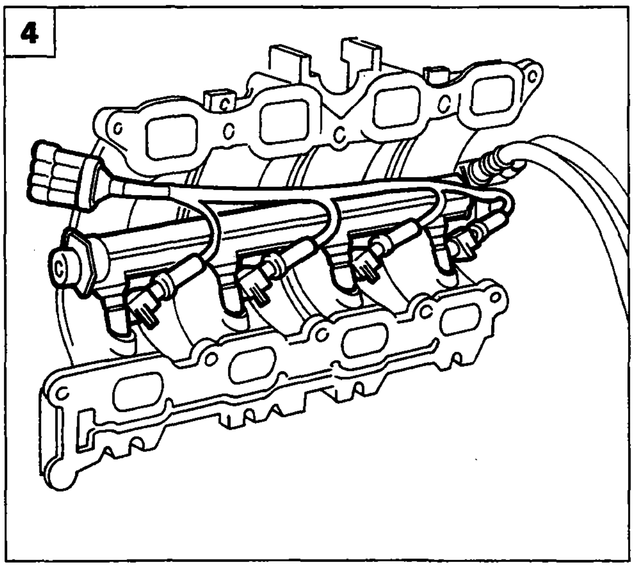
REMOVING-REFITTING FUEL MANIFOLD TOGETHER WITH INJECTORS AND PRESSURE REGULATOR

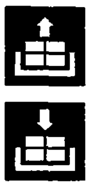
Disconnect the first section of the oil dipstick mount, disconnect the oil filler pipe, disconnect the injector lead coupling and the pipe connecting the regulator to the vacuum point.

1

P4A57CJ01

2

P4A57CJ02

3

P4A57CJ03

4

P4A42CJ01



1. Unscrew the bolts fastening the fuel supply manifold.

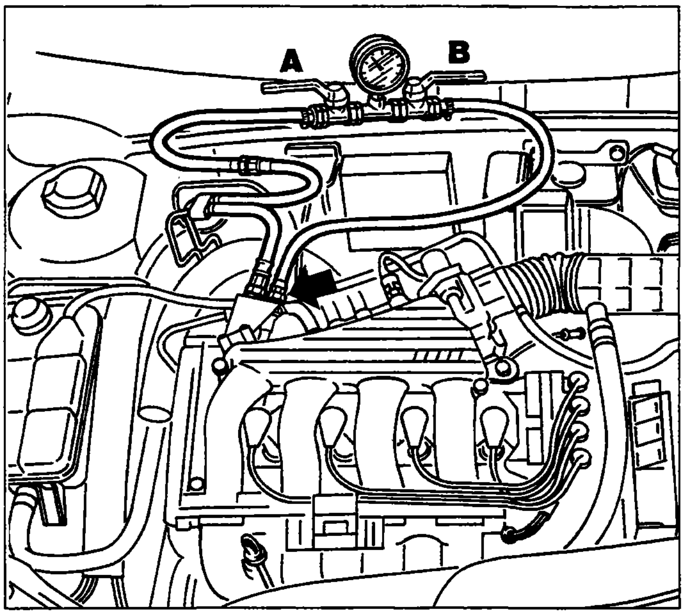
2. Unscrew the bolts fastening both sections of the intake manifold together.

3. Unscrew screws fastening the second section of the intake manifold to the engine block and remove.

4. Disconnect the fuel lines and remove the manifold together with regulator and injectors.

10.

CHECKING FUEL SUPPLY CIRCUIT



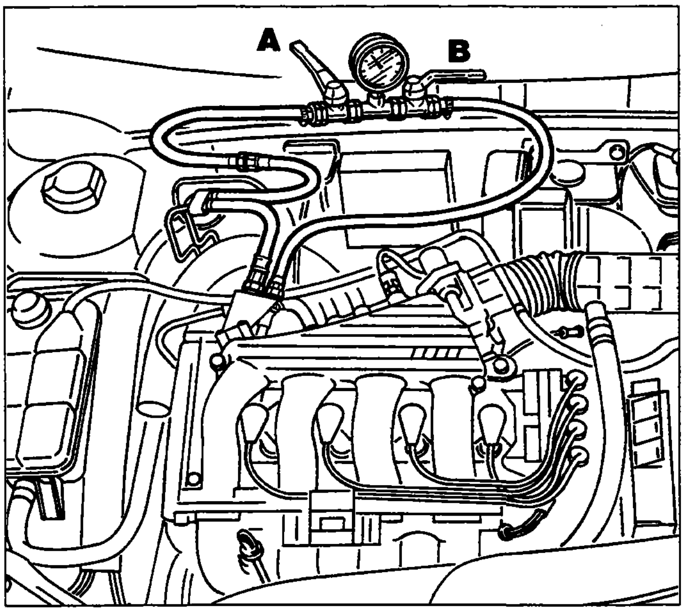
P4A58CJ01

Test 1

Testing fuel regulation pressure

- Disconnect fuel delivery line to manifold from arrowed fitting.
- Interpose pressure gauge 1895890000 between the disconnected pipe end and the fuel manifold with cocks (A) and (B) open.
- Activate fuel pump with engine off.

The last operation is carried out by selecting "fuel pump" test on a Fiat/Lancia tester.
Under these conditions, the pressure gauge reading should stabilise at 3.0 bar.
If pressure is insufficient, carry out the test 2.



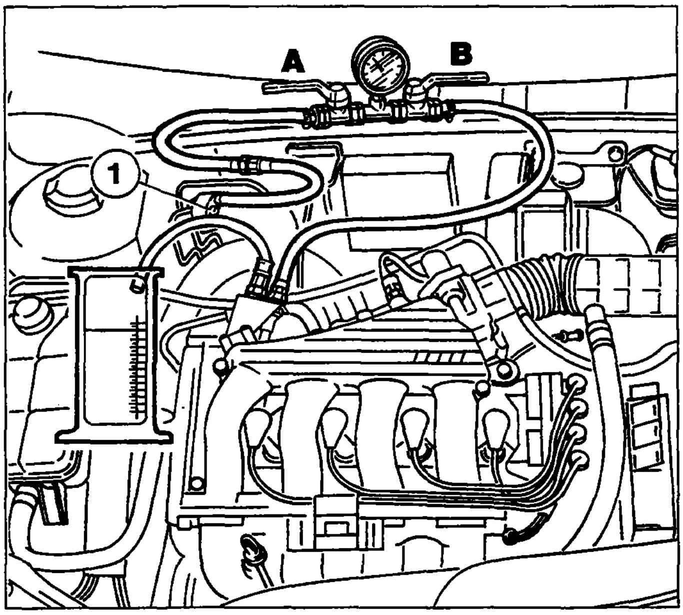
P4A58CJ02

Test 2

Testing maximum fuel feed pressure (or pump efficiency)

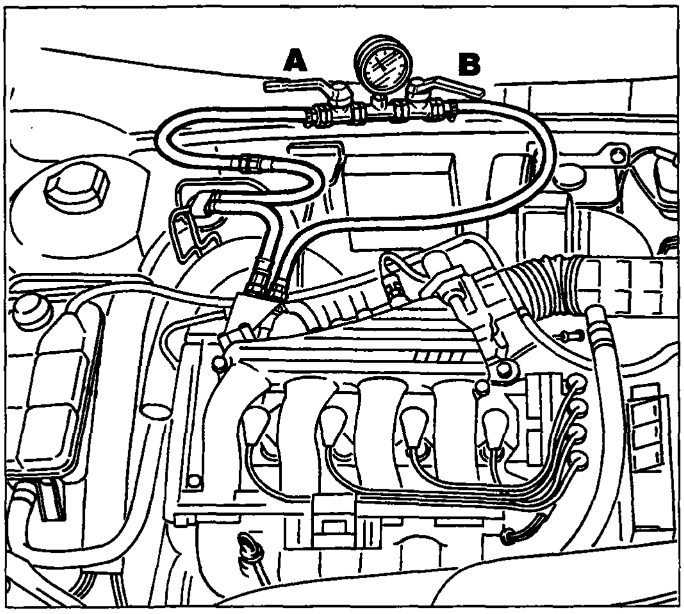
Same connections as previous test.

- Close fuel cock lever (A);
- operate the pump with the engine off, as described previously: pressure should not exceed 7 bar (pump pressure relief valve setting). Otherwise, replace the pump because it is defective.



P4A59CJ01

If pressure measured in test 1 (see previous page) exceeds 3 bars proceed as follows:
- disconnect fuel return pipe (at point (1) for connection to rigid fuel return line to pump) and place in a container suitable for collecting the fuel.
- open cocks A and B;
- operate the fuel pump with engine off as described on previous page, then take pressure reading off pressure gauge:
  a. if it reaches 3 bars replace the fuel return pipe to the tank because it is blocked or kinked;
  b. if it exceeds 3 bars replace the pressure regulator because it is defective.



P4A59CJ02

Test 3
Checking injector seal
To check for drips from the injectors, connect as described in first test (regulation pressure check) and then operate the pump with the engine off. When the regulation pressure is reached, close control lever B and simultaneously constrict fuel return line to tank; use pliers for this purpose and avoid damaging the pipe.

This operation is necessary to discriminate between true loss from the injectors and a faulty seal on the fuel pressure regulator runout valve.

Then:
- turn off the pump;
- see whether pressure remains constant for 60 seconds after stabilising (i.e. dropping slightly).

If it does not, one or more injectors or a fitting are leaking.
- In this case, disconnect the fuel manifold from the intake manifold and keep the pressure gauge connected.
- Repeat the previous test but leave the pressure gauge cock open.
- After supplying the pump with the engine off, look to see whether any of the injectors or connection sections are dripping.

Replace any dripping injectors and/or repair the defective seal in the leaking joint.

CHECKING ENGINE IDLE SPEED

If engine speed is not 850 ± 50 rpm, because the injection-ignition system is self-regulating, no adjustment can be carried out. It is therefore necessary to check that the accelerator linkage is properly adjusted and then search for the fault through full diagnosis using a Fiat/Lancia Tester.

CHECKING LEVELS OF POLLUTING EMISSIONS

The IAW - 1AF.13 system is self-adaptive and thus constantly monitors idle speed and CO levels. Therefore there is no need for manual adjustment (adjustment screws are no longer fitted). However, checking exhaust contents downstream of the catalytic converter can provide useful information about the injection-ignition system condition, engine and catalytic converter parameters

Checking CO and HC levels when idling

Measure levels of carbon monoxide (CO) and unburnt hydrocarbons (HC) with the catalytic converter hot (300 - 350 °C) (it is advisable to push the car engine on the road for about 5-10 minutes to ensure that the catalytic converter reaches service temperature), Then fit the probe of a suitably calibrated tester to at least 30 cm as indicated in the figure.

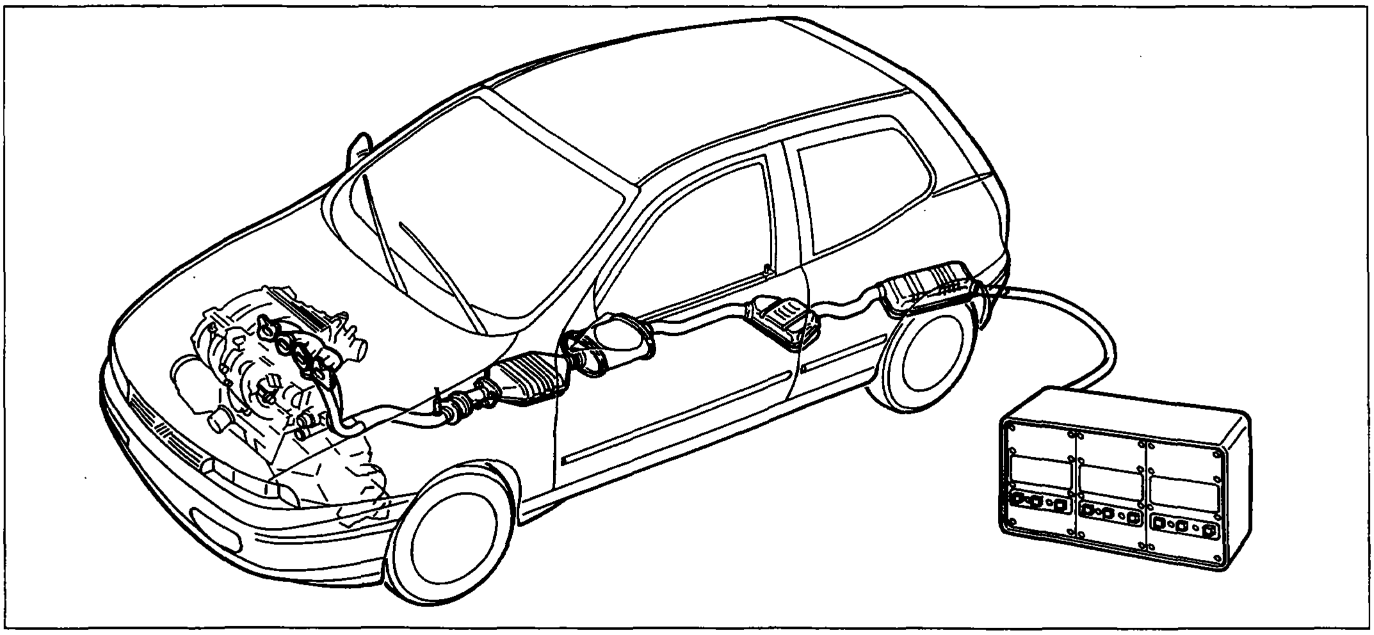
If the shape of the exhaust tail pape will not allow the probe to be fully inserted, add an extension pipe designed to ensure a seal in the joint area.

1. Check that CO and HC levels are as specified in the table;
2. If CO level is not as specified, check that:
   - Lambda probe is working properly, with the aid of a Fiat/Lancia Tester;
   - for air leaks in the area surrounding the lambda probe seat
   - the injection and ignition system **(particularly for spark plug wear).**

3. If HC level is not as specified, the engine is not properly tuned or the catalytic converter is not efficient.

CO (%)	HC (p.p.m.)	CO_2 (%)
$\leqslant$0.35	$\leqslant$90	$\geqslant$ 13

Summary table showing emission level tolerances downstream of converter



P4A60CJ01

DIAGNOSIS

System self-diagnosis

Self-diagnosis aims to reveal faults in the following components:

Actuators

- Injectors
- Idle speed actuator
- Ignition coils
- Vapour recirculation solenoid
- Fiat CODE

SENSORS

- Rpm and TDC sensor.
- Absolute pressure sensor
- Coolant temperature sensor
- Intake air temperature sensor
- Throttle position sensor
- Lambda probe
- Timing sensor

A warning light on the control panel will not necessarily come on if a fault occurs.

If sensors are not working, the system implements signal reconstruction strategies (recovery) in order that engine and catalytic converter can function adequately but without experiencing further damage

In this condition, the vehicle can be driven to a service centre for the necessary repairs.

Once the fault has been corrected, the warning light will go off

Any fault that occurs is memorised temporarily by the system control unit in order to facilitate repairs. When the ignition key is removed, these are transferred to the permanent memory where the can be read by a Fiat/Lancia Tester.

Diagnosis using Fiat/Lancia tester

Connect the Fiat/Lancia Tester (F.L.T.) to a socket beside the ECU.

Information is exchanged between ECU and Tester via two test lines (K e L); the communication protocol follows ISO 8 standards. Line K is two-way while line L is one-directional (from Tester at control unit).

The protocol is Master-Slave type sustained at 4800 baud on K line; dialogue is activated by directing to 5 bits on line L.

The Tester is connected to the ECU as follows:

1. Connect the Fiat-Lancia Tester using «ADAPTER ADT 101 A»

2. Activate TESTER either through the cigar lighter or by connecting directly to the battery (a special extra lead is provided for this purpose).

3. Connect the Tester socket to the test socket.

The Tester is able to perform the following functions:

- Engine parameter display

- Error display

- Active diagnosis

10.

DISPLAYED PARAMETERS

Engine rpm
Injection time
Absolute pressure to inlet manifold
Air temperature
Coolant temperature
Throttle opening angle
Battery voltage
Voltage LAMBDA probe status
Engine idle speed actuator
Self-adaptability
Vehicle speed
Mixture level
Petrol vapour solenoid
Fiat CODE

List of errors

RPM sensor	A.C-D.C.
Throttle potentiometer	A.C-D.C.
Absolute pressure sensor	A.C-D.C.
Air temperature sensor	A.C-D.C.
Coolant temperature sensor	A.C-D.C.
Battery	Power supply> 15.5V Power supply< 5V
Lambda probe	Status not plausible (probe disconnected or faulty)
Injector	D.C
Ignition coils	A.C-D.C. A.C-D.C.
Idle speed actuator	No. of subsequent steps
Fuel vapour solenoid	A.C-D.C.
Actuator relays	A.C-D.C.
Control unit	Microprocessor or ECU memory faults are indicated.
Self-adaptive parameters	Indication displayed when ECU self-adaptive limits reached. This indication means that engine conditions are much too far from specified levels and mechanical causes should also be investigated.
Timing sensor	A.C-D.C.
Speed sensor	Signal absent
Signal framework	Tooth count incorrect - Space between two missing teeth not recognised
Mixture level	Greater than maximum threshold Lower than minimum threshold
Fiat CODE	Code not recognised or not received

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HITACHI INTEGRATED INJECTION/IGNITION SYSTEM

Introduction

The Hitachi system fitted on the Bravo-Brava with the 1747 i.e. 16v engine belongs to the category of static advance digital electronic ignition systems integrated with multiple phased type intermittent electronic fuel injection systems.
This system therefore has only one control unit, one set of wiring and one set of common sensors for both systems.
The integrated system can be summarized in the following syb systems:

ELECTRICAL/ELECTRONIC CIRCUIT
AIR INTAKE CIRCUIT
FUEL SUPPLY CIRCUIT
EMISSION CONTROL DEVICES

The system is capable of detecting the following parameters via special sensors:
1. the engine rotation speed;
2. the position of each pair of pistons in relation to TDC for cylinder 1;
3. the engine intake air flow rate;
4. the position and the speed of the variation of the position of the accelerator butterfly;
5. the temperature of the engine coolant;
6. the effective strength of the mixture (through the Lambda sensor signal);
7. the presence of detonation;
8. the speed of the vehicle;
9. the battery voltage;
10. whether the climate control compressor is switched on.

This information, usually of an analogue type, is converted into digital signals by analogue/digital (A/D) converters in order to be able to be used by the control unit.
In particular, any engine operating point is detected, moment by moment, by two parameters:

- the engine rotation speed, measured in revolutions per minute (rpm);
- the engine load, which is constituted by the quantity of air drawn in by each cylinder.
  This quantity is calculated on the basis of the flow rate of the air drawn in and is represented by the parameter TP, measured in milliseconds (ms).

Inside the control unit memory there is a managment programme (software) which comprises a series of strategies, each of which manages a precise system control function.
By using the (input) information listed previously, each strategy processes a series of parameters, based on the data maps stored in the control unit memories and then controls the system (output) actuators which are the devices which allow the engine to operate, namely:

1. injectors;
2. ignition coils;
3. solenoid valves implementing various functions;
4. fuel pump;
5. control relays.

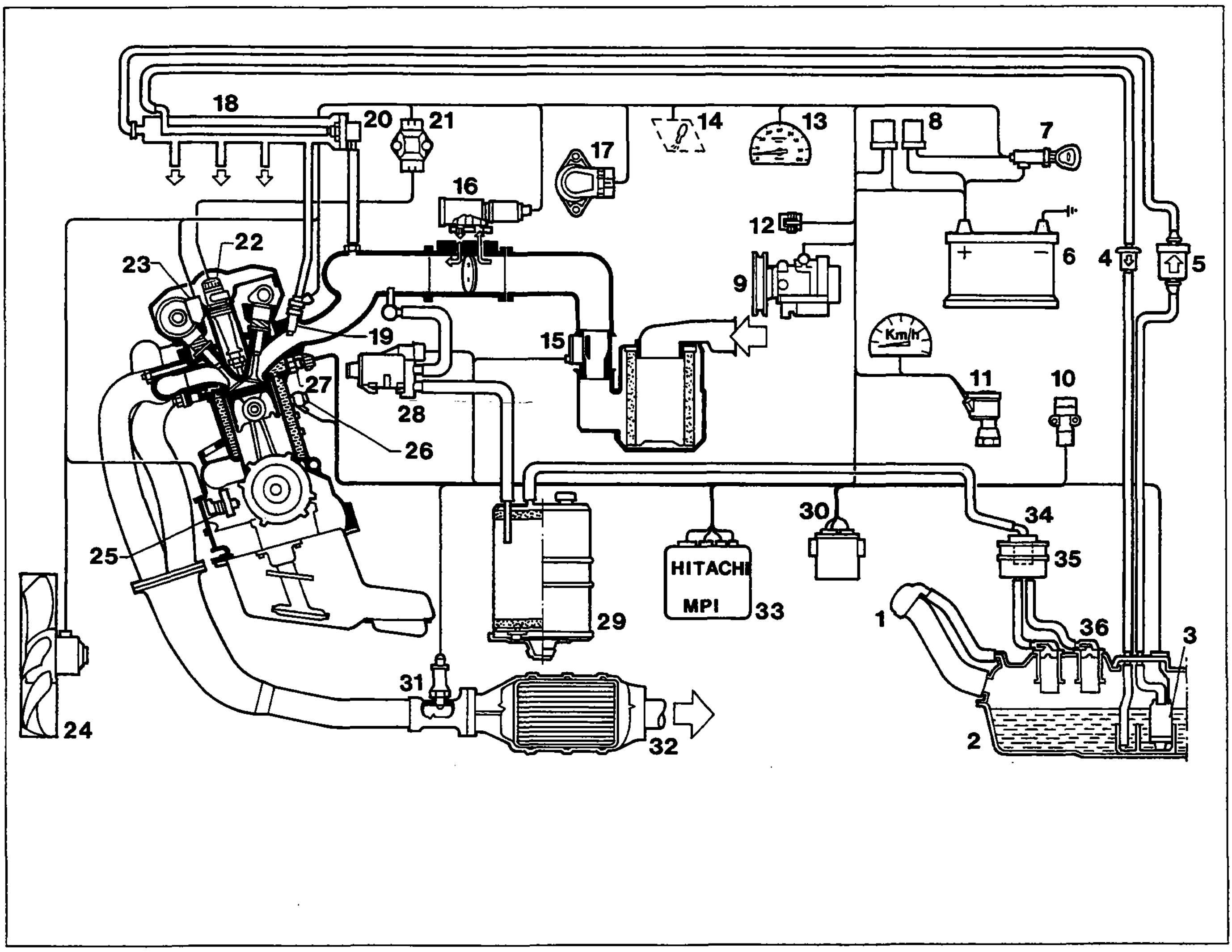
NOTE *The HITACHI injection/ignition system does not require any adjustment as it is self-regulating and self-adjusting.*

NOTE *In the diagrams, the numbers indicate the corresponding HITACHI engine control unit pins.*

NOTE *All the connectors are seen from the side opposite the cable input.*

10.

DIAGRAM SHOWING OPERATION OF HITACHI INJECTION/IGNITION SYSTEM



P4A02BJ01

1. Cap with safety valve
2. Fuel tank
3. Electric fuel pump
4. Anti-flow valve
5. Fuel filter
6. Battery
7. Ignition switch
8. System relays
9. Climate control compressor
10. Inertia switch
11. Vehicle speed sensor
12. F/L Tester connector (diagnostic socket)
13. Rev counter
14. System failure light
15. Air flow meter
16. Engine idle adjustment solenoid valve
17. Butterfly position sensor
18. Fuel manifold with integrated pressure regulator
19. Injector
20. Fuel pressure regulator
21. Ignition power module
22. Ignition coil
23. Engine timing sensor
24. Radiator fan
25. Engine rpm sensor
26. Detonation sensor
27. Coolant temperature sensor
28. Charcoal filter solenoid valve
29. Charcoal filter
30. Fiat CODE control unit
31. Lambda sensor
32. Catalytic silencer
33. HITACHI engine control unit
34. Multi-purpose valve
35. Fuel vapour separator
36. Float valve

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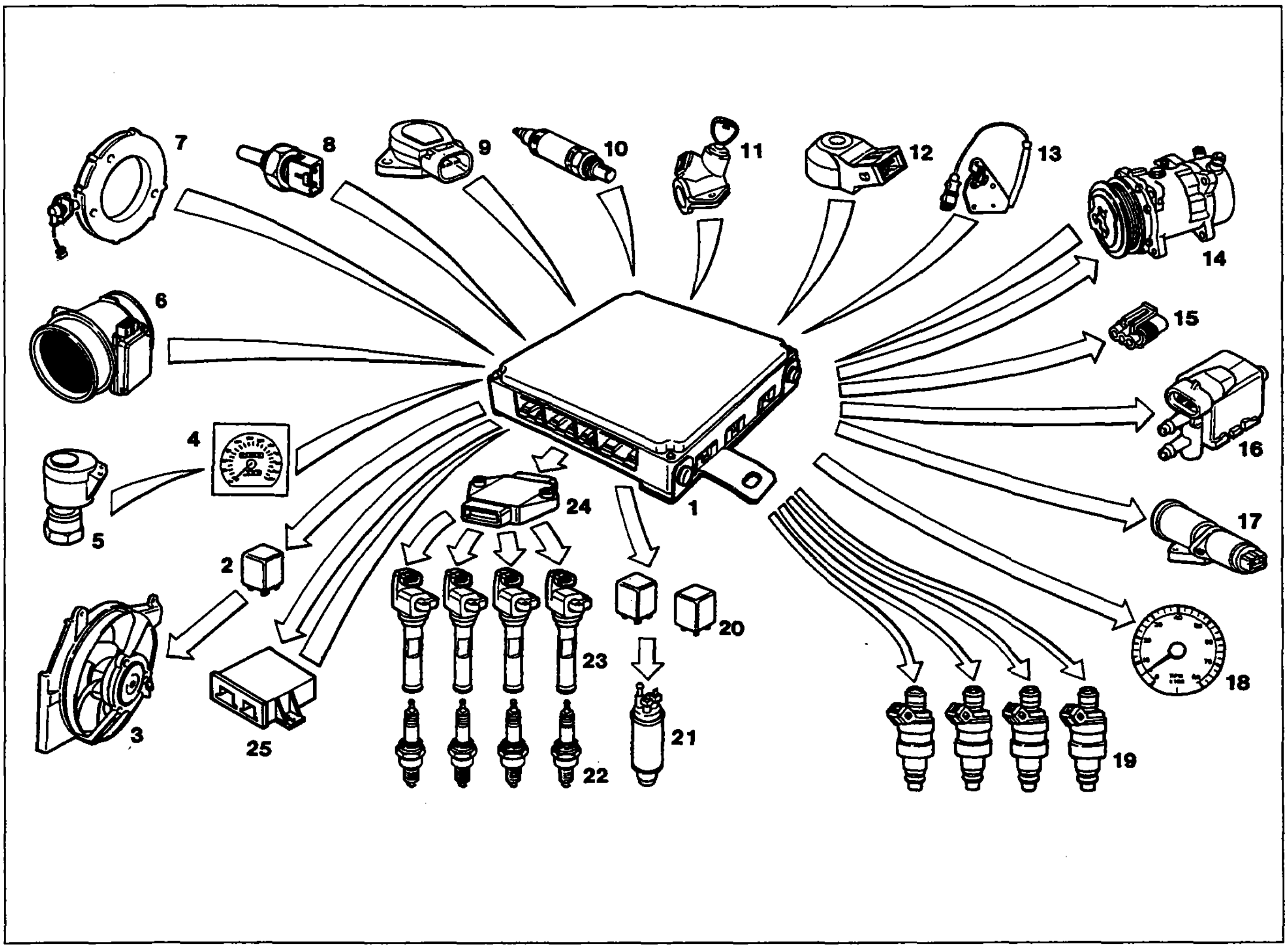
DIAGRAM SHOWING INFORMATION ARRIVING AT/LEAVING CONTROL UNIT AND HITATCH INJECTION/IGNITION SYSTEM SENSORS/ACTUATORS

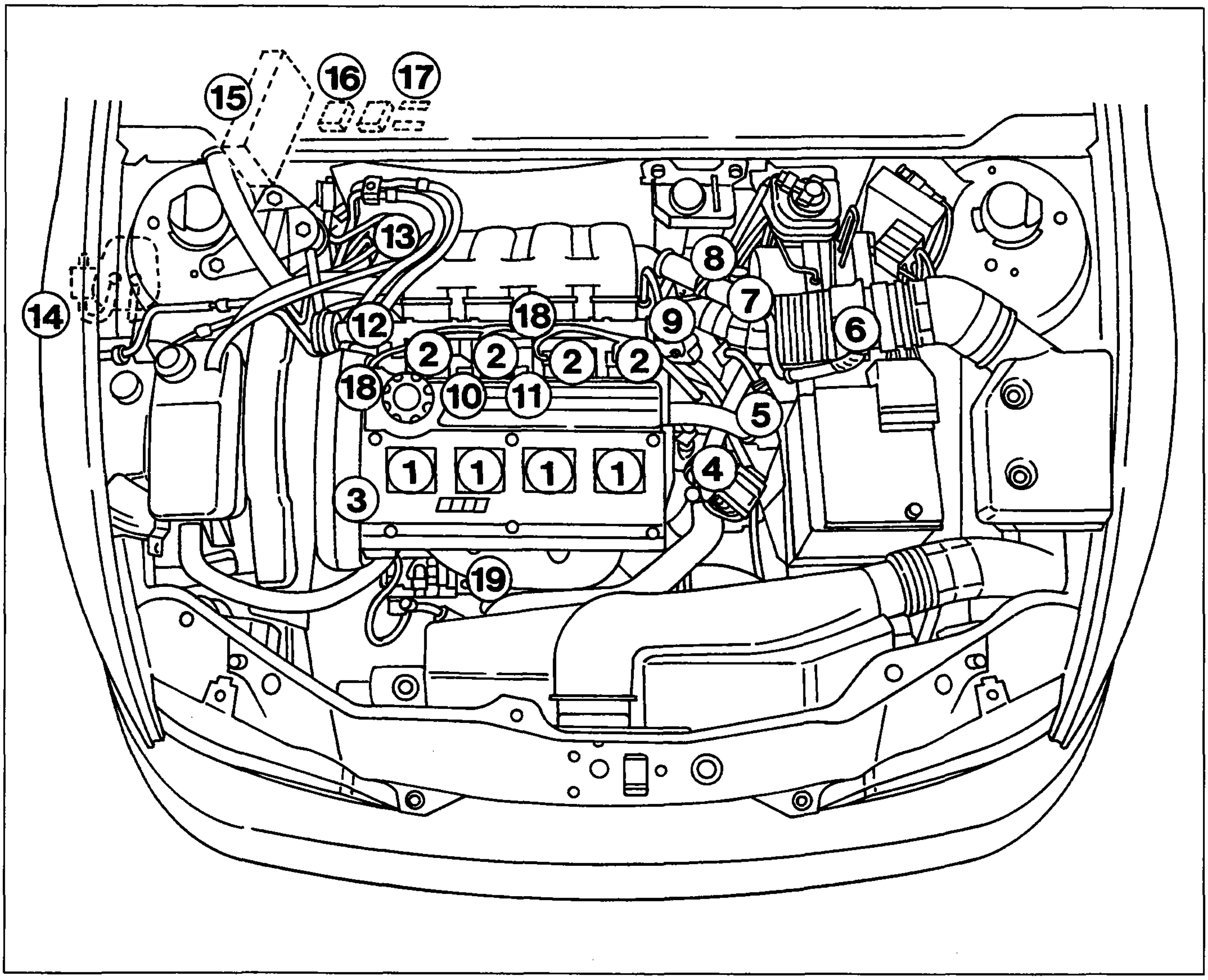


P4A03BJ01

1. HITACHI engine control unit
2. Radiator fan solenoid valve
3. Radiator fan
4. Speedometer
5. Vehicle speed sensor
6. Air flow meter
7. Engine rpm sensor
8. Coolant temperature sensor
9. Butterfly position sensor
10. Lambda sensor
11. Ignition switch
12. Detonation sensor
13. Engine timing sensor
14. Climate control compressor
15. F/L Tester connector (diagnostic socket)
16. Charcoal filter solenoid valve
17. Engine idle adjustment solenoid valve
18. Rev counter
19. Injectors
20. System relays
21. Electric fuel pump
22. Spark plugs
23. Ignition coils
24. Ignition power module
25. Fiat CODE control unit

10.

LOCATION OF HITACHI INJECTION/IGNITION SYSTEM COMPONENTS IN ENGINE COMPARTMENT



P4A04BJ01

1. Ignition coils
2. Injectors
3. Engine timing sensor
4. Coolant temperature sensor
5. Vehicle speed sensor
6. Air flow meter
7. Engine idle speed adjustment solenoid valve
8. Butterfly position sensor
9. Fuel pressure regulator
10. Engine rpm sensor
11. Detonation sensor
12. Fuel manifold
13. Ignition power module
14. Charcoal filter solenoid valve
15. HITACHI engine control unit
16. Relays
17. Fuses
18. Injection/ignition system earths
19. Lambda sensor

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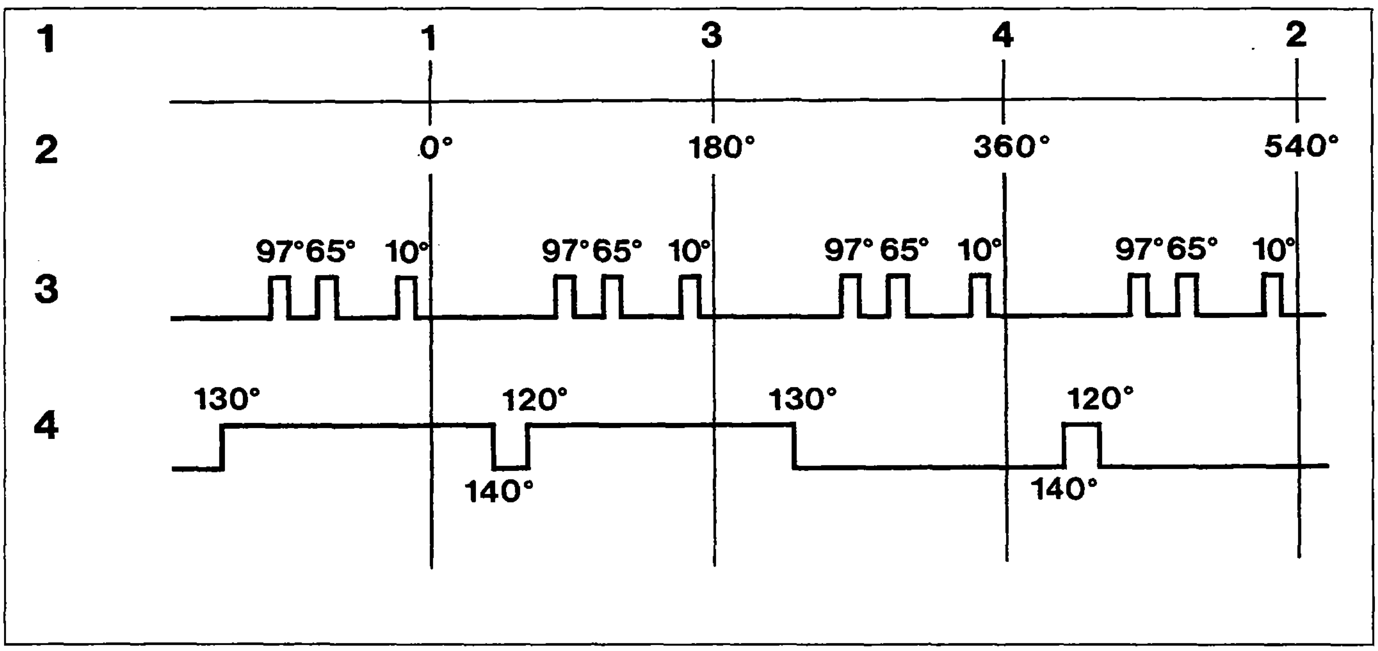
SYSTEM MANAGEMENT STRATEGIES

SIGNAL MANAGEMENT

During starting, the control unit recognizes the injection and ignition timing which are fundamental for the subsequent operation of all strategies.
This recognition is implemented on the basis of the interpretation of the succession of signals coming from the flywheel sensor on the crankshaft and from the engine timing sensor on the camshaft.

NOTE *The end of the signals refers to the collection of signans coming from the sensor on the crankshaft and the one on the camshaft which, featuring a precise reciprocal position, supply the control unit with a synchronized sequence of signals which the control unit is capable of recognizing.*

In particular, the signals are made up as follows:
- flywheel on the crankshaft: equipped with two symmetrical sets of teeth, located at 10°, 65° and 97°, respectively in advance of each TDC;
- flywheel on the camshaft: equipped with two long windows and a short one, wide enough and positioned in such a way as to supply the signal as shown in the diagram.



P4A05BJ01

1. cylinder TDC
2. Crankshaft angles
3. Crankshaft flywheel signal (engine rpm sensor)
4. Camshaft flywheel (engine timing sensor)

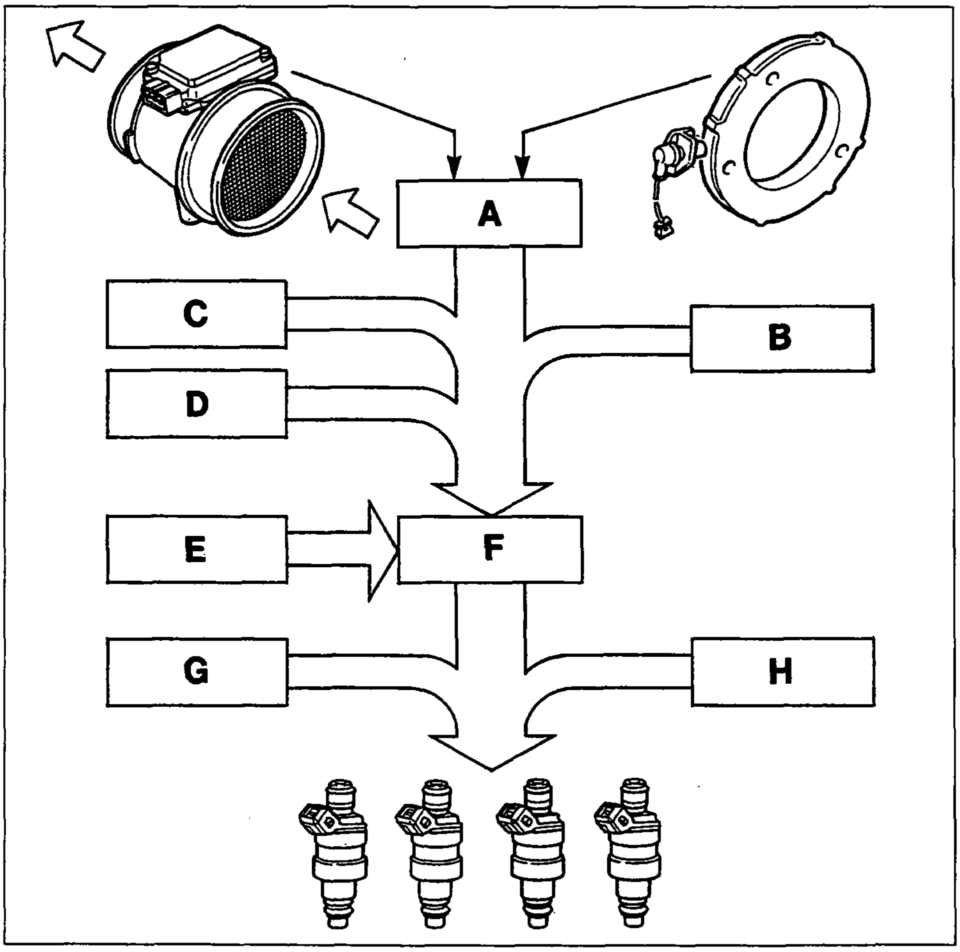
NOTE *The numerical values relating to the signals indicate the crankshaft angles in advance of TDC.*

INJECTION MANAGEMENT

The injection management strategies have the aim of supplying the engine with the correct quantity of fuel at the desired moment according to the engine operating conditions.

NOTE *The presence of the air flow meter makes it possible to directly measure the mass of intake air, making the presence of the intake air temperature sensor superfluous.*

The management of the injection consists essentially in the calculation of the injection time, the determining of the injection timing and the subsequent implementation by operaating the injector.
The "basic" injection time depends on the characteristics of the injector and corresponds to the quantity of fuel to be injected into each cylinder. The latter, in turn, multiplies the quantity of air drawn in by each cylinder (calculated on the basis of the quantity of intake air and on the engine rotation speed) for the desired mixture strength in relation to the engine operating point.
The final injection time is determined through a calculation algorhythm in which the "basic" injection time is corrected by a series of coefficients which take into account the different engine operating conditions which are shown by the various sensors present in the system.



A: "basic" injection time
B: corrective coefficients: low engine temperature, high engine temperature, starting and post-starting, butterfly fully open, deceleration, acceleration

C: checking mixture strength
D: self-adjustment
E: cut-off
F: intermediate injection time
G: extra-pulse
H: management not timed by injection

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Checking mixture strength

NOTE *The following ratio is defined as the mixture ratio and is denoted by the Greek letter α (alfa):*

$$\alpha = \frac{\text{quantity of air drawn in by the engine}}{\text{quantity of fuel injected}}$$

The following ratio is defined as the stoichiometric mixture and is denoted by α_{st}:

$$\alpha_{st} = \frac{\text{theoretical quantity of air to burn all the fuel injected}}{\text{quantity of fuel injected}}$$

The following ratio is defined as the mixture strength andis denoted by the Greek letter λ (lambda):

$$\lambda = \frac{\text{quantity of air drawn in by the engine}}{\text{theoretical quantity of air to burn all the fuel injected}}$$

It can easily be deduced that $\alpha / \alpha_{st} = \lambda$.
The stoichiometric ratio depends on the type of fuel: for current unleaded petrols it is around 14.7 - 14.8 which corresponds to a Lambda strength of 1.
We talk of a mixture being *rich* when the quantity of air is lower than the stoichiometric ratio in which case the Lambda <1:
we talk of a mixture being *poor* (or *lean*) when the quantity of air is higher than the stoichiometric ratio in which case the Lambda >1,

The strategy has the function of correcting the "basic" injection times so that the mixture strength constantly oscillates at a high frequency between 0.98 and 1.02.
The oscillation frequency varies according to the engine load and speed: it is in the order of tens of Hertz.

NOTE *1 Hz = 1 oscillation per second*

In conditions of:
- cut-off,
- butterfly opening above 70°,
- engine temperature below 25°C,

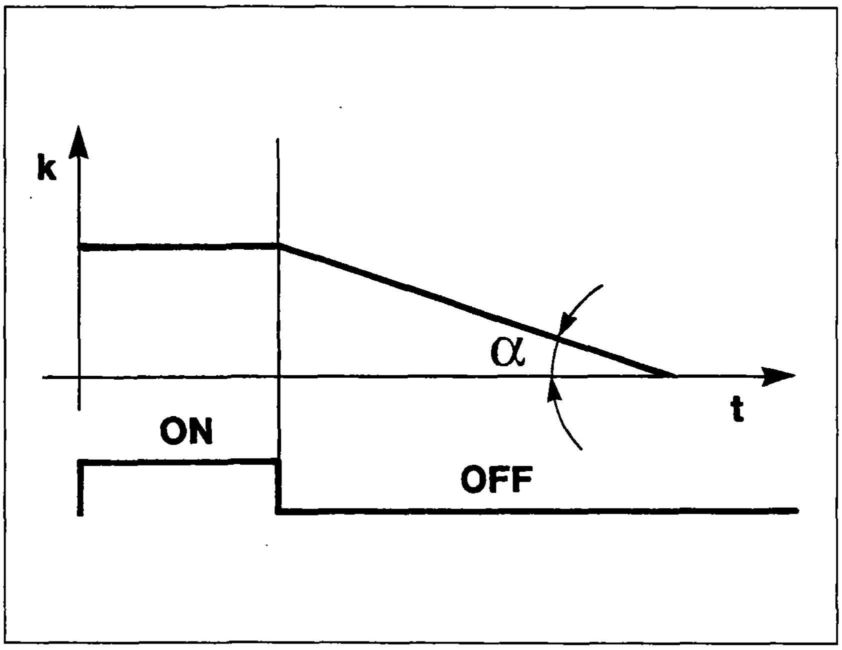
the strategy is disabled.

Self-adjustment

The control unit is equipped with a self-adjustment function which has the task of memorizing any differences between the basic map and the corrections set by the Lambda sensor which may occur during operation. These differences (due to the ageing of the system and engine components) are memorized permanently, allowing the adaption of the operation of the system to gradual alterations of the engine and the components in relation to the characteristics when new.
The strategy is disabled when the charcoal filter solenoid valve is open.
If the control unit is replaced it is necessary to carry out a road test which allows the engine to reach operating temperature and the control unit (above all during idling stops) to operate in the self-adjustment mode.

Starting and post-starting

During starting it is not possible to recognize the engine timing and consequently it is not possible to implement the timed injection.
During the first revolutions of the engine an initial simultaneous injection is carried out (also because the considerable fluctuations in the rotation speed do not allow the correct calculation of the injection timing) and subsenquently the injection is the timed type.
The "basic" injection time "is increased by a multiplication coefficient for the entire time the engine is driven by the starter motor.
After starting has taken place the coefficient is gradually reduced until is disappears within a given time which the lower the engine temperature the longer the time taken.



P4A08BJ01

k: enrichment coefficient
t: time
α: decrease depending on the engine temperature
ON : engine driven (crank)
OFF : engine started (run)

Operation when cold

In these conditions there is a natural weakening of the mixture as a result of the reduced evaporation and the strong condensation of the fuel on the inner walls of the inlet manifold: in addition, the increased viscosity of the lubrication oil causes an increase in the passive resistance of the engine.
The "basic" injection time is corrected by a multiplication coefficient which depends on the temperature and the speed of the engine.

Operation in full load conditions

The strategy is enabled when the butterfly opening exceeds 70°.
The "basic" injection time is multiplied by a coefficient (dependent on the engine speed) equal to around 1.1.

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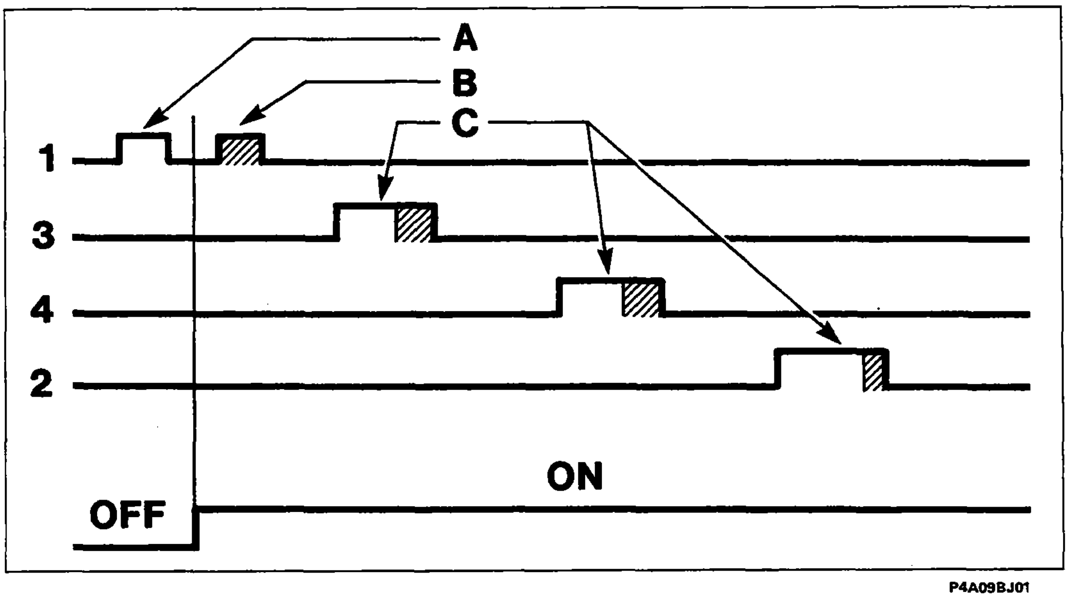
Operation during acceleration

During this stage the control unit increases the quantity of fuel supplied.
The "basic" injection time is multiplied by a coefficient depending on the temperature of the engine and the speed of the opening of the accelerator butterfly (avearge value 1.2).
If the brisk variation in the injection time is calculated when the injector is already closed, the control unit reopens the injector (extra pulse), in order to compensate the mixture strength with increased speed; the subsequent injectors are, on the other hand, increase on the basis of the previously mentioned coefficients.



A: normal injection time
B: injector re-opening (extra-pulse)
C: injection time including enrichment
OFF: engine at stationary speed
ON: engine in transition

Operation during deceleration

During this stage a negative transit strategy is implemented to decrease the quantity of fuel supplied: the "basic" injection time is multiplied by a coefficient which depends on the temperature of the engine, the speed and the load conditions at the moment immediately prior to the start of the deceleration.

Operation during cut-off

The cuto-off strategy is implemented when the control unit recognizes the bütterfly in the idle position (signal frombutterfly potentiometer) and the engine speed is above 1600 rpm (with the engine warm). The supply to the engine is re-enabled with the recognition of the butterfly in the not closed position or- when the speed goesbelow 1200 rpm (with the engine warm).

Rotation speed limiter

The strategy restricts the maximum speed which can be reached by the engine enabling the cut-off gradually, as shown in the table.
Maximum speed: 6550 rpm

method \ cylinders	1	2	3	4
1 cilindro	●			
2 cilindri	●			●
3 cilindri	●		●	●
4 cilindri	●	●	●	●

Electric fuel pump operation

The electric fuel pump is operated by the engine control unit via a relay.
The pump cut out takes place:

- if the engine speed goes below 50 rpm;
- after a certain time (about 5 seconds) with the ignition switch in the ON position without the engine being started up (timed inhibitor);
- if the inertia switch has intervened.

Injector operation

The operation of the injectors is the sequential timed type. However, during starting the injectors are operated once in parallel.
The timing of the operation of the injectors is variable according to the engine speed.

FIAT CODE ANTI-THEFT SYSTEM MANAGEMENT

The system is equipped with an anti-theft function. This function is achieved thanks to the presence of a special control unit (FIAT CODE), capable of dialogue with the engine control unit and an electronic key, equipped with a special transmitter for sending a recognition code.
Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the engine control unit.
If the key is turned to the ON position, the following operations take place in the order given:
1. the engine control unit (whose memory contains a secret code) sends the FIAT CODE memory a request so that the latter sends the secret code to deactivate the locking of the functions;
2. the Fiat CODE control unit responds by only sending the secret code after having, in turn, received the recognition code transmitted by the ignition key;
3. the recognition of the secret code allows the de-activation of the locking of the engine control unit and its normal operation.

NOTE *The presence of the FIAT CODE anti-theft system makes it strongly inadvisable, during diagnosis, to proceed with the test using another engine control unit. In effect, in such a case, the Fiat CODE control unit would transfer the (unrecognized) recognition code to the test control unit which would then make it unusable on other vehicles.*

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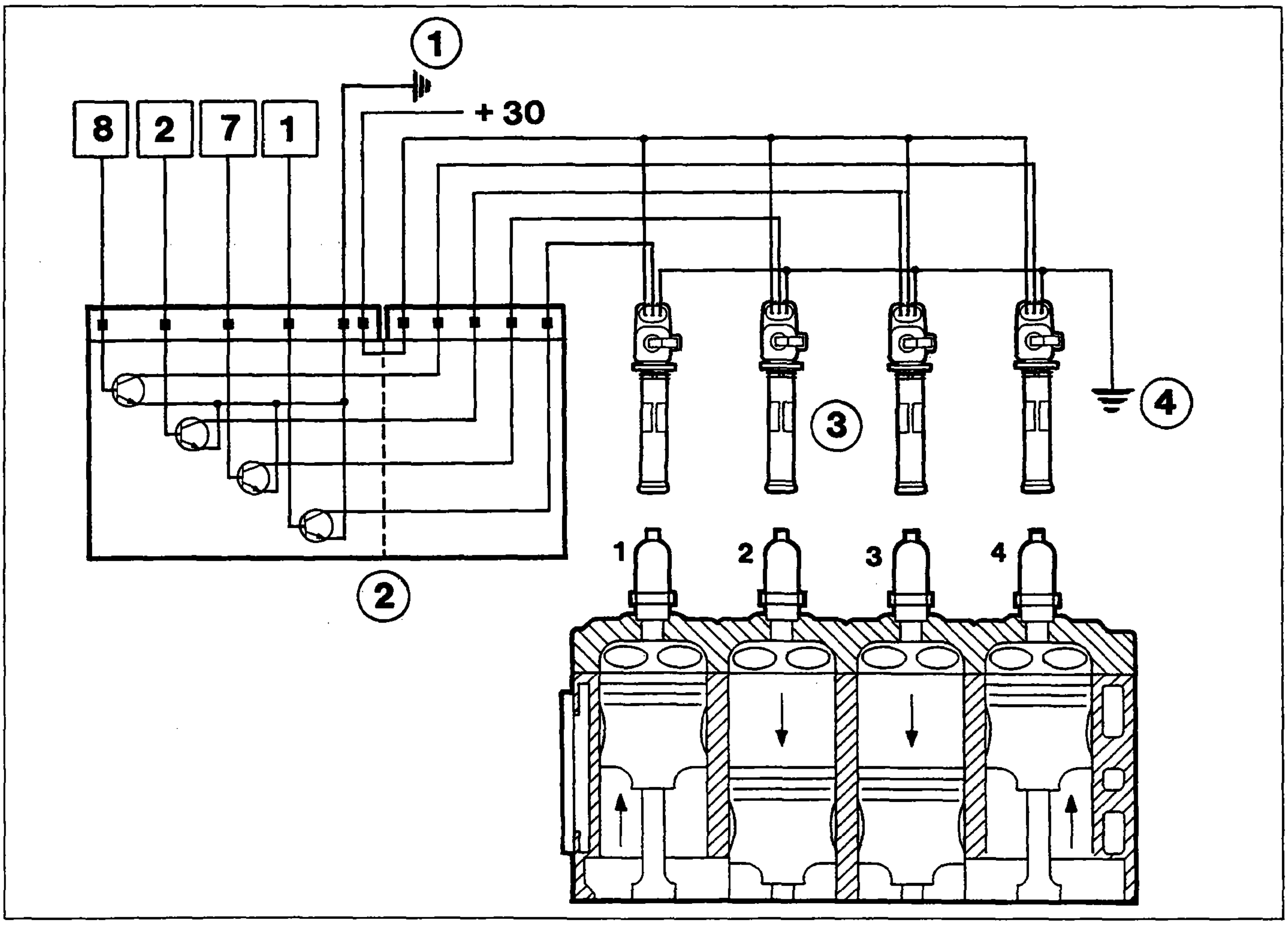
IGNITION MANAGEMENT

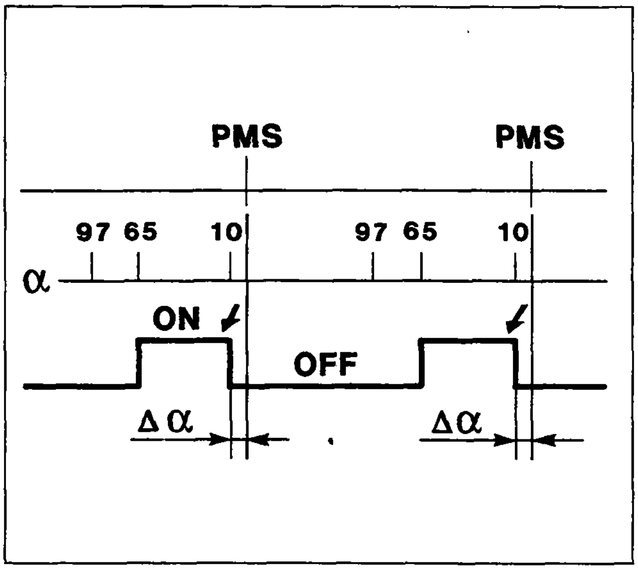
The ignition management strategies have the objective of striking the spark with the desired advance according to the engine operating conditions.

The management of the ignition basically consists of determining the ignition advance and its implementation by controlling the power module, connected externally to the control unit.
The value of the "basic" advance, calculated on the basis of the intake air flow rate and the engine speed, is then corrected depending on the different engine operating conditions.
The control unit determines the moment of the start of the conduction of the current in the coil primary winding on the basis of the engine rotation speed.
This moment obviously varies in relation to explosion TDC for each cylinder and the greater the engine rotation speed, the greater the advance because the time *(dwell)* required to saturate the current in the coil primary winding is more or less constant.
The moment of the start of conduction is corrected according to the battery voltage.



P4A11BJ01

1. Ignition power module earth
2. Ignition power module
3. Single ignition coil (plug-top)
4. Secondary coil earth



P4A12BJ01

α: crankshaft flywheel signal
Δ α: fixed ignition advance (10° engine)
ON : activated coil conduction
OFF: de-activated coil conduction

Starting

During starting it is not possible to carry out the normal management of the advance because the considerable fluctuations in the rotation speed do not allow the correct calculation of the dwell and the advance.
The advance is therefore managed by taking the following as a reference:
- for the start of conduction, the tooth at 65°;
- for the ignition advance, the tooth at 10°.

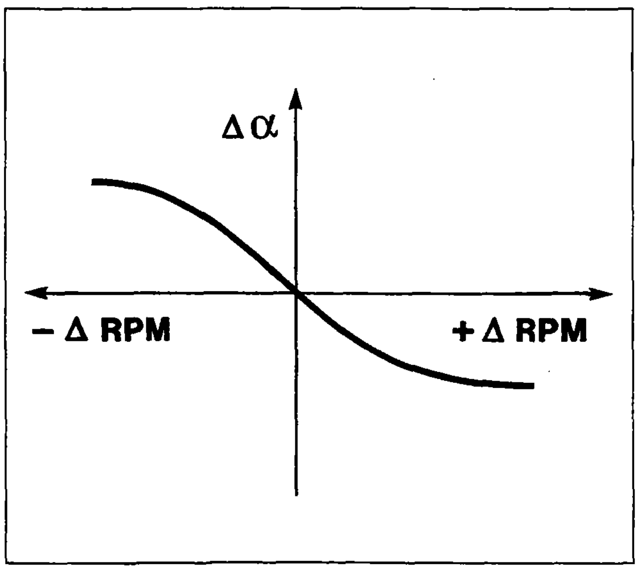
As a result there is a fixed advance at 10° for the entire time the engine is driven by the starter motor.

Operation when cold

During operation when cold an additional correction of the advance is implemented: the increase in the advance in relation to the one in the memory is inversely proportional to the temperature of the engine.

Operation during cut-off

The ignition advance is increased at the entry into cut-off: from the moment the supply of fuel is re-enabled the advance is gradually restored to the "base" value.



P4A12BJ02

Δ α: correection of ignition advance during idling
+Δ RPM: the idle speed exceeds the nominal value
-Δ RPM: the idle speed is lower than the nominal value

Operation with engine idling

When the engine is idling, the management of the advance is implemented independently of the "basic" advance.
The value of the advance during idling, which varies according to the temperature of the coolant (10° with the engine warm) is corrected in accordance with the variation of the speed in relation to the pre-set speed, which also depends on the temperature.
In particular, the advance is increased if the speed decreases and is reduced if the speed increases, in order to ensure the stability of the actual speed.

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Checking detonation

The strategy has the task of detecting the presence of the phenomenon of detonation, by processing the signal coming from the appropriate sensor. The strategy constantly compares the signal coming from the sensor with a level which, in turn, is constantly updated to take into account the background noise and the ageing of the engine.
If the system recognizes the presence of detonation, the strategy reduces the ignition advance, producing a step of 2° up to a maximum of 6°, until the phenomenon disappears. As a result, the advance is gradually restored until the basic value or until the phenomenon arises again. In particular, the advance increases are gradully implemented, whilst the reductions are introduced immediately.
During acceleration conditions, the strategy uses a higher level, to take into account the increased engine noise under these circumstances.
The strategy is also equipped with a self-adjustment function which permanently memorizes the advance reductions which must be continuously repeated in order to adapt the advance to the different conditions in which the engine finds itself (for example, the use of a low octane rating fuel). The strategy is capable of restoring the advance to the value in the memory if the conditions which have caused the reduction no longer exist.

ENGINE IDLE CONTROL MANAGEMENT

The general objective of the strategy is to maintain the engine speed around the memorized value (engine warm: 850 rpm): the position assumed by the actuator depends on theengine speed and conditions and the speed of the vehicle.

Starting stage
When the key is inserted the actuator assumes a position which depends on the temperature of the engine and the battery voltage (open-loop position).

Engine started with accelerator pedal released
The engine speed varies according to the temperature of the engine and is constantly maintained close to this value modifying the position of the shutter to compensate for any oscillations in the speed.
This takes place in particular when external loads are applied (power assisted steering, heated rear windscreen, etc).
If the electric fans and the air conditioning are switched on, both of which are managed by the control unit, the strategy manages the advance actuator as appropriate.

Normal opeartion
In these conditions the actuator is in the open-loop position.

During deceleration
In deceleration conditions outisde of idling, the control unit operates the position of the actuator through a special curve *(dash-pot curve)*, or it slows down the return of the shutter towards its housing, achieving a reduction in the engine braking effect.

CHARCOAL FILTER MANAGEMENT

The strategy controls the position of the charcoal filter solenoid valve as follows:
- during the starting stage the solenoid valve remains closed, preventing the fuel vapours from enriching the mixture; this condition persists until the engine coolant reaches 25°C;
- with the engine at operating temperature, the control unit causes the solenoid valve to operate in duty-cycle to control the quantity of fuel vapours sent to the inlet, according to the engine speed and load conditions.

In the following operating conditions:
- butterfly in closed position,
- speed below 1250 rpm,
- engien load TP < 1 ms,

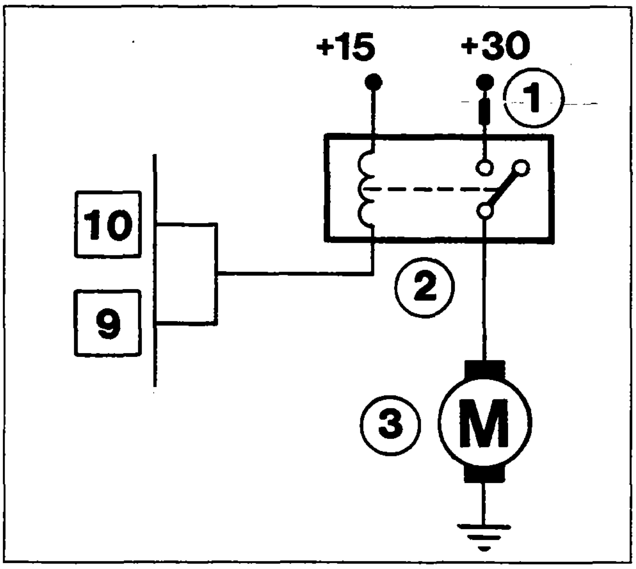
the operation of the solenoid valve is disabled, keeping it in the closed position.

10.

RADIATOR FAN MANAGEMENT

The control unit directly controls the operation of the radiator fan depending on the coolant temperature and whether or not there is a climate control system.

NOTE *Since the temperature of the engine is measured by the appropriate sensor there is no longer a thermal contact on the radiator.*

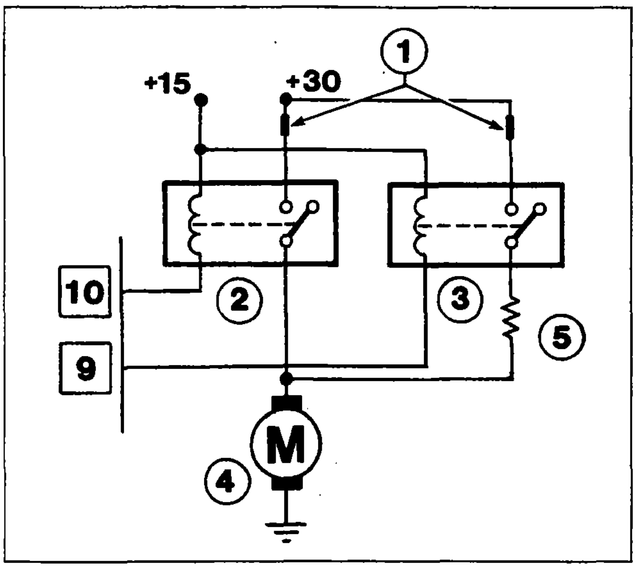


P4A14BJ01

Version without climate control

There is an electric fan which switches on when the temperature of the coolant exceeds 95°C.
It switches off with a hysteris of 2°C around the temperature level.

1. Fuse
2. Fan relay
3. Electric fan



P4A14BJ02

Version with climate control

There is an electric fan with two operating modes:
- low speed,
- high speed.

1. Fuse
2. High speed relay
3. Low speed relay
4. Electric fan
5. Resistance

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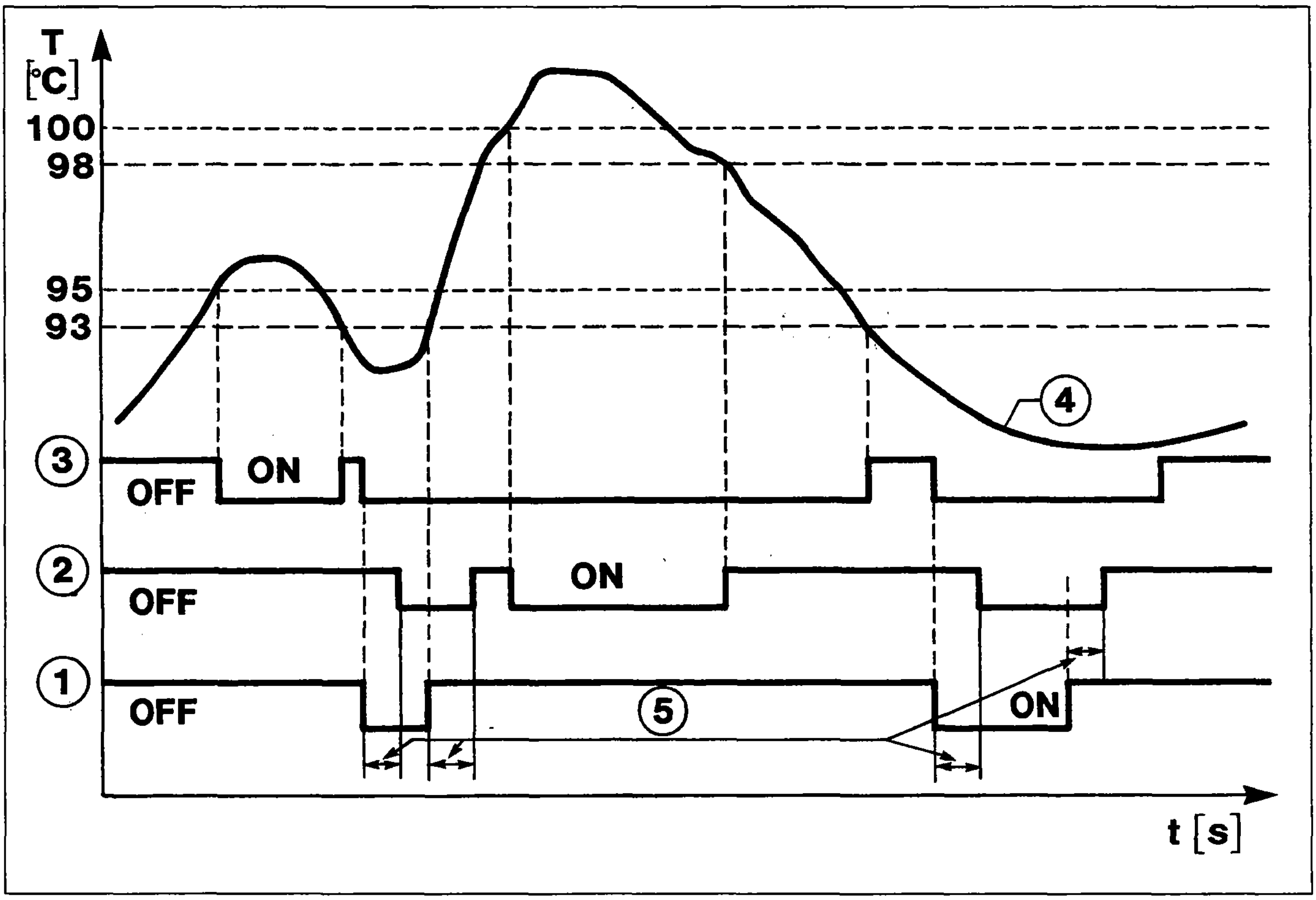
Diagram showing operation of electric fan for version with air conditioning

Low speed: it switches on when the temperature of the coolant reaches 95°C.
High speed: it switches on when the temperature of the coolant reaches 100°C.
The speed of the electric fan also depends on the state of the three stage pressure switch for the climate control system which determines the engagement of the first speed and, with a certain delay, that of the second and the subsequent switching off.



P4A15BJ01

1. State of the three stage pressure switch
2. High speed operating condition
3. Low speed operating condition
4. Coolant temperature trend
5. Three stage pressure switch attachment/detachment delay

ON: speed/pressure switch activated
OFF: speed/pressure switch deactivated

CLIMATE CONTROL SYSTEM MANAGEMENT

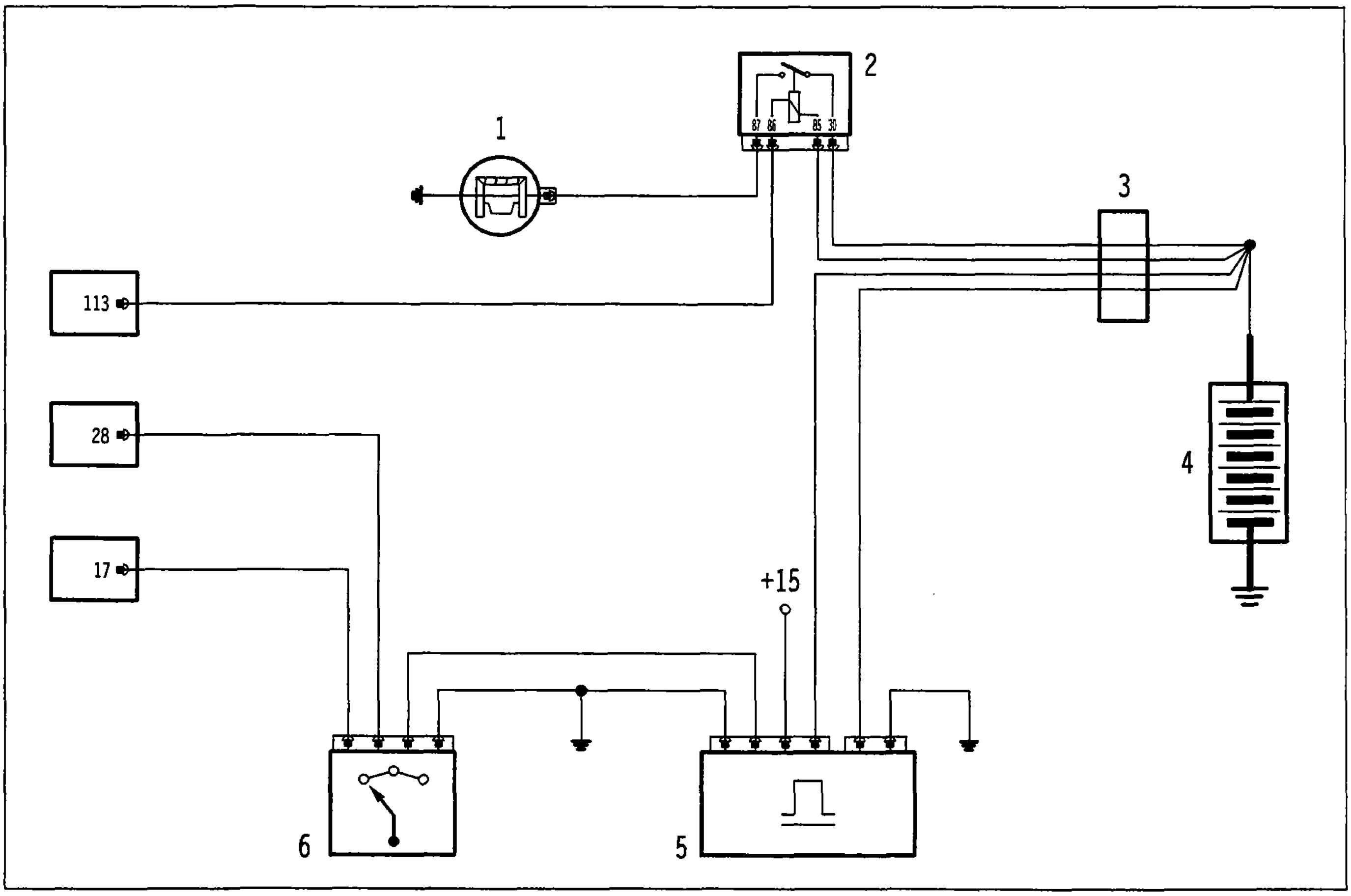
The Hitachi engine control unit is operationally connectedto the climate control system and:

1. receives the request to switch on the compressor from the climate control system control unit via pin 28 and operate the relevant functions (additional air);
2. gives the go ahead to switch on the compressor via pin 113 when the conditions laid down by the strategies are confirmed;
3. receives information concerning the state of the three stage pressure switch from pin 17 and operates the relevant functions (radiator fan operation).

As far as point 1 is concerned, if the engine is idling, the control unit increases the air flow rate which goes from the idle actuator in advance of the switching on of the compressor and viceversa places the actuator in the normal position in delay in relation to the switching off of the compressor.
On the other hand, as far as point 2 is concerned, the control unit automatically operates the switching off of the comrpessor:

a) for a time of 6 s (timed switching off):
- in butterfly opening conditions of more than 70°,
- when the vehicle is accelerating;

b) when the following critical conditions persist:
- at coolant temperatures conditions above 114°C,
- when the engine idle speed is below 750 rpm.



P4A16BJ01

1. Compressor
2. Compressor relay
3. Fuse box
4. Battery
5. Climate control unit
6. Three stage pressure switch

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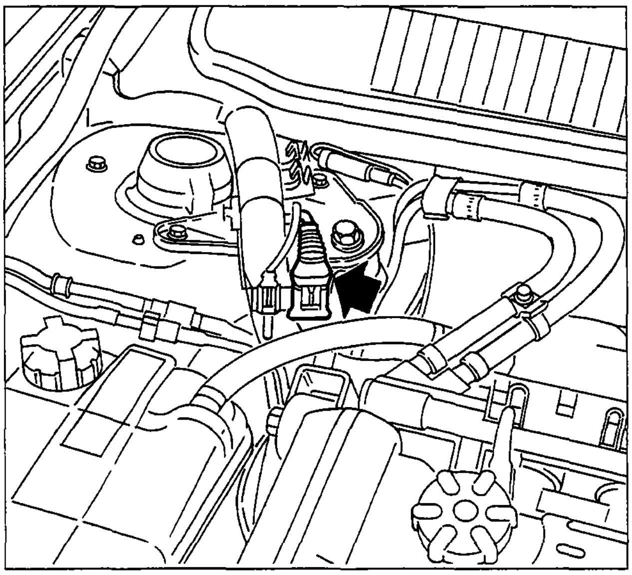
DIAGNOSIS

The system is equipped with an autodiagnostic function which checks for any irregular state in the following components:

Actuators
injectors
coils
charcoal filter solenoid valve
engine idle adjustment solenoid valve
electric fuel pump relay
climate control compressor relay (if fitted)
electric fan low speed relay
electric fan high speed relay (if fitted)

Sensors
engine rpm sensor
engine timing sensor
air flow meter
Lambda sensor
coolant temperature sensor
butterfly position sensor
vehicle speed sensor
detonation sensor

Location of F/L Tester connector



P4A17BJ02

The detection of a fault, if confirmed, involves it being permanently memorized, as well as excluding the relevant sensor from the system until it is repaired.
The detection of a confirmed fault usually involves the warning light in the dashboard coming on: the warning light goes out when the fault is repaired.

Working with the Fiat Lancia Tester it is possible to carry out a complete fault diagnosis of the system which consists of three stages:
1. displaying a series of functional parameters (with the engine running);
2. displaying errors and cancelling them;
3. activating certain actuators (active diagnosis).

1. Parameters displayed

The following engine parameters are displayed:
- air flow rate,
- coolant temperature,
- butterfly sensor position,
- Lambda sensor voltage,
- battery voltage,
- Lambda sensor state,
- vehicle speed,
- engine rpm,
- air flow rate/maximum flow rate,
- ignition advance,
- charcoal filter solenoid valve duty cycle,
- injection time,
- engine load (TP),
- objective engine idle speed,
- engine idle speed adjustment solenoid valve duty cycle,
- FIAT CODE state,
- errors present.

2. Detecting and cancelling faults

Detecting faults
This is carried out during the basic functions through which the sensor/actuator is managed.

Memorizing the error and the structure of the errors memory
The errors are memorized in the control unit in the order in which they occur.
The following is memorized for each of them:
- the error code (component and type of error),
- the error counter,
- the time elapsed since the error was detected,
- two environmental conditions (specific for each type of fault) at the time the fault was detected.

Classification of the fault
If a fault is recognized for the first time and the error state persists for a certain length of time, the fault is memorized as "permanent". If this fault later disappears, then it is memorized as "not present". The classification of a fault as "permanent" activates the recovery functions: when the fault disappears, normal operation is restored.
The presence of a "permanent" fault also involves the system failure warning light in the dashboard coming on.

Frequency counter
The counter, which goes from 0 to 127 and which is activated in the case of a fault, is decreased each time the engine is started up without the fault reappearing: when the counter reaches zero, the fault is automatically cancelled from the memory.

Failure warning light
The failure warning light comes on when there is at least on "permanent" fault in the memory.

NOTE *During starting, the warning light is:*

- on for 4 seconds,
- off for 0.15 seconds,
- kept on/off according to whether or not there are "permanent" errors.

Cancelling of the errors
When the frequency counter reaches zero, the fault and the parameters associated with it are cancelled.
The immediate cancelling of the entire errors memory takes place in the following cases:

- through the "cancel errors memory" command sent by the F/L Tester;
- by interrupting the electrical supply for the control unit (disconnecting the battery or the control unit connectors) for at least 60 seconds.

3. Activating the actuators (active diagnosis)

The following actuators are activated with the engine switched off via a command from the F/L Tester:
- injectors (in the order cyls. 1, 2, 3 and 4),
- coils (in the order cyls. 1, 2, 3 and 4),
- electric fuel pump relay,
- charcoal filter solenoid valve,
- engine idle adjustment solenoid valve,
- system failure light,
- rev counter signal,
- climate control compressor relay (if fitted),
- electric fan low speed relay,
- electric fan high speed relay (if fitted).

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RECOVERY STRATEGIES

If a problem is detected with the sensors/ actuators the control unit, where possible, replaces the missing data, reconstructing it using software (recovery) to allow the operation of the engine.
For the sensors/actuators not mentioned in the list below, there is not type of recovery.

Engine timing sensor
recovery: the engine cannot be started up, however if the problem occurs with the engine started up, it stays operating.

Air flow meter
recovery: the air flow rate is calculated on the basis of the butterfly position and rotation speed values.
additional provisions: self-adjustment of the mixture strength and idle disabled; charcoal filter solenoid valve disabled.

Coolant temperature sensor
recovery: during starting T = 20°C; otherwise T = 20°C increased by 1°C every 6 seconds until reaching 80°C; during starting or with the key in the OFF position the radiator fan is off, otherwise it is activated.
additional provisions: self-adjustment of mixture strength and idle disabled.

Butterfly position sensor
recovery: fixed butterfly angle = 7°; if the engine load (TP) is below 1.75 ms and the speed is below 1000 rpm, then the engine is idling, otherwise it is outside of idling.
additional provisions: self-adjustment of idling disabled.

Vehicle speed sensor
recovery: speed = 0.
additional provisions: self-adjustment of idling disabled.

Lambda sensor
recovery: the reading of the sensor voltage is disabled (open-loop).

Detonation sensor
recovery: the "basic" advance is reduced by an average of 5° if the engine load TP is above 2.5 ms.

Engine idle speed adjustment solenoid valve
recovery: the valve is kept open at a pre-set value.

10.

ELECTRICAL/ELECTRONIC CIRCUIT

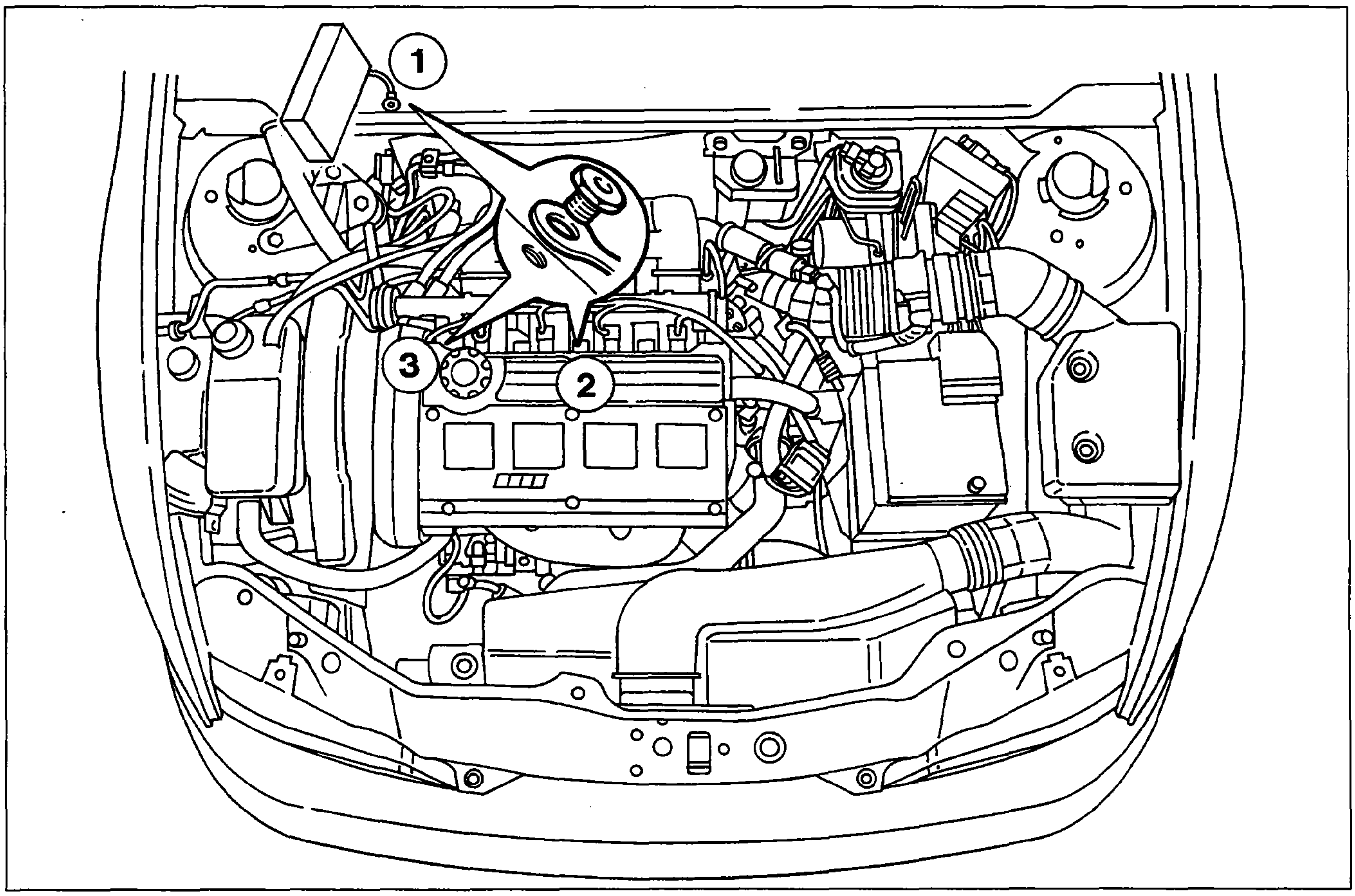
This circuit electrically connects all the components of the system and is made up of the following components:

- wiring with fuses;
- HITACHI engine control unit;
- system and pump relay;
- sensors:
  butterfly position sensor,
  coolant temperature sensor,
  air flow meter,
  engine rpm sensor,
  engine timing sensor,
  Lambda sensor,
  vehicle speed sensor,
  detonation sensor;
- actuators:
  electric fuel pump,
  injectors,
  engine idle speed adjustment solenoid valve,
  charcoal filter solenoid valve,
  electric pump cut out inertia switch,
  ignition power module,
  ignition coils;
- devices connected to the cotnrol unit:
  radiator fan relays,
  climate control compressor relay (if fitted),
  Fiat CODE control unit.

Layout of system earth points

In order to increase the electro-magnetic compatibility and the operational reliability special care has been taken over the layout of the earth points, as shown in the diagram below:

1. control unit casing, connected to the vehicle bodyshell;
2. secondary coils connected under the cylinder head cover;
3. control unit internal earths (pins 6, 12, 107, 108, 116, 40, 48), Lambda sensor heater earth, relay earths, ignition power module earth connected to the engine cylinder block/crankcase.



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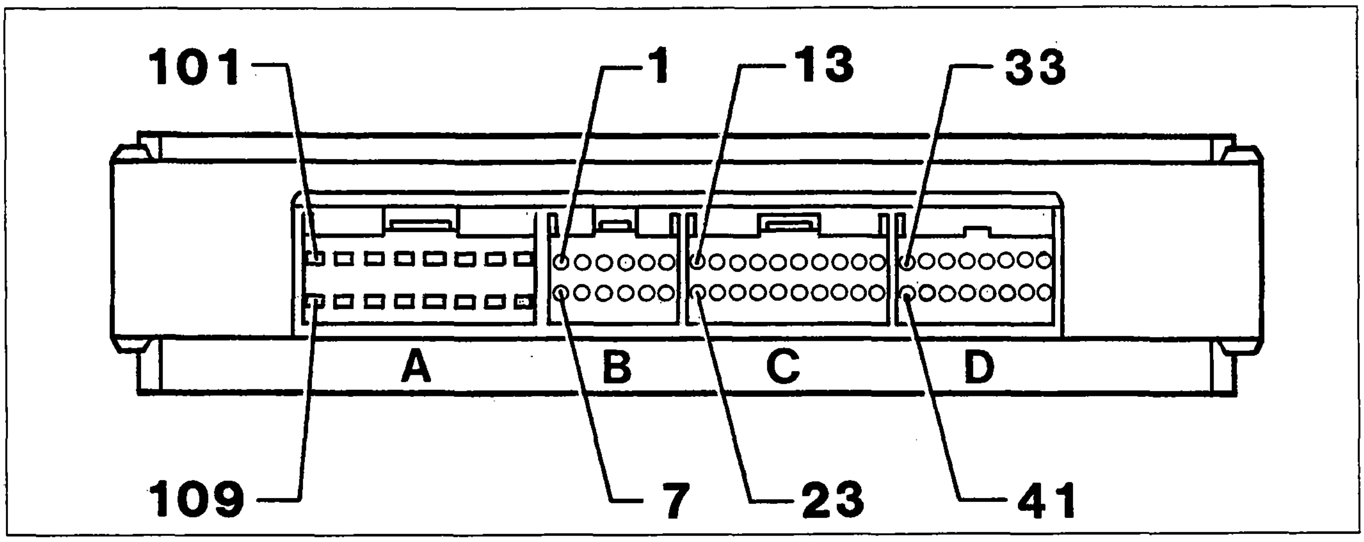
HITACHI SYSTEM CONTROL UNIT PIN-OUT



P4A21BJ01

Connector A

101. Operation of injector for cylinder 1
102. N.C.
103. Operation of injector for cylinder 2
104. Pump relay operation
105. Operation of injector for cylinder 3
106. Negative for charcoal filter solenoid valve
107. Earth
108. Earth
109. Negative for engine idle adjustment solenoid valve
110. Operation of injector for cylinder 4
111. Positive for engine idle adjustment solenoid valve
112. Control unit supply
113. Climate control compressor relay feed (if fitted)
114. N.C.
115. N.C.
116. Earth

Connector B

1. Operation of coil for cylinder 1
2. Operation of coil for cylinder 3
3. Operation of rev counter
4. N.C.
5. N.C.
6. Earth
7. Operation of coil for cylinder 3
8. Operation of coil for cylinder 4
9. Operation of electric fan low speed relay
10. Operation of electric fan high speed relay *
11. Operation of system failure light
12. Earth

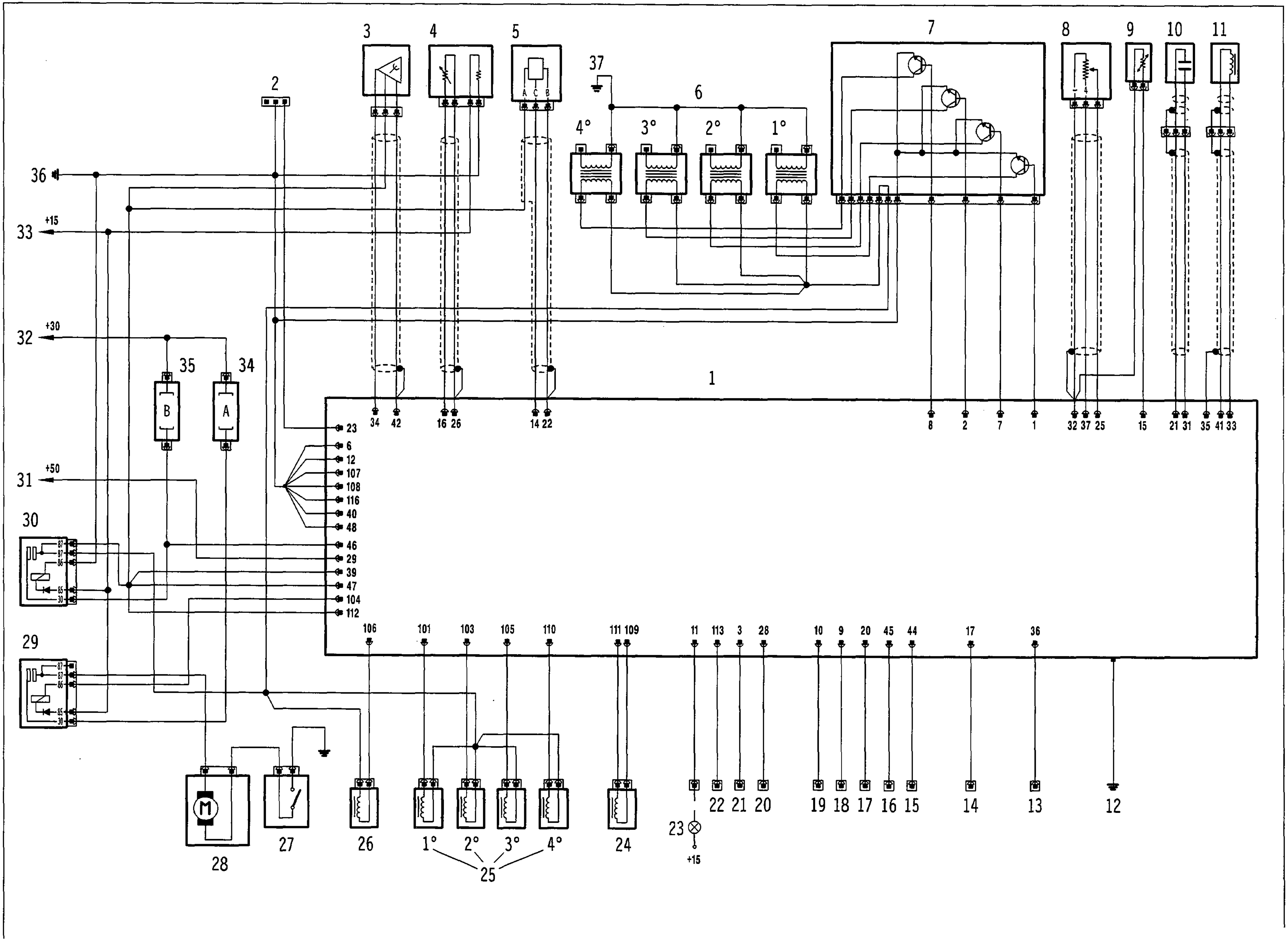
Connector C

13. N.C.
14. Positive for air flow meter
15. Positive for coolant temperature sensor
16. Positive for Lambda sensor
17. Signal for three stage pressure switch (if fitted)
18. N.C.
19. N.C.
20. Connection with FIAT CODE
21. Positive for detonation sensor
22. Negative for air flow meter
23. Line K
24. N.C.
25. Signal for butterfly position sensor
26. Negative for lambda sensor
27. N.C.
28. Signal for engaging compressor (if fitted)
29. AVV signal from ignition switch (+50)
30. N.C.
31. Earth for detonation sensor
32. Negative for coolant temperature and butterfly position

Connector D

33. Positive for engine rpm sensor
34. Positive for engine timing sensor
35. Earth for engine rpm sensor
36. Signal for vehicle speed sensor
37. Positive for butterfly position sensor
38. N.C.
39. Control unit supply
40. Earth
41. Negative for engine rpm sensor
42. Negative for engine timing sensor
43. N.C.
44. Calibration selection
45. Trim level selection (to earth for versions without climate control)
46. Control unit supply
47. Control unit supply
48. Earth

* Short circuited at pin 9 for versions without climate control



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A
B
M
+15
+30
+50

Hitachi system wiring diagram key

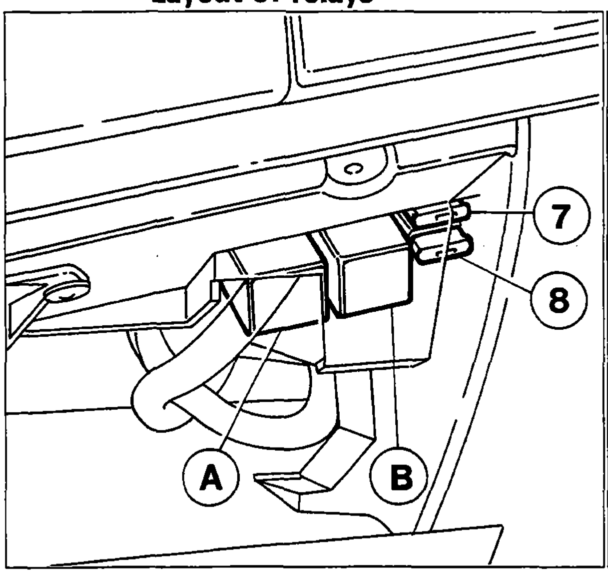
1. Engine control unit
2. F/L Tester (line K)
3. Engine timing sensor
4. Lambda sensor
5. Air flow meter
6. Ignition coils
7. Ignition power module
8. Butterfly position sensor
9. Coolant temperature sensor
10. Detonation sensor
11. Engine rpm sensor
12. Control unit casing earth on vehicle bodyshell
13. Vehicle speed inlet
14. Intake from three stage pressure switch (climate control if fitted)
15. Calibration selection
16. Trim level selection (to earth for versions without climate control)
17. Connection with Fiat CODE control unit
18. Operation of electric fan low speed relay
19. Operation of electric fan high speed relay (short circuited at pin 9 for versions without climate control)
20. Intake for request to engage climate control compressor (if fitted)
21. Operation of rev counter
22. Climate control compressor relay feed (if fitted)
23. Operation of system failure light
24. Engine idle speed adjustment sol. valve
25. Injectors
26. Charcoal filter solenoid valve
27. Inertia switch
28. Electric fuel pump
29. Electric fuel pump relay
30. System relay feed
31. AVV signal from ignition key (+50)
32. Supply from battery (+30)
33. Supply from ignition key (+15)
34. Pump fuse (30 A)
35. System fuse (15 A)
36. Earth (on engine block)
37. Earth (under cylinder head cover)

SYSTEM RELAYS

With the ignition key in the ON position (+15) the energizing coils for both relays are supplied, which close the respective power contacts.
Relay (A) supplies the electric fuel pump, receiving voltage directly from the battery.
Relay (B) ensures the multiple supply of the control unit and the various system sensors and actuators, both directly and via the connectors.

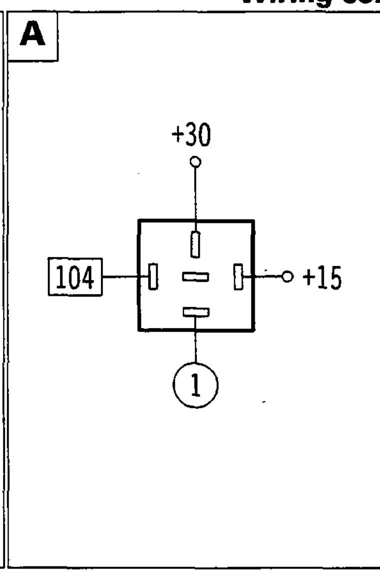
NOTE *The layout of relays (A) and (B) and fuses (7) and (8) can vary through production requirements. They should be recognized on the basis of the electrical connections.*

Layout of relays

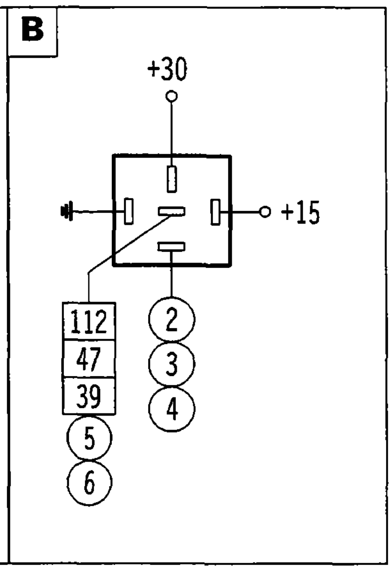


P4A23BJ01

Wiring connectors



P4A23BJ02

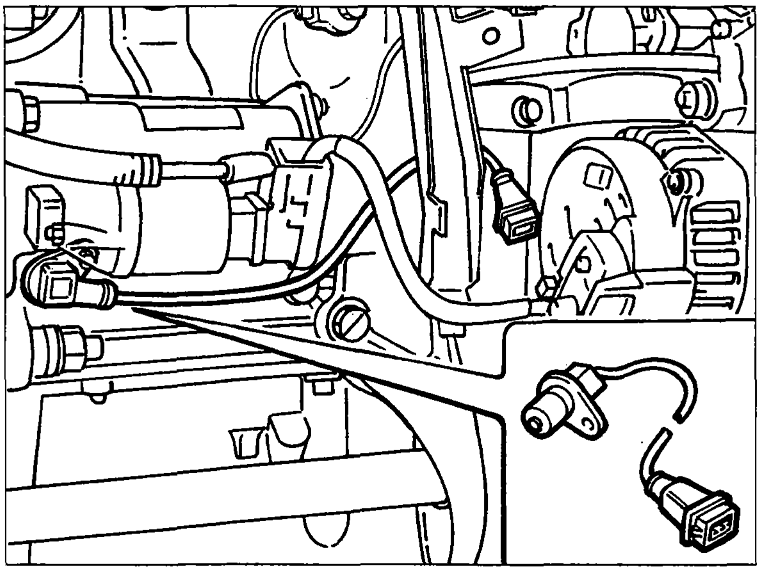


P4A23BJ03

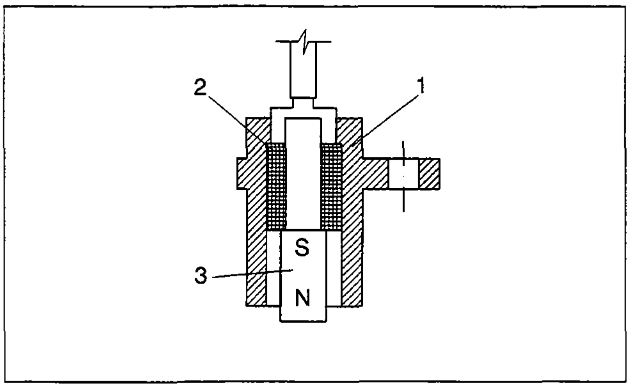
1. Electric fuel pump
2. Injectors
3. Charcoal filter solenoid valve
4. Ignition power module
5. Air flow meter
6. Butterfly position sensor
7. Fuse
8. Fuse

A. Electric fuel pump relay
B. System relay feed

ENGINE RPM SENSOR


P4A24BJ01

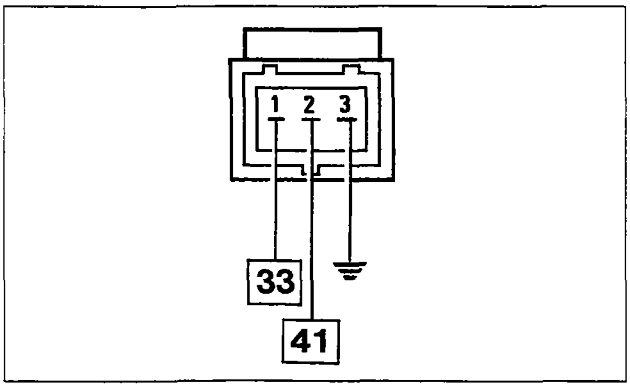
The sensor is fixed to the cylinder block-/crankcase: the flywheel is fixed with a crankshaft crank.



P4A24BJ02

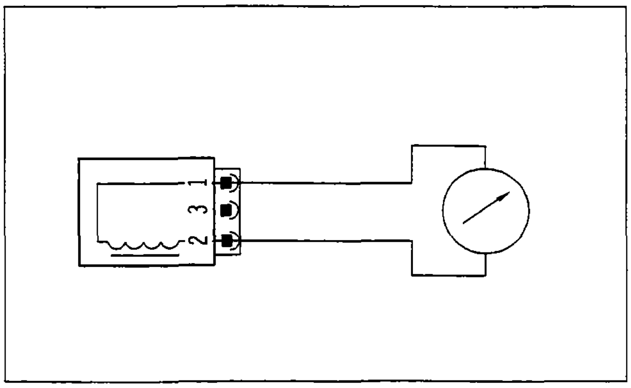
Operating principle

The sensor is made up of a tubular casing (1) which houses a permanent magnet (3) and an electrical winding (2).
As a result of the flywheel teeth passing by, the magnetic flow produced by the magnet (3) undergoes oscillations resulting from the variation of the gap.
These oscillations create an electro-motive force in the winding (2) which produces a voltage which is alternatively positive (tooth facing the sensor) and negative (gap facing the sensor): see paragraph on "signal management". The peak sensor output voltage depends, with other factors being equal, on the distance between the sensor and the tooth (gap).



P4A24BJ03

Wiring connector



P4A24BJ04

The resistance of the sensor can be measured by disconnecting the connector and connecting an ohmmeter to the sensor

Resistance: 570 ± 57 ohm at 20°C

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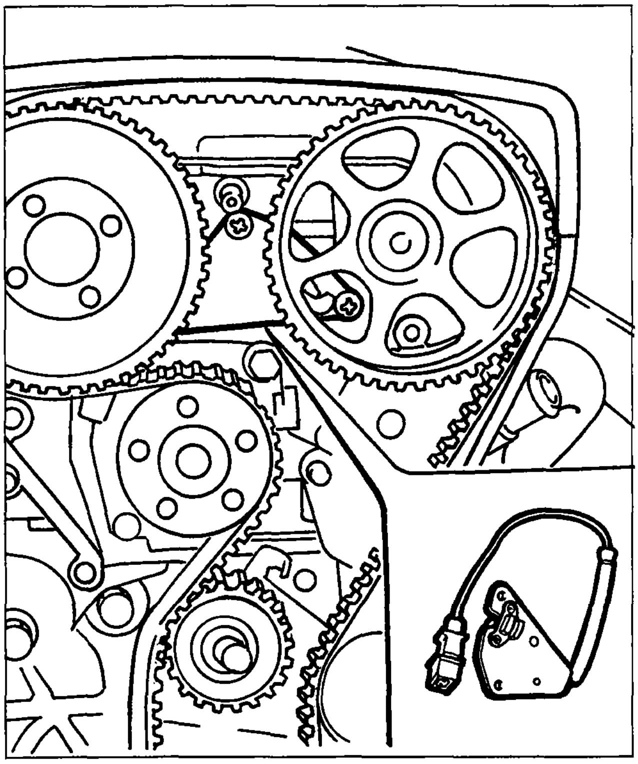
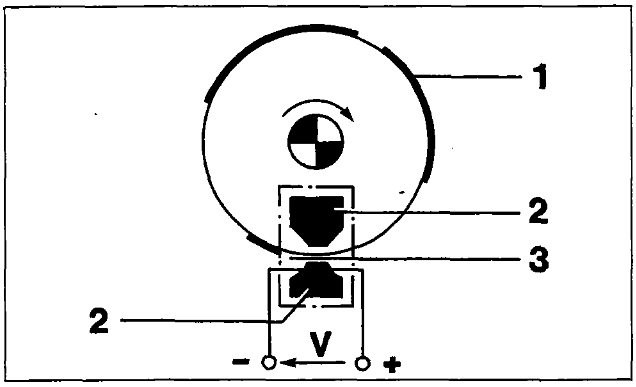
ENGINE TIMING SENSOR



P4A25BJ01

The engine timing signal, together with the engine rpm and TDC signal, allows the control unit to recognize the succession of cylinders to implement the injection timing.
This signal is generated by a Hall effect sensor, fitted by the exhaust camshaft drive pulley.

NOTE *It is not possible to carry out any adjustments to the angular position of the sensor.*



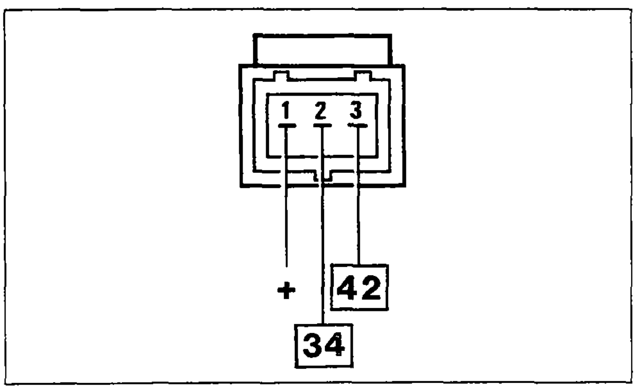
P4A25BJ02

1. Deflector
2. Magnetic material
3. Gap

Operating principle

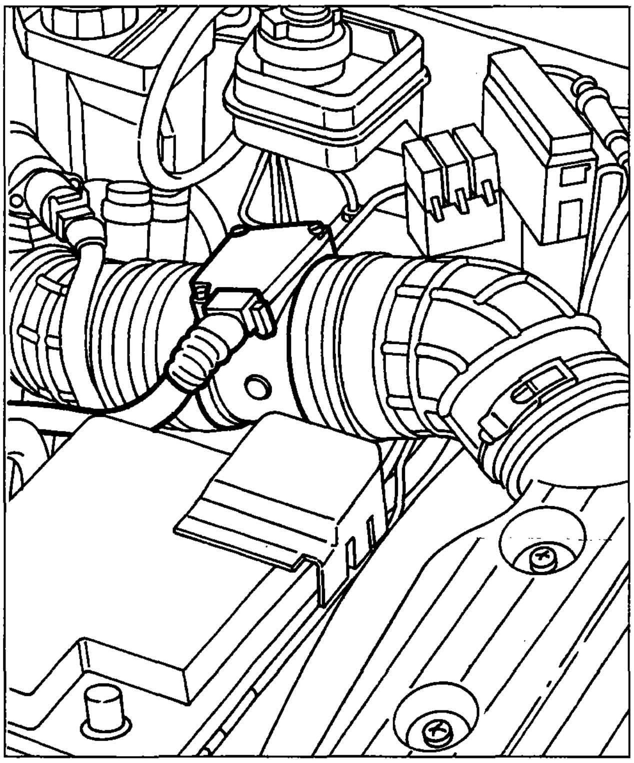
A semi-conductor layer through which the current flows, immersed in a normal magnetic field (lines of force perpendicular to the direction of the current) generates a difference in power, known as Hall effect voltage.
If the intensity of the current remains constant, the voltage generated only depends on the intensity of the magnetic field. It is therefore sufficient if the intensity of the field varies periodically to obtain a modulated electrical signal.
In pratice, to obtain this change, the sensor has a metal ring passed through it (fixed to the inner part of the timing pulley) equipped with a series of openings: as it moves, when the ring covers the sensor, it blocks the magnetic field and the signal remains low, whilst as it passes the openings, the field closes and the signal becomes high.
The alternating of the signals therefore depends on the succession of the openings (see "signal management" chapter).

Wiring connector

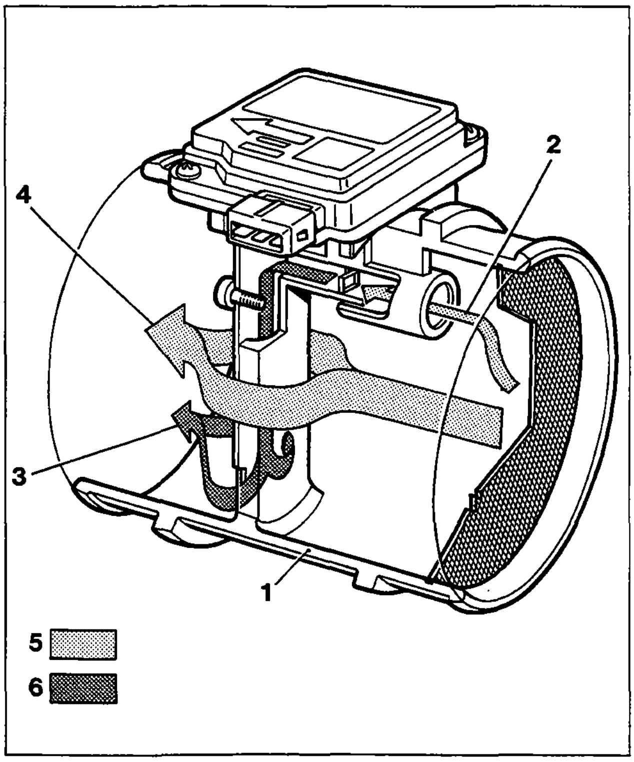


P4A25BJ03

10.



P4A26BJ01



P4A26BJ02

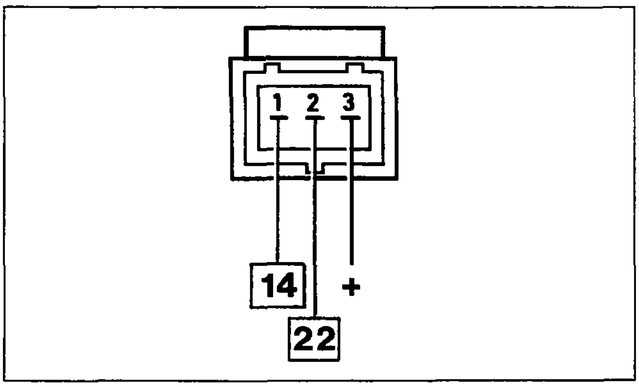
1. Flow meter casing
2. Air intake into the duct
3. Air outlet from the duct
4. Outlet air
5. Intake air
6. Air measured

AIR FLOW METER

The air flow meter is the hot wire type where the flow rate is measured at source.
The upper part has a duct parallel to the main flow inside of which there is the heated wire.
One part of the intake air flow is introduced into the duct and, after having passed through it, it flows out of the opposite part, returning to the main flow.
Consequently, only part of the mass of air which passes through the flow meter is measured: this quantity is, however,proportional to the total mass in the flow meter.
The electrical voltage leaving the flow meter is therefore representative of the total flow rate which is calculated by applying suitable proportional parameters.
This type of flow meter has two advantages compared with the full flow type:

- considerable insensitivity to the phenomenon of air column pulses, particularly present at low speeds and heavy loads;
- less fouling of the wire, thanks to the reduced mass of air coming into contact with it; in effect the control unit does not have any wire cleaning strategy *(burn-in)*.

Wiring connector



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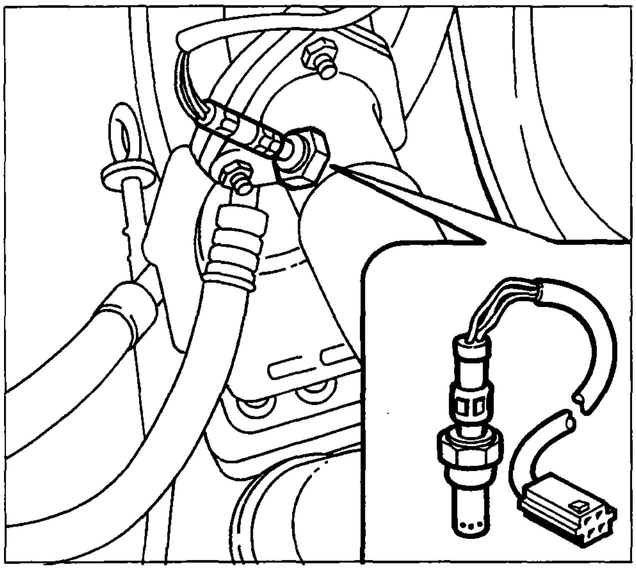

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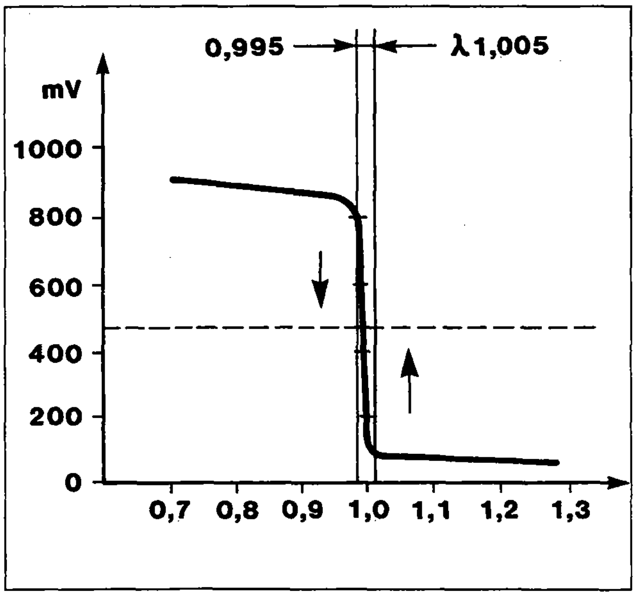


P4A27BJ02

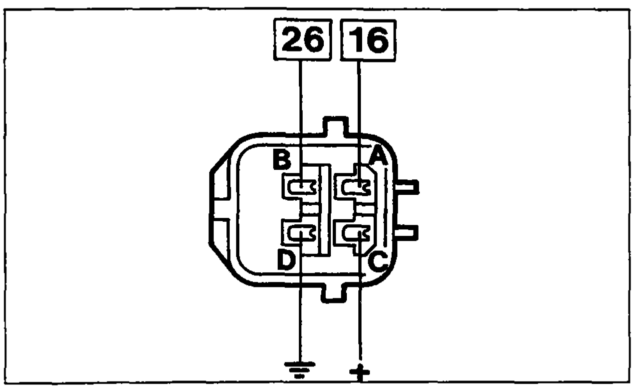
lambda = 1: stoichiometric mixture
lambda < 1 : rich mixture, the CO values tend to be high
lambda > 1 : lean mixture, the CO values tend to be low

LAMBDA SENSOR

The Lambda sensor measures the oxygen content in the exhaust gases: it is fitted on the exhaust pipe upstream of the catalytic silencer.
The sensor output signal is sent to the control unit to correct *(feed-back)* the mixture strength.
When the sensor supplies a low signal (voltage below 200 mV) the control unit recognizes a lean mixture and increases the injection time; subsequently, when the sensor signal is high (voltage above 800 mV), the control unit recognizes a rich mixture and decreases the injection time.
This sequence of operations is repeated with a frequency in the order of tens of Hertz, so that the engine operates with a mixture strength constantly oscillating around the stoichiometric value.
At temperatures below 300°C the ceramic material is not activated, therefore the sensor does not send reliable signals: to ensure rapid heating during starting and to maintain the temperature during idling, the sensor is equipped with a heater where the electrical resistance is always on.

The sensor can be rapidly put out of action by the presence of even the smallest amounts of lead in the fuel.

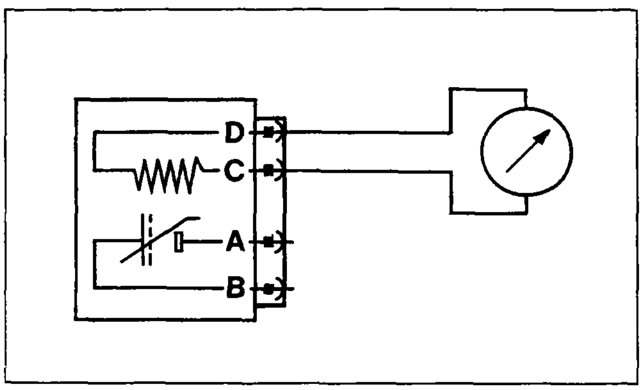
Wiring connector



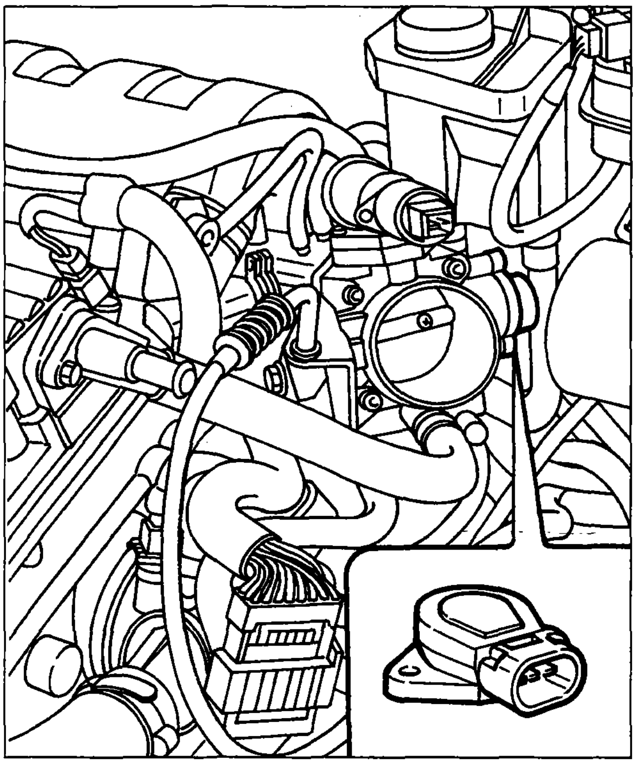
P4A27BJ03

The resistance of the sensor heater can be measured by disconnecting the connector and connecting an ohmmeter as shown in the diagram.

Resistance: 4,5 ± 0,5 ohm at 20°C



P4A27BJ04

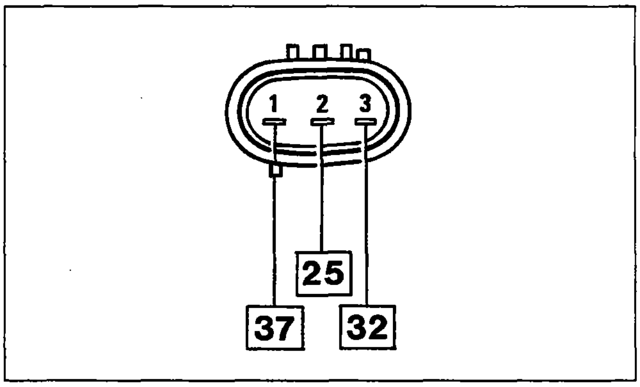


P4A28BJ01

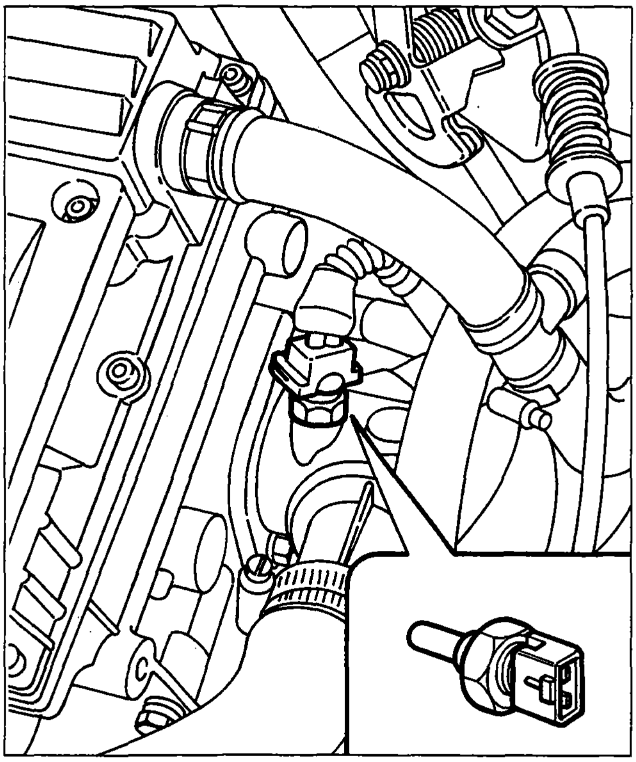
BUTTERFLY POSITION SENSOR

It is made up of a single track potentiometer where the moving part is rotated by the accelerator butterfly shaft.

Wiring connector



P4A28BJ02

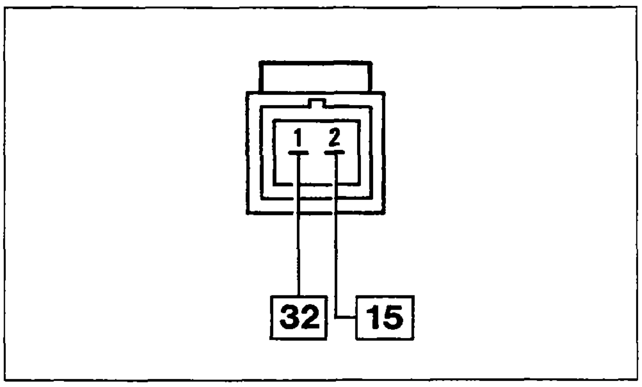


P4A28BJ03

COOLANT TEMPERATURE SENSOR

The sensor is fitted on the thermostat.
It is made up of a brass casing which protects the resistive element made up of an NTC (Negative Temperature Coefficient) thermistor where the electrical resistance decreases as the temperature increases.
The reference voltage is 5 Volt: since the control unit input circuit is designed as a voltage divider, the reference voltage is shared between a resistance in the control unit and the actual sensor.
As a result the control unit is capable of evaluating the variations in the sensor resistance through the changes in voltage.

Wiring connector



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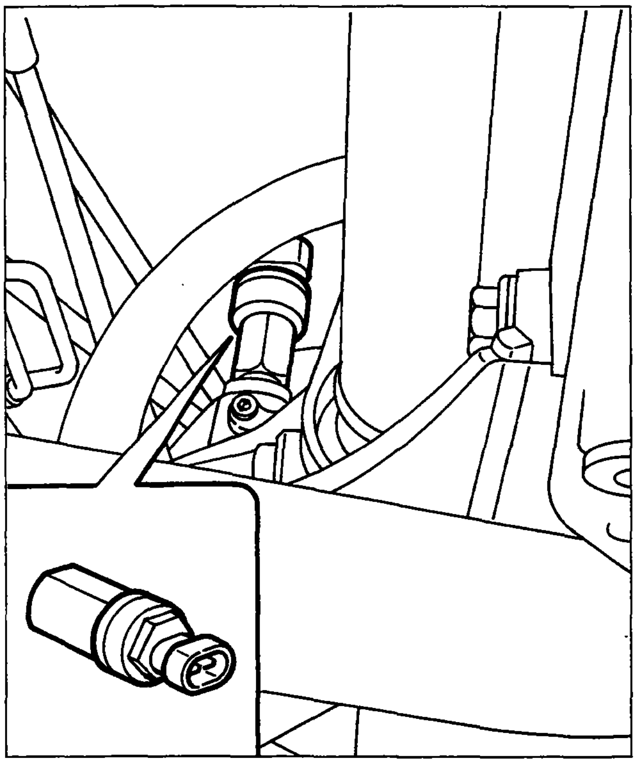
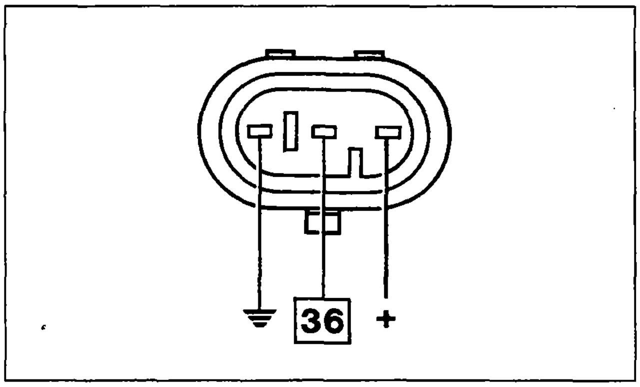
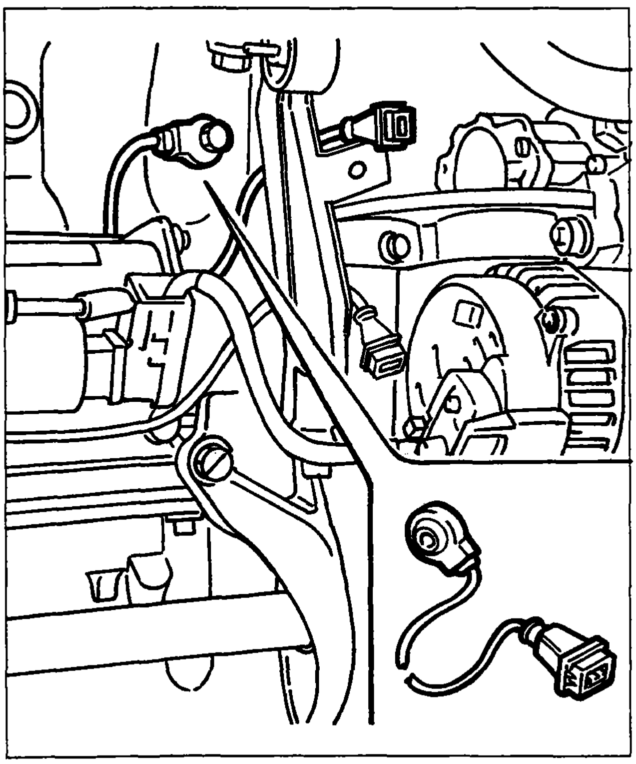


Wiring connector

VEHICLE SPEED SENSOR

The sensor is positioned on the differential outlet, by the left drive shaft coupling and transmits the information relating to the vehicle speed to the control unit: the signal is also used for the operation of the speedometer. The sensor is the Hall effect type (see "engine timing sensor" paragraph) and it is calibrated so that for each impulse there is a corresponding travel of one metre: on the basis of the frequency of the impulses it is therefore possible to know the speed of the vehicle.

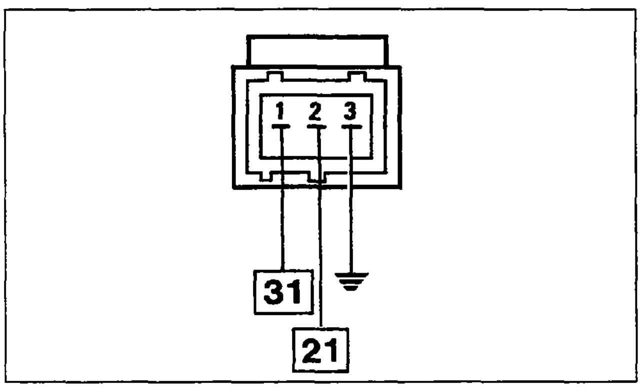




Wiring connector

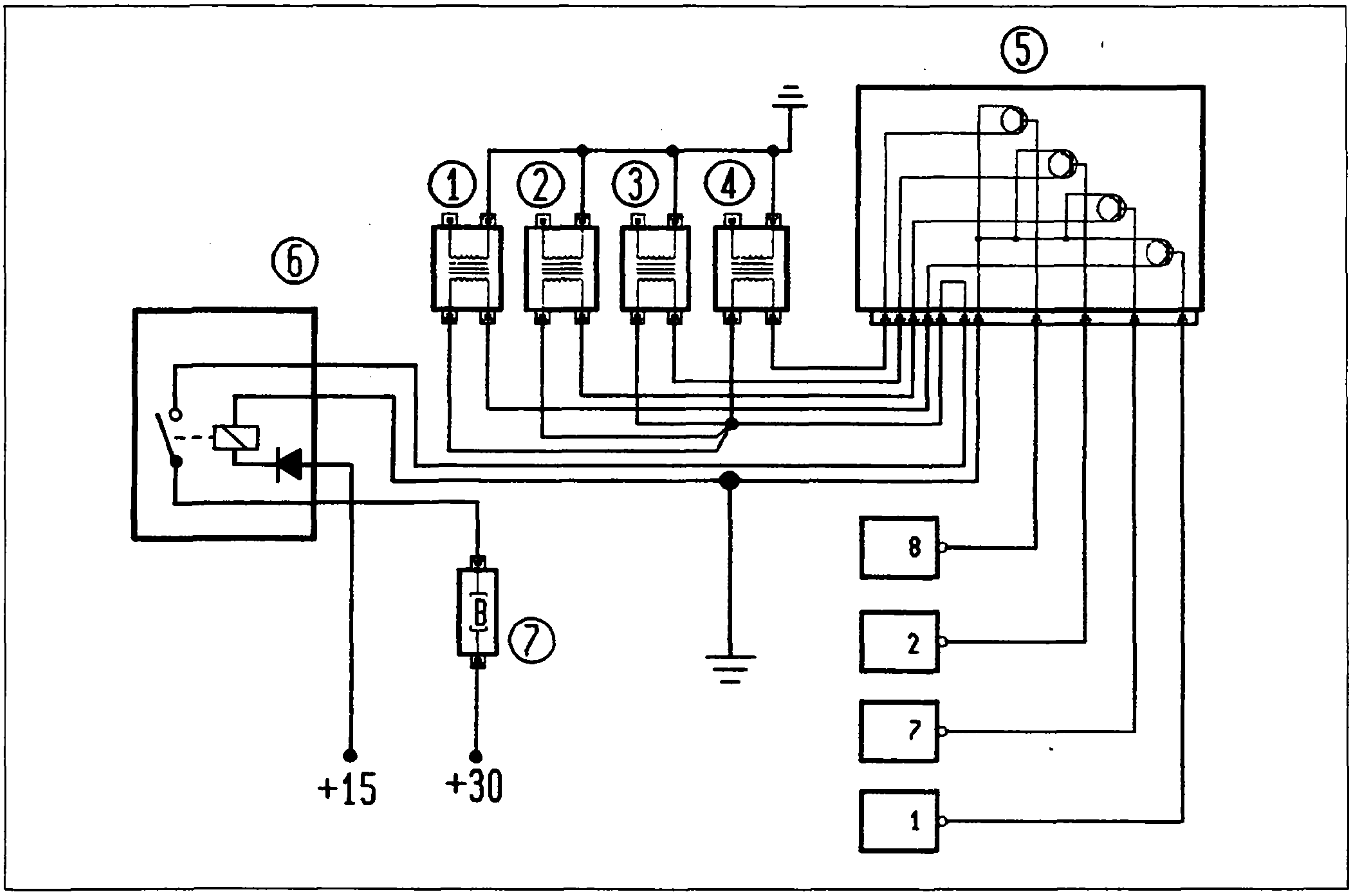
DETONATION SENSOR

This sensor is the piezoelectric type and is fitted on the engine crankcase in a symmetrical position in relation to the pairs of cylinders 1-2 and 3-4.
This position is determined by the need to detect the start of detonation similarly for all cylinders.
When there is detonation, vibrations of a particular frequency are created in the crankcase which are transformed by the sensor into a signal whose voltage is proportional to their intensity.



IGNITION SYSTEM

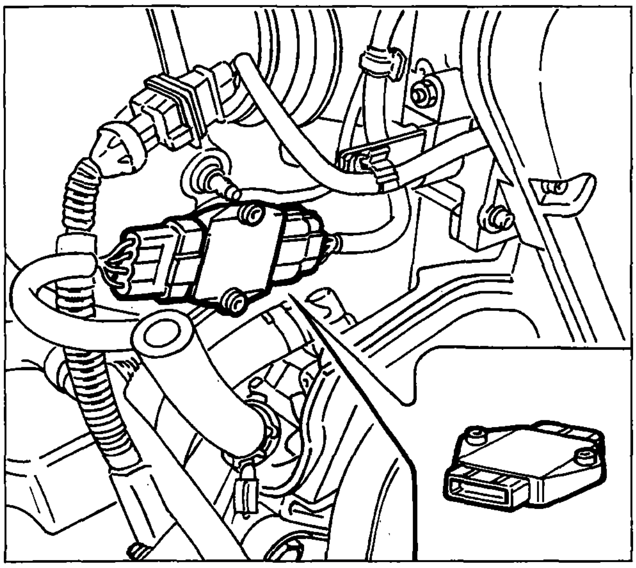
The ignition circuit is the static advance inductive discharge type. The power module is outside of the control unit, whilst the high tension is supplied by four ignition coils fitted directly on the spark plugs (top-plug type coils).
The primary winding for each coil is supplied by the battery voltage via the system relay and is connected to the control module for connection to earth.
The optimum ignition advance is calculated by the control unit depending on the engine speed and load and is implemented in the form of the time between the moment in which the primary circuit supply is interrupted and the explosion stroke TDC.



P4A30BJ01

1. Coil for cylinder 1
2. Coil for cylinder 2
3. Coil for cylinder 3
4. Coil for cylinder 4
5. Ignition power module
6. System relay
7. Fuse

Print no. 506.670

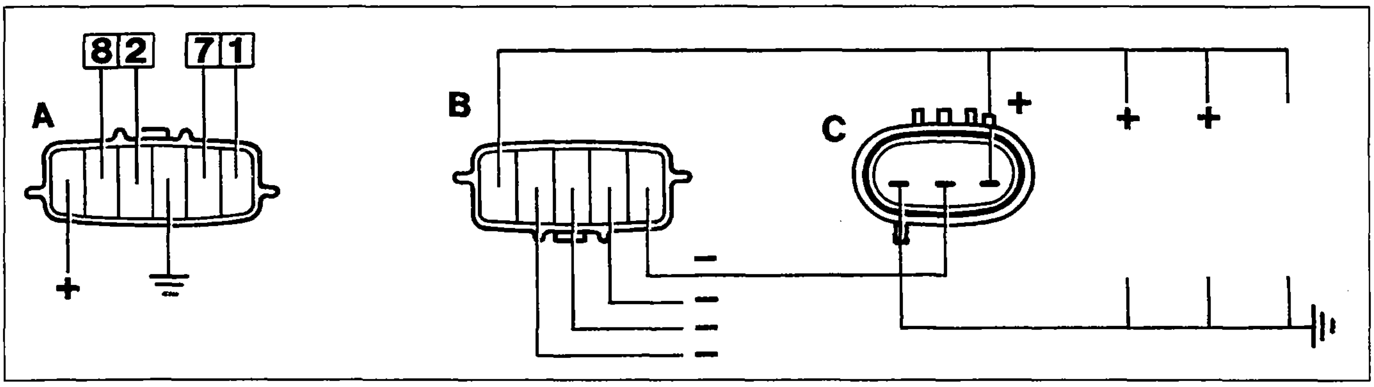

P4A31BJ01

IGNITION POWER MODULE

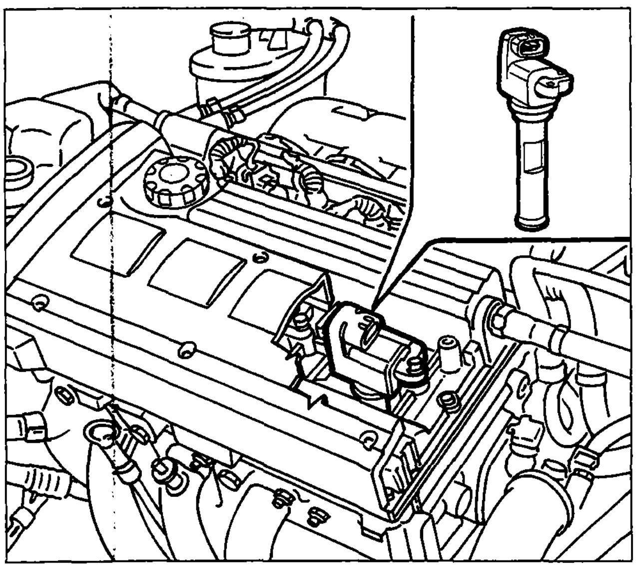
The power module, located on the side of the inlet manifold, is basically an electronic switch which, by means of the impulses coming from the control unit, controls the current in the ignition coil primary winding.
Through a particular circuit it limits the current which circulates in the coil primary winding when the maximum value is reached in order to reduce the heating of the actual module.
To prevent the overheating of the coil if the ignition takes place with the engine switched off, the module has a rest closing device when the ignition impulses cease arriving from the control unit.

Wiring connector

A: module input B: module output C: ignition coil



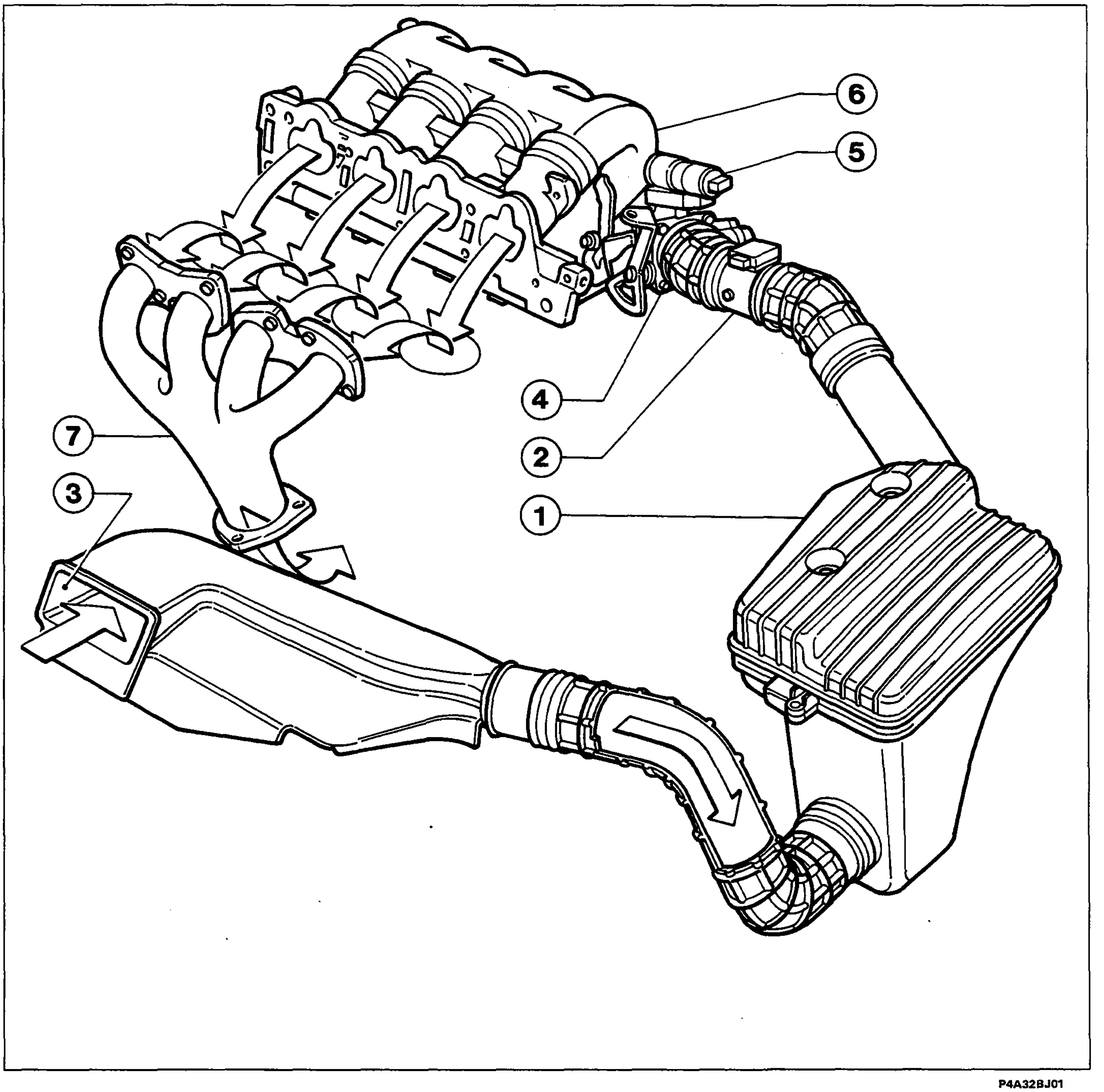
P4A31BJ02


P4A31BJ03

IGNITION COIL

The coil used is the closed magnetic circuit type with the windings in a plastic container immersed in epoxide resin.
The coil is connected directly to the spark plug by a silicon material extension which has high dielectric characteristics.
The earth for the secondary circuit is obtained with a special cable as the coil is insulated by the cylinder head.

DIAGRAM SHOWING INTAKE CIRCUIT



P4A32BJ01

1. Air filter
2. Air flow meter
3. Inlet
4. Butterfly casing
5. Engine idle adjustment solenoid valve
6. Inlet manifold
7. Exhaust manifold

Print no. 506.670

INTAKE CIRCUIT

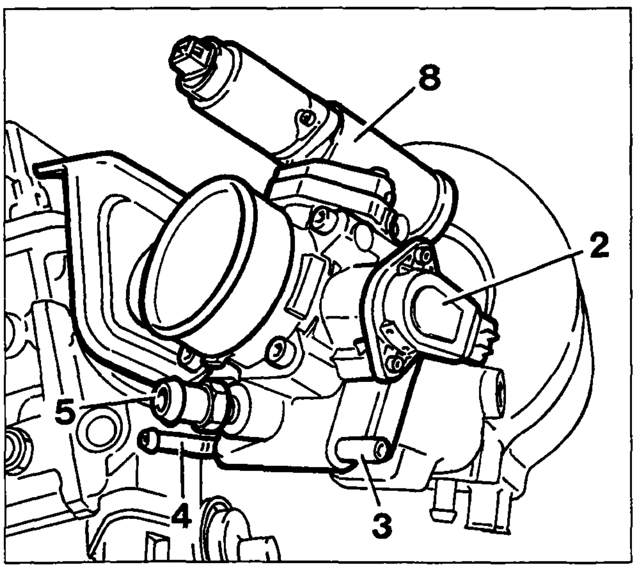
The intake circuit is made up of the following components:
- *air filter with relevant sleeves;*
- acoustic resonator fitted in parallel to the inlet sleeve;
- inlet manifold, on which the fuel manifold is fitted;
- butterfly casing, where the butterfly position sensor, the PCV valve *(Positive Crank Ventilation)* for the oil vapour recirculation circuit and tne engine idle adjustment solenoid valve are fitted.

BUTTERFLY CASING

The butterfly casing has the task of metering the quantity of air supplied to the engine (and therefore the power developed) according to the driver's request via the accelerator control.
The butterfly casing is fixed to the inlet manifold by four bolts: the butterfly is opended by means of levers which create a small opening which, consistent with the pedal travel, produce small butterfly openings with the pedal gently pressed and viceversa large angle openings with the pedal strongly pressed. With the pedal completely released (engine decelerating or idling) the additional air required is supplied by the engine idle adjustment solenoid valve: under these circumstances the butterfly opening lever is in contact with screw which prevents the butterfly from being locked in the closed position.

To prevent the formation of ice in the butterfly and the port connected to the PCV valve, the butterfly casing is heated with a small amount of coolant coming from the engine thermostat circulating in a chamber inside the actual casing.
The PCV valve for the oil vapour recirculation system and the butterfly position sensor are also fitted on the butterfly casing.

The screw is adjusted during operation by fluxing in the factory and should never be tampered with.



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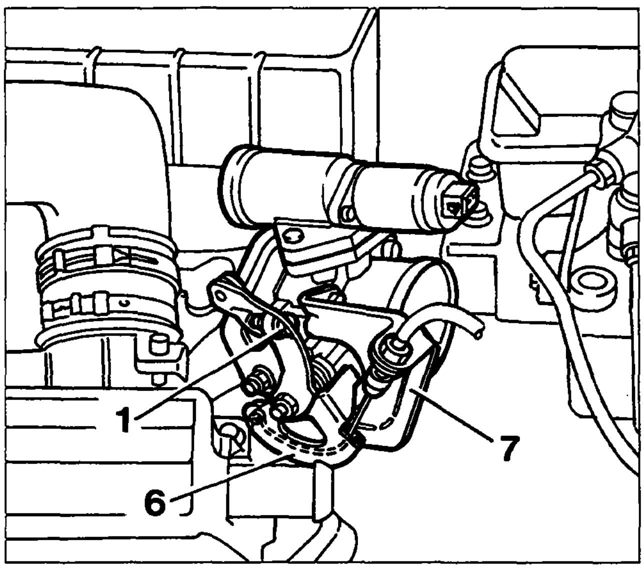
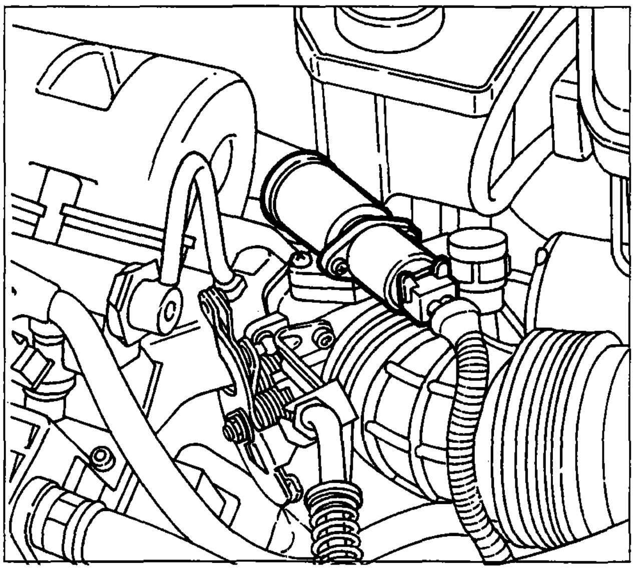
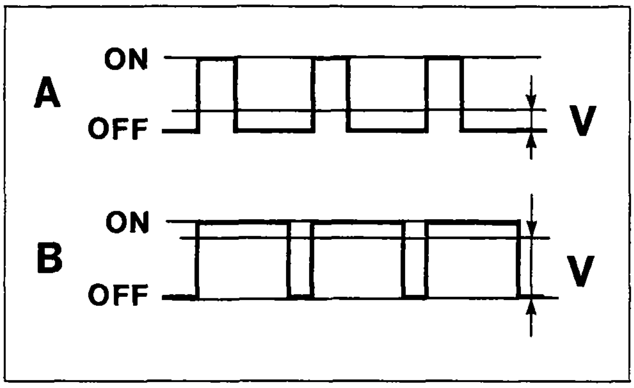


P4A33BJ02

1. Screw
2. Butterfly position sensor
3. Engine coolant inlet
4. Engine coolant outlet
5. PCV valve
6. Accelerator control lever
7. Accelerator cable adjustment bracket
8. Engine idle speed adjustment solenoid valve


P4A34BJ01



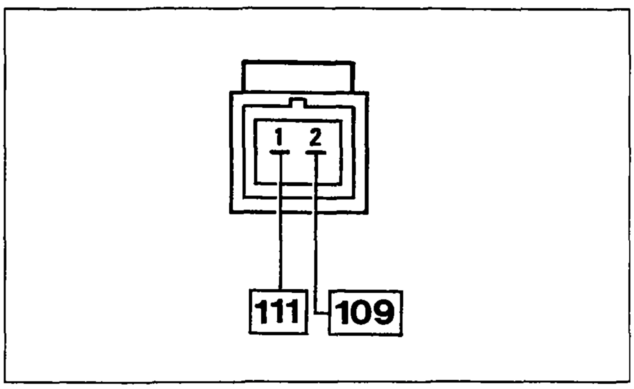
P4A34BJ02

Operation in duty-cycle

A: mainly OFF signal = low effective value
mainly ON signal = high effective value
B: effective value

V:

Wiring connector



P4A34BJ03

ENGINE IDLE SPEED ADJUSTMENT SOLENOID VALVE

The solenoid valve, fitted on the butterfly casing, intercepts the flow of air which, coming from the air upstream of the butterfly, returns it downstream: it has the task of ensuring the additional air for the engine with the butterfly closed, in all conditions where it is required (idle, deceleration).
The valve is the proportional type where the shutter is fixed to a metal core surrounded by an electrical winding.

Operating principle

The position of the shutter depends on the intensity of the effective value of the current passing through the winding which creates a magnetic field which attracts the core.
The vairation in the effective value is obtained by modulating the winding electrical supply (operation in duty-cycle).
This operation consists of varying the battery voltage value (12 Volt nominal) until zero at a frequency where the shutter is not capable of moving following the instant voltage value, but reaches an intermediate position which depends on the proportion between the voltage presence time and the absence time.

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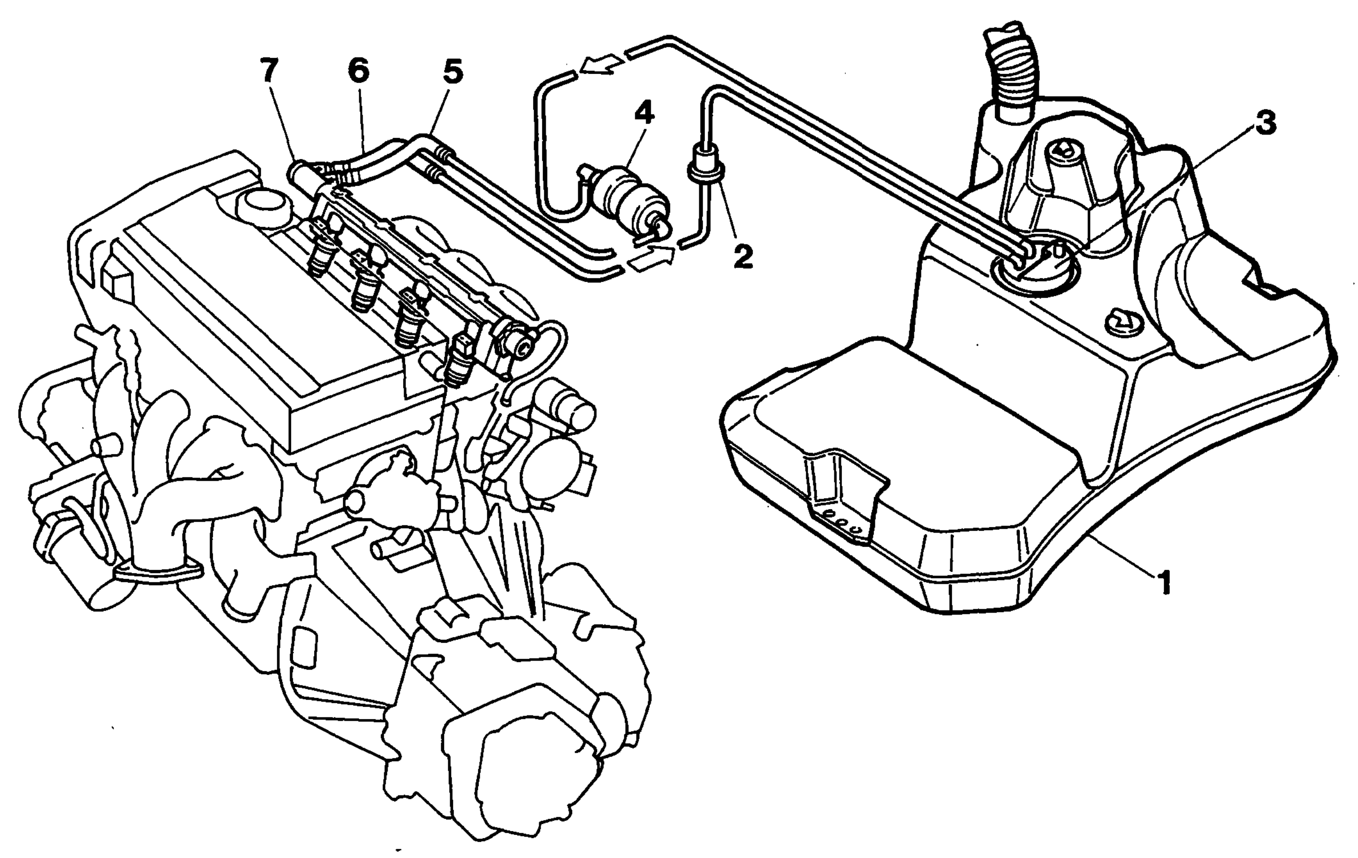
DIAGRAM SHOWING FUEL SUPPLY CIRCUIT



P4A35BJ01

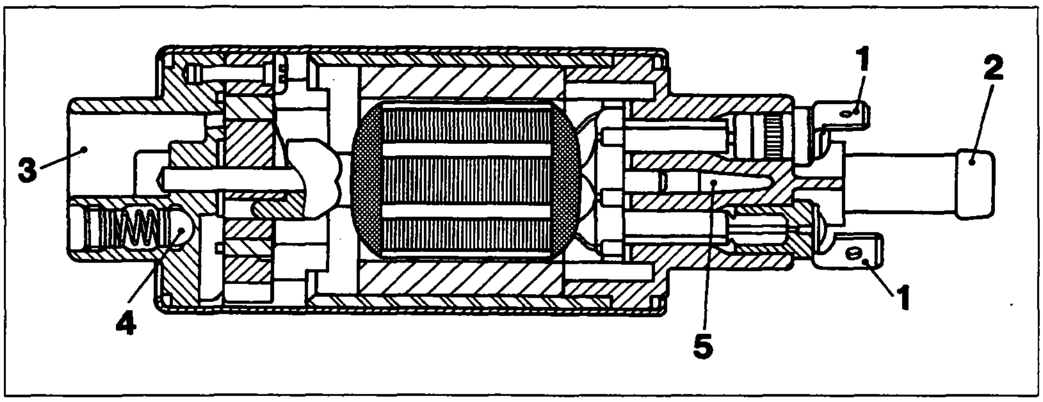
1. Fuel tank
2. Anti-flow valve
3. Electric fuel pump
4. Fuel filter
5. Fuel supply
6. Fuel return
7. Fuel manifold

FUEL SUPPLY CIRCUIT

The fuel supply circuit is made up of the following components:
- fuel tank;
- electric pump immersed in the tank, equipped with gauze pre-filter;
- fuel filter;
- supply line;
- injectors;
- fuel pressure regulator;
- return line;
- anti-flow valve.

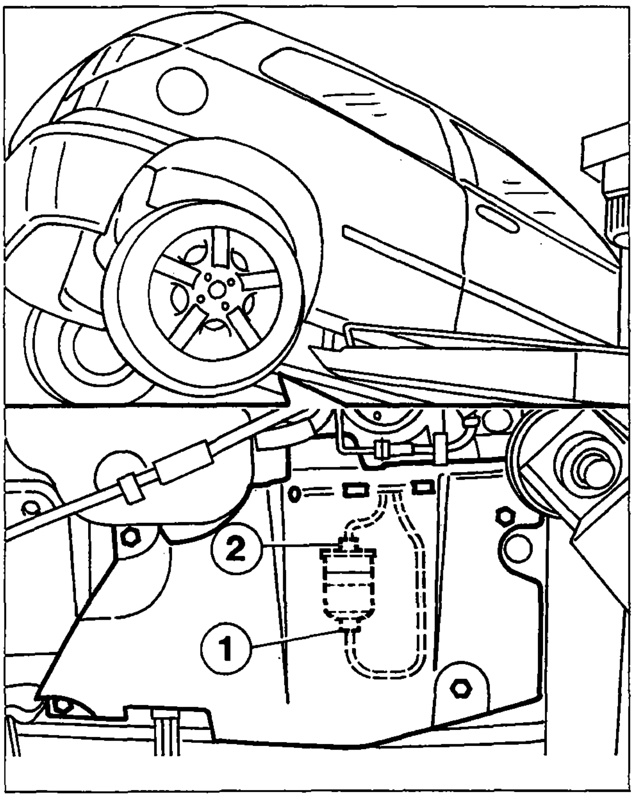
ELECTRIC FUEL PUMP

The pump is housed inside the fuel tank on a special tray which also supports the fuel level gauge and is fitted with a gauze filter at the pump inlet.
The pump is the volumetric type (G-Rotor) and is designed to run on unleaded fuel.
The rotor is moved by a direct current motor supplied at the battery voltage directly by the appropriate relay operated by the control unit.
The motor is immersed in the fuel which has a detergent and cooling effect on the blades and the manifold.
The pump is equiped with an excess pressure valve, which short circuits the supply with the inlet if the pressure in the supply circuit exceeds 5 bar, to prevent the electric motor from overheating.
In addition, a one-way valve on the supply prevents the draining of the entire fuel circuit when the pump is not working.
The nominal capacity of the pump varies according to theangular speed of the rotor and therefore the supply voltage: with a voltage of 12 V it is around 140 l/h.



P4A36BJ01

1. electrical connectors
2. supply port
3. inlet port
4. excess pressure valve
5. one-way valve



P4A36BJ02

1. Fuel inlet
2. Fuel outlet

FUEL FILTER

The filter, protected by a shield fixed under the bodyshell, is inserted along the fuel supply pipe. It is made up of a steel casing and a polyurethane internal support which has a high filtering capacity element.

NOTE *There is an arrow on the outer casing which indicates the direction of the flow of the fuel and the correct fitting position.*

⚠ *The fuel filter should be changed at intervals of 30,000 Km.*

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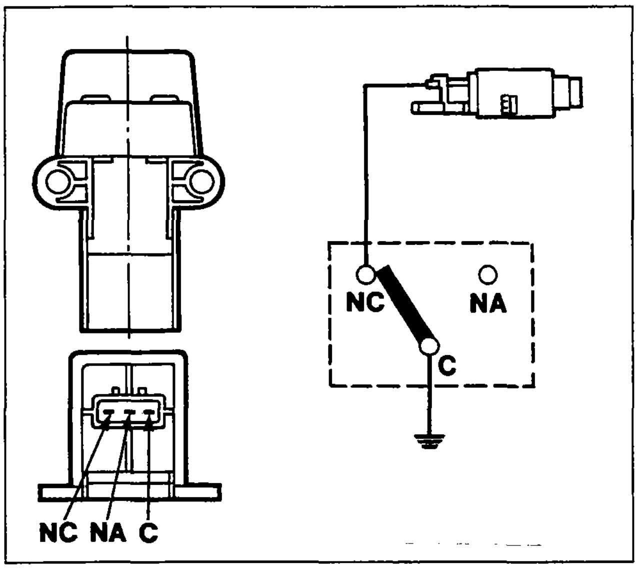
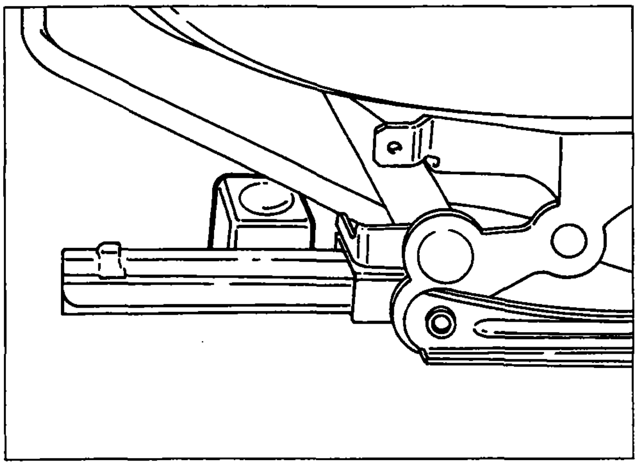


P4A37BJ01



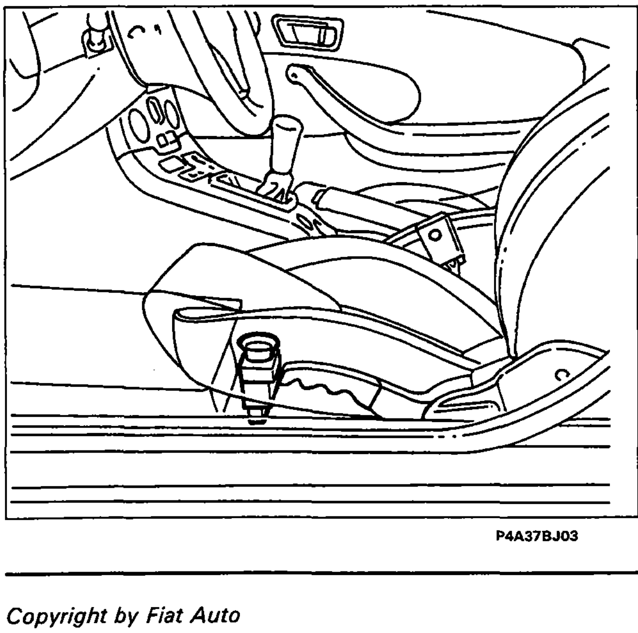
P4A37BJ02

INERTIA SAFETY SWITCH

The inertia switch has the task of interrupting the electrical supply for the electric fuel pump if the vehicle undergoes violent deceleration (impact) to prevent fuel from escaping and creating a fire hazard if the fuel manifold or the supply pipe are damaged.
The switch is made up of a steel ball in a conical shaped housing kept in position by the attraction force of a permanent magnet.
Under the action of the acceleration due to the inertia force the ball can be released from the magnetic clip and gradually come out of the conical housing with an upwards movement depending on the angle of the cone.

Above the ball there is a rapid attachement mechanism which forms a normally closed (NC) circuit. When struck by the ball, the mechanism changes position to the normallyopen (NA) circuit, thereby interrupting the electrical supply to the electric pump causing it to cut out.
The calibration of the switch causes its operation at acceleration above 1.2 g (about 11.7 m/s^2, corresponding to an impact at a speed of around 25 Km/h).
The switch can be restored by pushing the upper button protected by a flexible cover.

After an apparently slight impact, if there is a smell of fuel or there are leaks from the fuel system, do not turn the switch back on, but search for the problem and eliminate it to prevent the risk of fire.
If this is not the case and there are no leaks and the vehicle can be driven again, press the button to reactivate the electric pump.



P4A37BJ03

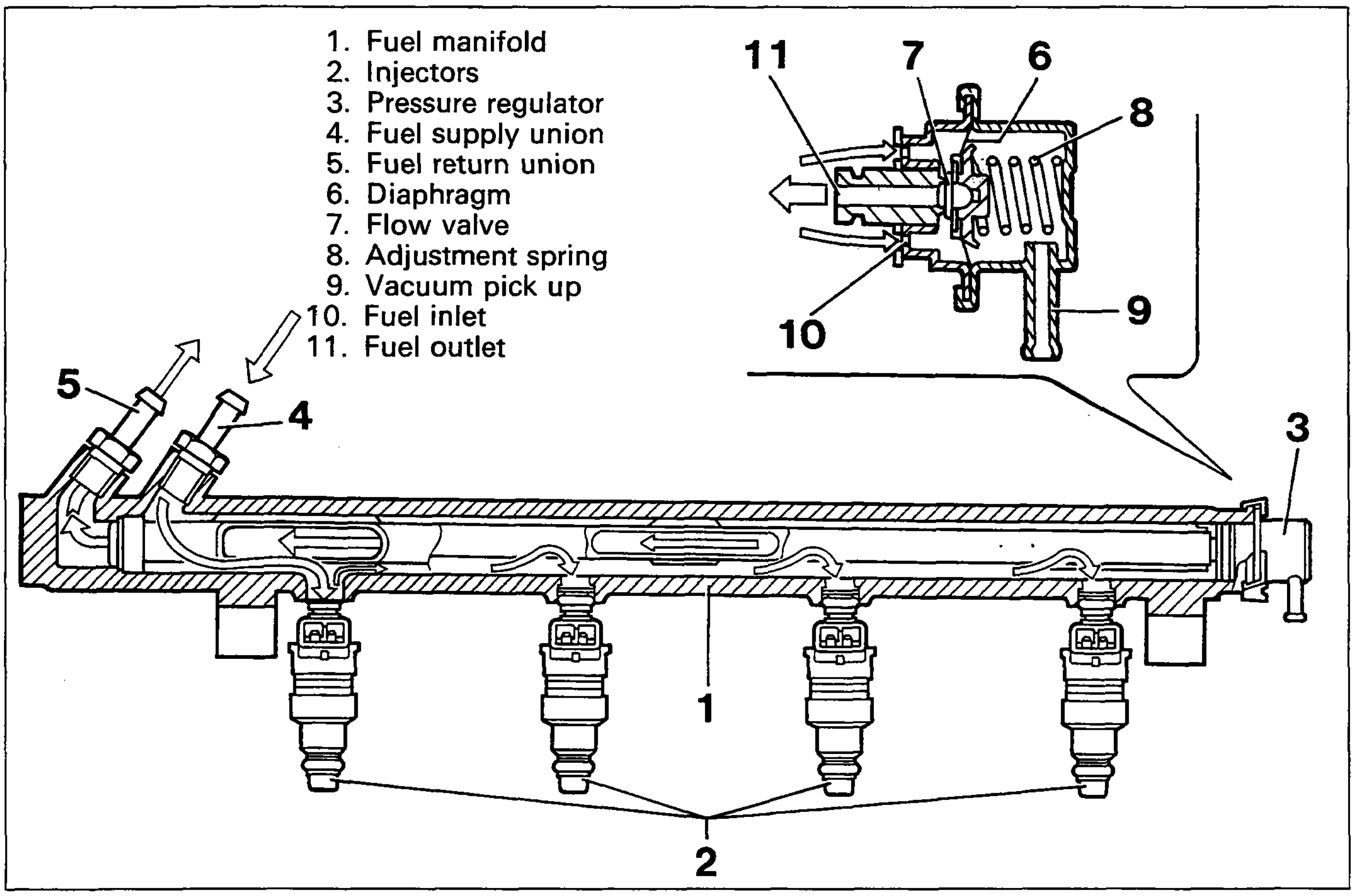
SINGLE-ACTING ANTI-FLOW VALVE

This is a safety valve fitted in the fuel return pipe near the tank.
The valve allows the return of fuel to the tank preventing it, however, from flowing out in the opposite direction if the pipe breaks.

10.

FUEL MANIFOLD

The fuel manifold, which has the function of distributing the fuel to the injectors, is made from die-cast aluminium and incorporates the housings for the injectors and for the pressure regulator.
The fuel inlet is achieved with a sealed fixing bolt.
The fuel recirculation is obtained by means of a pipe inside the manifold connected at one end to the regulator and at the other end to the outer fuel return pipe to the tank.



P4A38BJ01

FUEL PRESSURE REGULATOR

This is a differential diaphragm device, adjusted during manufacture to a pressure of 3.00 ± 0.05 bar. The fuel under pressure, coming from the pump, exerts a force on the flow valve (7) opposed by the calibrated spring (8). When the calibration pressure is exceeded, the flow valve opens and the excess fuel returns to the tank, thereby stabilizing the pressure in the circuit.
In addition, via the pick up (9), the vacuum in the inlet manifold (at which the *nose* of the injector) also finds itself, acts on the regulator diaphragm, reducing the load exerted by the calibration spring.
In this way the differential in pressure between the fuel and the environment (inlet manifold) in which the injector finds itself in all engine operating conditions is kept constant.
Consequently, the injector flow rate (for a certain supply voltage) depends only on the injection time established by the control unit.

NOTE *The pressure is assumed by the control unit as a fixed parameter: as a result the regulator should never be tampered with so as not to alter the mixture strength for the engine.*

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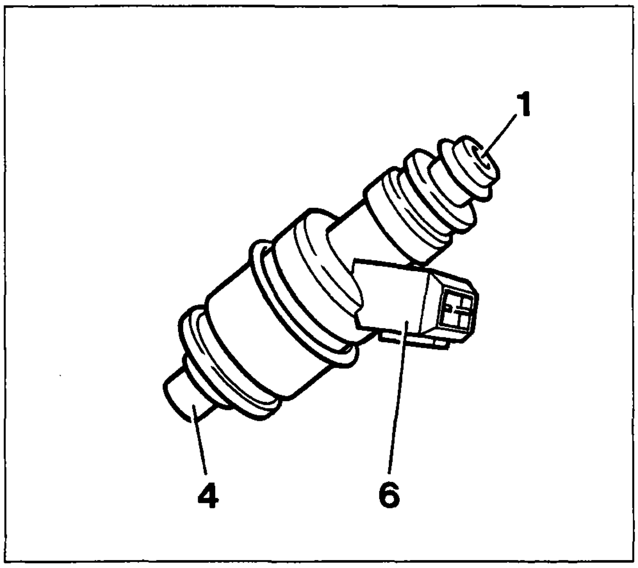
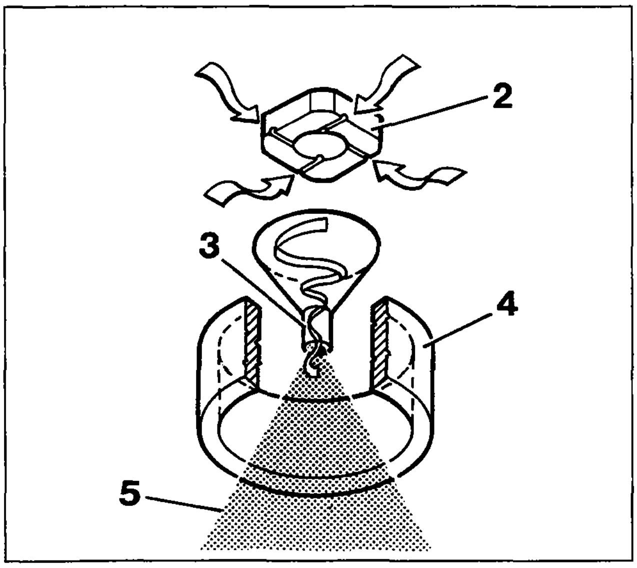


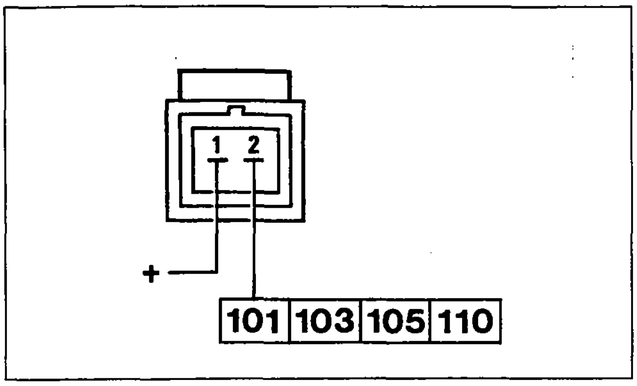
P4A39BJ01

1. Fuel inlet
2. Deflector
3. Jet
4. Nose
5. Jet of fuel
6. Electrical connector



P4A39BJ02

Wiring connector

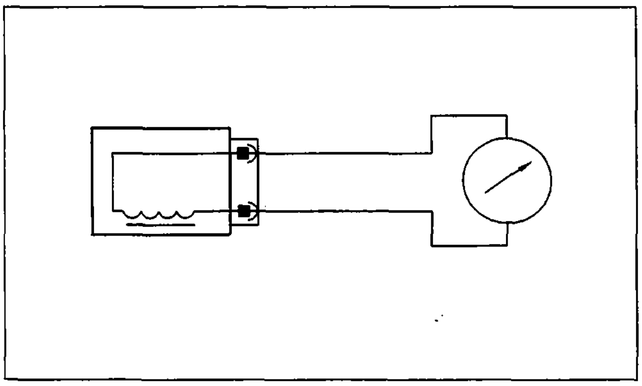


P4A39BJ03

INJECTORS

The injectors have the task of supplying the quantity of fuel required for the operation of the engine: the fuel is injected into the inlet manifold, immediately upstream of the inlet valve.
The injector is the "top-feed" type, with the supply of the fuel from the rear of the casing, where the electrical winding connected to the connector (6) is also housed.
When the current passes through the winding, the magnetic field produced attracts the shutter causing the opening of the injector and the flow of fuel.
As the pressure differential between the inside and the outside of the injector is constant (thanks to the presence of the regulator), the quantity of fuel supplied, like the electrical voltage, only depends on the opening time, established by the control unit.
The end section of the injector or *nose* (4) is fitted with a jet (3) which gives the fuel a rotary motion, thanks to a deflector (2) fitted with four tangentially positioned flow ports.

The resistance of the injector can be measured by disconnecting the connector and connecting an ohmmeter as shown inthe diagram.
Value of the resistance: 12 ± 1,2 ohm.



P4A39BJ04

10.

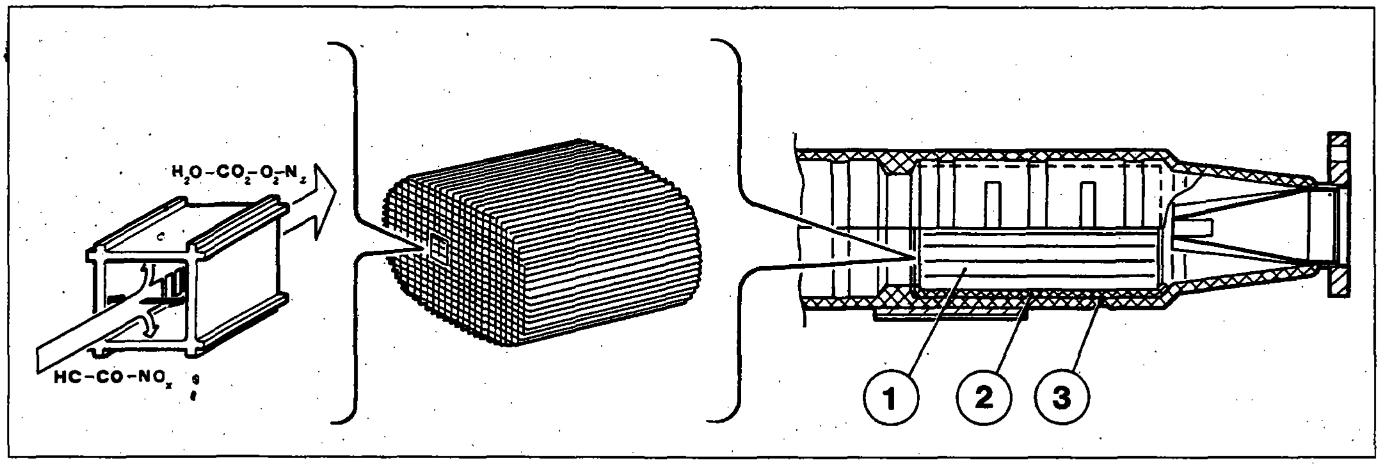
EMISSION CONTROL DEVICES

The devices used have two objectives:
- to keep down the pollutant substances present in the exhaust, via the catalytic silencer;
- to eliminate the dispersion towards the outside of the unburnt hydrocarbons, via the (fuel) anti-evaporation system and the (lubrication) oil vapour recirculation system.

CATALYTIC SILENCER

The catalytic silencer is a device which makes it possible to simultaneously keep down the three main pollutant compounds present in the exhaust: unburnt hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx).
Two types of chemical reaction take place inside the catalyzer:
- oxidation of the CO and the HC, converted into carbon dioxide (CO_2) and water (H_2O);
- reduction of the NOx, converted into Nitrogen (N_2).

These reactions can take place in extremely short periods of time thanks to the presence inside the catalyzer structure (ceramic support) of a layer of active substances (platinum and rhodium) which greatly accelerate the conversion speed of the harmful substances.
The effectiveness of this conversion process is conditioned by the fact that the mixture strength at which the engine operates is constantly oscillating around the stoichiometric value, which is achieved thanks to the feed-back control carried out by the control unit on the basis of the Lambda sensor signals.
Lastly, the conversion processes are activated at temperatures in excess of 300 - 350°C: it is therefore vital that the catalyzer reaches this temperature as soon as possible in order to work properly.



P4A40BJ01

1. Ceramic monolith
2. Metal support
3. Steel outer casing

When it is necessary to operate near the catalytic silencer, it is necessary to leave the vehicle to rest for some time, since the (internal) operating temperature of the catalyzer is between 500 and 850°C.

There are basically two causes of the destruction of the inside of the catalyzer:

- *the presence of lead in the fuel which lowers the degree of conversion at levels of practically nil ("lead poisoning") and which also irreparably damages the Lambda sensor;*
- *the presence of totally unburnt fuel in the exhaust gases, due to failed ignition, which causes an increase in the temperature which involves the fusion of the ceramic support. As a result, the connector for the coils should never be disconnected with the engine running: in the case of tests, the silencer should be replaced first with an equivalent section of pipe.*

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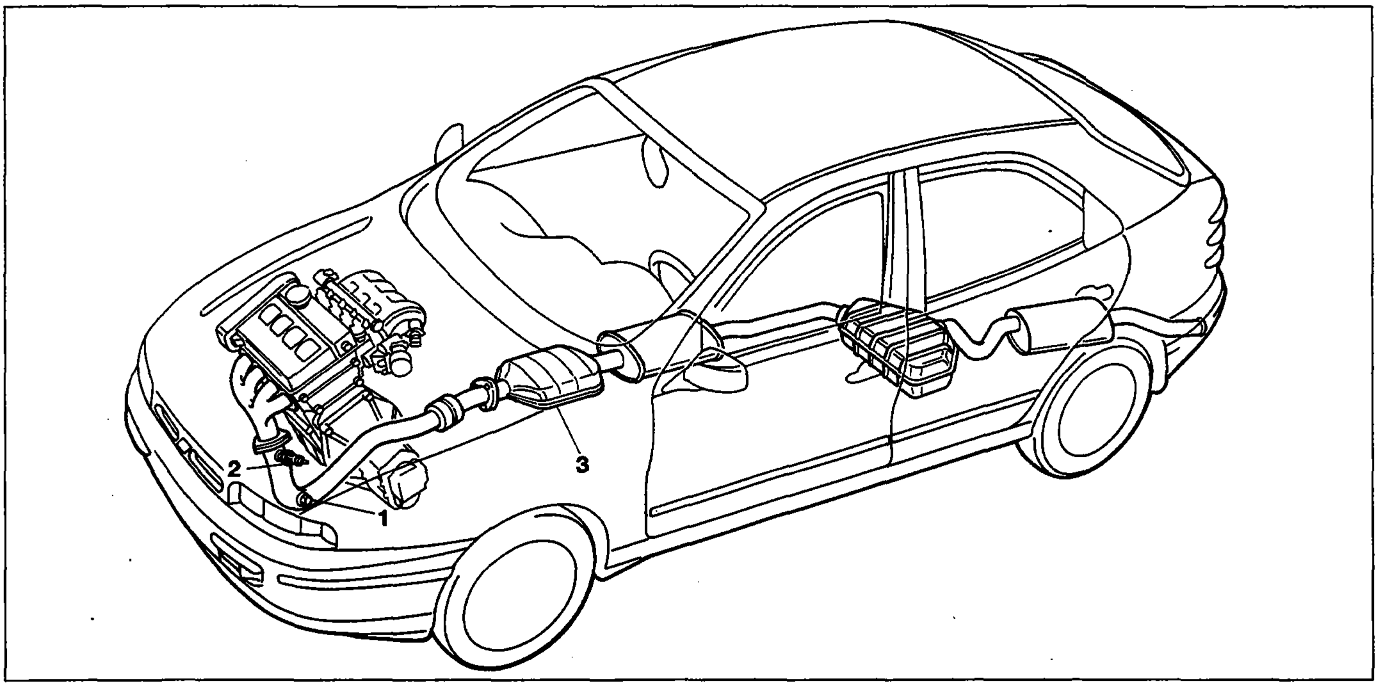
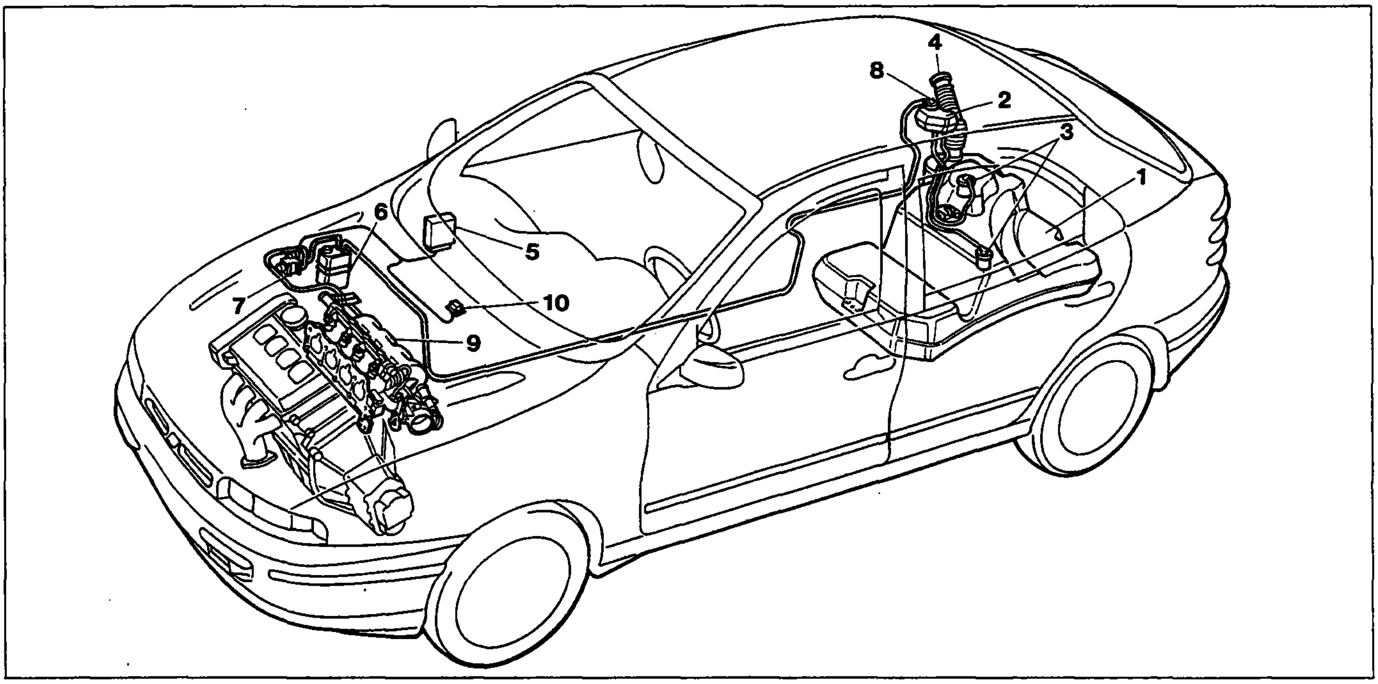


P4A41BJ01

Exhaust system with catalytic converter

1. CO socket
2. Lambda sensor
3. Catalytic silencer

FUEL ANTI-EVAPORATION SYSTEM



P4A41BJ02

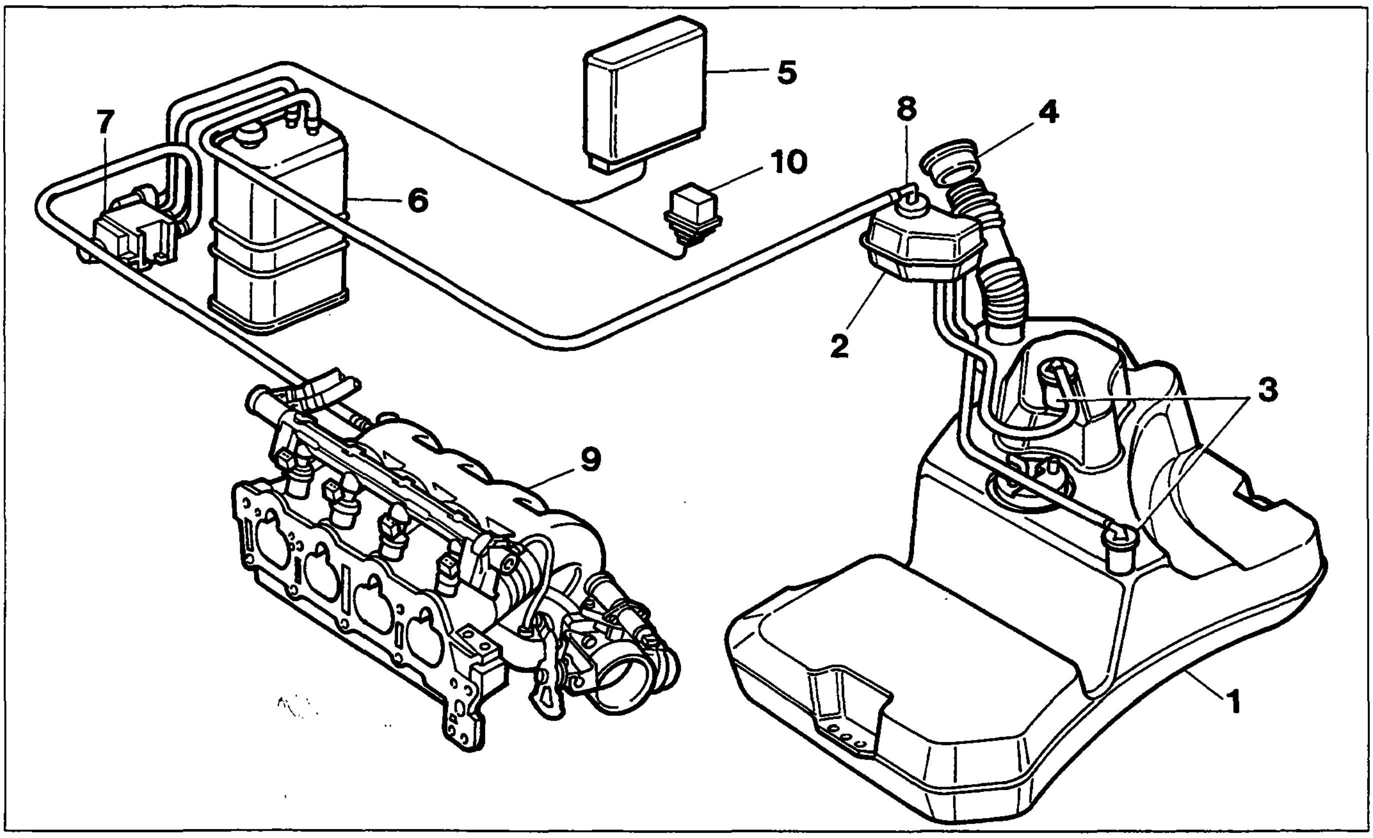
Location of anti-evaporation system components

1. Fuel tank
2. Vapour separator
3. Float valve
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter solenoid valve
8. Multi-purpose valve
9. Inlet manifold
10. Relay

10.

Operating principle

The anti-evaporation system has the aim of preventing the fuel vapours, made up of the lightest parts of the hydrocarbons which basically form in the tank, from being discharged into the atmosphere.
The system operates, above all at high outside temperatures when the temperature of the fuel increses and consequently the tendency towards evaporation increases: in this situation there is an increase in the pressure inside the tank.
In particular, even with the tank (1) full, with the vehicle stationary the two float valves (3) remain open as they are located higher than the breather pipe and therefore they allow the vapours to reach the separator (2) from where they mainly return to the tank as they condense.
If, on the other hand, there is strong splashing when the vehicle is driving or it overturns, the valves (3) close preventing fuel from escaping.
When the pressure inside the tank reaches about 30-40 mbar, the multi-purpose valve (8) opens and the fuel vapours reach the charcoal filter (6). The valve (8) also allows an intake of air into the tank through the charcoal filter if necessary following the lowering of the level of fuel and the consequent vacuum which is created inside the tank.
When the engine is running, the control unit operates the charcoal filter solenoid valve which allows the intake of vapours by the engine and the consequent scavenging of the charcoal filter.
If as a result of the malfunction of one of the components, the pressure inside the tank increases to dangerous levels, the safety valve located in the cap (4) allows the pressure to be discharged outwards. If necessary, this valve can open in the opposite direction, to ventilate the tank and prevent the vacuum reaching excessive values.



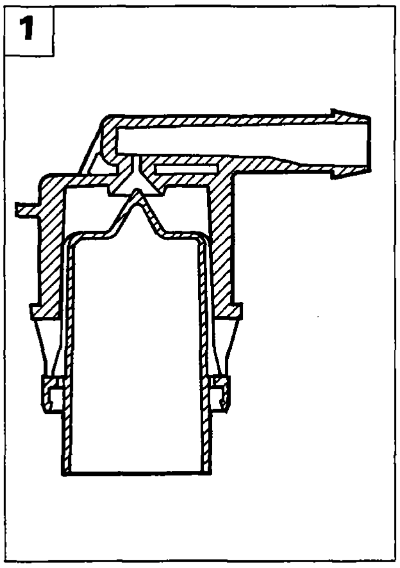
P4A42BJ01

1. Fuel tank
2. Vapour separator
3. Float valve
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter solenoid valve
8. Multi-purpose valve
9. Inlet manifold
10. Relay

Print no. 506.670

Float valve

The float valve has the task of allowing the flow of vapours towards the separator, without, however, allowing the escape of liquid fuel.
The valve contains a float, one end of which closes the valve outlet port in the following conditions:
- strong side acceleration (vehicle taking a bend) or longitudinal acceleration (vehicle braking) with the relevant movement of the mass of fuel as a result of the inertia force;
- overturning of the vehicle.



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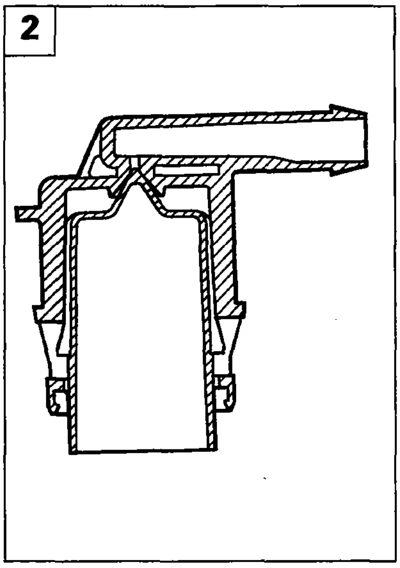

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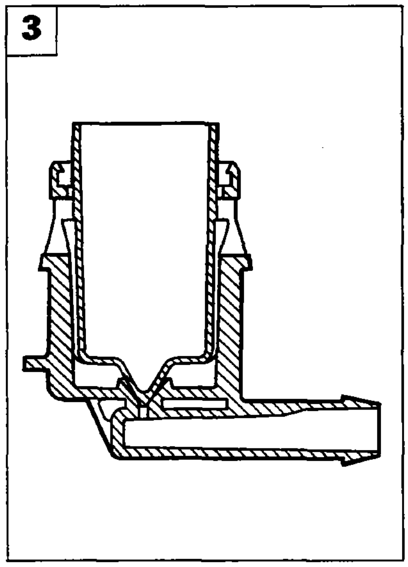
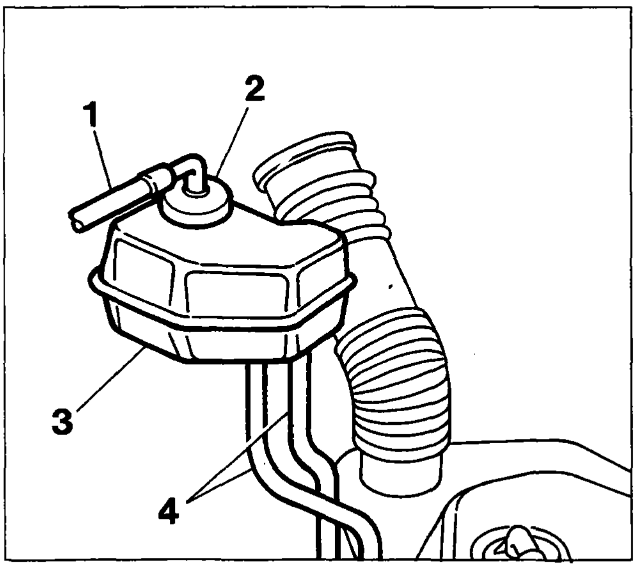


P4A43BJ03

1. Normal operating conditions: valve open
2. The fuel pushes the float upwards as a result of strong acceleration: valve closed
3. Vehicle overturned: valve closed



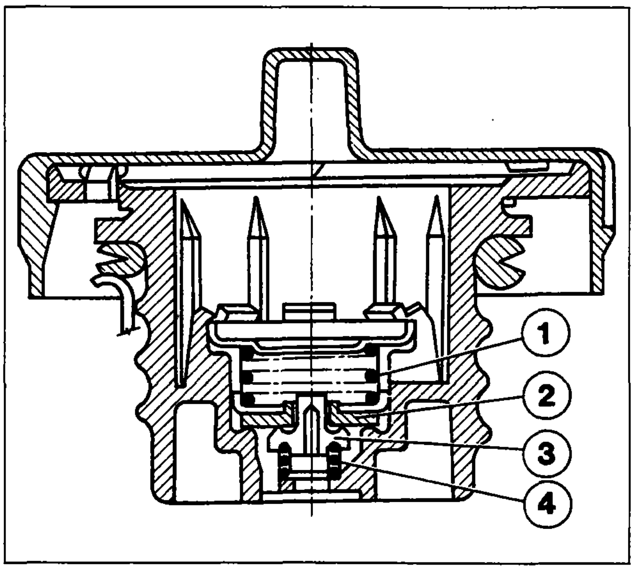
P4A43BJ04

1. Pipe connecting fuel vapour separator to the active charcoal filter
2. Multi-purpose valve

Fuel vapour separator and multi-purpose valve

The fuel vapours coming from the tank reach the vapour separator (3), located at the side of the fuel filler, via the pipes (4).
Part of the vapours condense and return to the tank via the same pipes (4), whilst the remaining vapours escape from the separator through the multi-purpose valve (2) and are directed to the active charcoal filter via the pipe (1).

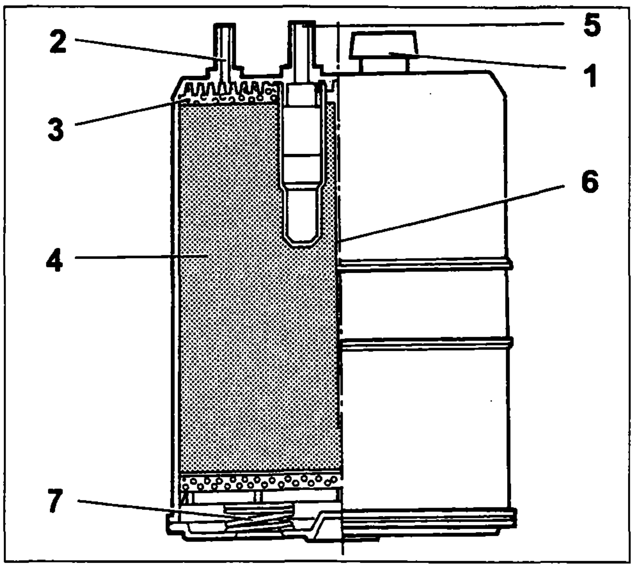
3. Fuel vapour separator
4. Pipes connecting vapour separator to the fuel tank



P4A44BJ01

Safety and ventilation valve

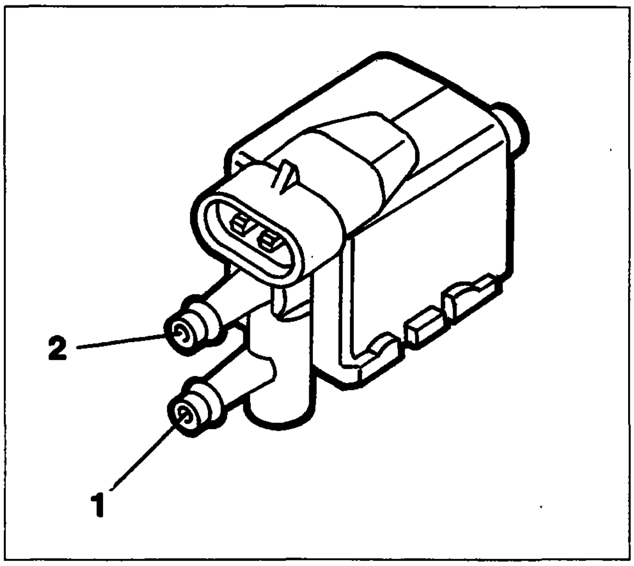
This valve is located in the fuel filler cap and carries out the following functions:
- discharging the excess pressure outwards which forms inside the tank (safety function); the pressure acts on the plate (2) and, overcoming the spring (1) loading, allows the excess vapours to be discharged outwards;
- allowing the flow of outside air in the tank when an excessive vacuum is formed inside the tank through the effect of the fuel consumption (ventilation function): when the vacuum exceeds the loading of the spring (4), it moves the valve (3), allowing the intake of air.



P4A44BJ02

Active charcoal filter

This is made up of granules of charcoal (4) which trap the vapours entering through the inlet (5).
The scavenging air which enters through the inlet (1), passes through the paper filter (3), comes into contact with the charcoal granules removing the vapours and directs them towards the outlet (2) and from there towards the filter valve.
The air, having entered through the inlet (5) can also be sent by the vacuum into the tank for ventilation.
The partition (6) ensures that the warm scavenging air drawn in comes into contact with all the granules of charcoal.
There are also two springs (7) which allow the expansion of the mass of granules when the pressure increases.



P4A44BJ03

Charcoal filter solenoid valve

This valve, of the normally closed type, controls the flow of vapours reaching the inlet manifold and is operated by the control unit with duty-cycle operation.

NOTE *The inlet which has the word CAN (canister) written on it should be connected to the charcoal filter.*

1. From the charcoal filter
2. To the inlet manifold

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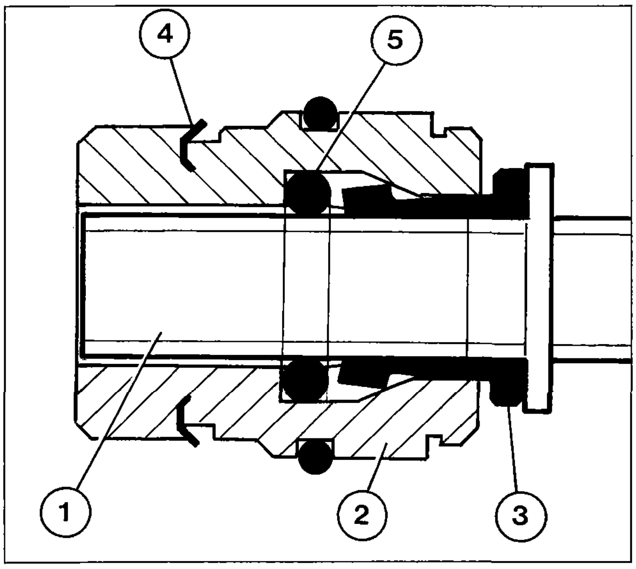
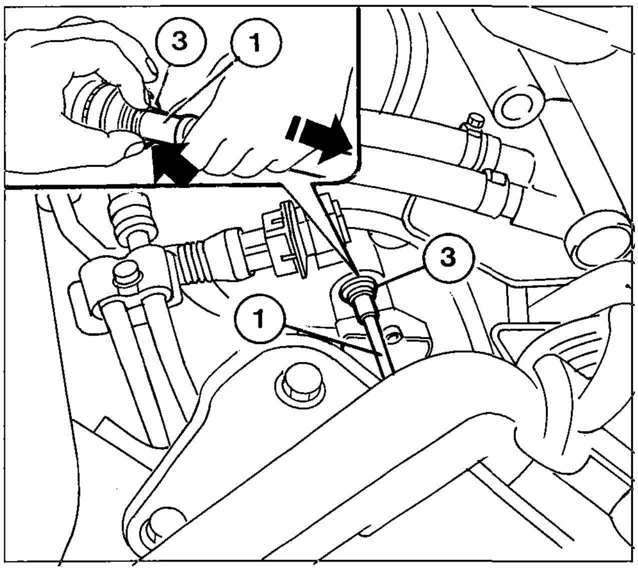


P4A44BJ04

PROCEDURE FOR DISMANTLING THE RAPID ATTACHMENT PIPE FOR THE ANTI-EVAPORATION SYSTEM FROM THE INLET MANIFOLD

The pipe for the anti-evaporation system (1) is held in place on the inlet manifold cartridge (2) by the small clamp (3). A flexible washer (4) keeps the cartridge (2) in its housing preventing any fuel vapours from escaping by means of an O ring (5).

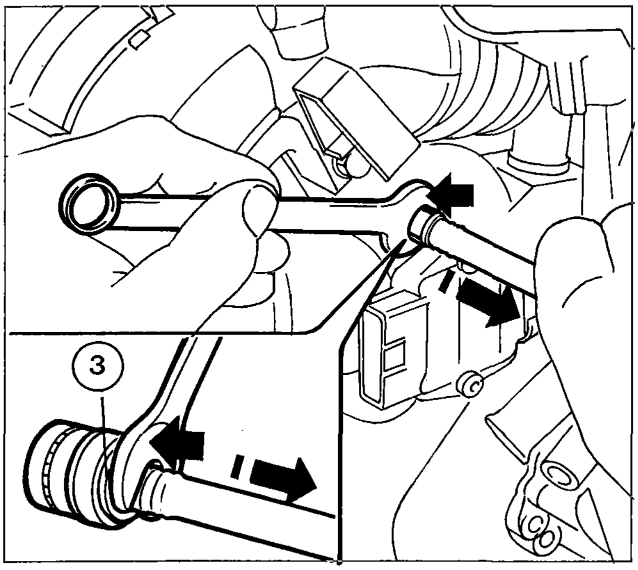
1. Anti-evaporation system rapid attachment pipe
2. Cartridge
3. Pipe retaining clamp
4. Flexible washer
5. O-ring



P4A44BJ05

In order to extract the pipe (1), push the clamp (3 with your fingers towards the manifold and, at the same time, extract the actual pipe. The operation can also be carried out with the help of an 11 mm spanner to facilitate the movement of the clamp (3) towards the manifold.

Do not use tools to extract the pipe which could damage the system.



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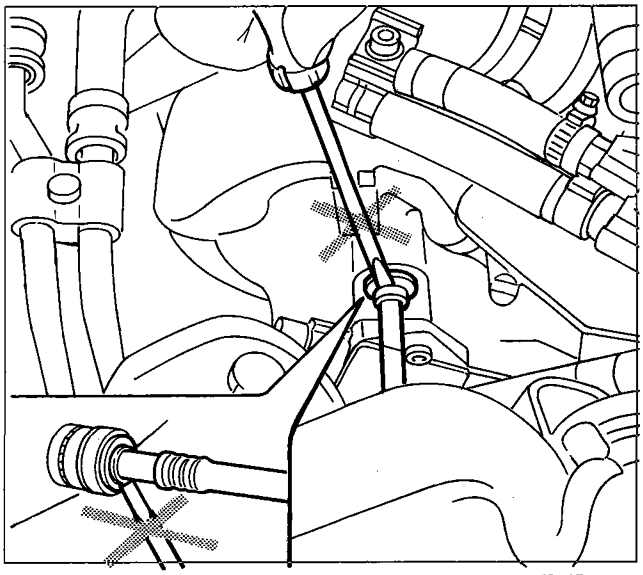

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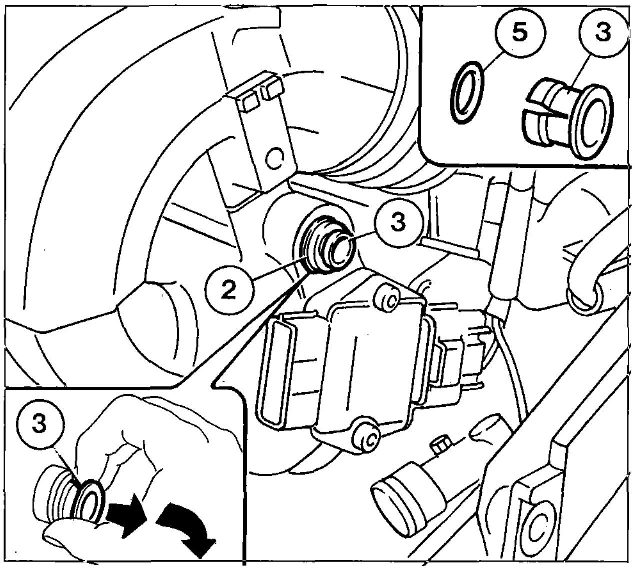
10.



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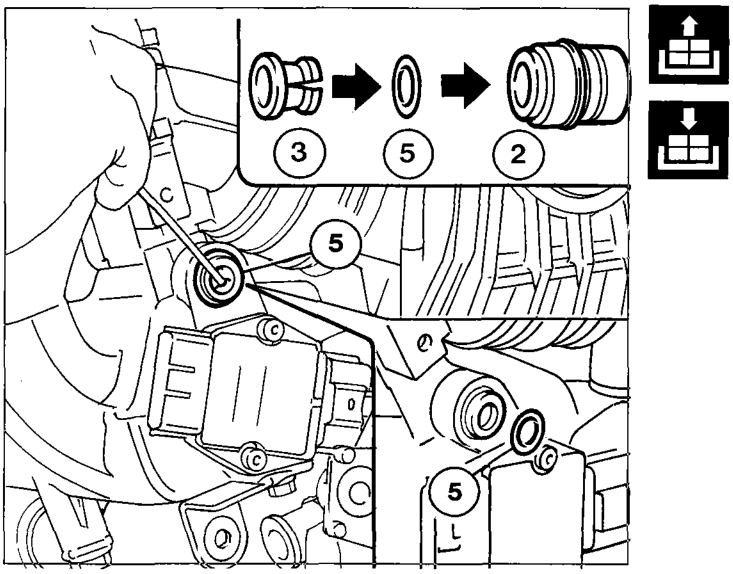

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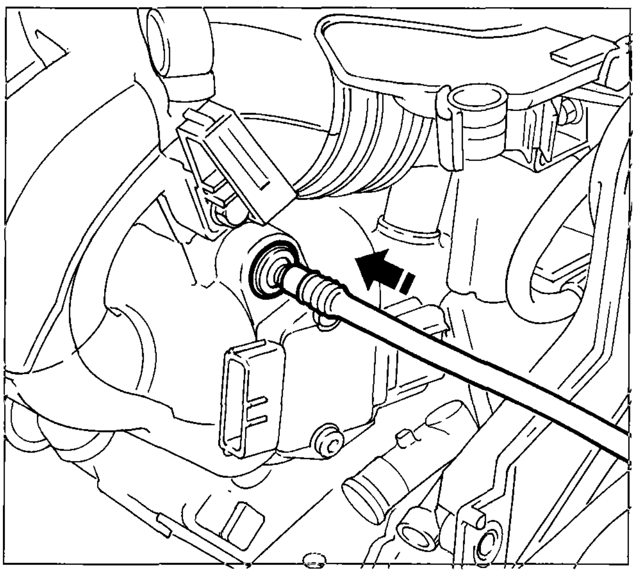
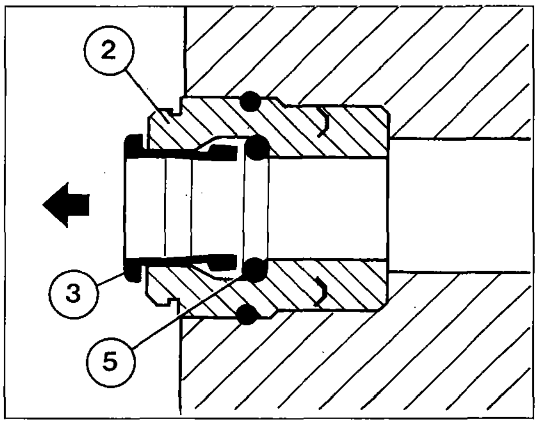


P4A44BJ10

Replacing clamp

A kit is available for replacing the clamp which comprises an O-ring (5) and a clamp (3).
After having removed the pipe for the anti-evaporation system, insert your fingers between the clamp (3) and the cartridge casing (2) (to facilitate the operation, move the clamp aside using a screwdriver, working very carefully). Pull outwards and rotate the actual clamp.



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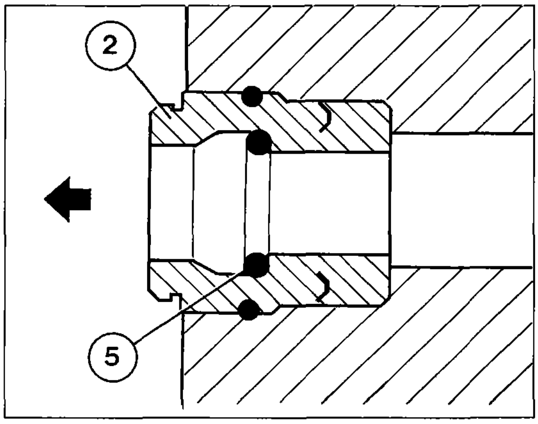


P4A44BJ12

Extract the O-ring (5) inside the cartridge. Clean the interior of the cartridge with an air jet and insert the new O-ring in its housing; then insert the new clamp.

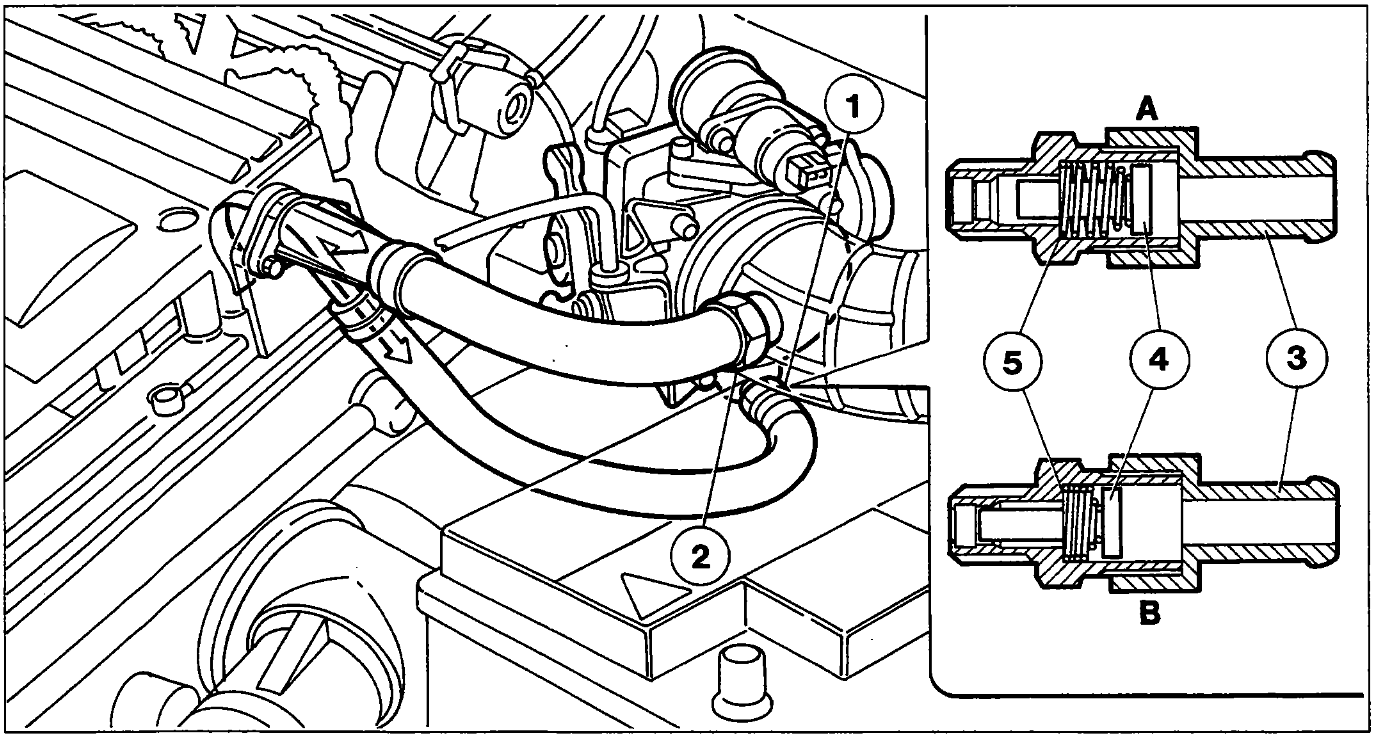
Clean all impurities from the end section of the pipe before it is inserted inside the cartridge. Insert the pipe pushing it into the end of travel position.

4A60BJ

II-97 - Update
Print no. 506.670/09

SYSTEM FOR RECIRCULATING GASES COMING FROM THE CRANKCASE (BLOW-BY)

This system controls the emissions from the crankcase of breather gases, made up of mixtures of air, fuel vapours and burnt gases which escape through the piston seals and of lubricant oil vapours, drawing them in again and burning them in the engine.
The breather gases coming from the crankcase reach the cylinder head and are directed into two different inlets (1) and (2).
With the butterfly open, the gases flow through the inlets (1) and (2) to be drawn into the manifold.
With the butterfly closed the vacuum in the inlet manifold draws in the gases through the intake (1) in which there is a PCV limiting valve (3) *(Positive Crank Ventilation)* which shutters the intake.
The PCV valve, in effect, can be modulated and the quantity of gases which pass through is proportional to the vacuum in the inlet manifold.
When the butterfly valve is completely open (condition A), the vacuum inside the inlet manifold is minimal, the spring (5) is completely extended and the PCV valve allows the maximum flow of breather gases.
Viceversa, with the butterfly completely closed (condition B), the vacuum inside the manifold is maximum, this causes the movement of the piston (4) which shutters the opening for the flow of breather gases inside the PCV valve and thereby restricts the intake into the manifold of the actual gases.



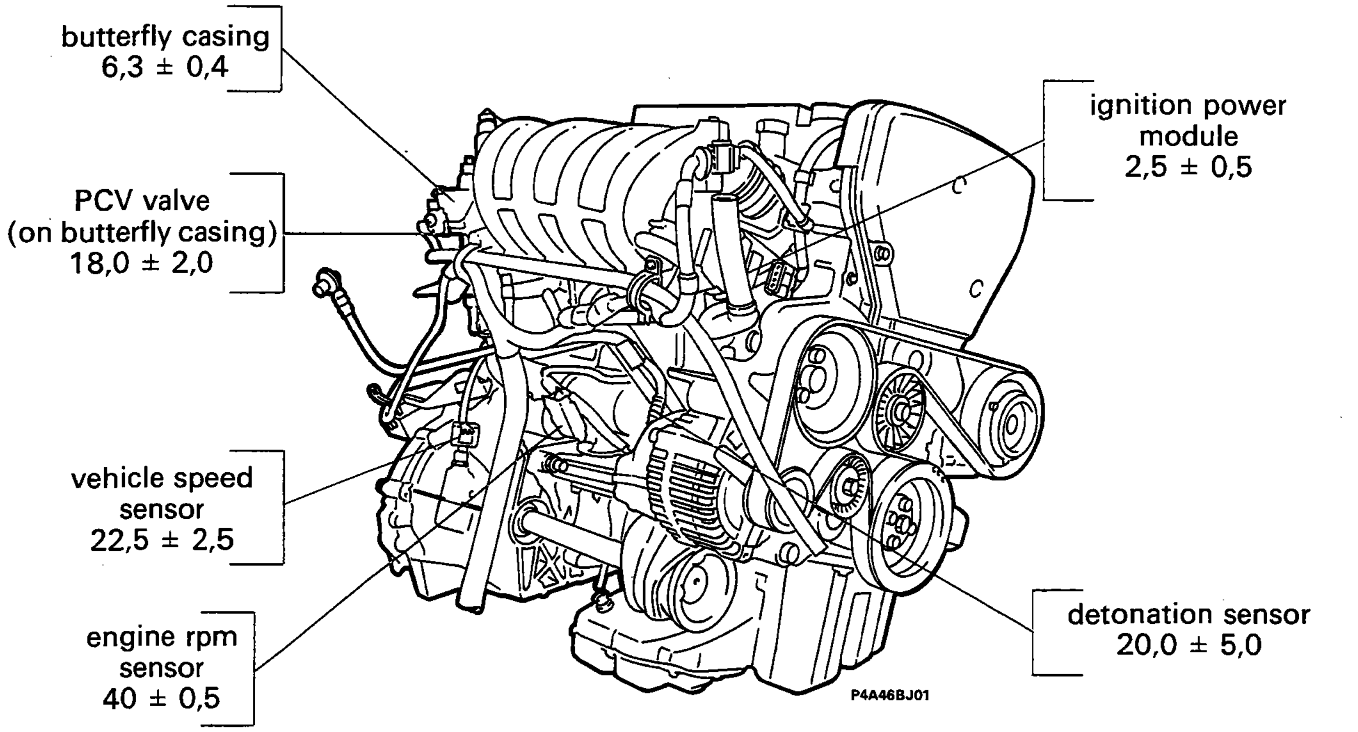
P4A45BJ01

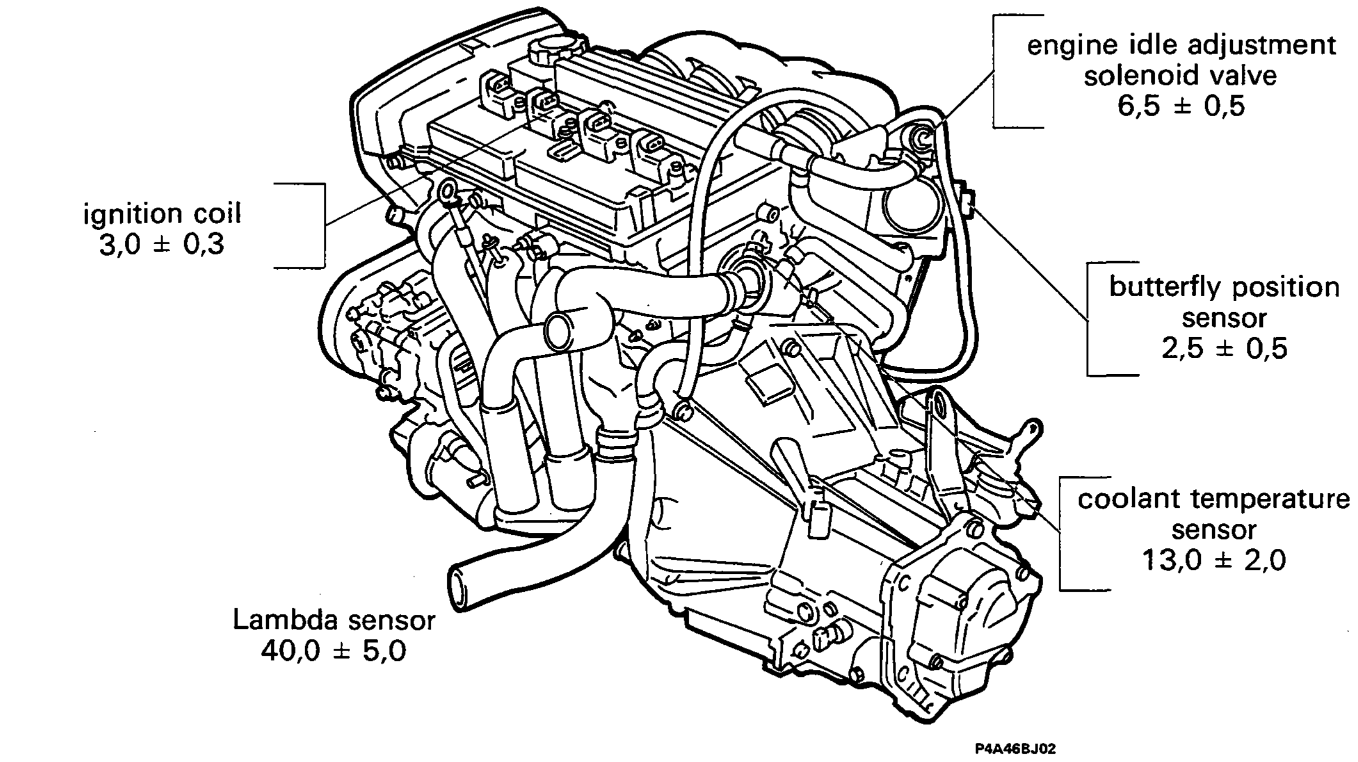
1. Inlet on butterfly casing with PCV
2. Inlet on sleeve
3. PCV valve
4. Piston
5. Spring

10.

TIGHTENING TORQUES

The main tightening torques for the HITACHI injection/ignition system components are given below (values in Nm).





Print no. 506.670

CHECKS, ADJUSTMENTS AND REPAIR OPERATIONS ON HITACHI MPI SYSTEM

When working on a vehicle equipped with a Hitachi MPI system, the following precautions should be observed:
- *do not start up the engine with the electrical connection terminals not properly connected or slack at the battery poles;*
- *do not use a rapid battery charger to start the engine;*
- *never disconnect the battery from the electrical system with the engine running;*
- *for the rapid charging of the battery, disconnect it first from the electrical system;*
- *if the vehicle is going in a drying oven after painting where the temperatures will be in excess of 80°C, it is necessary to remove the engine control unit from the vehicle;*
- *do not connect/disconnect the multiple connector for the control unit with the ignition switch in the ON position;*
- *always disconnect the negative battery lead before carrying out electrical welding on the vehicle.*

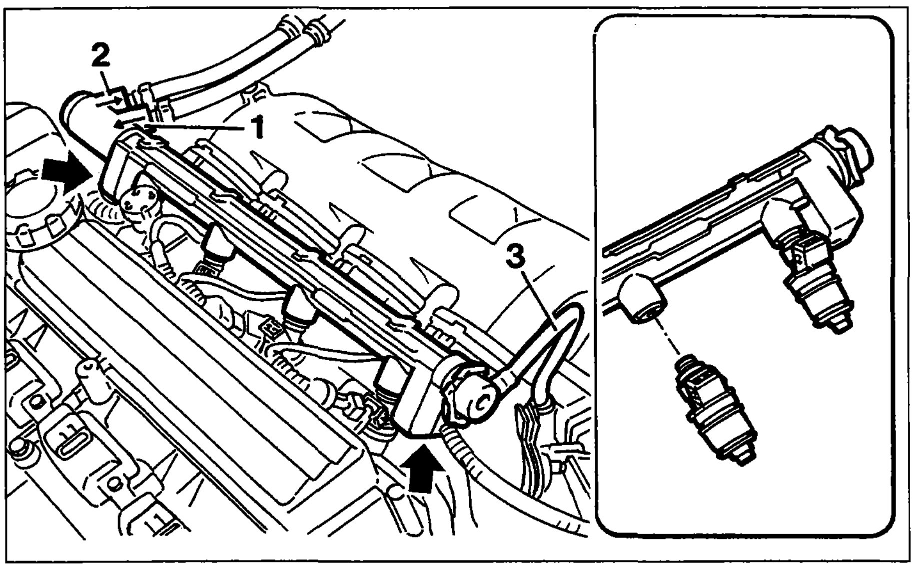
The system has a memory which is directly supplied by the battery, even with the ignition switched off, where the values obtained during self-adjustment are stored. The operation of disconnecting the battery causes the loss of this data which can only be obtained again after a certain distance: therefore this operation should be restricted as far as possible.

FUEL SUPPLY CIRCUIT

NOTE *Before working on the supply circuit, it is advisable to drain the pressure for the circuit by disconnecting the vacuum pick up pipe between the pressure regulator and the inlet manifold and applying a slight vacuum.*

Removing-refitting fuel manifold

Remove the fuel manifold complete with injectors by carrying out the following operations:

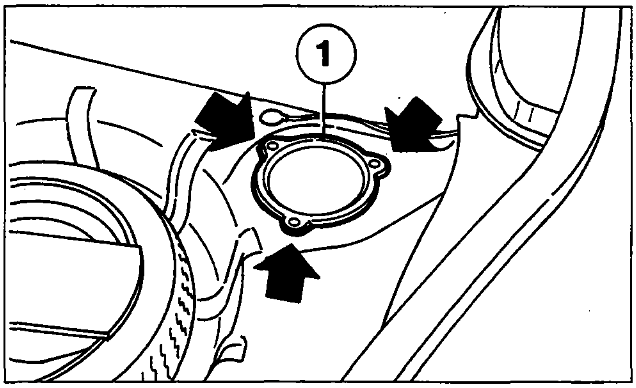


P4A47BJ01

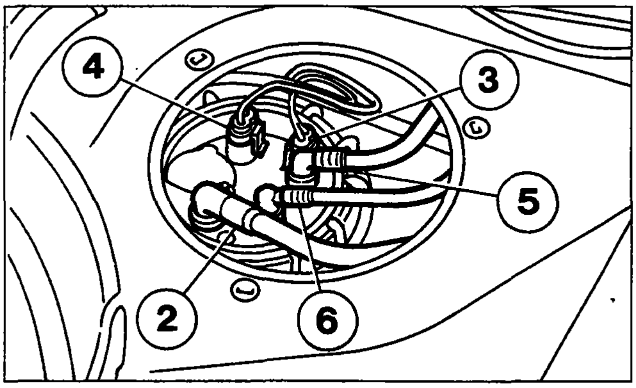
- disconnect the fuel supply pipe (1) and the return pipe (2) from the respective unions at the fuel manifold;
- disconnect the vacuum pick up pipe (3) from the pressure regulator;
- disconnect the electrical connectors from the injectors;
- undo the two bolts fixing (arrow) the fuel manifold and remove it complete with injectors and pressure regulator.

The injectors do not have a clip: to remove them therefore simply release them from their housing (see detail).

10.



P4A48BJ01

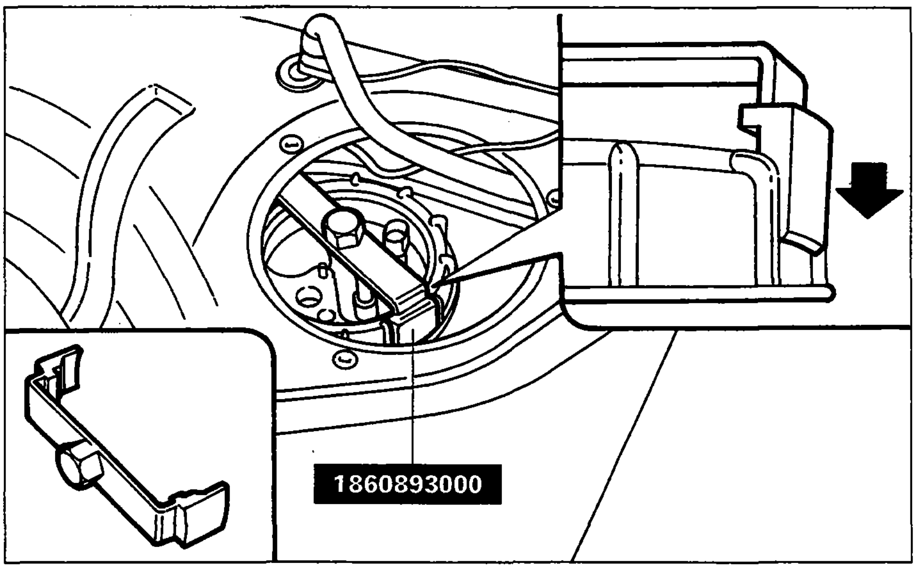


P4A48BJ02

Removing-refitting electric fuel pump

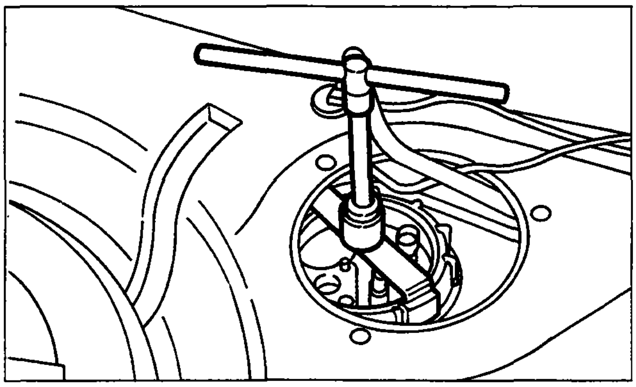
Proceed with the removal of the pump as follows:
- working from the luggage compartment, remove the cover to gain access to the pump housing cover;
- undo the three fixing bolts (arrow) and remove the cover (1);
- undo the union (2) fixing the breather pipe and remove the pipe;
- disconnect the electrical connector for the fuel level gauge (3) and the one for the pump (4) supply;
- remove the rapid attachment fuel supply (5) and return (6) unions from the tray;

NOTE *When removing and refitting the rapid unions, refer to the procedures given in the service notes.*



P4A48BJ03

- fit tool 1860893000 on the tray fixing flange, taking care to insert it correctly between the projections on the flange, as shown in the diagram;



P4A48BJ04

- undo the flange and remove it together with the tool, then carefully remove the tray complete with seal.

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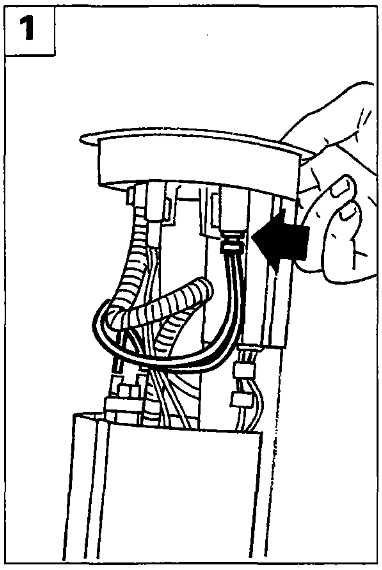
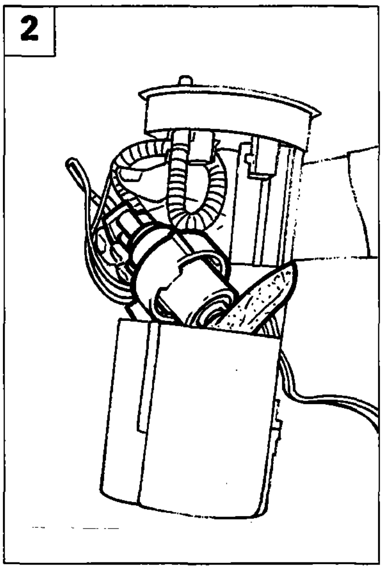


P4A49BJ02

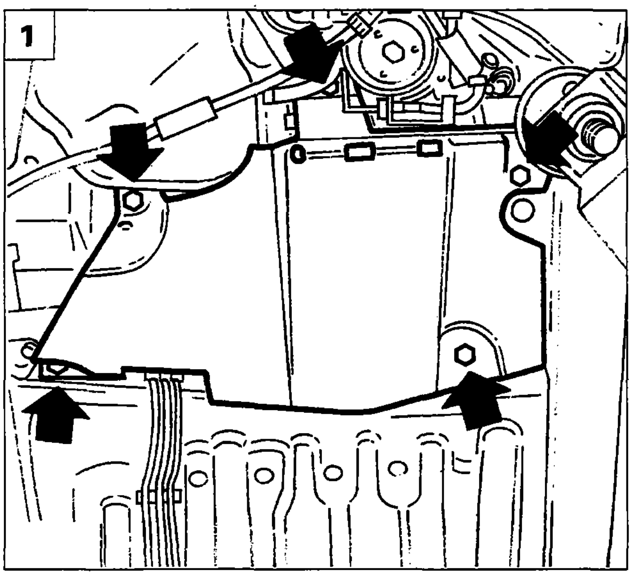


P4A49BJ01

With the drip tray removed, proceed as follows:

1. disconnect the pump supply connector from the drip tray;
2. lift up the pump and extract it by bending it sideways, as shown in the diagram.

Then open the band fixing the supply pipe and remove the pipe from the pump.
Lastly, remove the gauze filter from the pump.

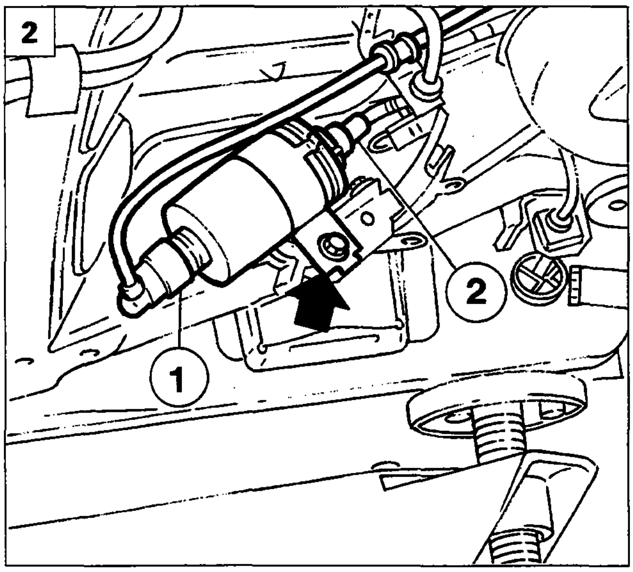


P4A49BJ04

Removing-refitting fuel filter

Raise the vehicle, then proceed as follows:

1. unto the four bolts and the nut (arrow) fixing the shield and remove the shield;
2. disconnect the fuel rapid inlet (1) and outlet (2) connectors from the filter and collect the fuel which comes out during the operation in a suitable container, then seal the connectors without either bending or twisting the pipes; lastly, undo the fixing bolt (arrow) and remove the filter.



P4A49BJ03

NOTE *When removing and refitting the rapid connectors, refer to the procedures described in the service notes.*

The fuel filter should be replaced every 40,000 km.
After replacing the filter, start up the engine and check that no fuel is leaking from the connectors.

10.

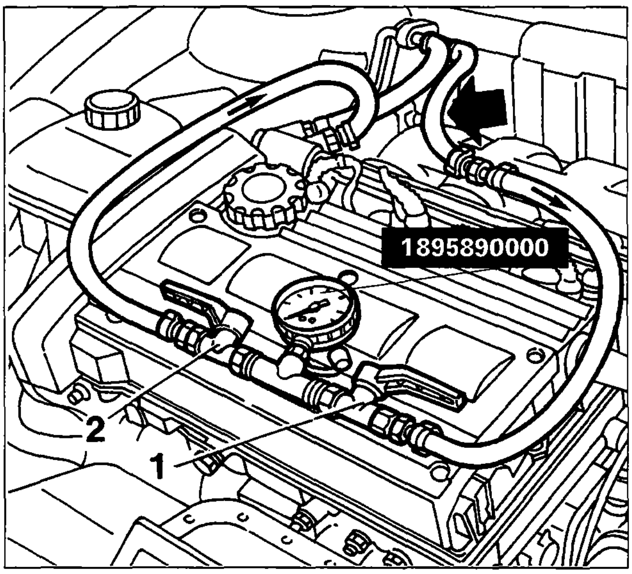
FUEL CIRCUIT PRESSURE CHECKS

Checking fuel regulation pressure

Disconnect the pipe coming from the filter (shown by the arrow) from the injector fuel manifold.
Place pressure gauge 1895890000 and two taps (1) and (2) between the end of the disconnected pipe and the fuel manifold, as illustrated in the diagram.

Supply the electric pump with the engine switched off through the "active diagnosis" function of the F/L Tester.
Alternatively, proceed as follows:
- extract the pump relay from the socket
- make a connection as shown in the diagram using a suitable bridge for this purpose.

The pressure reading on the gauge should stabilize, in these conditions, at 3.0 bar ± 0.2 bar.
If the pressure is too low, carry out the next test.



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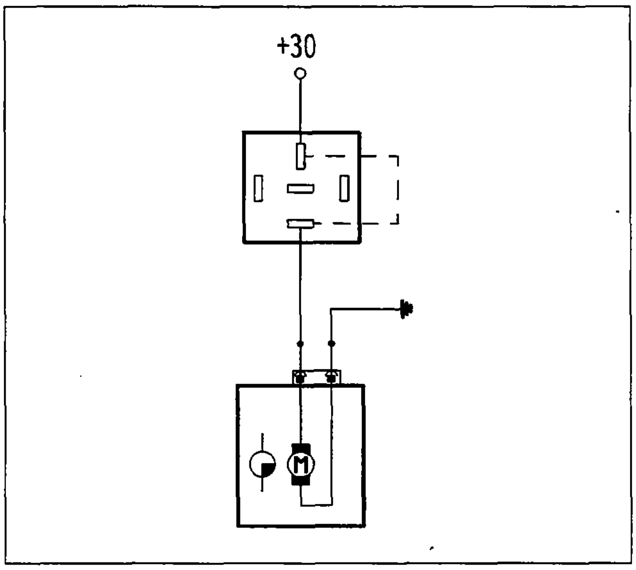

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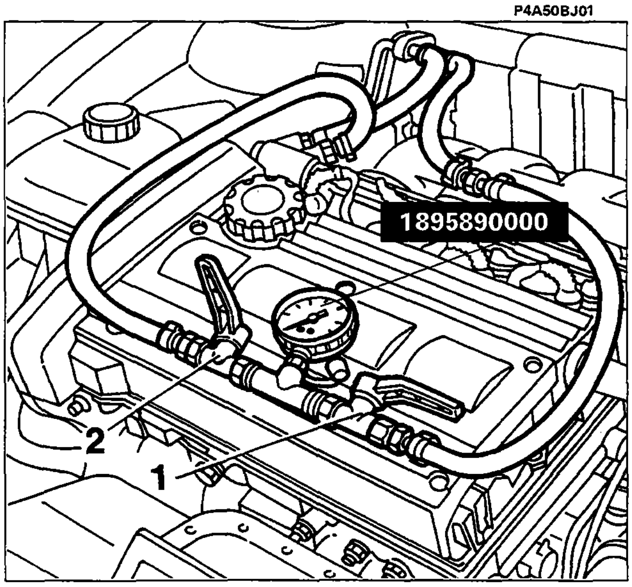

P4A50BJ03

Checking maximum fuel supply pressure (or efficiency of electric pump)

Keeping the same connections as for the previous test, close the tap (2) located downstream of the pressure gauge, operate the electric pump with the engine switched off, as described for the previous test: the pressure should reach 5 bar and not exceed 7 bar (pump safety valve setting). If this is not the case, replace the electric pump because it is defective.

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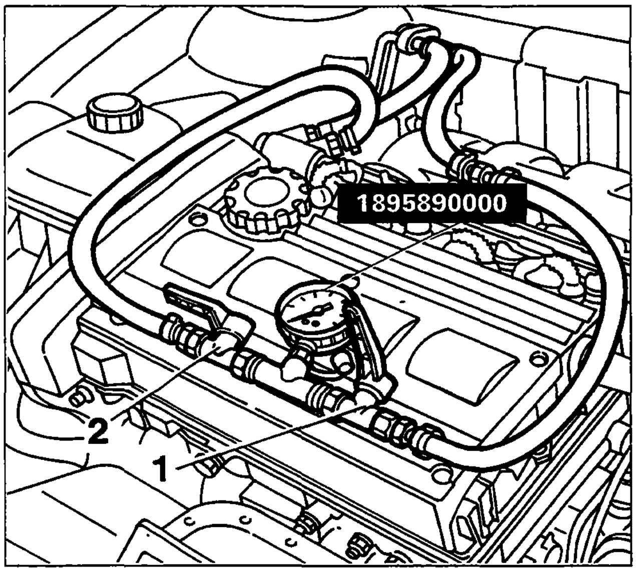
If the pressure value in the previous test was higher than 3.0 bar it is necessary to:
- disconnect the fuel return pipe from the pressure regulator and replace it, temporarily, with a pipe which, inserted on the filler, allows the return of fuel to the tank.
- supply the electric pump with the engine switched off as described in the previous test, then read off the pressure value on the gauge:
  1. if it reaches 3.0 bar then the fuel return pipe to the tank must be replaced because it is obstructed or bent;
  2. if it exceeds 3.0 bar then the pressure regulator must be replaced because it is defective.

NOTE *At the end of the tests refit the pump relay in its housing if it has been removed.*

Checking pneumatic part of pressure regulator

Start up the engine and let it idle.
The reading on the presure gauge should be around 2.5 bar.
If this is not the case, the air connecting pipe between the pressure regulator and the inlet manifold is damaged or the regulator itself is defective and should be replaced.

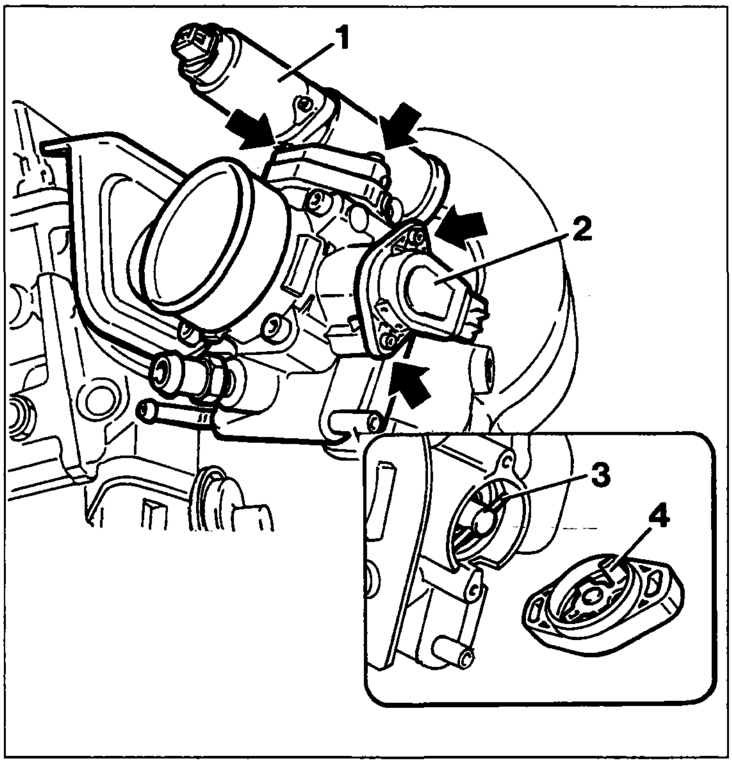


P4A51BJ01

Checking injector seal

In order to check if the injectors are dripping, make the connection as described for the regulation pressure test. Then proceed as follows:
- supply the electric pump with the engine switched off;
- fully close the tap (1) Upstream of the pressure gauge once the regulation pressure has been reached: in this way the pressure in the fuel manifold and the injectors will be the same;
- switch off the electric pump and observe whether as soon as the pressure stabilizes (i.e. decreases slightly) it remains constant for around 60 secs; if this is not the case, there is a leak from one or more of the injectors or from a union.

In this case, remove the injectorsand the fuel manifold from the inlet manifold, keeping the connection with the pressure gauge.
Repeat the previous test leaving the tap (1) open.
When supplying the electric pump with the engine switched off, observe whether there is dripping from any connecting sections.
Replace any dripping injectors and/or renew any defective seals where there are leaks.



P4A52BJ01

INTAKE CIRCUIT

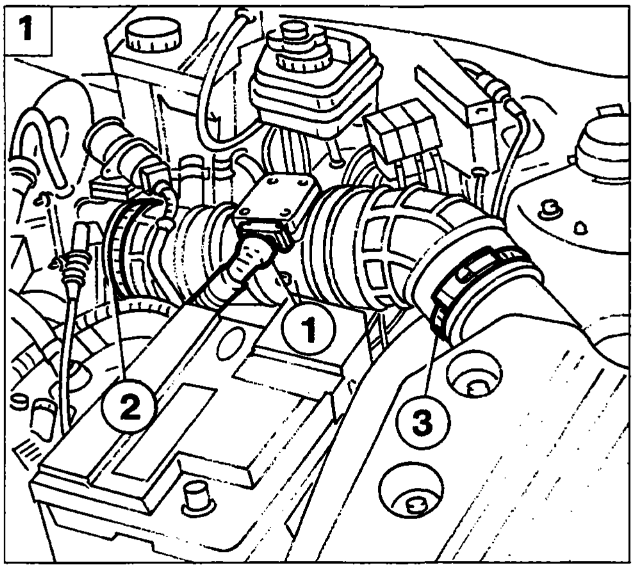
Removing-refitting engine idle adjustment solenoid valve and butterfly position sensor

- Undo the fixing bolts (arrow) to remove the engine idle adjustment solenoid valve (1);
- undo the fixing bolts (arrow) to remove the butterfly position sensor (2).

NOTE *When refitting the butterfly position sensor, take care that the operating lever fitted on the butterfly shaft (3) is above the sensor driving element (4), as shown in the diagram.*

Removing-refitting air flow meter

1. Remove the battery, disconnect the electrical connector (1) from the meter, loosen the bands (2) and (3) fixing the inlet sleeve;
2. disconnect the blow-by sleeve (4) from the inlet sleeve, undo the two bolts (arrow) fixing the flow meter mounting bracket and remove the assembly; then loosen the bands at the flow meter and remove the two sleeves.



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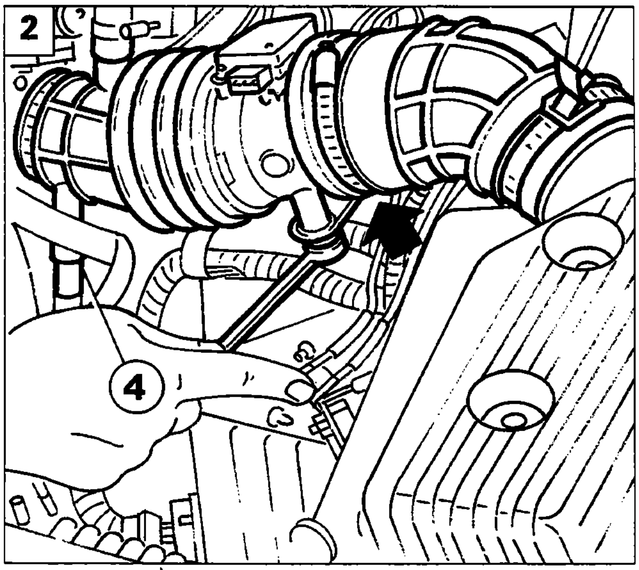

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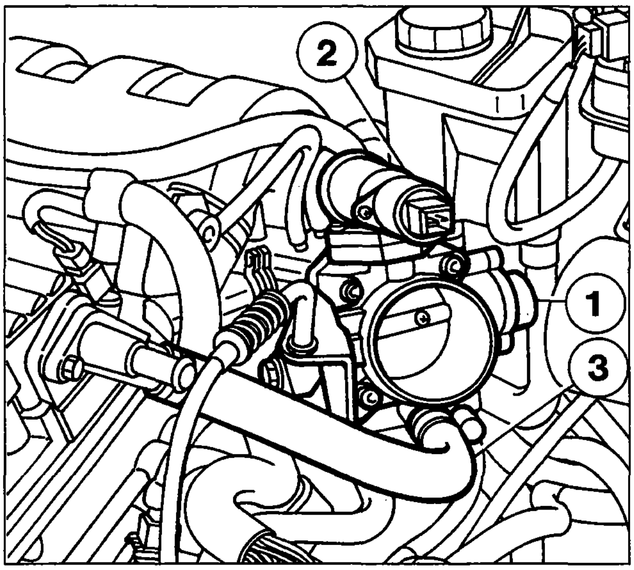
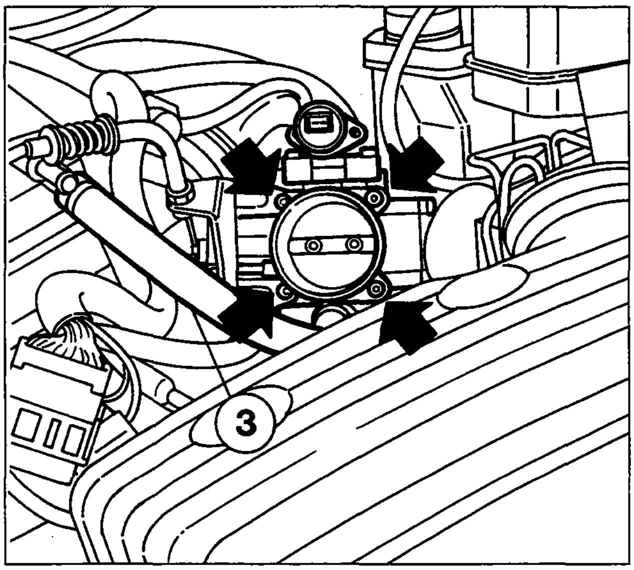


P4A53BJ01

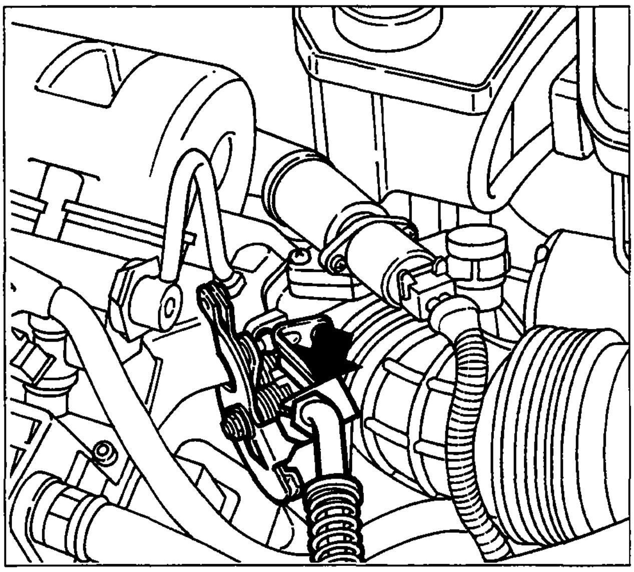
Removing-refitting butterfly casing

Proceed as described for the removal of the air flow meter, removing the meter complete with the two sleeves.
Then, proceed as follows:
- disconnect the electrical connectors from the butterfly position sensor (1) and from the engine idle adjustment solenoid valve (2);
- remove the band fixing the blow-by pipe (3), cylinder head cover side and remove the pipe;



P4A53BJ02

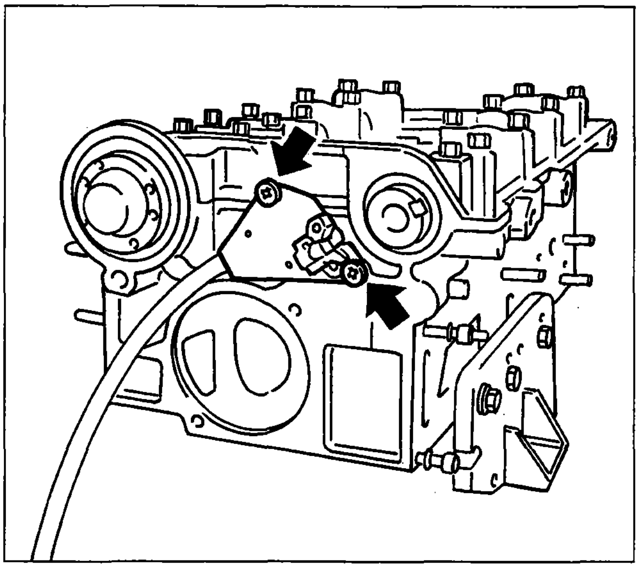
- undo the four bolts fixing the butterfly casing (arrow) to the inlet manifold;
- release the end of the accelerator cable from the control lever;
- remove the coolant connecting pipes from the inlet and outlet pipes, sealing them as appropriate;
- lastly, remove the blow-by pipe (3) from the butterfly casing.



P4A53BJ03

Adjusting accelerator control cable

Adjust the accelerator control cable by carrying out the following operations:
- loosen the lock nut at the bottom of the bracket;
- acting on the adjustment nut (arrow), adjust the accelerator cable clearance;
  tighten to **reducee** the clearance,
  loosen to **increase** the clearance;
- when the adjustment is complete, lock the lock nut.



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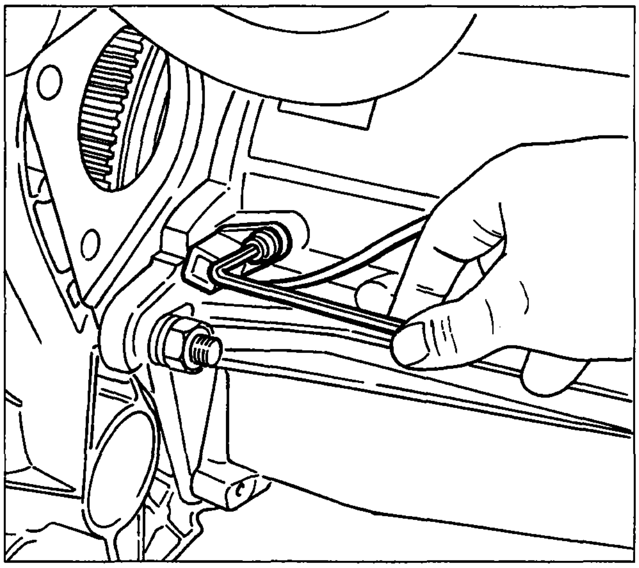

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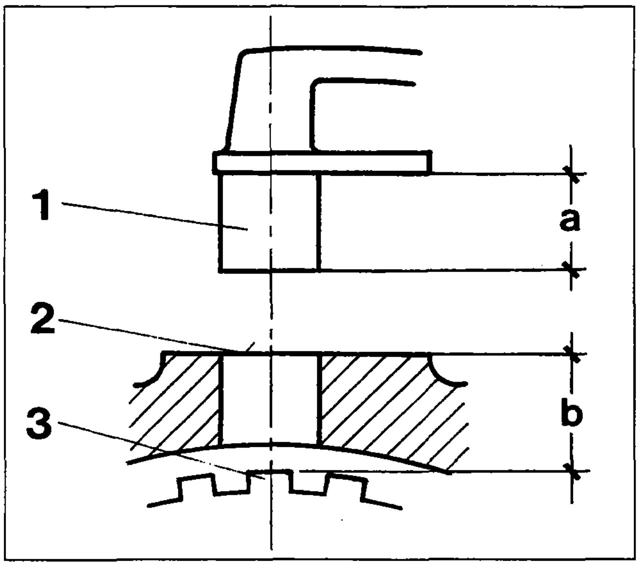

P4A54BJ03

ELECTRICAL CIRCUIT

Removing-refitting engine timing sensor

This operation involves removing the timing belt and the camshaft toothed pulley, exhaust side.
Having carried out these operations, it is necessary to:

- disconnect the electrical connector;
- undo the two fixing bolts (arrow) and remove the sensor.

When refitting carry out the procedure in the reverse order, following the instructions for fitting and tensioning the toothed belt.

NOTE *The sensor does not require any type of adjustment.*

Removing-refitting engine rpm sensor

Position the vehicle on a lift, then, working from underneath the vehicle:

- disconnect the electrical connector;
- undo the bolt fixing the sensor and remove it from its housing.

NOTE *The sensor is fitted in production with tolerances which ensure a gap of 0.8 ± 0.4 mm without requiring further adjustments. This gap is also ensured if the sensor is replaced with a replacement one.*

If you wish to check the gap between the sensor and the flywheel, proceed as follows:

- measure the distance between the end of the sensor and the lower part of the sensor bracket (distance "a");
- measure the distance between the fitting element on the cylinder block/crankcase and the upper part of the tooth (distance "b"), repeating the measurement for at least two opposite teeth.
  The gap (t = b-a) should be between 0.4 and 1.2 mm.

1. Sensor
2. Fitting element
3. Flywheel tooth

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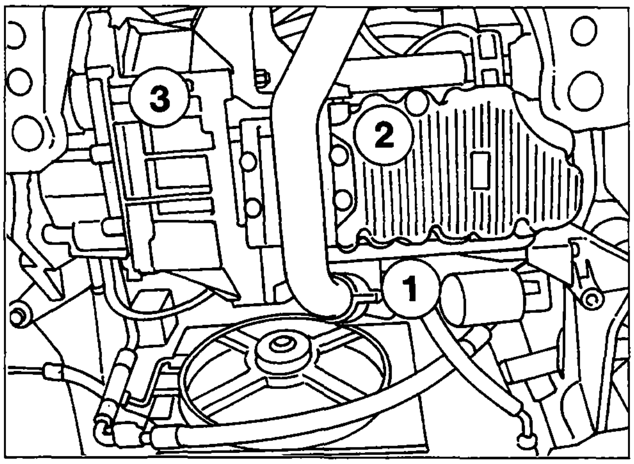
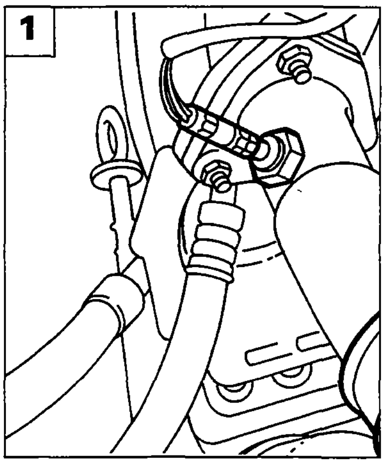


P4A55BJ01

Removing-refitting:
1. Lambda sensor
2. Detonation sensor
3. Vehicle speed sensor



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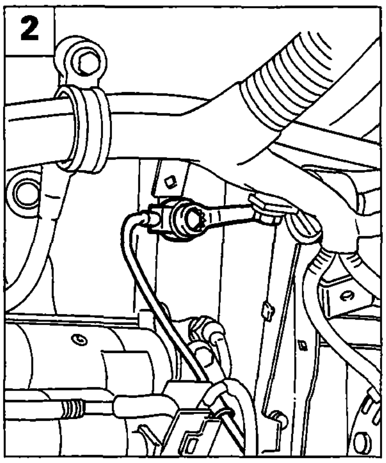

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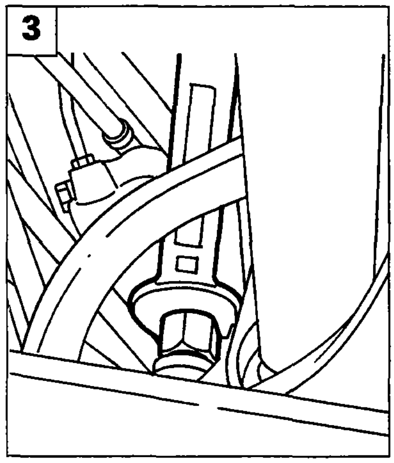
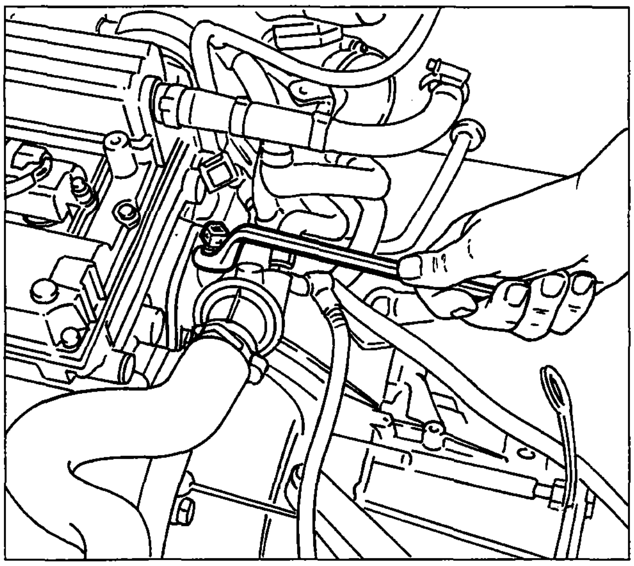


P4A55BJ04

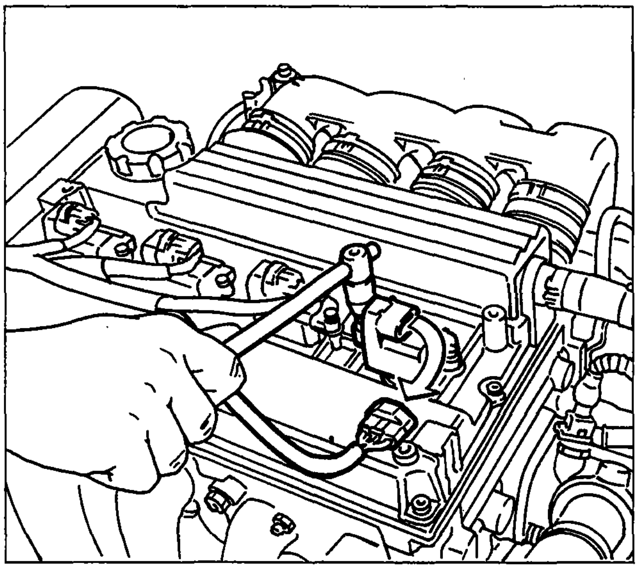
1. Disconnect the electrical connector, then undo the Lambda sensor and remove it from its housing.
2. Disconnect the electrical connector, undo the bolt fixing the detonation sensor and remove it.
3. Disconnect the electrical connector and undo the casing for the vehicle speed sensor, removing it from its housing.


P4A55BJ05

Removing-refitting coolant temperature sensor

- Disconnect the electrical connector from the sensor;
- undo the sensor removing it from its housing.

Take great care that the sensor is correctly refitted and over the electrical connection, since the information sent by the sensor is also used by the control unit for operating the radiator fan.

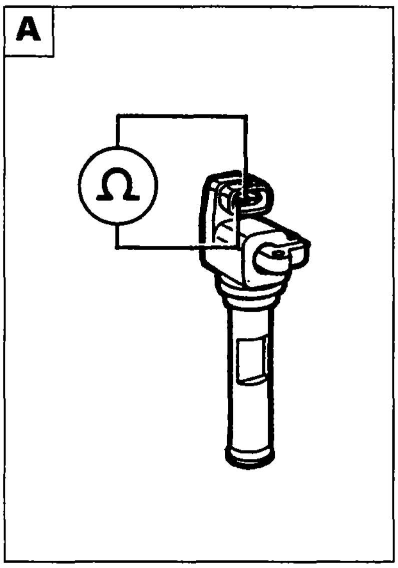


P4A56BJ01

Removing-refitting ignition coils

Proceed with the removal of the ignition coils by carrying out the following operations:
- disconnect the electrical connector;
- undo the two fixing bolts and remove the coil, extracting it from the housing.

NOTE *The coil is fitted with an extension made from a silicon material with a high dielelectric power inside of which there is a pressure switch with a spring loading.*
Do not dismantle the two components so as not to risk losing the internal contact or getting it dirty.
In the case of replacement, it is not necessary to separate the coil from the extension because the complete coil/extension assembly is available as spares.



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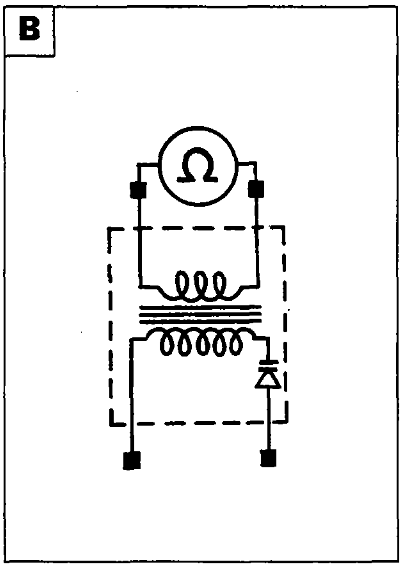

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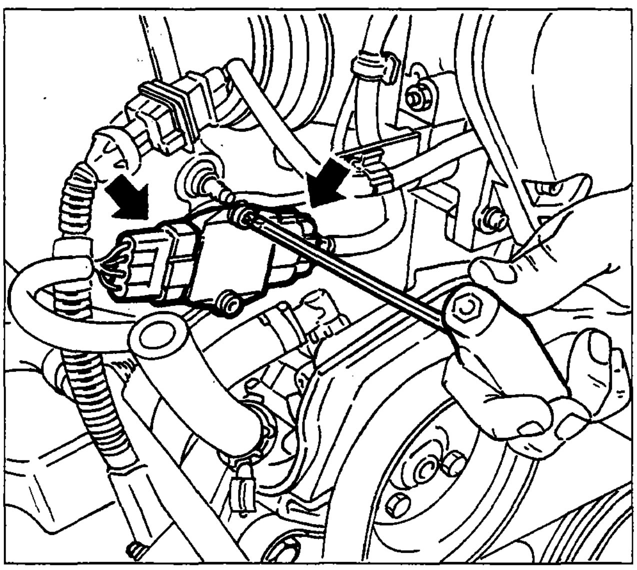
Checking primary circuit coil resistance

The resistance is checked by following the diagram.

Primary resistance: 0.6 ± 0.06 ohm



P4A56BJ04

Removing-refitting ignition power module

Remove the ignition power module carrying out the following operations:
- disconnect the electrical input and output connectors (arrow);
- undo the two fixing bolts and remove the module.

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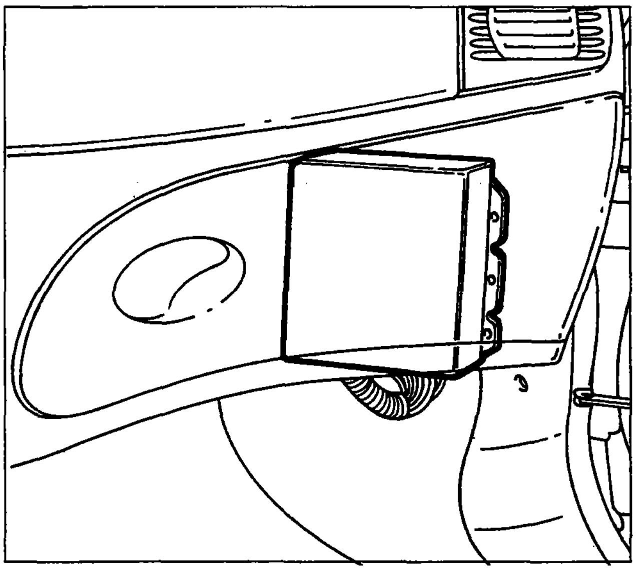

P4A57BJ01

Removing-refitting engine control unit

The control unit is located under the glove compartment.
Proceed with removing the control unit by carrying out the following operations:
- remove the glove compartment;
- undo the bolt fixing the mounting bracket and rest the control unit on the floor of the vehicle;
- undo the bolt fixing the earth cable to the bodyshell;
- disconnect the electrical connectors, one by one;
- remove the bracket from the control unit.

CHECKING EMISSION CONCENTRATION

This system manages the content of carbon monoxide (CO) and the idle air flow rate which cannot, however, be manually adjusted.
However, checking the content of the exhaust gases upstream and downstream of the catalyzer can provide a useful indication of the injection/ignition system operating conditions, the engine parameters and the catalyzer.

Checking idle concentration of CO and HC upstream of the catalytic silencer

In order to check the concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) upstream of the catalyzer, proceed as follows:

1. Undo the cap located in the exhaust pipe, upstream of the catalyzer, and tighten the tool in its place.
2. Connect a suitably calibrated CO-tester sensor to the tool.
3. Start up the engine and let it reach operating temperature.
4. Check that the speed is correct.
5. Check that the idle concentration of CO is within the recommended limits (see table); if this is not the case, it is necessary to check:
   - that the Lambda sensor is working properly, using the F/L Tester;
   - for the presence of air penetration in the area surrounding the Lambda sensor housing;
   - the injection and ignition systme **(in particular the state of wear of the spark plugs).**
6. In the same conditions, check that the concentration of HC is less than 500 p.p.m.
7. If these values are not found, proceed with checking the engine, paying particular attention to:
   - the timing;
   - the engine compression.

NOTE *The engine is fitted with hydraulic tappets for the automatic recovery of the clearances.*

10.

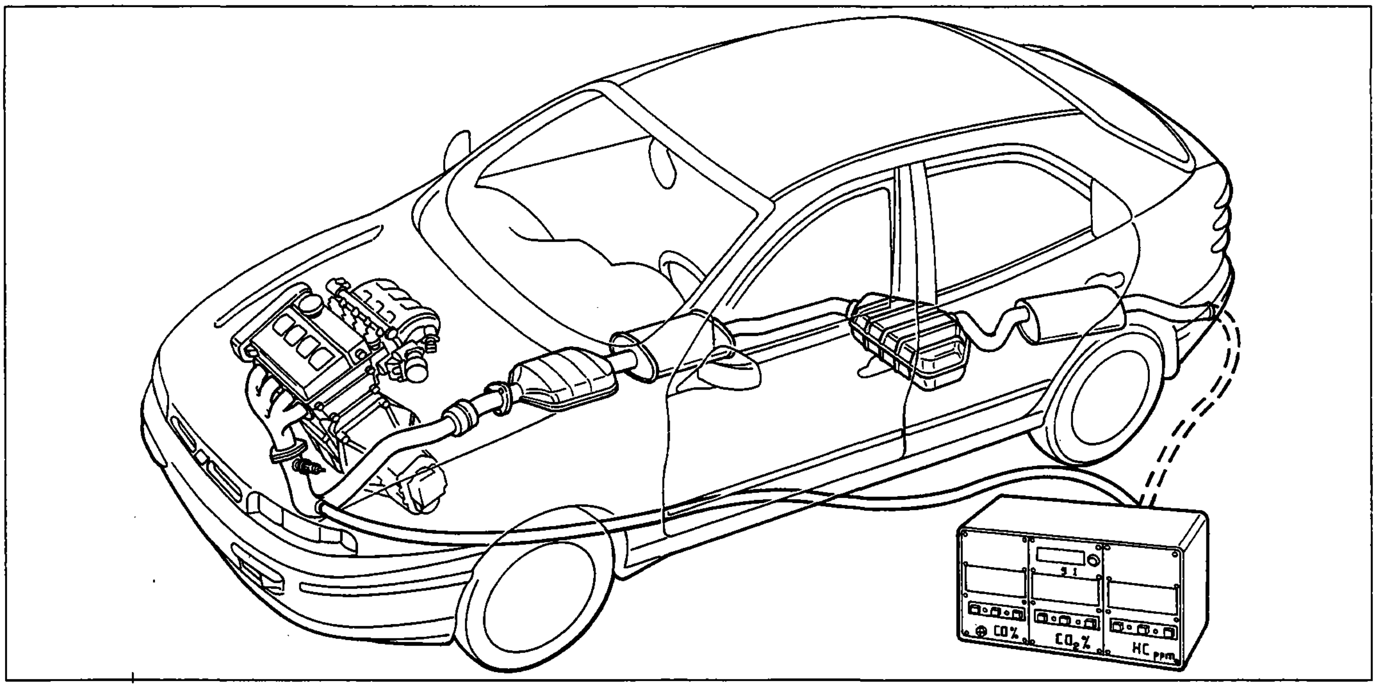

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Table summarizing pollutant emission tolerance values

	CO(%)	HC (p.p.m.)	CO_2 (%)
Upstream of the catalyzer	0,4 ÷ 1	< 500	> 12
Downstream of the catalyzer	< 0,35	< 90	> 13

Checking exhaust concentration of CO and HC

The concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) at the exhaust is measured by inserting a suitably calibrated sensor probe at least 30 cm into the end section of the exhaust pipe.

1. Check that the idle CO and HC concentration values are as recommended (see table).
2. If the HC value is outside of the recommended limits, whilst that previously measured upstream of the catalyzer was okay, then the engine parameters are taken to be correct and the cause of the problem should be sought in the decreased efficiency of the catalyzer.

CHECKING ENGINE IDLE SPEED

If the engine idle speed is not correct as the system is the self-adjusting type it is not possible to carry out any adjustment: therefore it is necessary to check that the accelerator linkage is correctly adjusted and therefore the problem should be sought by means of a complete fault diagnosis using the F/L Tester.

CHECKING IGNITION ADVANCE

In order to check the ignition advance values at different speeds it is necessary to use the F/L Tester diagnostic equipment.

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COMPOSITION AND OPERATION

- Clutch with mechanical release mechanism 1
- Clutch with hydraulic release mechanism 2

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CLUTCH OPERATION

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- Clutch pedal 6
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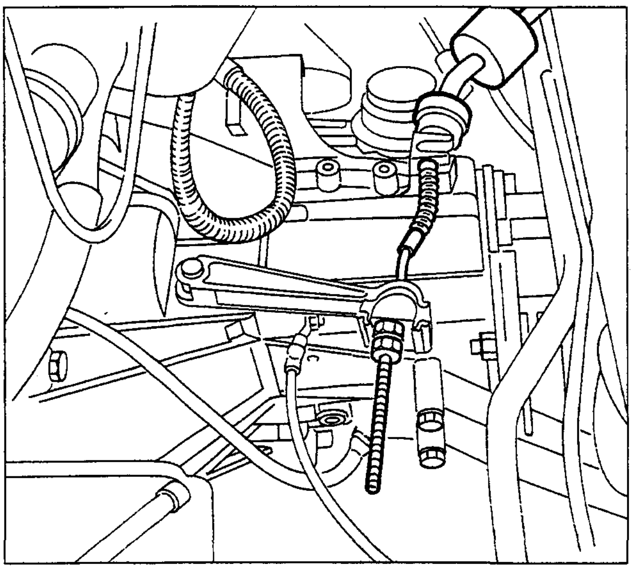
CLUTCH WITH MECHANICAL RELEASE MECHANISM (1370 - 1581 - 1747 - 1929 D engines)

The clutch is the dry, single plate type, with the thrust bearing always in contact with the pressure plate spring.
The driven disc is driven by the pressure exerted by a diaphragm spring.
The clutch release is obtained by means of a cable mechanically operated by the pedal.
The mechanical clutches adopted are all the " Thrust " type (see section which follows).

Technical data		**1370**	**1581**	**1747**	**1929 D**
Spring loading	daN	465	450	500	420
External diameter	mm	190	200	215	200
Internal diameter	mm	130	137	145	137
Pedal travel	mm	163	163	163	163



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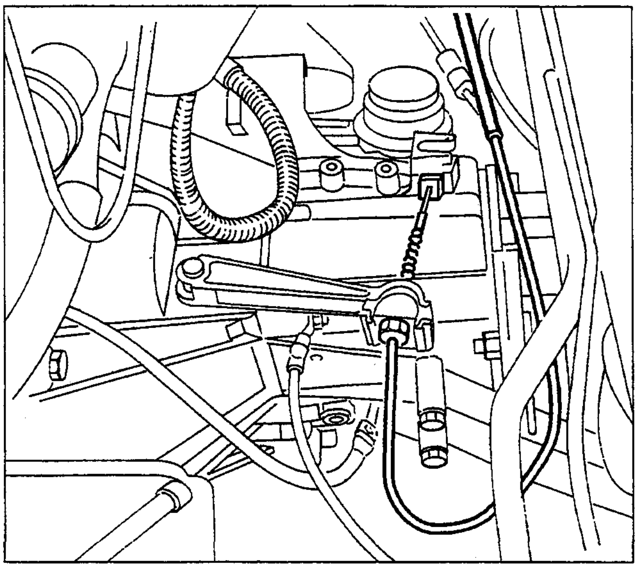
Clutch release cable "drawn type cable" (for 1370 12v)



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Clutch release cable "pushing outer cable type" (for 1581, 1747, 1929 D)

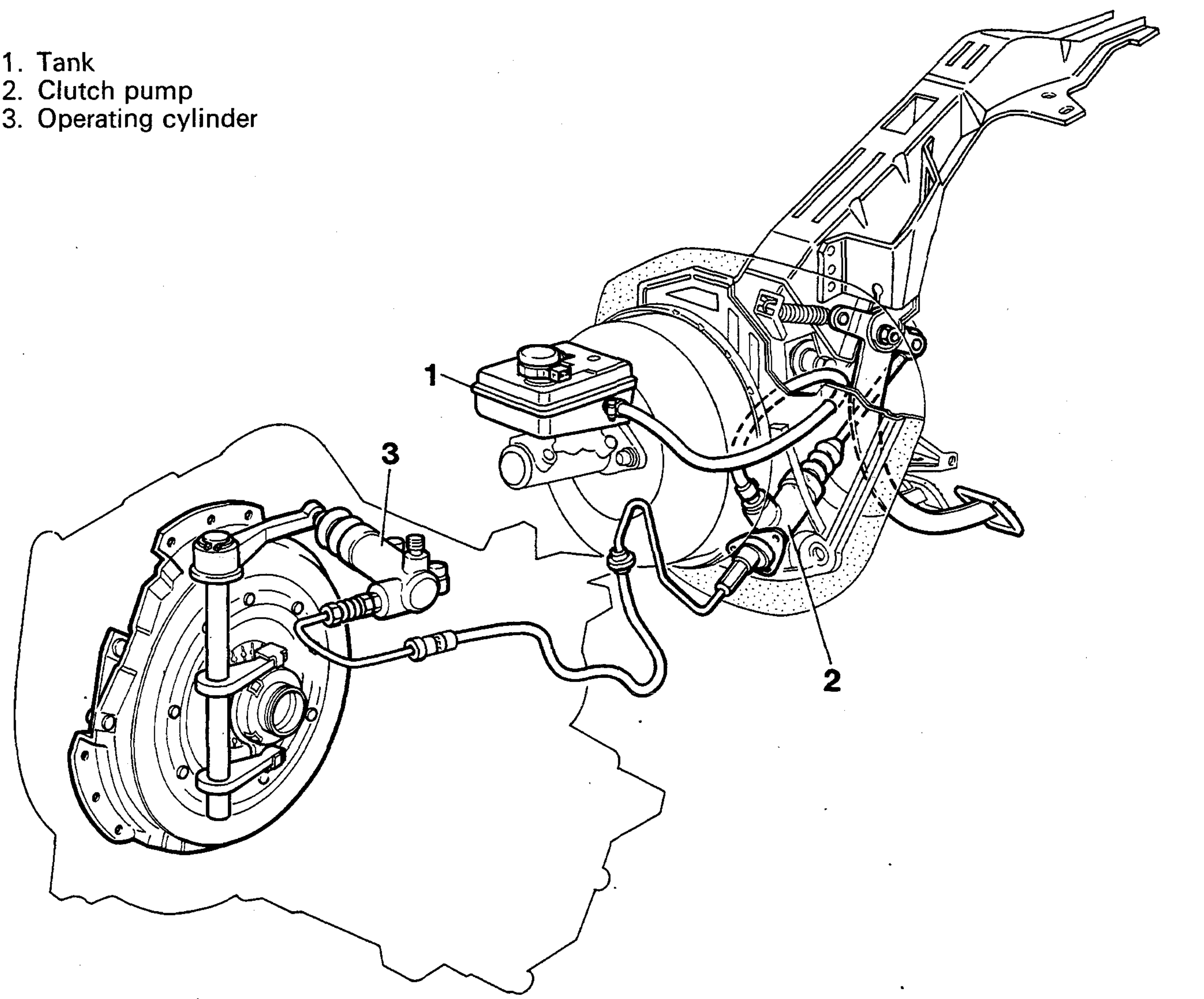
CLUTCH WITH HYDRAULIC RELEASE MECHANISM (1998 20v)

Composition

In order to improve quietness levels and performance, a hydraulic device has been fitted on the 1998 20v version. This device is made up of a reservoir, common to the braking system (1), a pump (2) fixed to the pedals assembly and an operating cylinder (3) fixed to the bell housing.

Driving the vehicle will be more comfortable because there will be a reduction in the vibrations transmitted by the power unit due to the damping effect of the hydraulic system.
The adoption of this device dispenses with the need for periodic adjustment because any clearance and the recovery of the wear of the driven disc take place automatically.

1. Tank
2. Clutch pump
3. Operating cylinder



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Operation

The clutch is the dry, single plate type, with a hydraulic release mechanism and a thrust bearing always in contact with the spring. The driven disc is driven by means of the pressure exerted by a diaphragm spring.

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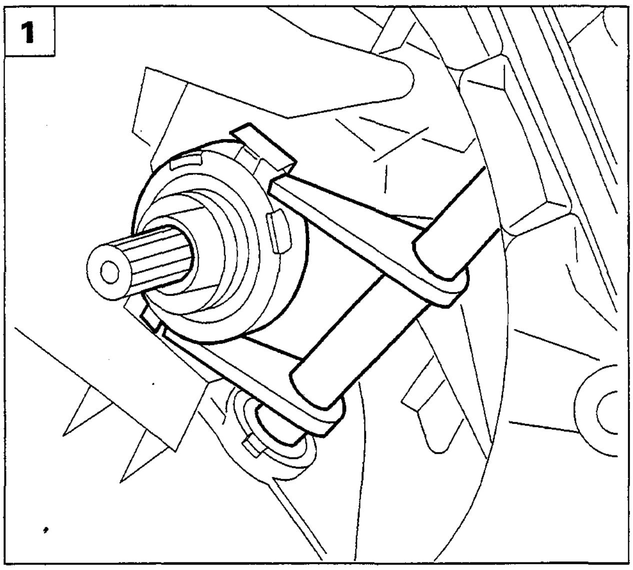

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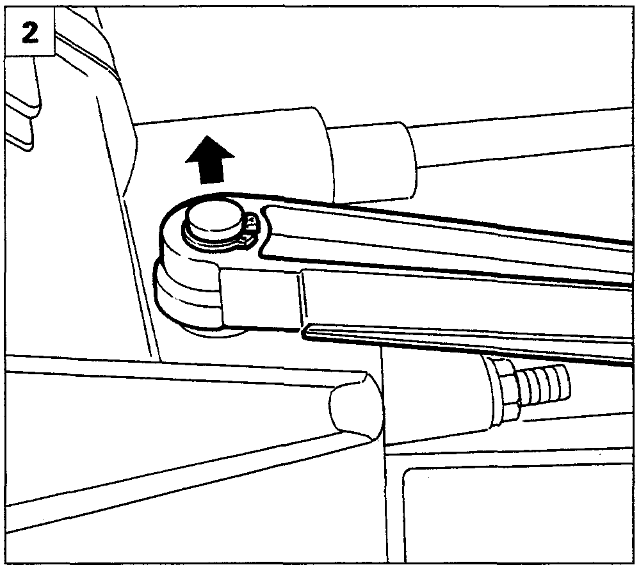

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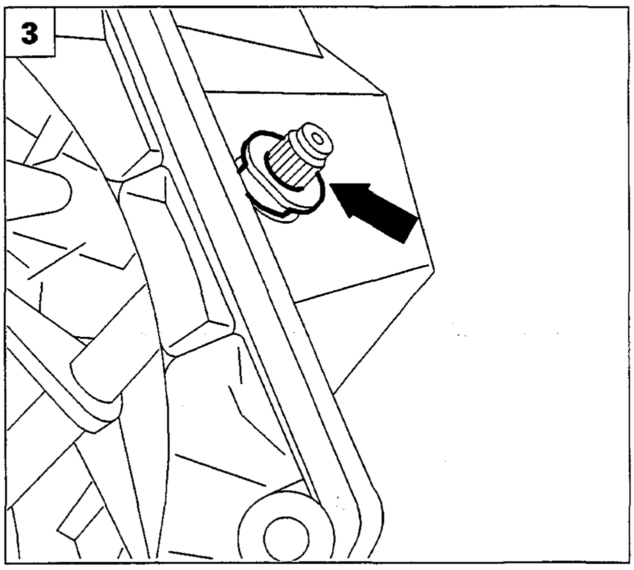

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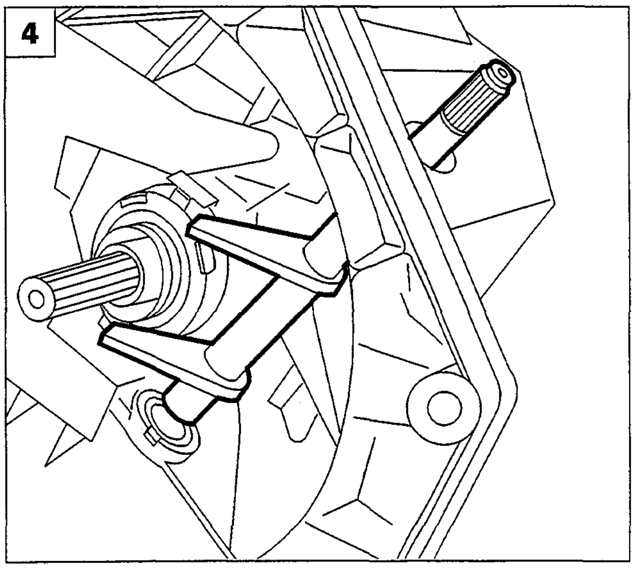


P4A005C04

THRUST BEARING

1. The thrust bearing should not show signs of sticking or noise during rotation or else it must be replaced.

FORK CONTROL SHAFT

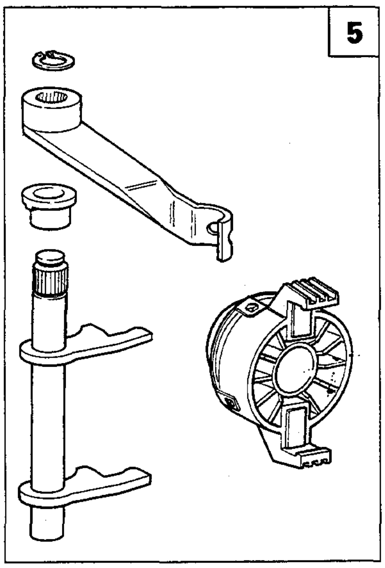
Removing - refitting

2. Remove the circlip for the release lever and remove the actual lever.

3. Remove the upper bush.

NOTE *The bush in question is replaced eachtime the clearance for the fork control shaft is too great.*

4. Remove the fork control shaft, releasing it from the lower housing.
5. View of components removed



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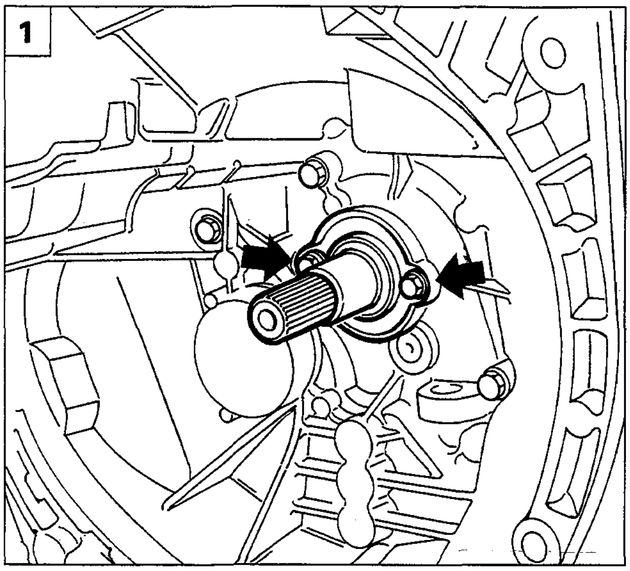

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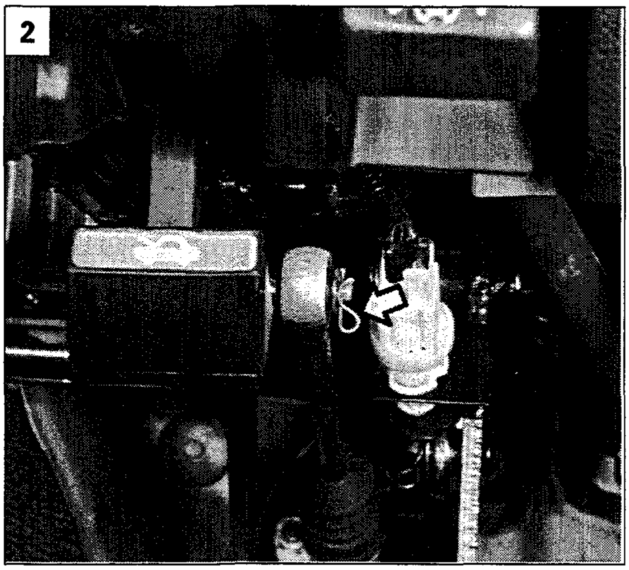
THRUST BEARING SLEEVE (only for 1581 - 1747 - 1998 - 1929 D versions)

NOTE *The 1370 M.P.I. version is not fitted with a thrust bearing sleeve.*

Removing - refitting

1. Undo the bolts shown and remove the sleeve.

NOTE *The seal is replaced each time leaks of gearbox oil are noticed. When refitting, smear the contact surfaces with silicon sealant which will act as a seal.*



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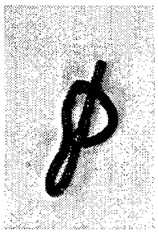
CLUTCH PEDAL



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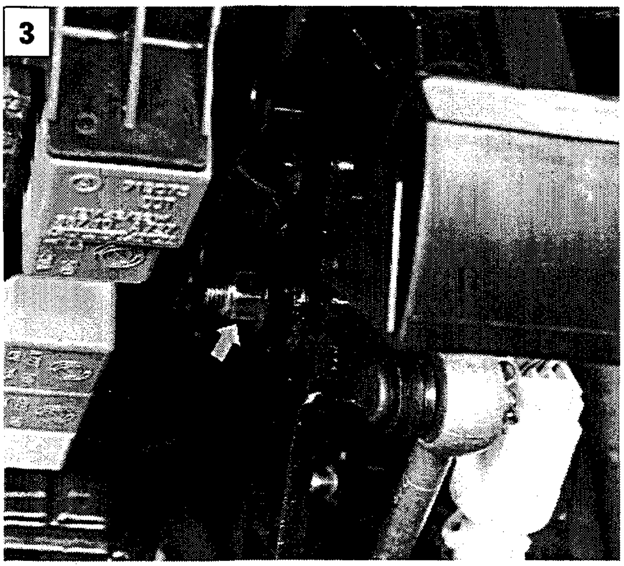
2. Remove the clip fixing the clutch pump to the pedal (only for versions fitted with hydraulic mechanism - 1998 20v)



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Removing-refitting clutch pedal

3. Remove the clutch pedal acting at the point shown by the arrow and also disconnect the end of the clutch cable (value for all versions).

the parts concerned before fitting.

For the 1998 20v versions do not lubricate the rubber bush (Silent-block) connecting the pump - pedal as this will cause the material to deteriorate.

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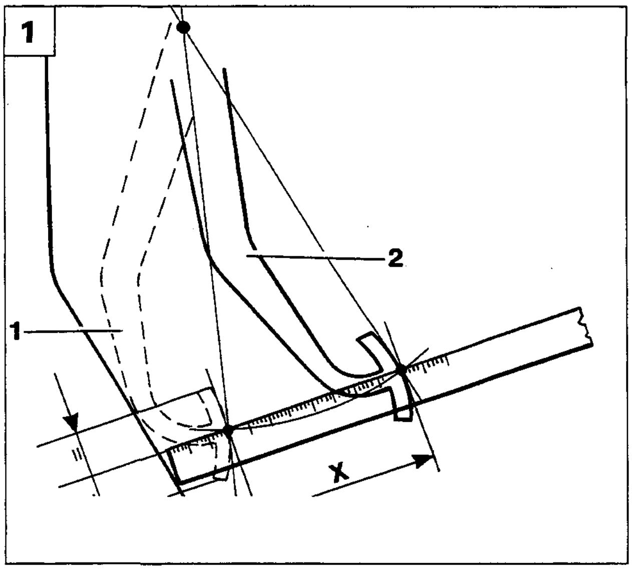

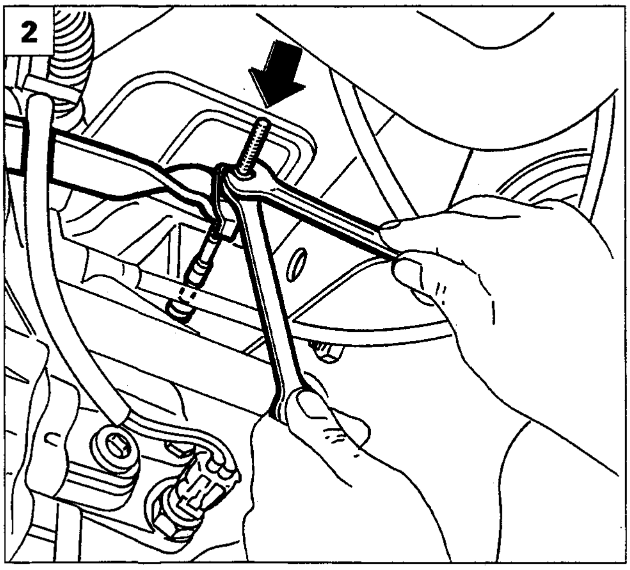

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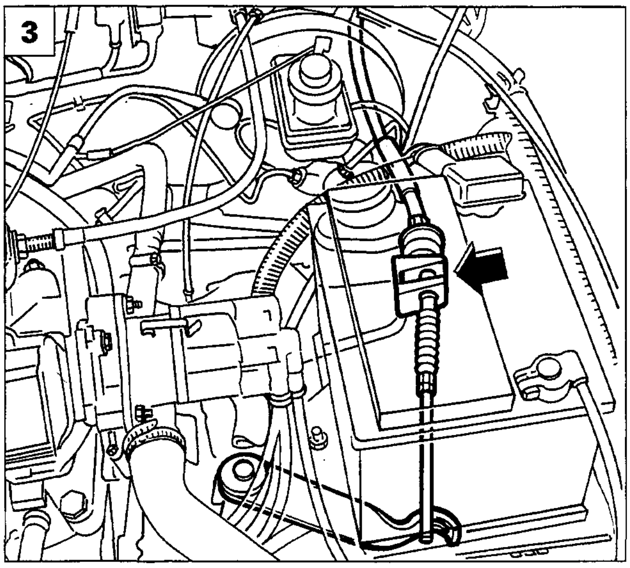


P4A007C05 P4A007C04

CLUTCH PEDAL POSITION ADJUSTMENT (for vehicles with mechanical release mechanism)

1. Measure the clutch pedal travel:
   1. Pedal in end of travel position
   2. Pedal in rest position
   X. Pedal travel:
   163 mm for 1370-1581-1747-1929 D

Carefully measure the pedal travel to ensure the correct clutch release (± 5 mm).

2. In order to adjust the clutch pedal in the rest position, it is necessary:
   to bed in the clutch release mechanism by fully depressing the pedal at least 5 times. Check that the travel "X" is within the values given above. The travel is measured with a rule by the centre line of the pedal and corresponds to the distance between the position in the end of travel position (pedal in contact with the dashboard bulkhead) and that of the pedal in the rest position.
   Any adjustment of the travel is carried out acting on the nut and, where present, the lock nut for the clutch cable, gearbox side.

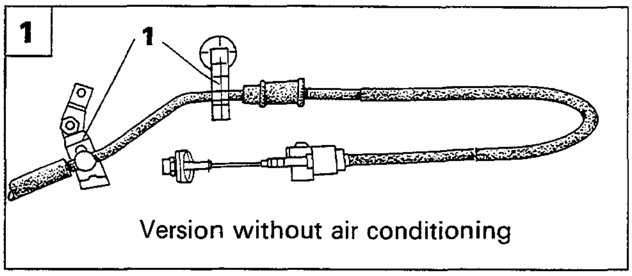
REMOVING-REFITTING CLUTCH CABLE

In order to be able to release the clutch cable it is necessary to remove the:

- Battery
- Relay holder casing
- Battery drip tray

3. Remove the nut and the lock nut, which fix the clutch cable to the control lever (for the 1370 version). For the 1581 - 1747 - 1929 versions, release the cable from the anchorage on the gearbox - differential.

The diagram shows the clutch cable fitted on the 1370 version.



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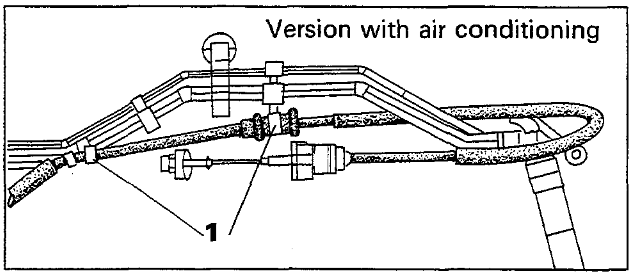

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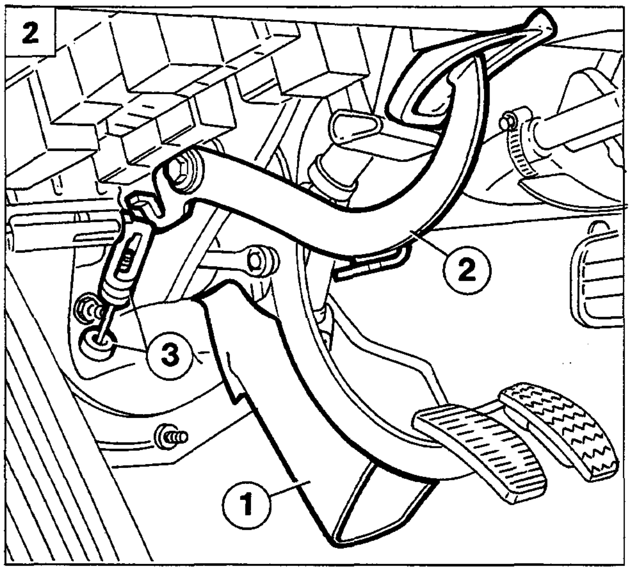

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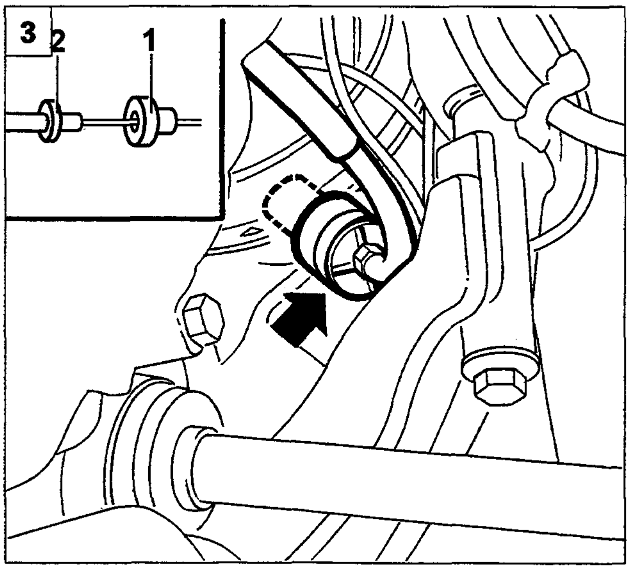

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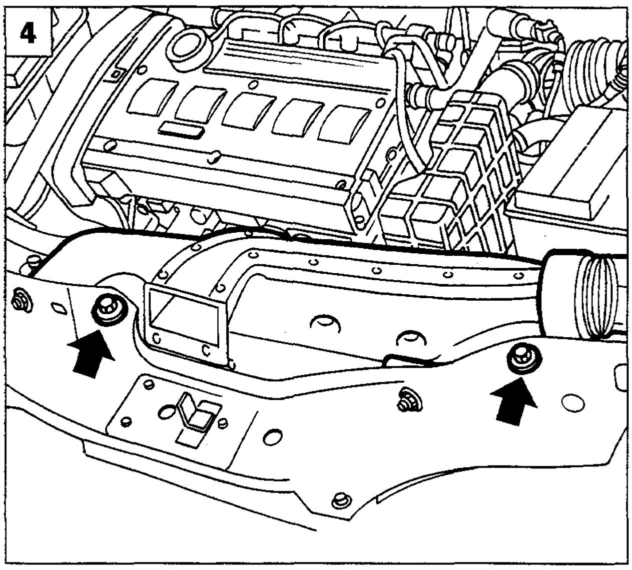

P4A008C03

1. Release the clutch cable from the anchorages (1) on the bodyshell as illustrated in the diagrams above at the side (for 1581 - 1747 - 1929 D versions only).
2. Lift up the carpet (1) near the clutch pedal.
   Disconnect the end (3) of the clutch cable from the pedal (2) (for all versions).
3. From inside the engine compartment, remove the flexible buffer from the anchorage hole in the dashboard bulkhead and extract the complete clutch cable (for all versions).

When refitting the clutch cable it is necessary to position the flexible rubber buffer (1) on the dashboard bulkhead and then insert the rigid buffer (2) in the opening in the flexible buffer. When the operation is completed, check and adjust the pedal travel as described previously. For the 1581-1747 -1929 D versions, take care when refitting the cable in the mountings on the gearbox or else the cable will deteriorate.

REMOVING-REFITTING HYDRAULICALLY OPERATED CLUTCH COMPONENTS (1998 20v)

CLUTCH PUMP

4. Remove the air intake duct acting on the bolts shown in the diagram.
   Disconnect the positive battery pole and remove the battery from the engine compartment working on the nut fixing the retaining bracket.

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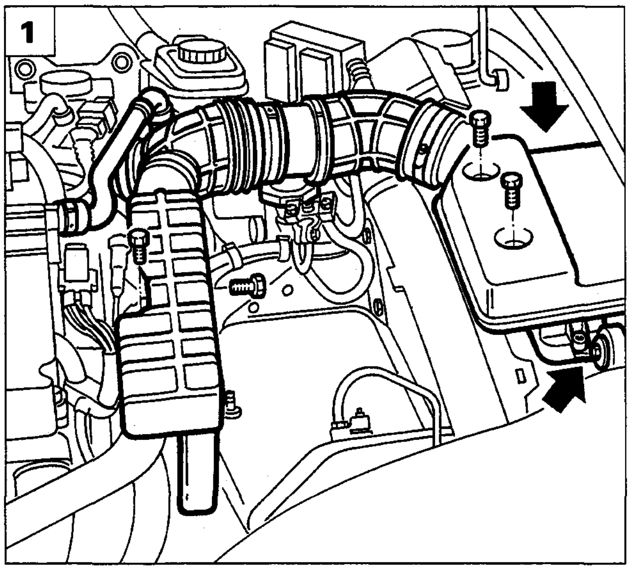

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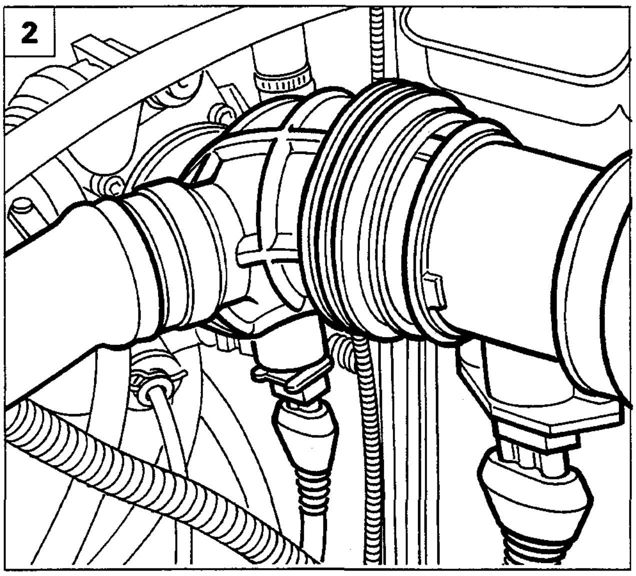

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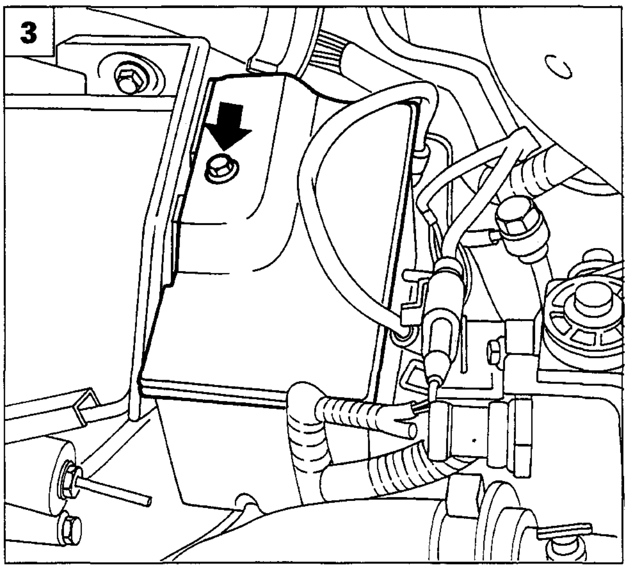


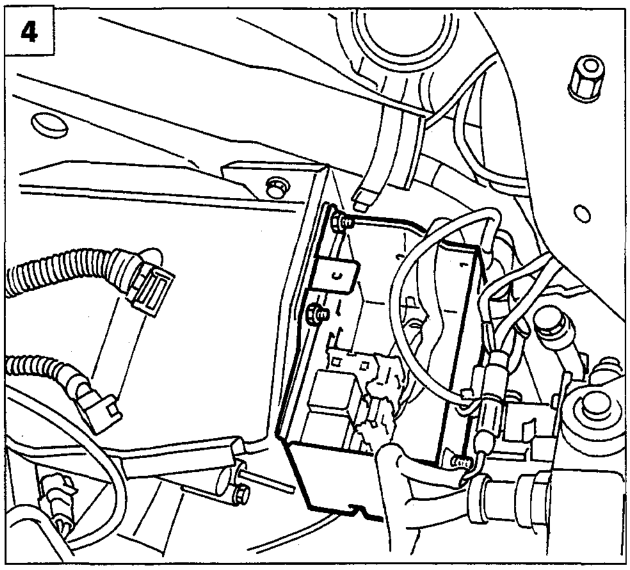
P4A009C01

1.2. Disconnect the pipe connecting the air filter to the butterfly casing acting as illustrated in the diagram also removing the resonator.

3. Remove the relay box cover.

4. Remove the nuts fixing the relay box to the battery drip tray, then place it at the side.

5. Remove the bolts (1) and loosen the bolt (2) fixing the battery drip tray to the bodyshell. Before removing the battery drip tray, disconnect the band underneath retaining the cables.



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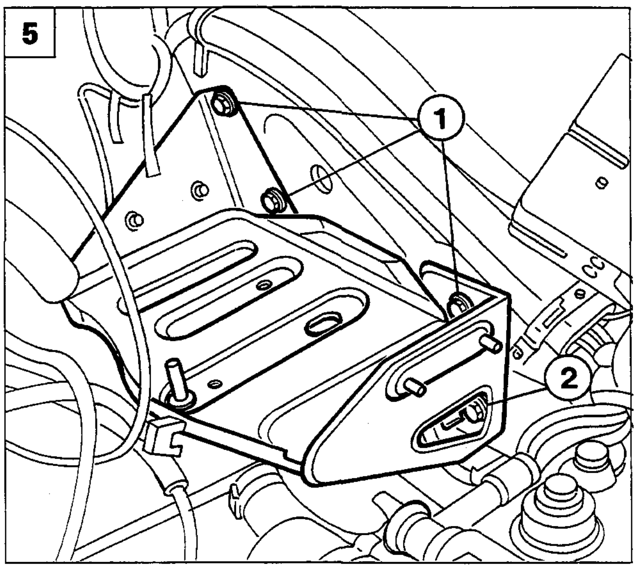

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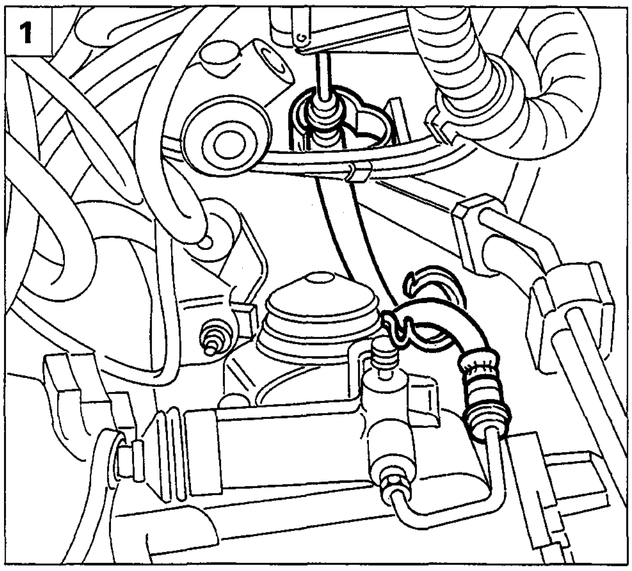

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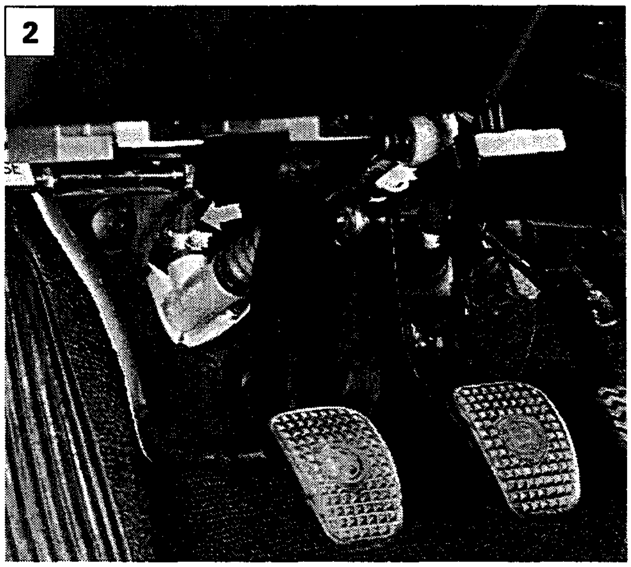

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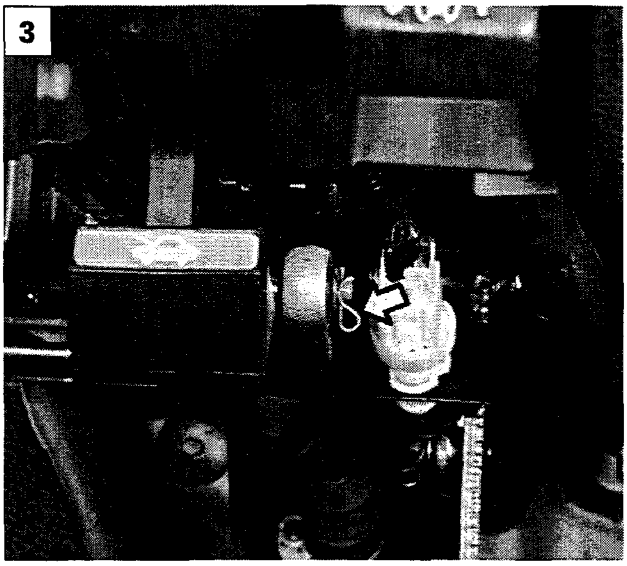

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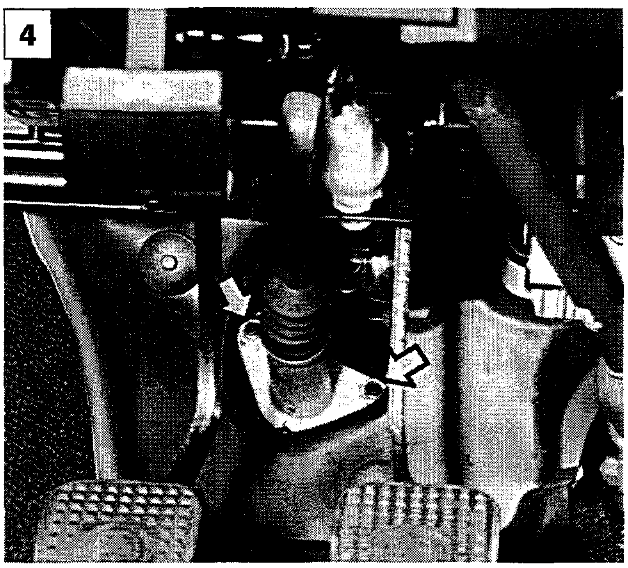
1. Release the pipe connecting the operating cylinder to the retaining bands.
2. Disconnect the pipe for the hydraulic system from the clutch pump.

Before disconnecting the pipe it is necessary to drain the hydraulic system.

3. Remove the clip fixing the clutch pump to the pedal.
4. Undo the nuts fixing the clutch pump to the bodyshell.
5. Disconnect the brake fluid supply union from the clutch pump, then remove it.



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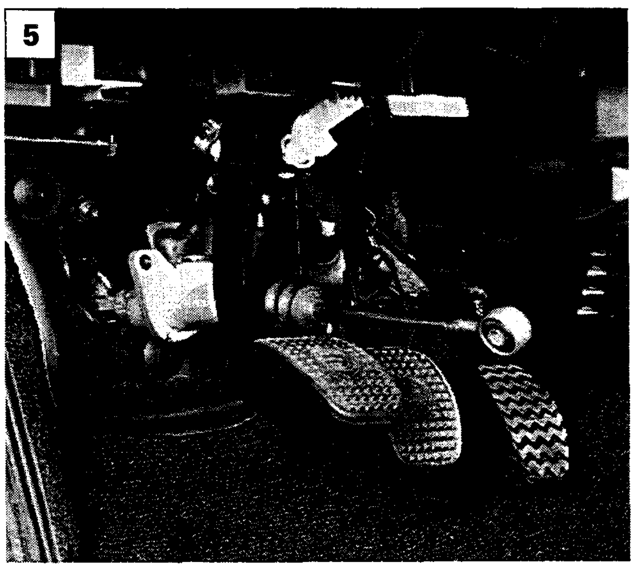

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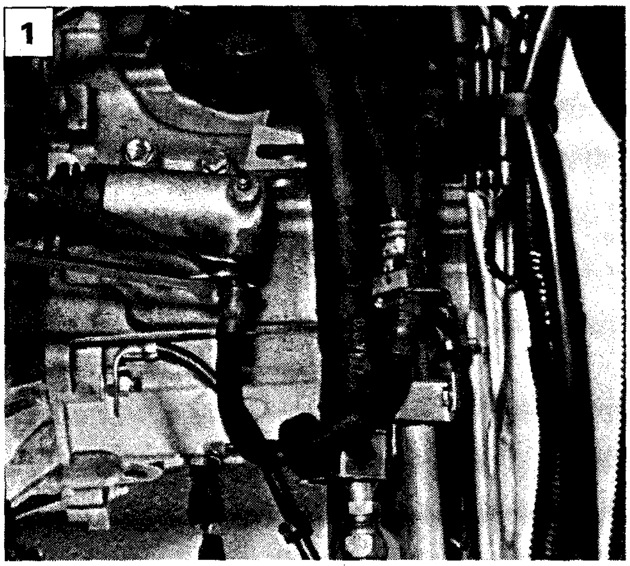

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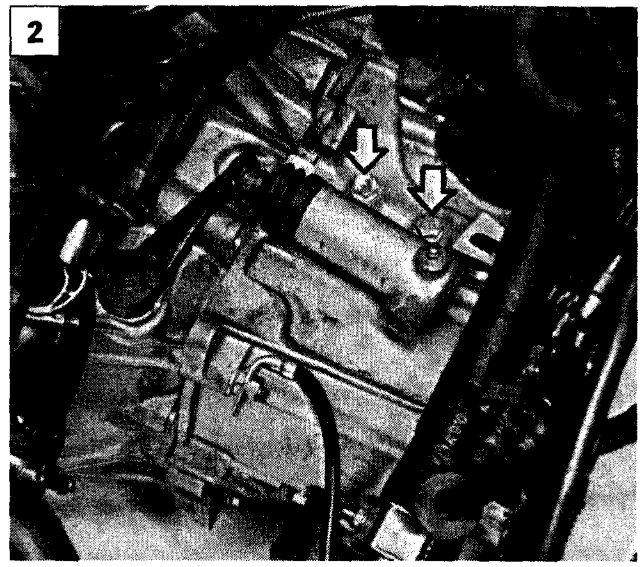

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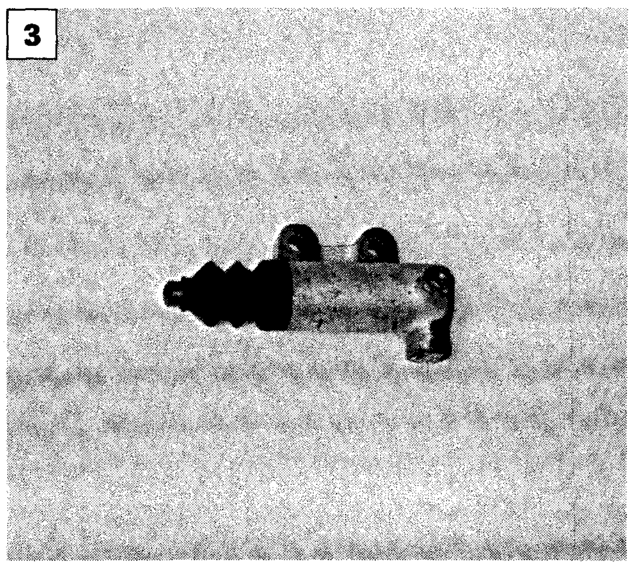
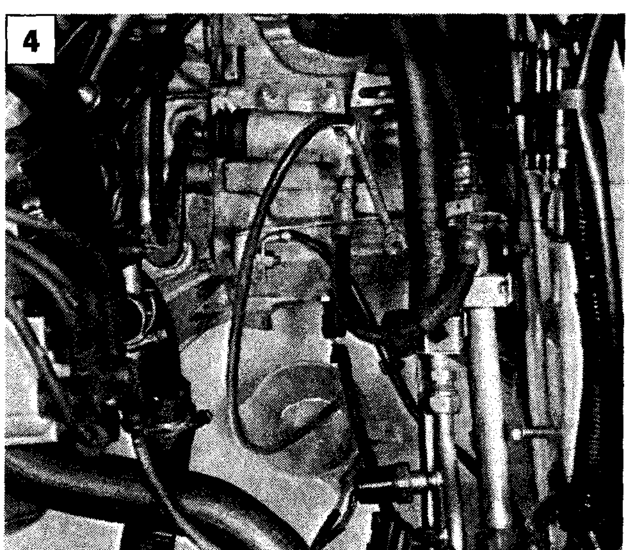


OPERATING CYLINDER (1998 20v)

1. Disconnect the flexible pipe from the operating cylinder.
2. Undo the nuts shown and remove the clutch operating cylinder.
3. View of clutch operating cylinder assembly.



P4A013C03

BLEEDING (1998 20v)

4. Do not, under any circumstances, reuse the fluid recovered.
   The level should be topped up with new brake fluid.

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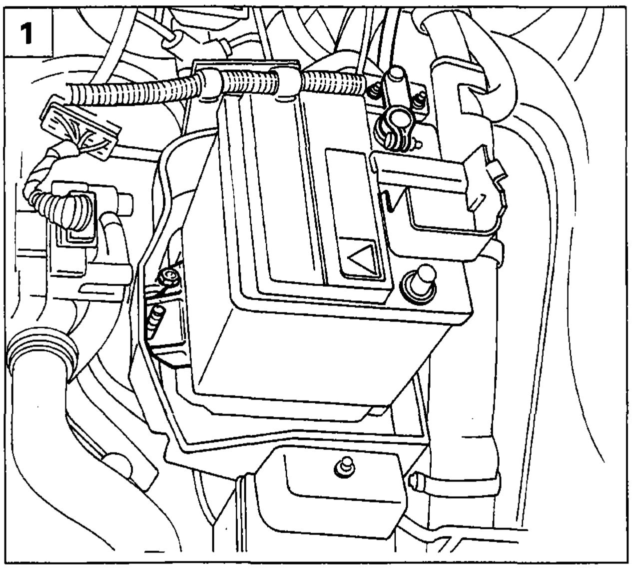
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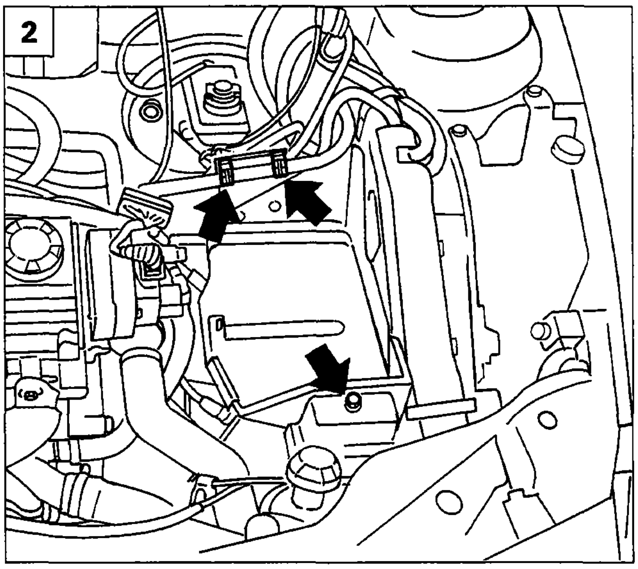
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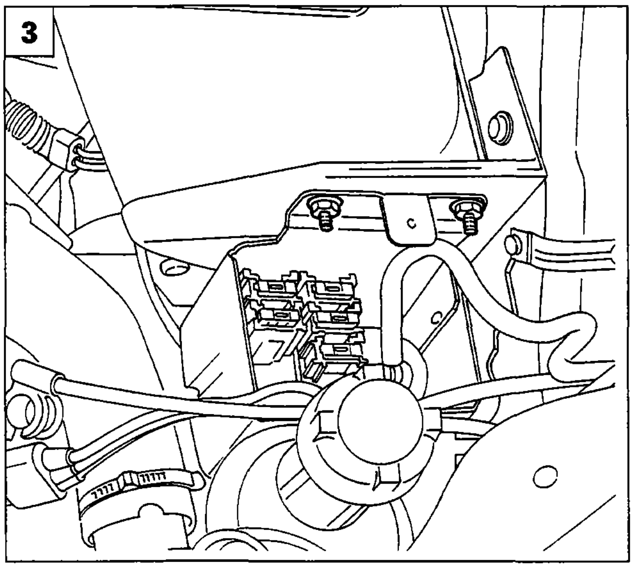
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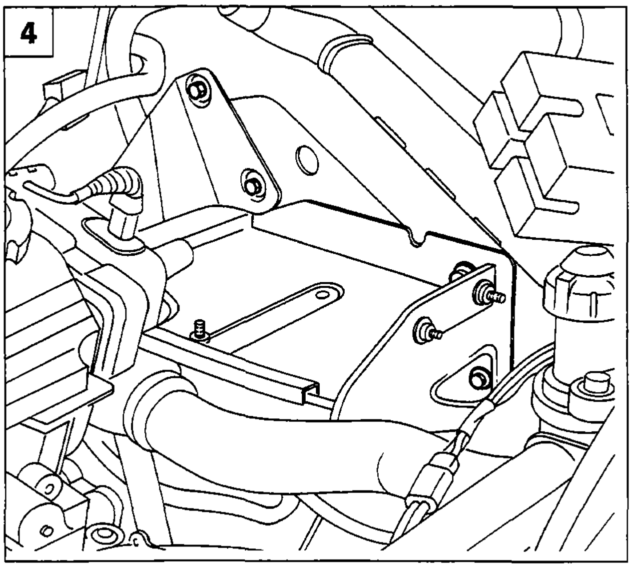
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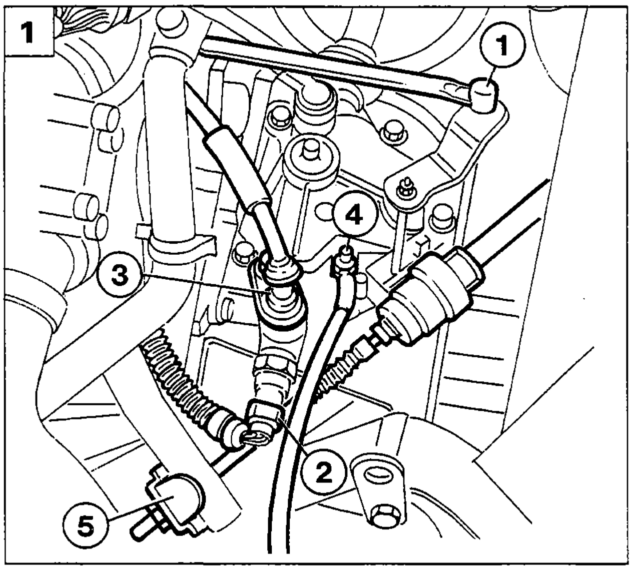
REMOVING - REFITTING

Removing

Place the car on ramps, remove the front wheels, then proceed as described below:

1. Disconnect the battery's negative terminal, lift the protective cover from the positive terminal and disconnect the latter; undo the nut securing the battery mounting bracket to the battery cage and remove the battery.
2. Release the electrical cables shown in the figure from their clamps, then undo the bolts securing the relay box cover.
3. Remove the nuts securing the relay box to the battery cage, then move the box over to one side.
4. Undo the bolts shown in the figure and remove the battery cage from the engine compartment.

21-27.



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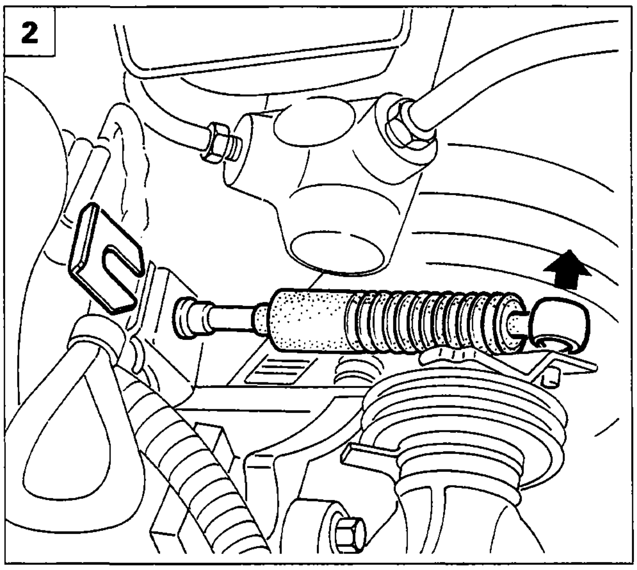

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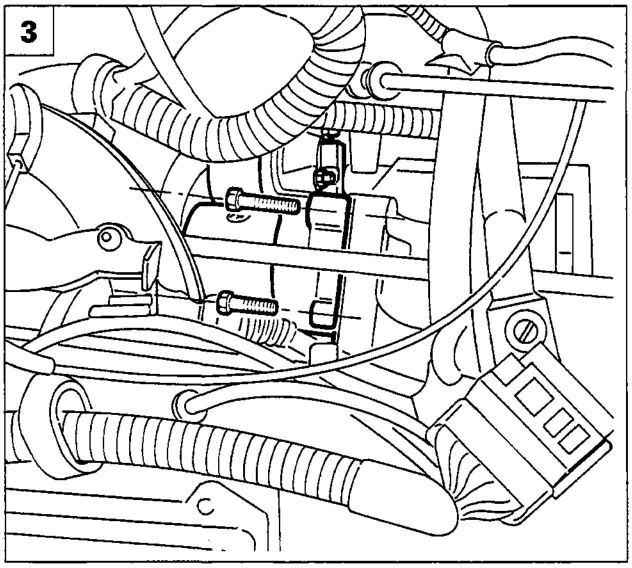

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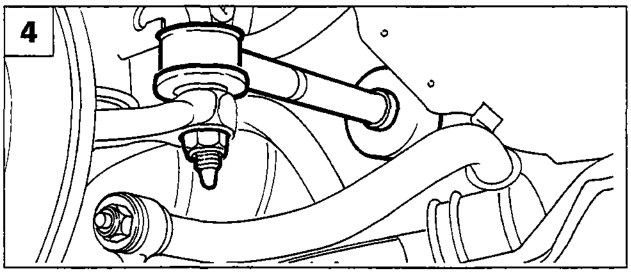

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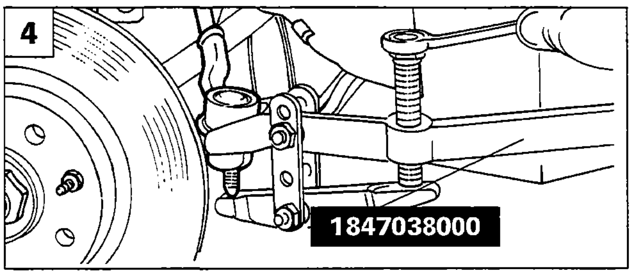

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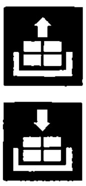
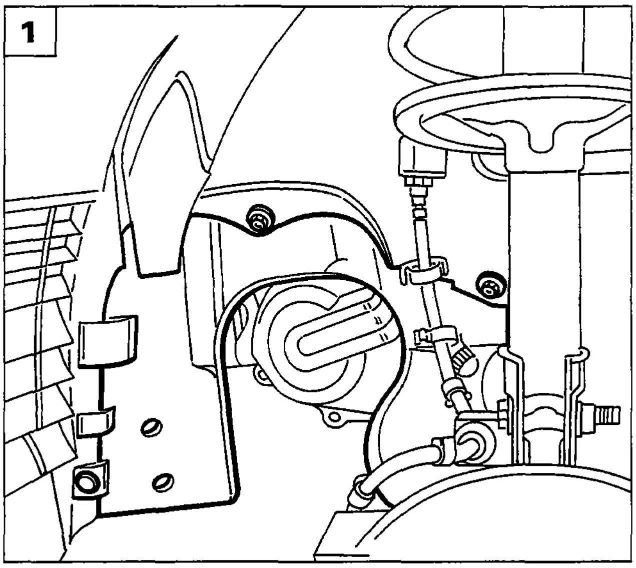


1. Disconnect the gear selector rod (1), disconnect the reversing lights switch (2), inhibition cable (3), earth cable (4) and clutch cable (5).

2. Disconnect the head of the gear engagement flexible transmission cable, disconnect the odometer connection then move the assembly aside in the engine compartment.

3. Undo the top bolts securing the starter motor to the gearbox.

4. Raise the ramps, undo the nut securing the steering tie-rod end, then using tool 1847038000 disconnect it from the vertical link. Repeat the procedure for the tie-rod end on the other side.



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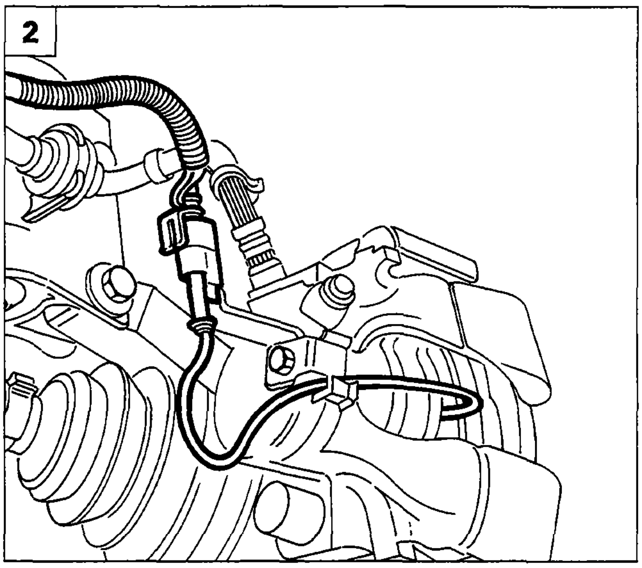

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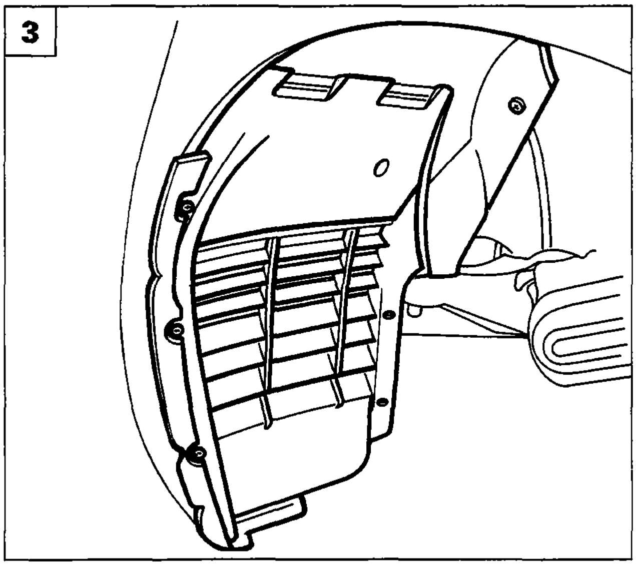

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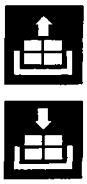
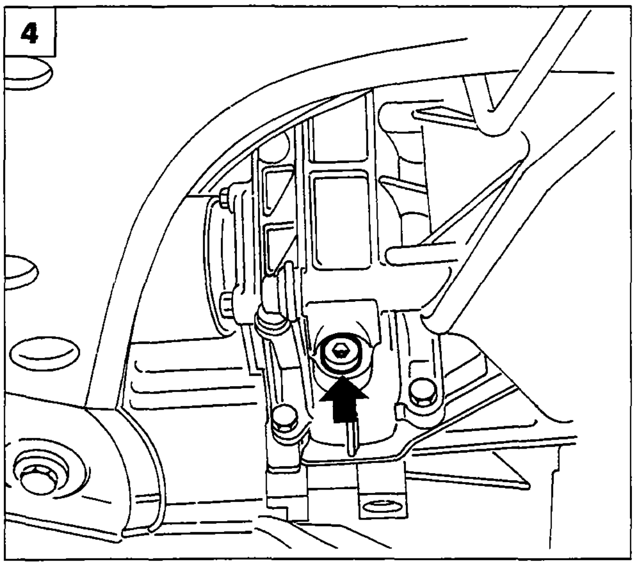


1. Using tool 1878077000, remove the button securing the dust guard to the body shell, then undo the bolts and release the guard from its seating. Repeat the procedure on the dust guard on the other side.
2. Disconnect the brake pad connector then withdraw the central dust guard from the car. Repeat the procedure on the right side.
3. Remove the front dust guard by undoing the attachments illustrated.
4. Prepare a tray to collect the gearbox oil, then undo the plug (arrowed) and drain the gearbox oil.
5. Remove the bolts securing the damper to the vertical link and turn the vertical link inwards, releasing the brake pipe from the damper.



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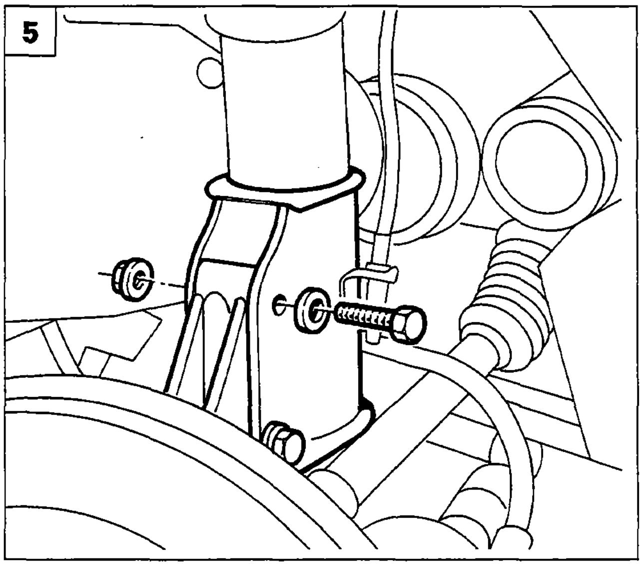

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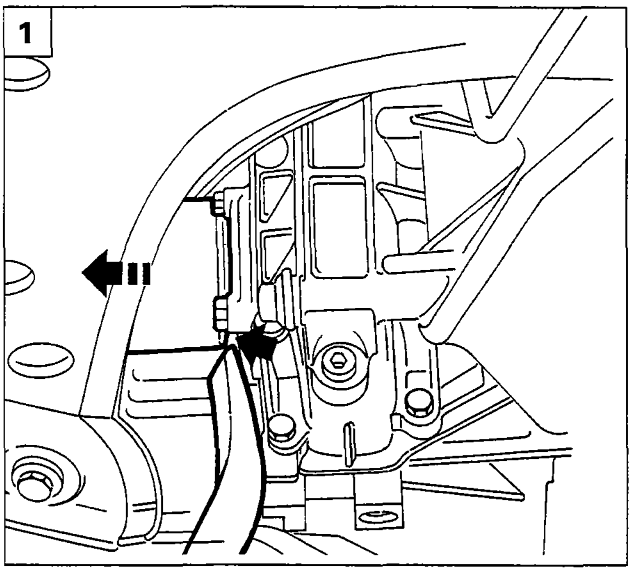

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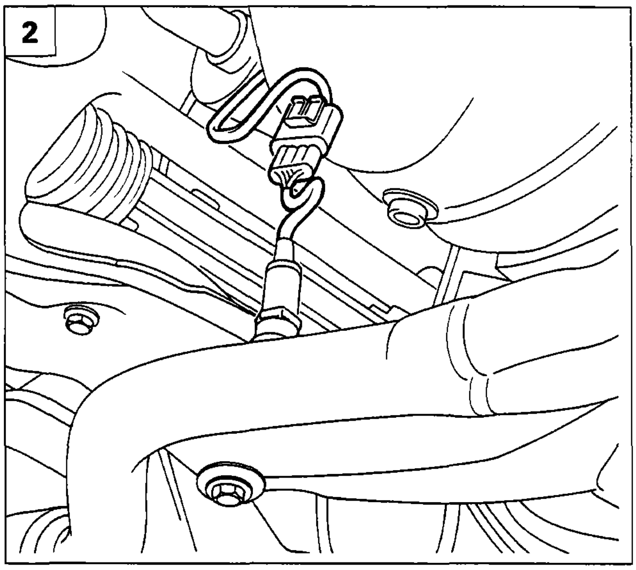

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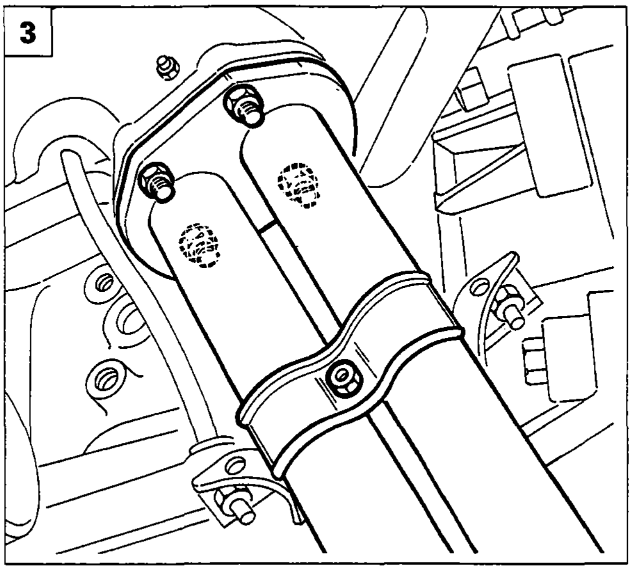
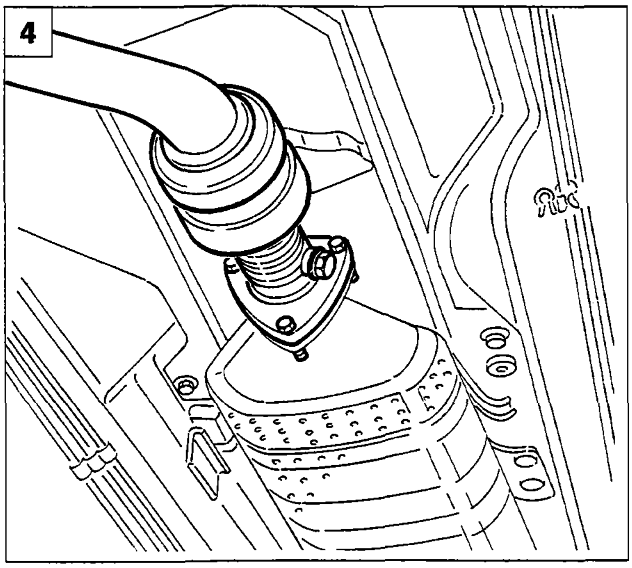


P4A004B03

1. Disconnect the drive shaft, gearbox side, from the differential, levering on the engagement point, and move it away from the working area.
2. Disconnect the Lambda probe wiring connector.
3. Undo the nuts securing the first section of the exhaust pipe to the manifold.
4. Undo the rear attachments and remove the first section of the exhaust pipe from the car.
5. Disconnect the drive shaft, intermediate shaft side, from the differential, levering on the engagement point.



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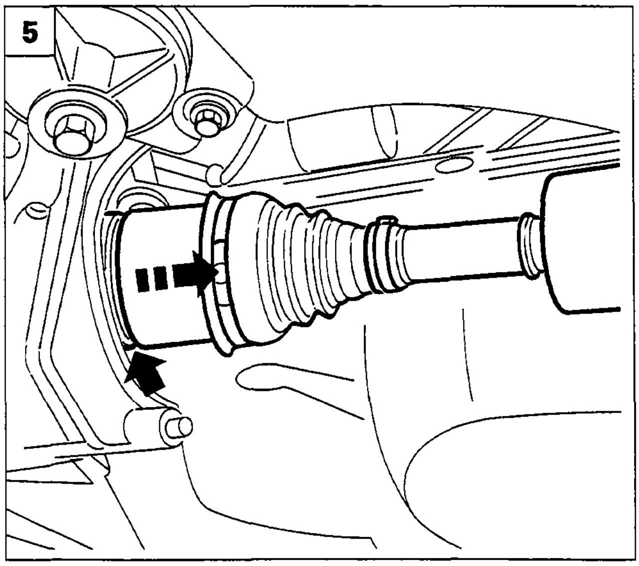

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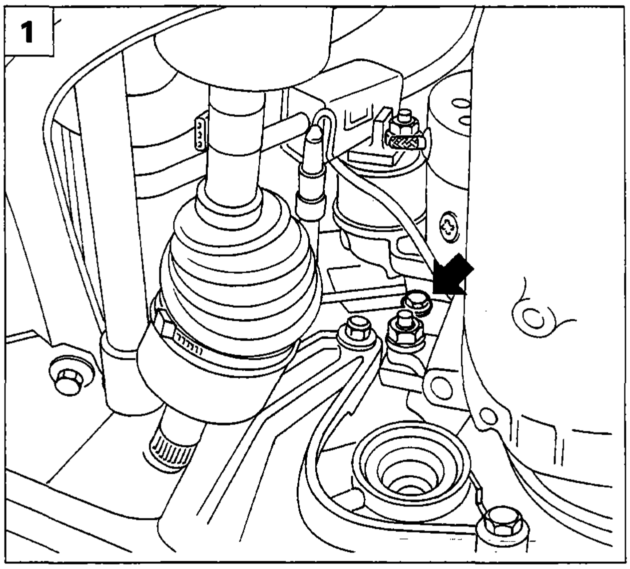

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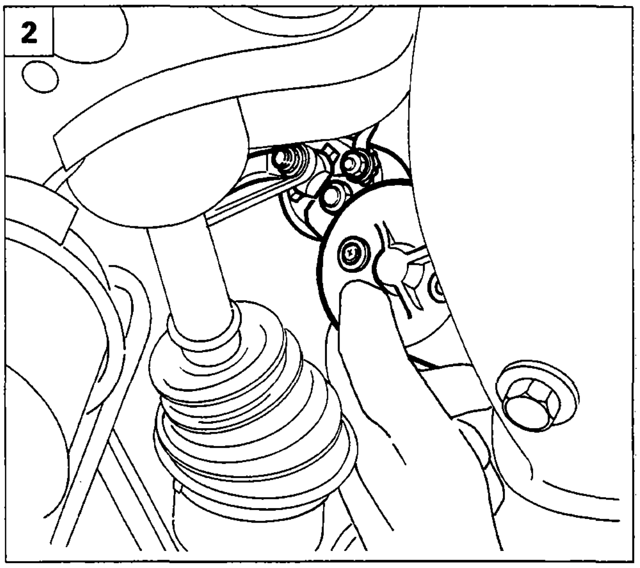

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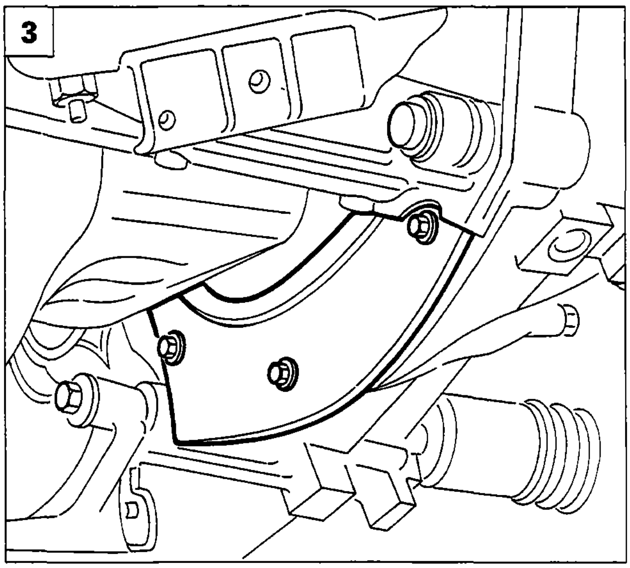
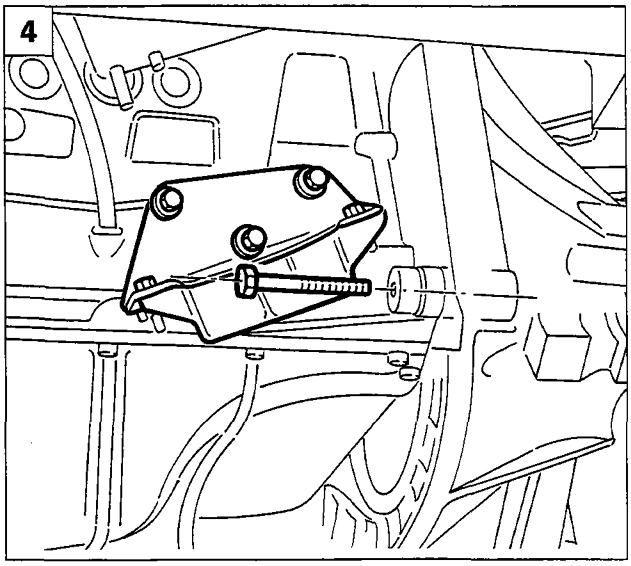


P4A005B03

1. Undo the bottom bolt securing the starter motor.
2. Disconnect the starter motor cables and disconnect the starter motor.
3. Remove the flywheel cover by undoing the bolts illustrated.
4. Remove the mounting bracket securing the first section of the exhaust pipe, to enable a spanner to be inserted to remove the bolt securing the gearbox to the engine.
5. Lower the ramps and remove the left windscreen wiper arm.



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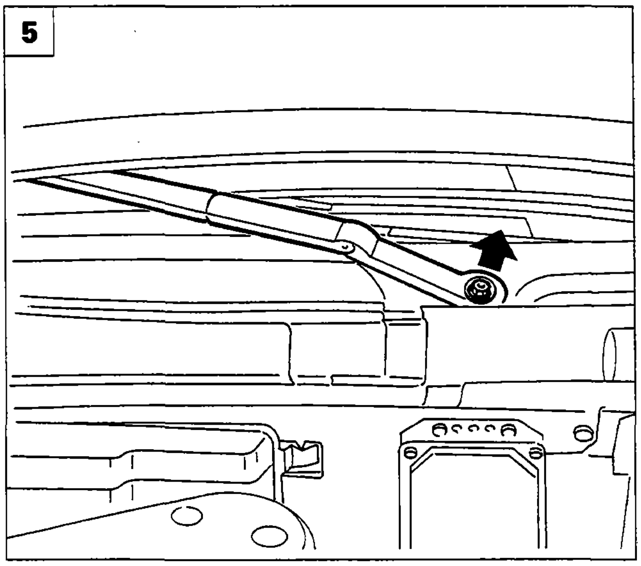

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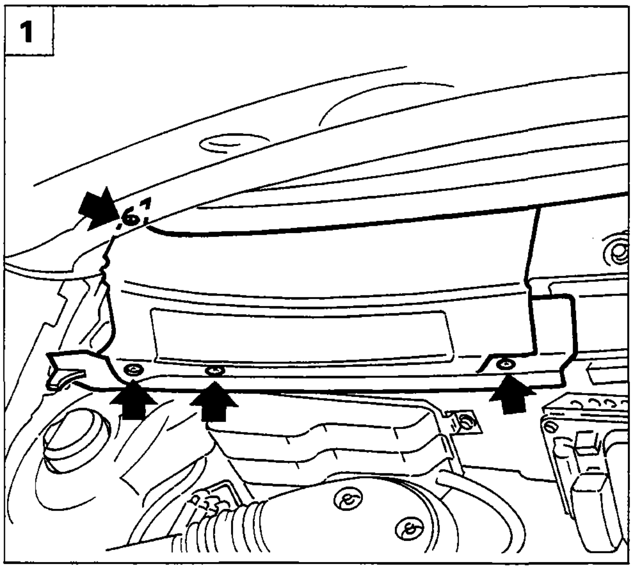

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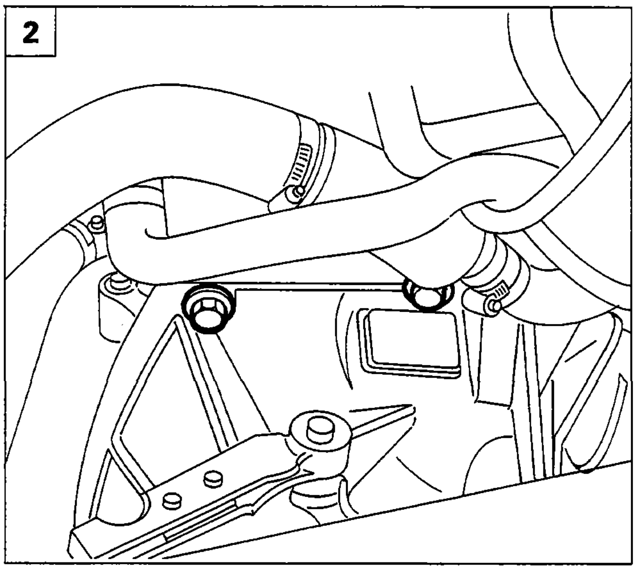


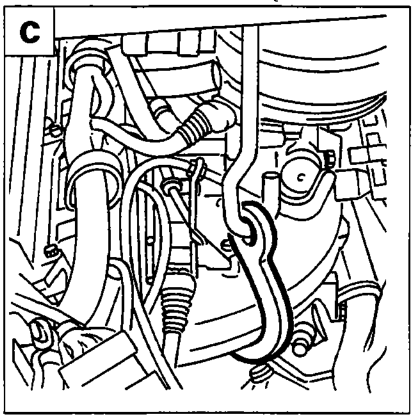
P4A006B02

1. Remove the plastic cover from the anti-pollen filter by undoing the screws illustrated.
2. Undo the top bolts securing the gearbox to the engine.
3. Fit the engine support stand 1860851000 on its mounting points.

a. Front mounting: insert the tool in the seat of the safety catch so that it rests on the front crossframe.

b. Rear mounting: position the tool level with the central reinforcement of the fire-proof bulkhead.

c. Secure the hook of the support stand to the inlet manifold so that it supports the power unit centrally.



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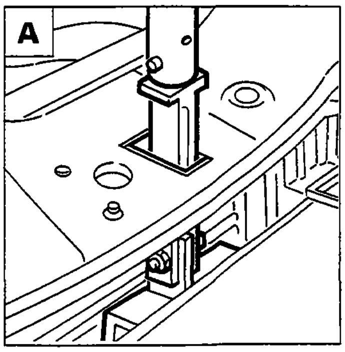

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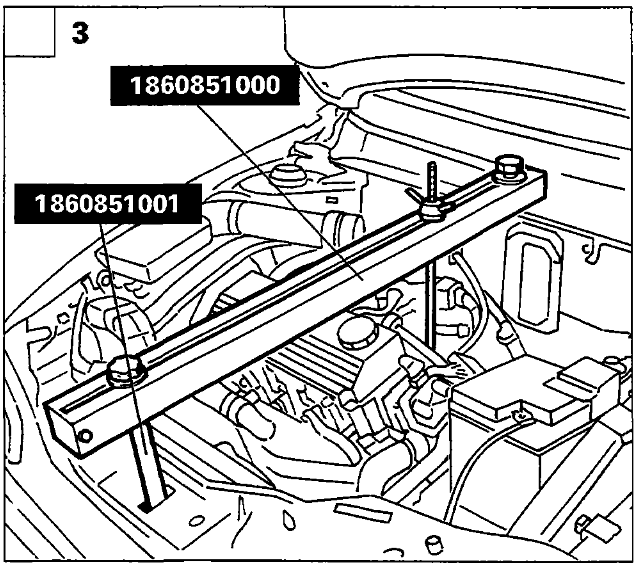

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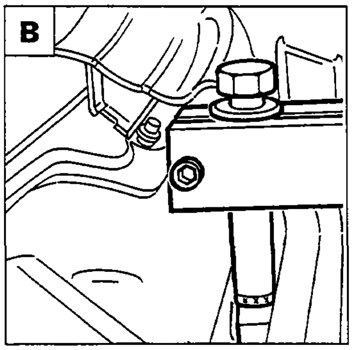

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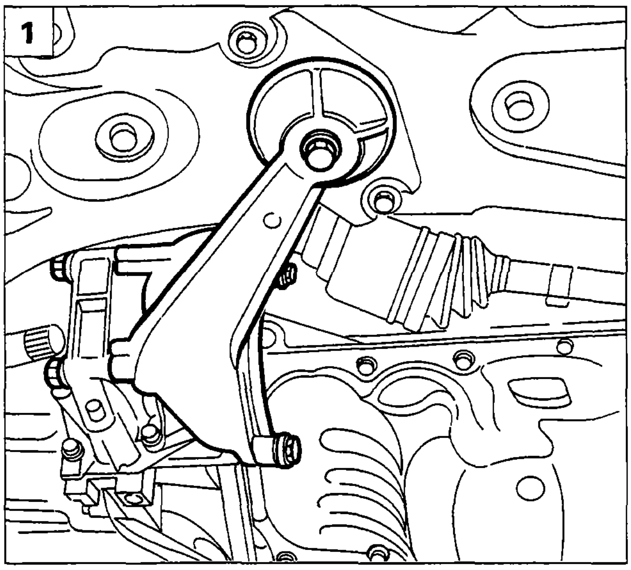
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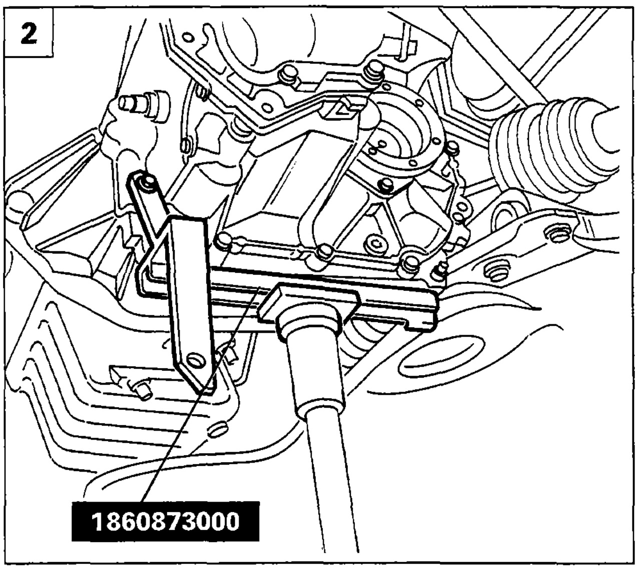

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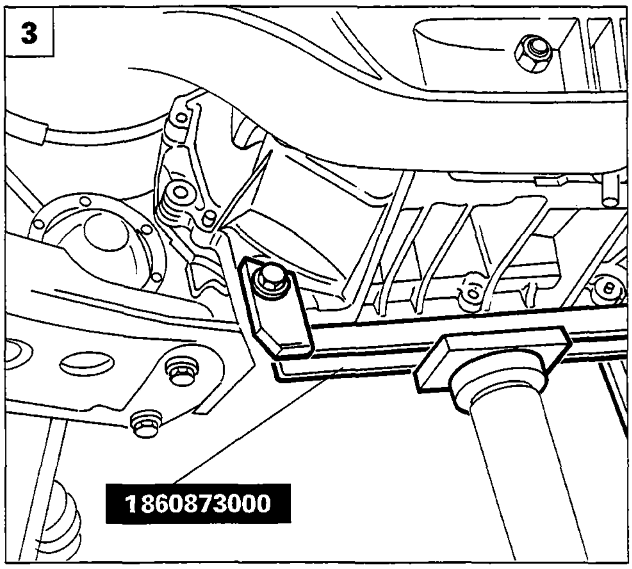


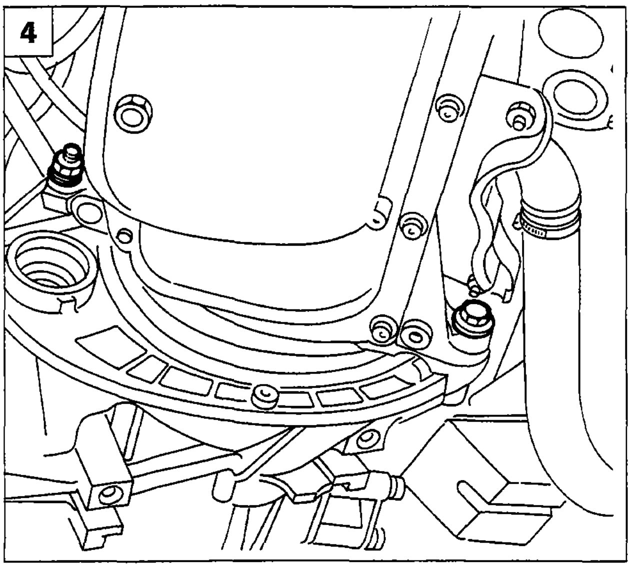
P4A026B03

1. Raise the car and disconnect the central power unit mounting from the bodywork and the gearbox.

2.3 Install the tool illustrated to support the gearbox during the removal operation.

4. Undo the remaining bolts securing the gearbox to the engine.

5. Remove the front power unit mounting, gearbox side, from the bodywork and the gearbox.

4

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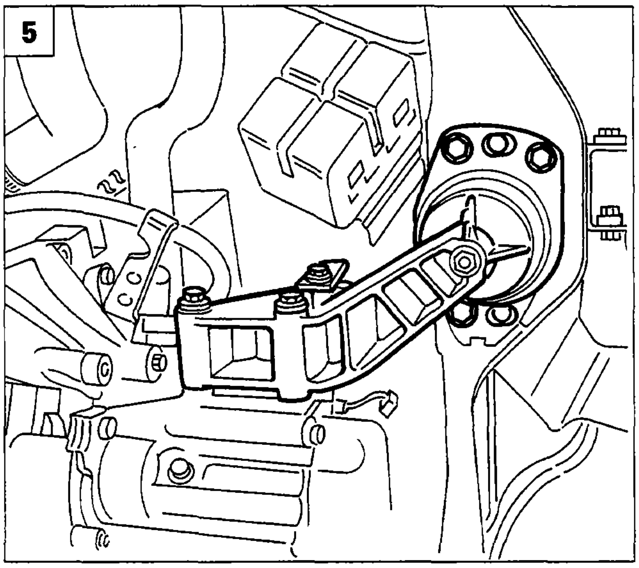
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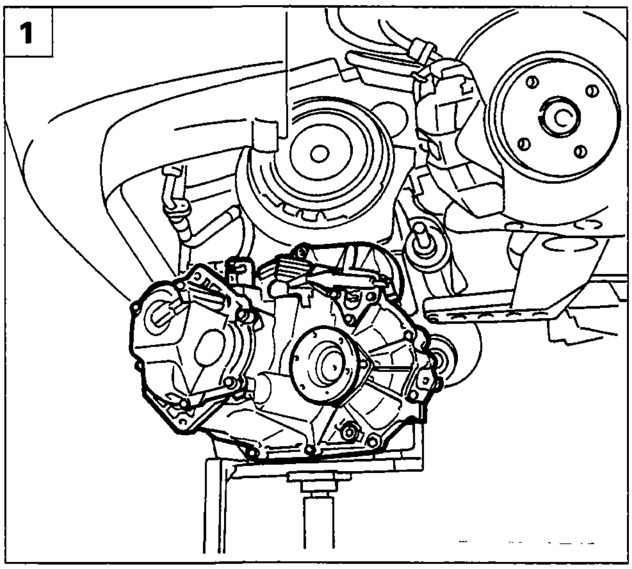
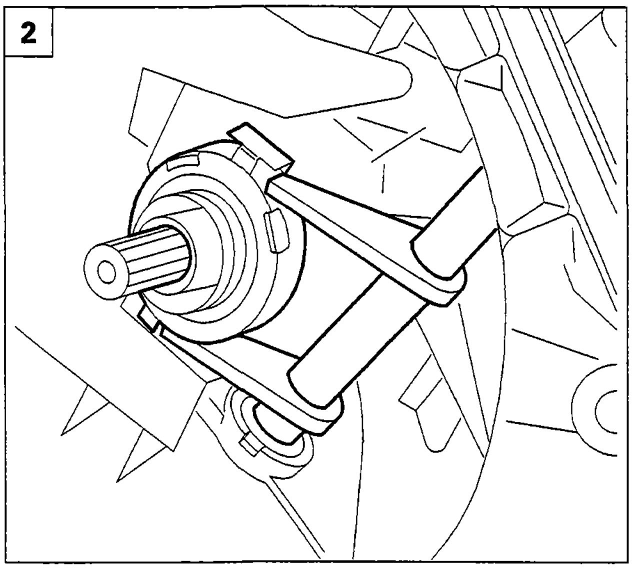


P4A008B01

1. Manoeuvre the jack as appropriate to release the gearbox from the centring studs, then remove the gearbox from the engine compartment by slowly lowering the hydraulic jack.

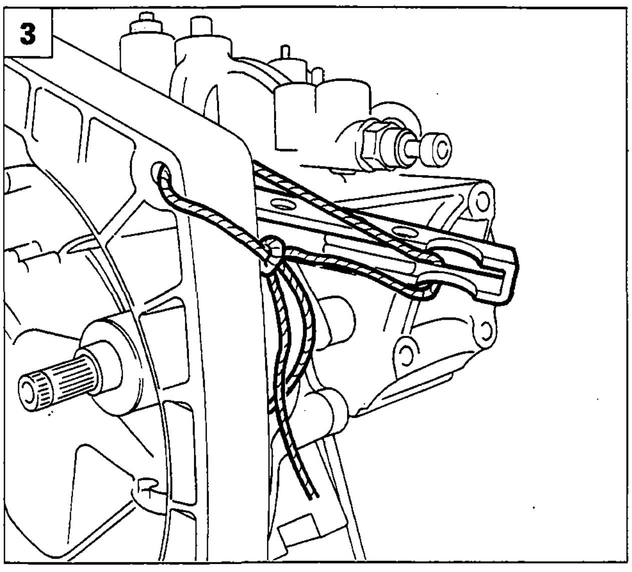


P4A008B02

Refitting

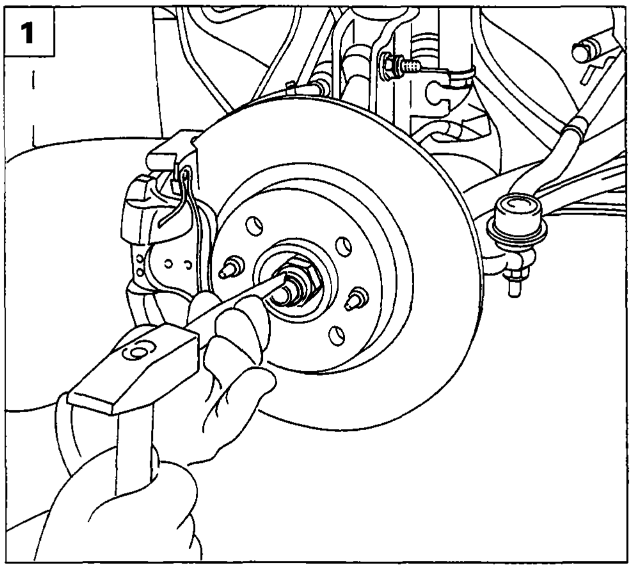
Before refitting the gearbox-differential unit, check that the clutch release bearing has remained in the bellhousing and has not engaged with the clutch. Carry out the operations below:

2. Check that the clutch release bearing is positioned correctly on the gearbox main shaft.



P4A008B03

3. Secure the clutch release lever, in the fully back position, to the bellhousing, then using the hydraulic jack bring the gearbox-differential unit to the clutch, centre ot in its references and secure it to the engine. For the subsequent operations, reverse the procedure for removal.

1

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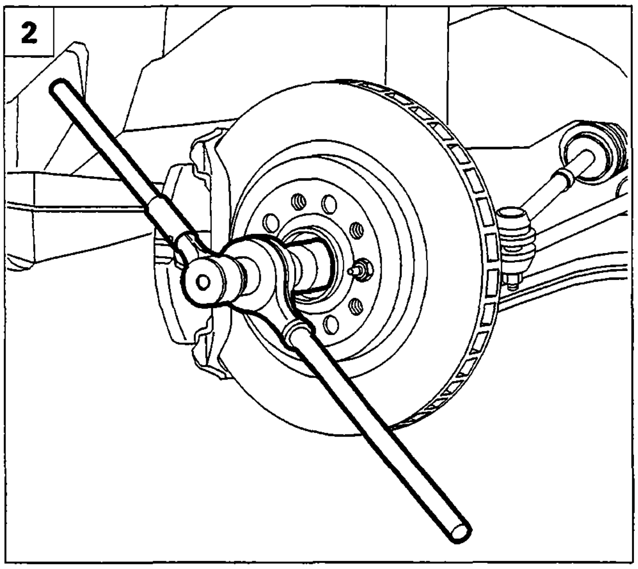
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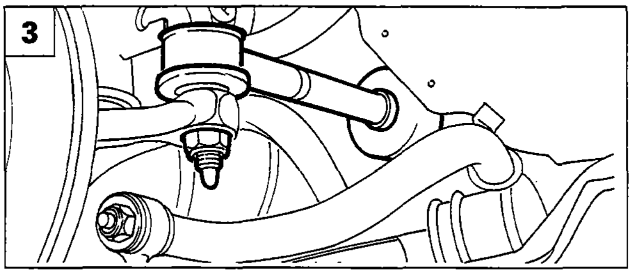
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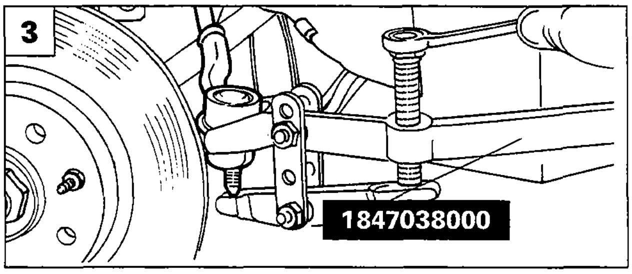

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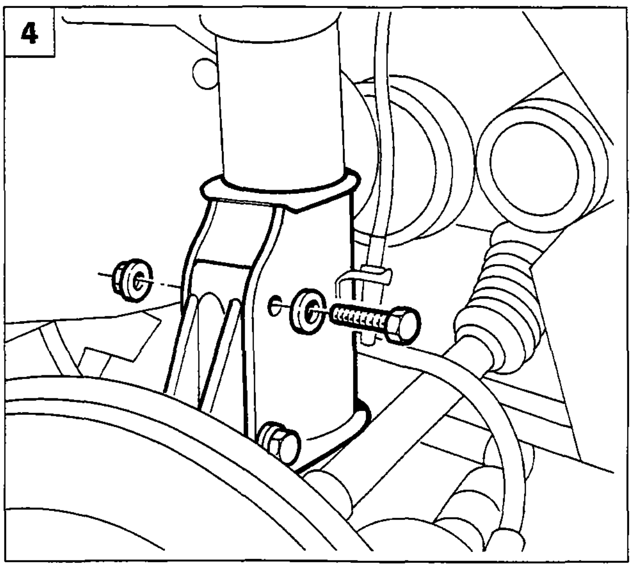

P4A003B05

REMOVING - REFITTING

Place the car on ramps, disconnect the battery's negative terminal, remove the front wheels and then proceed as follows:

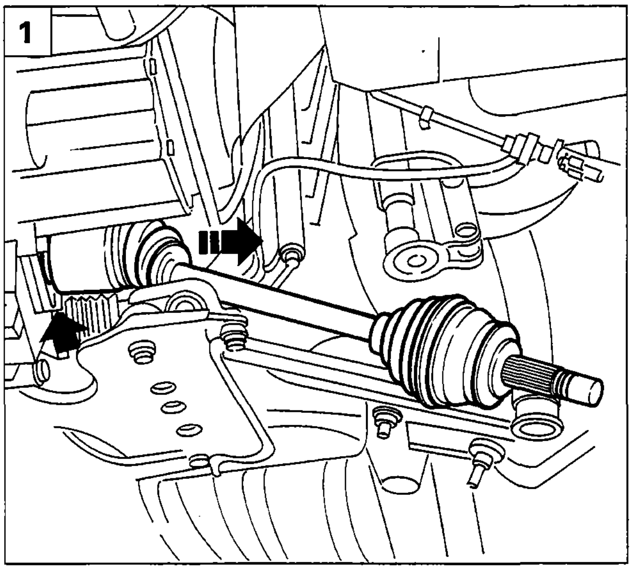
1. Using a hammer and chisel, relieve the staking on the hub nut.

2. Unscrew the hub nut.

3. Undo the bolt on the tie-rod end then use tool 1847038000 to disconnect the tie-rod.

4. Undo the bolts securing the vertical link to the damper, and angle the vertical link to release the shaft.

21-27.



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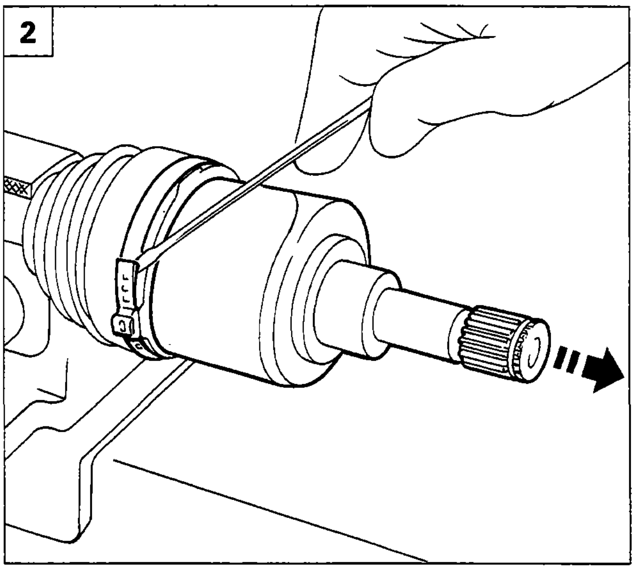

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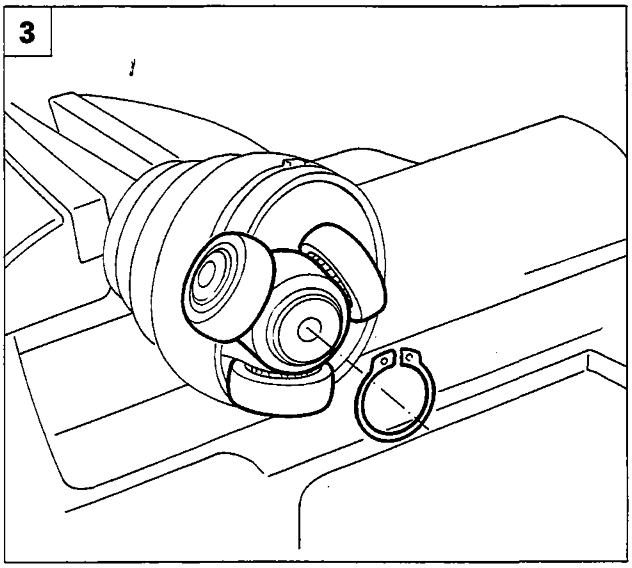

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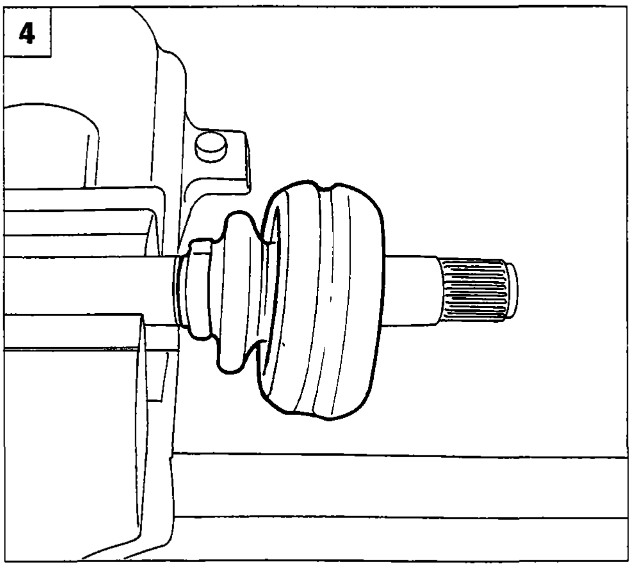


P4A010B04

1. Disconnect the drive shaft from the differential levering on the engagement point, then withdraw it from the car.

NOTE *To refit, reverse the procedure for removal, tightening the hub nut to the specified torque.*

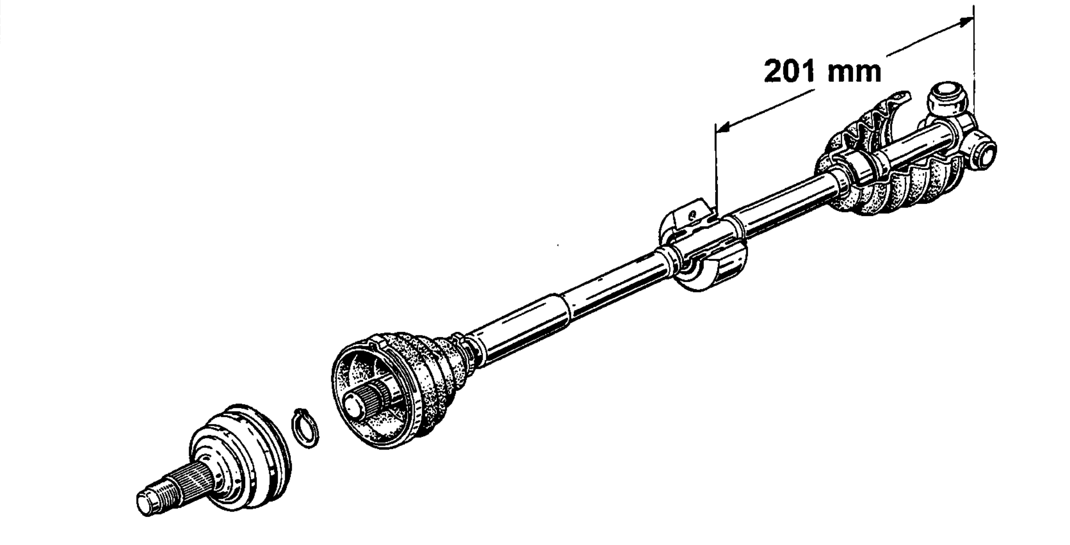
DISMANTLING

2. Place the drive shaft in a vice, remove the protective gaiter from the joint on the gearbox side, then remove the joint.

3. Remove the circlip from the tripod joint and withdraw the joint from the drive shaft.

NOTE *If the joint is damaged, it should be renewed.*

4. Undo the clip on the protective gaiter on the gearbox side, then withdraw it from the drive shaft.

1


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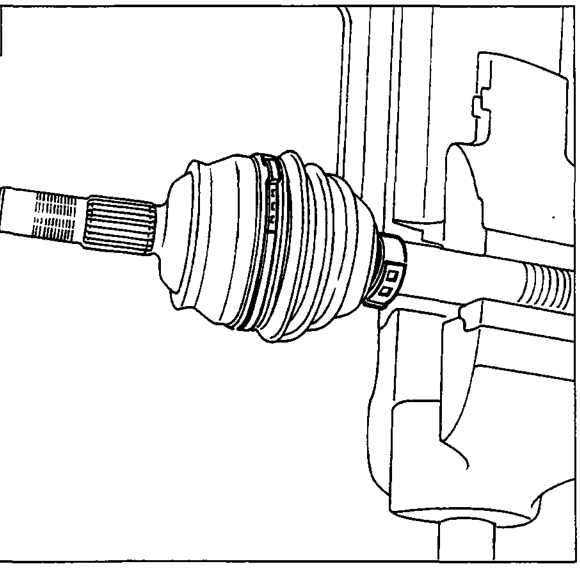
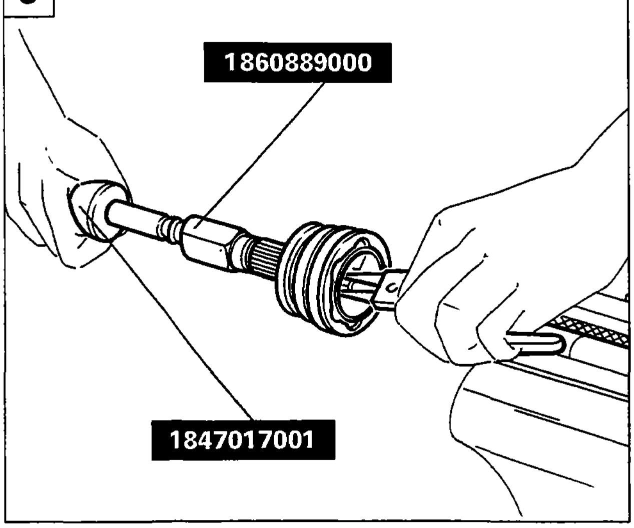


P4A011B02

1. If interventions on the right drive shaft involve dismantling the damping weight, during reassembly refit the weight at the distance specified in the figure.
2. Undo the clips securing the protective gaiter on the constant velocity joint, wheel side, then withdraw it from the side opposite the drive shaft.
3. Clean the grease off the inside of the constant velocity joint, and using tools 1847017001 and 1860889000 simultaneously on the circlip inside the joint, remove the joint from the drive shaft.
4. Check that the drive shaft is not deformed or out of true, and that the seal contact surface is not worn.

3


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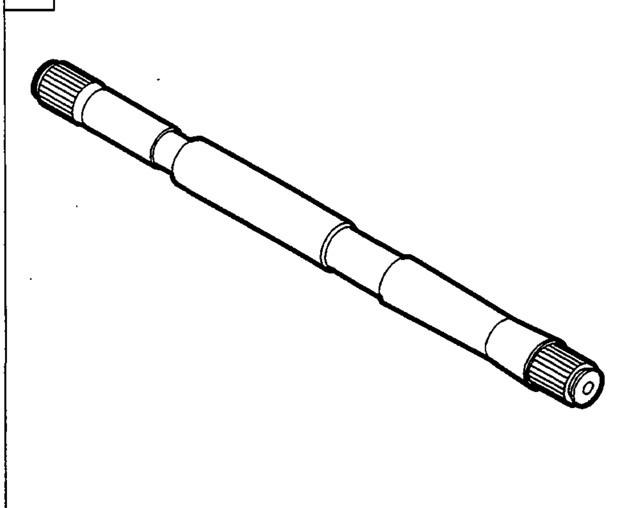

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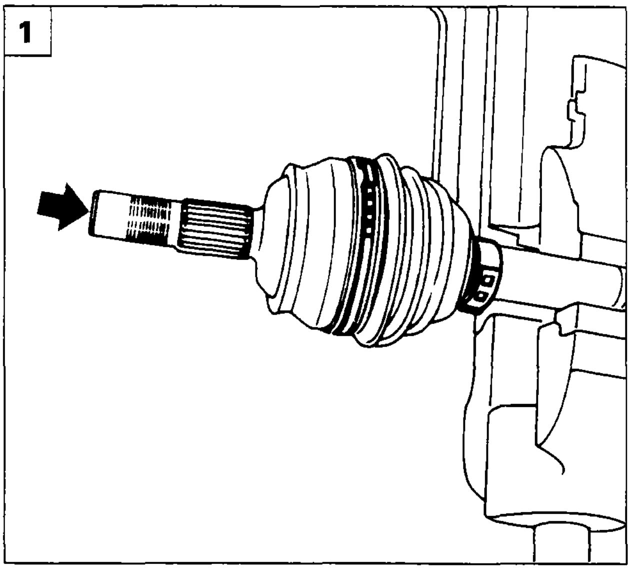


P4A012B01

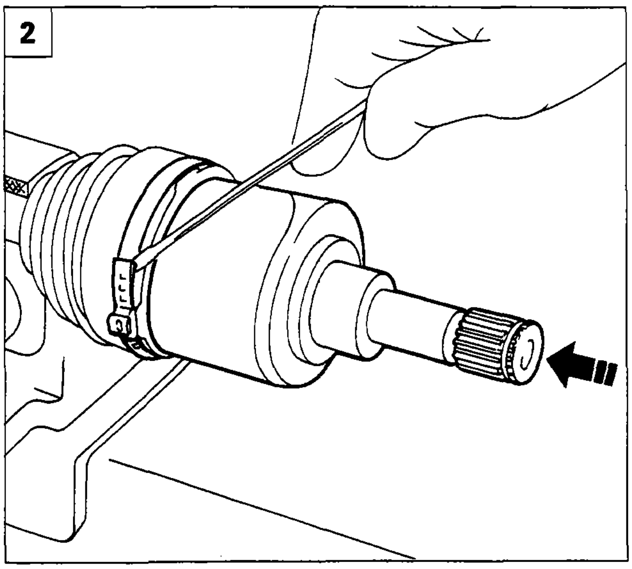
REFITTING

1. Refit the protective gaiter on the wheel side and fit the constant velocity joint, applying appropriate pressure.

It is advisable to replace the protective gaiters whenever they are removed, and it is important to fill both constant velocity joint and gaiter with TUTELA MRM2 grease.

Shaft-joint coupling on wheel side			
Shaft classification		Joint classification	
Categ.	Colour	Categ.	Colour
A	Blue	A	Blue
		B	White
B	Red	C	Red

When refitting, the constant velocity joints must be coupled to the shaft as shown in the table. Category B joints are coupled with both categories of drive shaft; conduct a further check on the joint to make sure there are no signs of seizure or scoring.

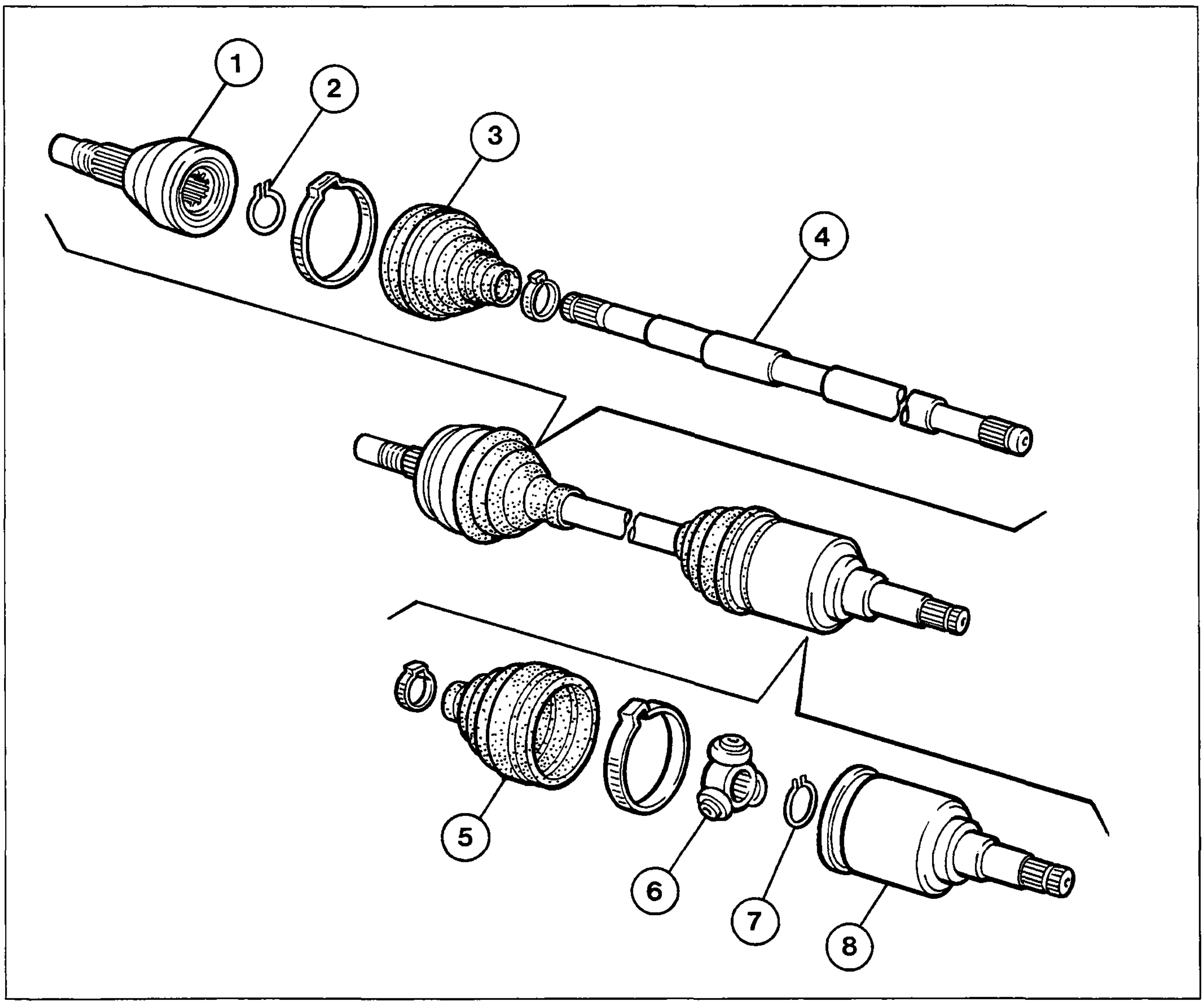


P4A012B02

2. Refit the protective gaiter on the gearbox side, fit the tripod joint securing it with the circlip, and then fit the joint on the gearbox side and secure the gaiter with its clips.

It is advisable to replace the protective gaiters whenever they are removed, and it is important to fill both joint and gaiter with TUTELA MRM2 grease.

DRIVE TRANSMISSION COMPONENTS



P4A013B01

Key

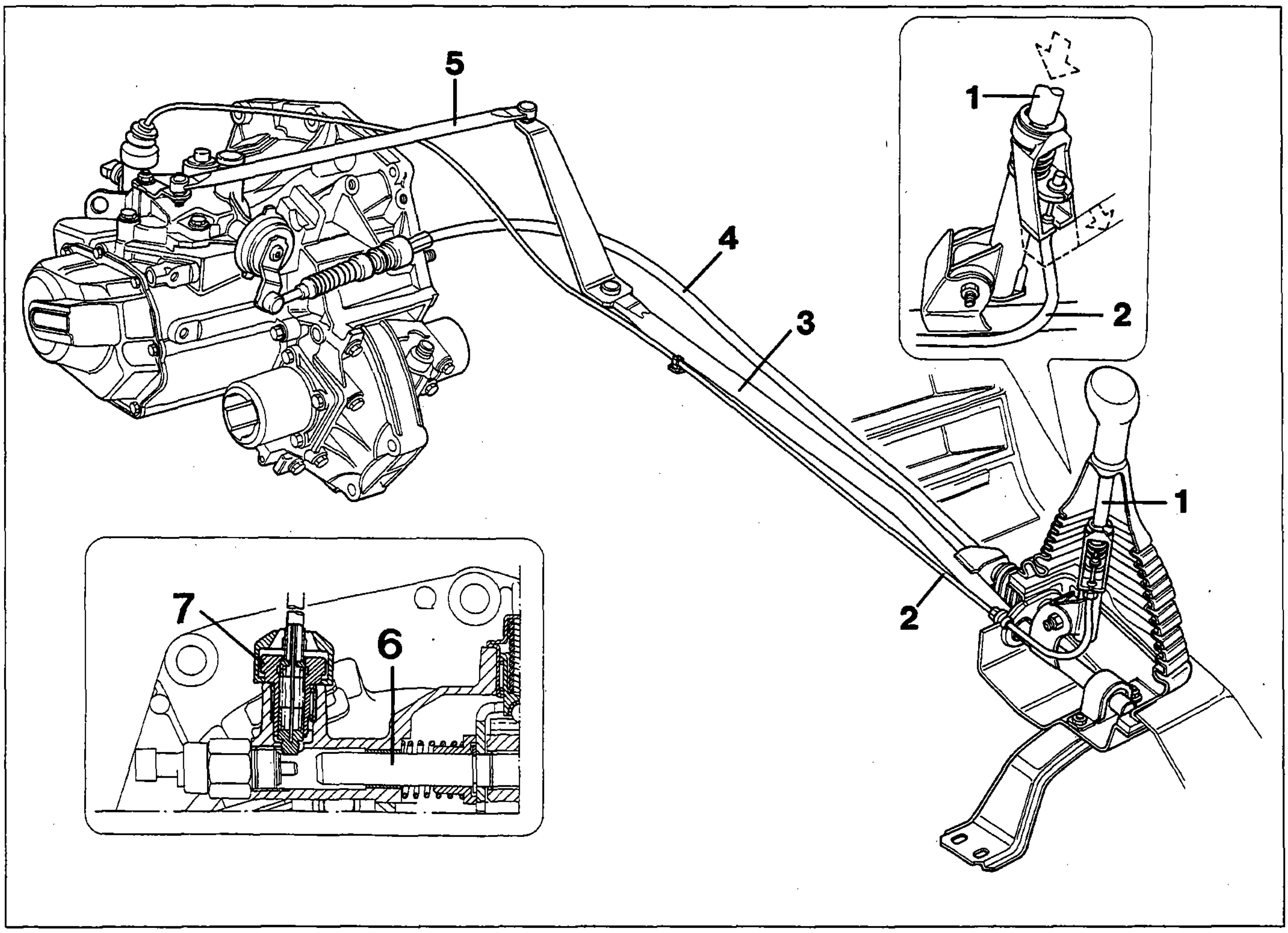
1. Constant velocity joint wheel side
2. Circlip securing constant velocity joint
3. Protective gaiter
4. Drive shaft
5. Protective gaiter
6. Tripod joint
7. Circlip securing tripod joint
8. Joint, gearbox side (part not present on 1581 16V engine)

21-27.

DIAGRAM OF REMOTE CONTROL ASSEMBLY

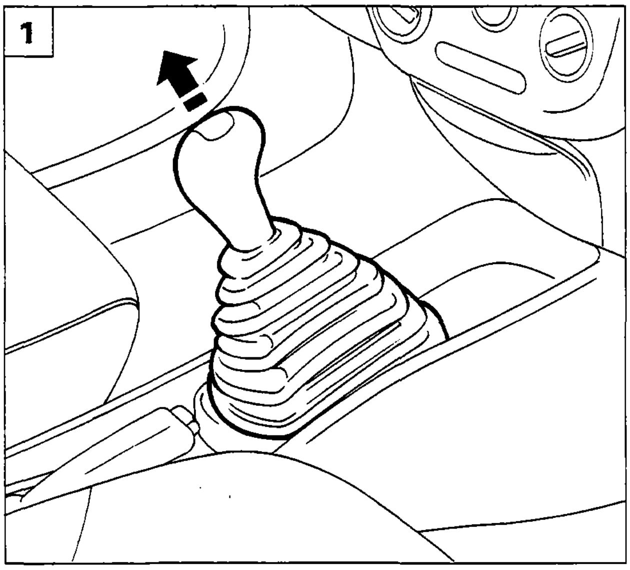
The Bravo-Brava with 1370 12v engine has a remote control assembly system consisting of a rigid rod (3) and a flexible cable (4).
The rigid rod (3) controls gear selection by means of a relay link (5); the flexible cable (4) instead controls gear engagement.
There is also a safety device (7) for preventing accidental selection of reverse gear.

To operate this device, press the knob (1) of the gearlever downwards; this, by means of the flexible cable (2), lifts the pushrod of the device (7) which in turn permits the travel of the control shaft (6) for selecting reverse gear.



Perspective view of remote control assembly with device for inhibiting accidental selection of reverse gear

1. Sliding part of gearlever
2. Flexible cable controlling device for inhibiting accidental selection of reverse gear
3. Rigid rod controlling gear selector link
4. Gear engagement flexible cable
5. Gear selector control link
6. Gear selector and engagement shaft
7. Device for inhibiting accidental selection of reverse gear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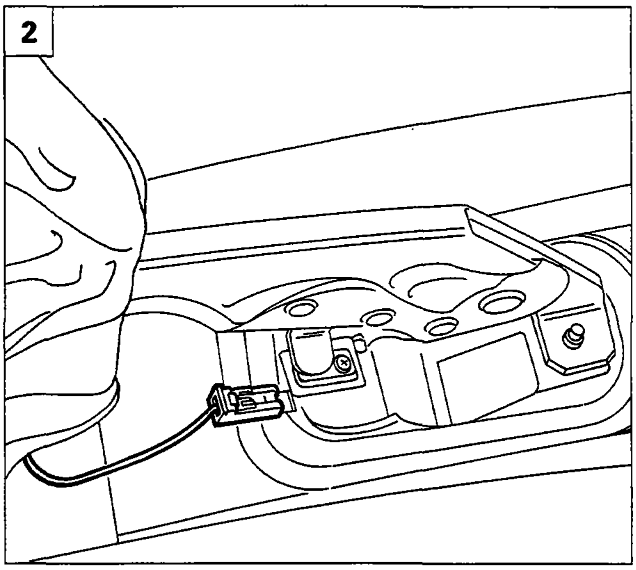
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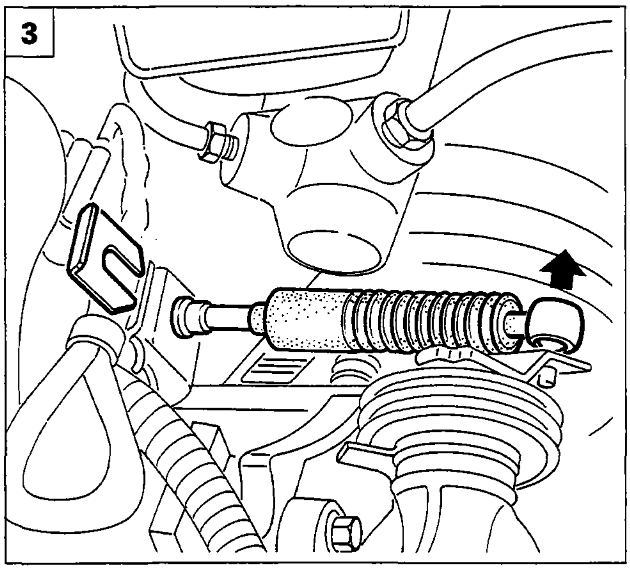
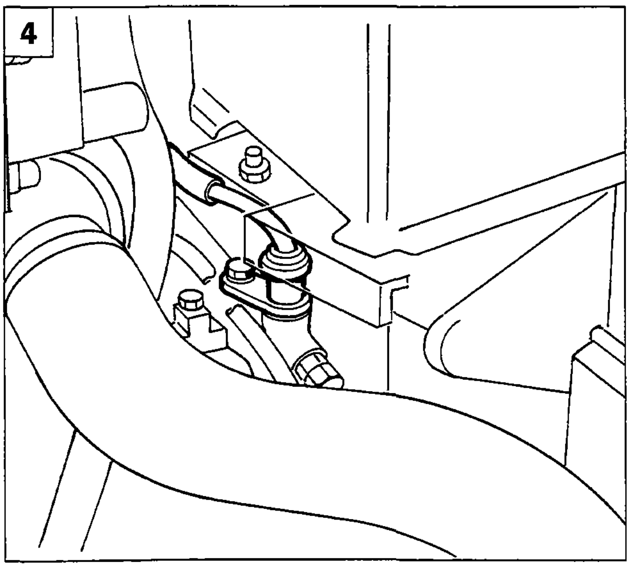

P4A002B02

REMOVING - REFITTING

Disconnect the battery's negative terminal, and remove the remote control assembly as described below:

1. From inside the car, remove the gearlever trim.
2. Remove the protective boot from the handbrake, then disconnect the electrical connection underneath.
3. Disconnect the gear engagement flexible transmission cable from the gearbox.
4. Disconnect the reverse gear inhibitor from the gearbox.
5. Remove the reaction and gear selector link from the gearbox.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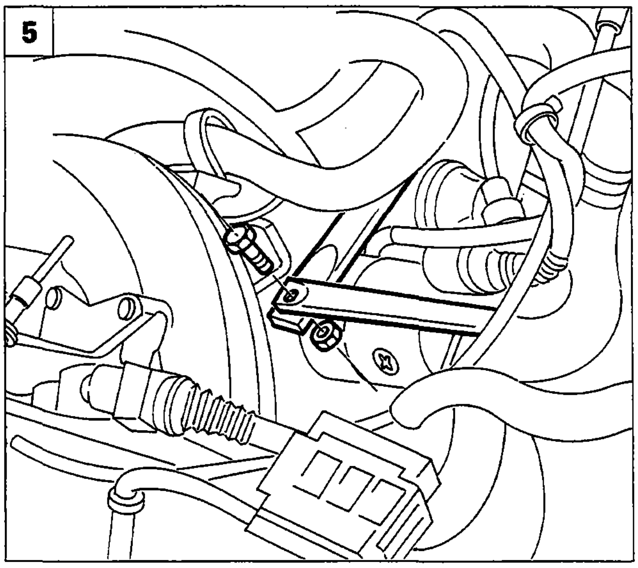
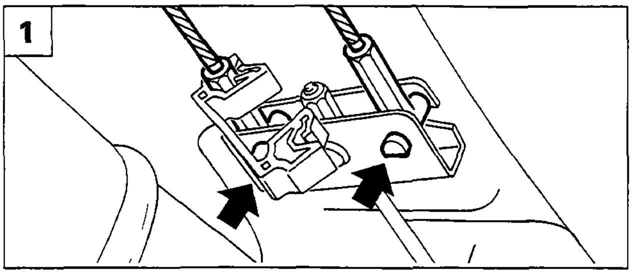

P4A015B05

21-27.



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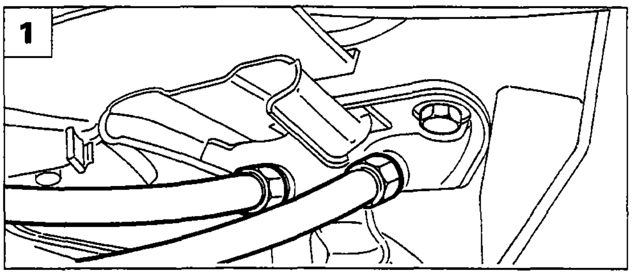

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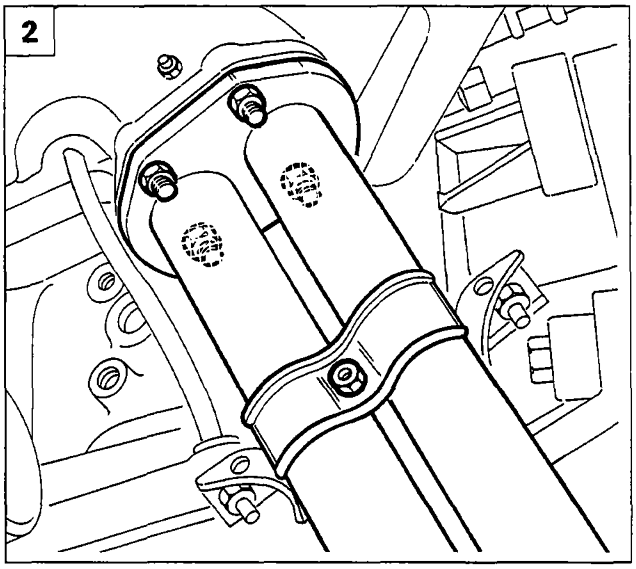
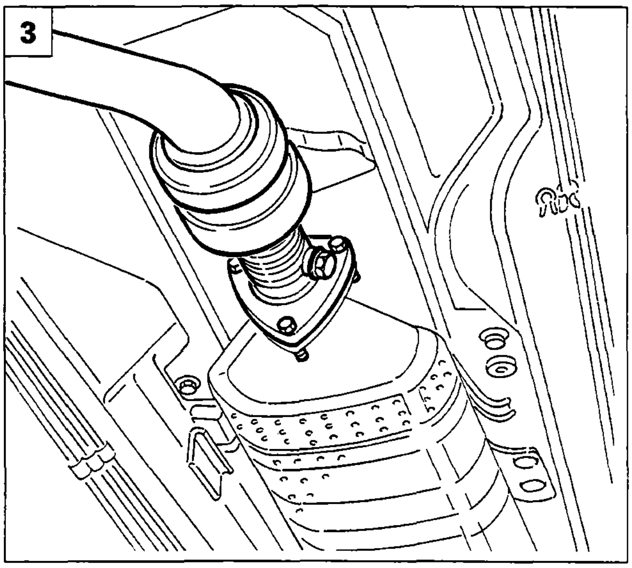
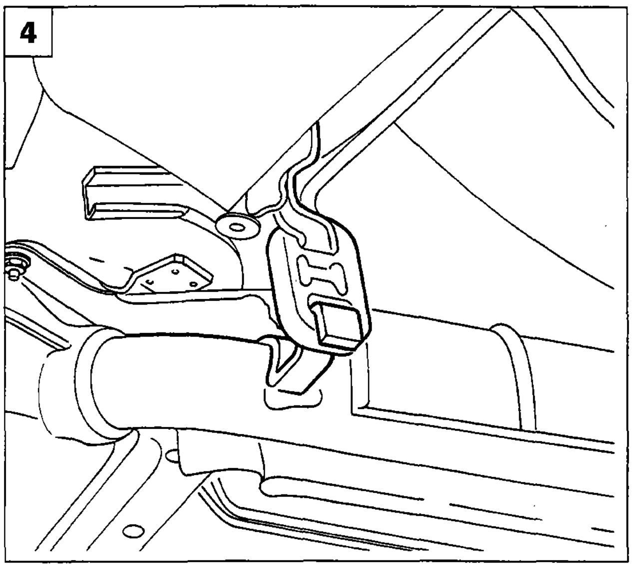


P4A004B03



P4A004B04

1. Raise the car, then disconnect the hand-brake cables from the mounting and release them from the bracket.
2. After disconnecting the Lambda probe electrical connection, undo the bolts securing the first section of the exhaust pipe to the manifold.
3. Disconnect the first section of the exhaust pipe from the rear mountings.
4. Release the exhaust pipe from the rubber mount indicated.
5. Undo the bolts securing the exhaust pipe front mounting bracket.



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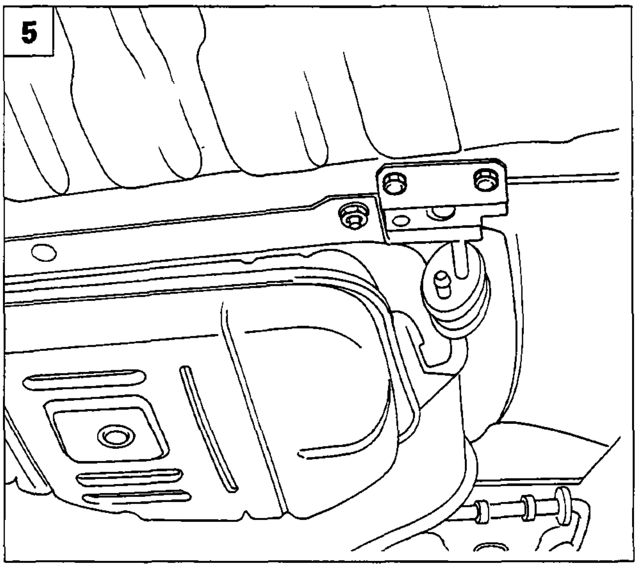

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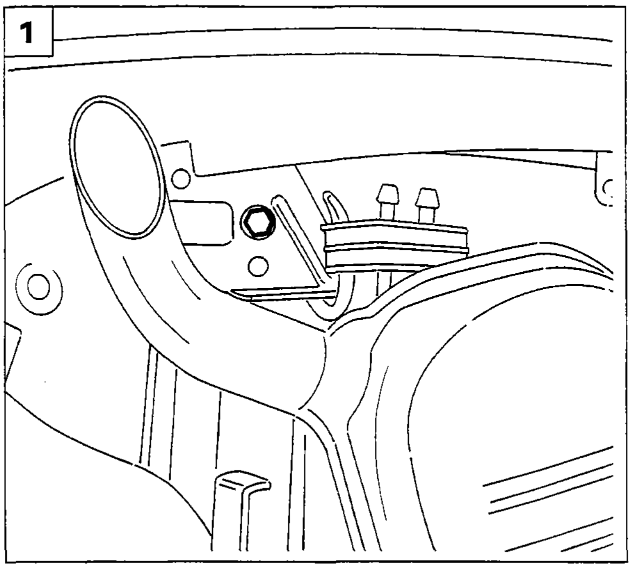

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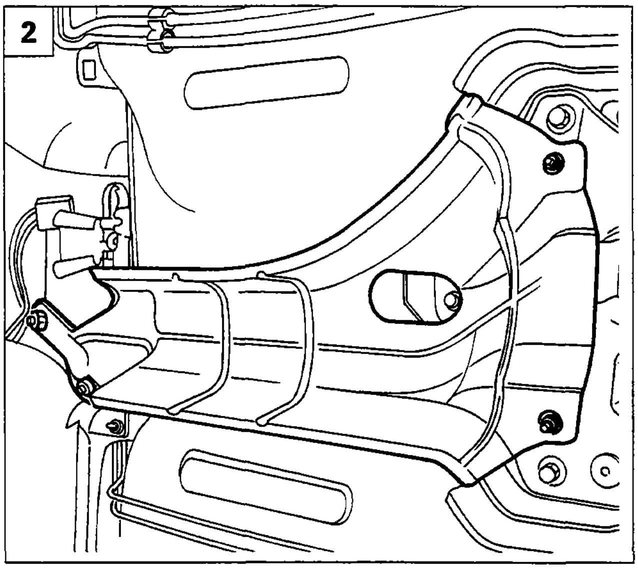

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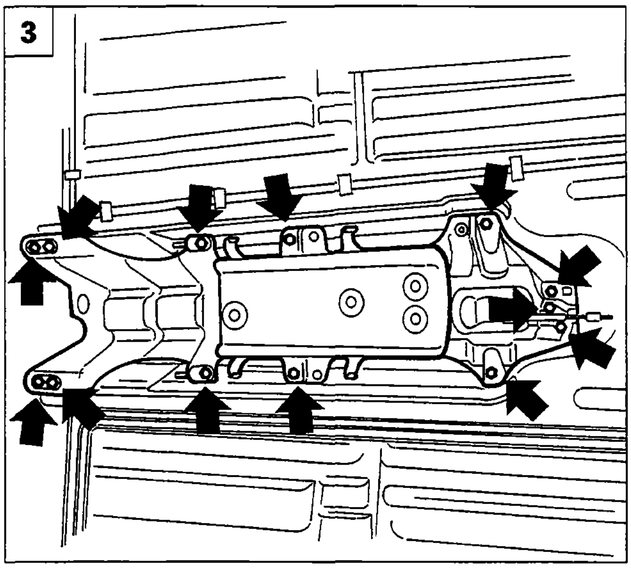

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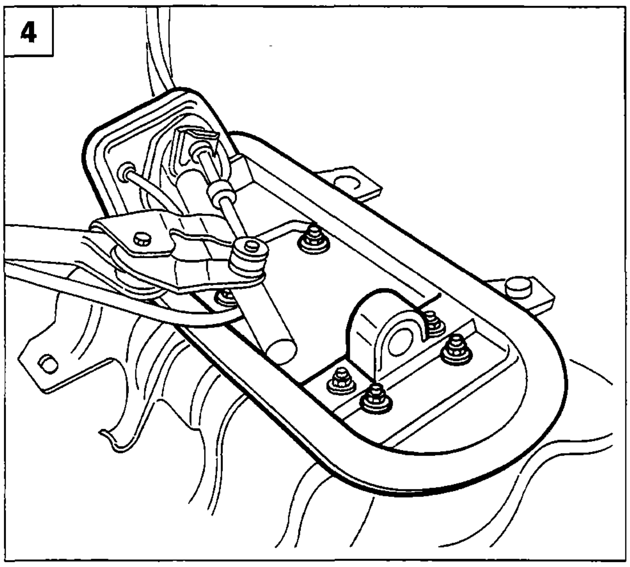


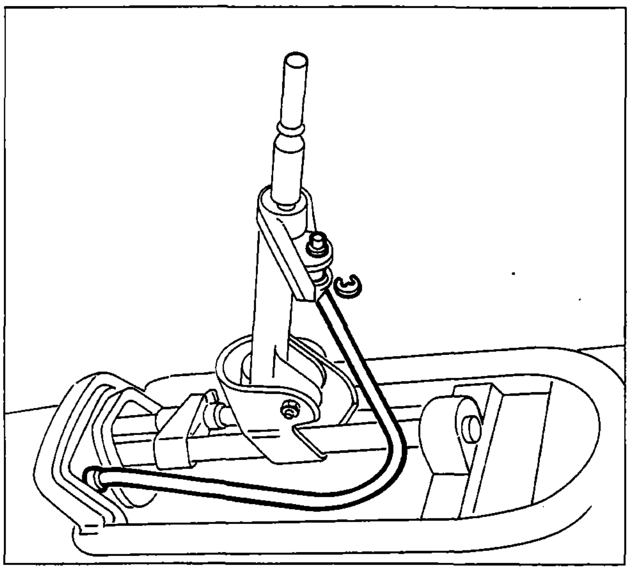
P4A017B04

1. Undo the bolt securing the exhaust pipe rear bracket, then withdraw it from the car.
2. Remove the heat shield by undoing the bolts indicated.
3. Undo the front and rear bolts of the hand-brake and remote control assembly mounting.
4. Carefully lower the assembly from its seating, and undo the nuts securing the remote control assembly to the gearlever mounting and remove it from the car.

Withdraw the cables and reaction rod from the engine compartment and withdraw the assembly from the car.

21-27.

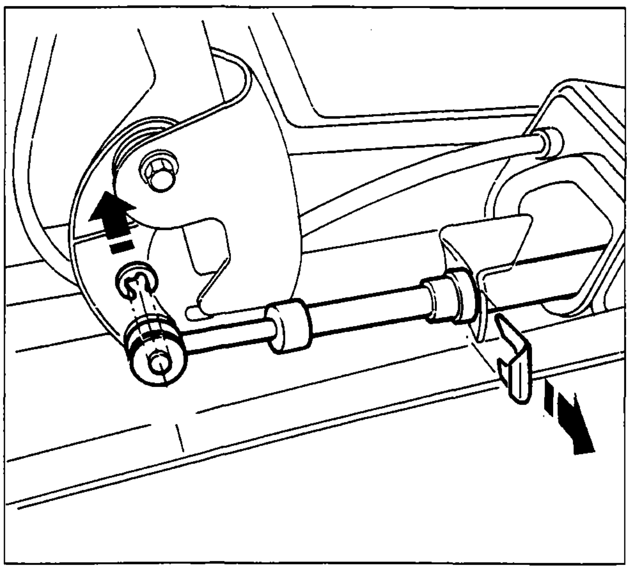
DISMANTLING AT THE BENCH



P4A018B01

Dismantling - refitting reverse gear engagement inhibitor

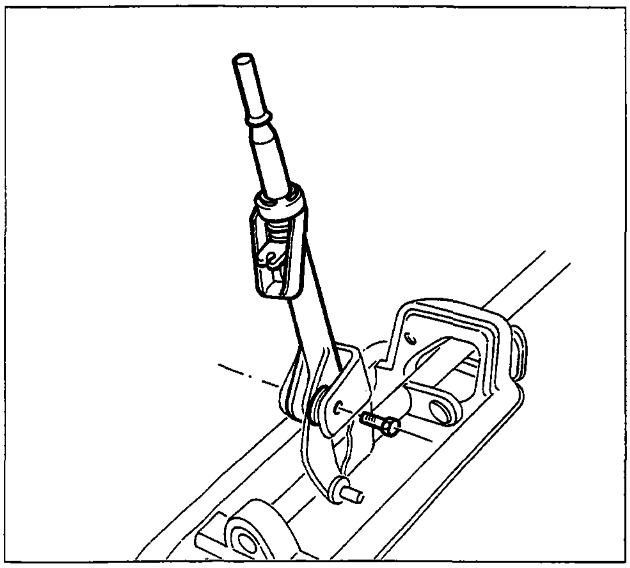
- Remove the circlip, withdraw the cable from the plastic mounting, then withdraw it from the assembly.



P4A018B02

Dismantling - refitting gear engagement flexible transmission cable

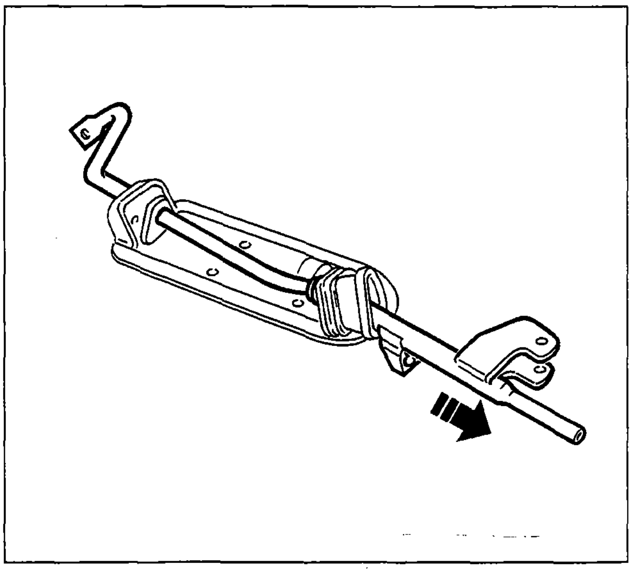
- Remove the gearlever circlip and clip from the gearlever, then withdraw the flexible cable after releasing it from its clamp.



P4A018B03

Dismantling - refitting gearlever

- Disconnect the reverse inhibitor and gear engagement flexible transmission cable;
- undo the bolt securing the lever to the mounting, then remove the lever.

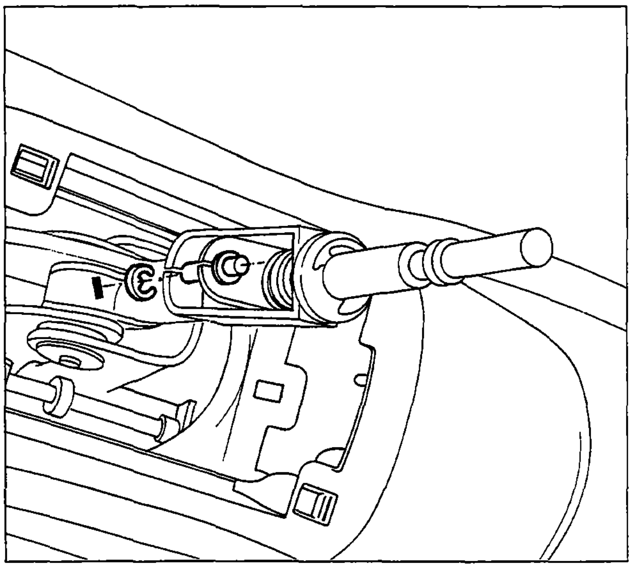


P4A019B01

Dismantling - refitting reaction link

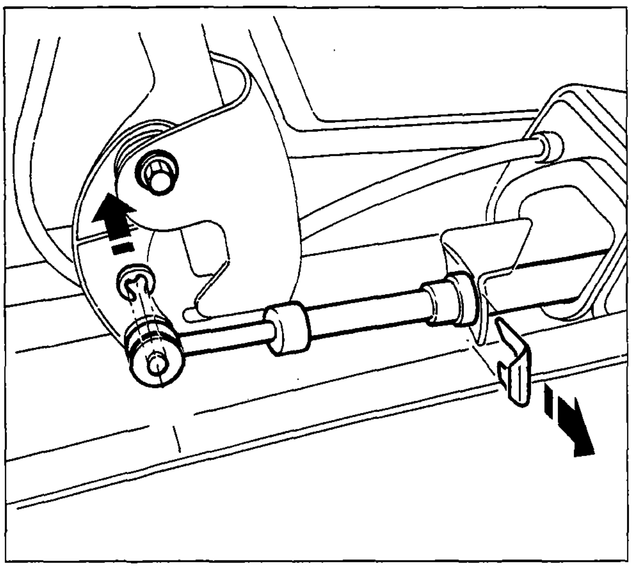
- Remove the reverse gear inhibitor cable, the gear engagement flexible transmission cable and gearlever, then withdraw the reaction link.

REMOVING - REFITTING GEARLEVER ON CAR



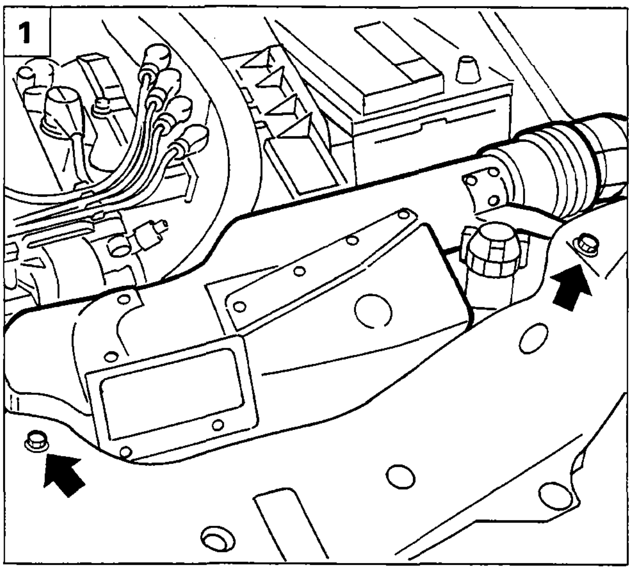
P4A019B02

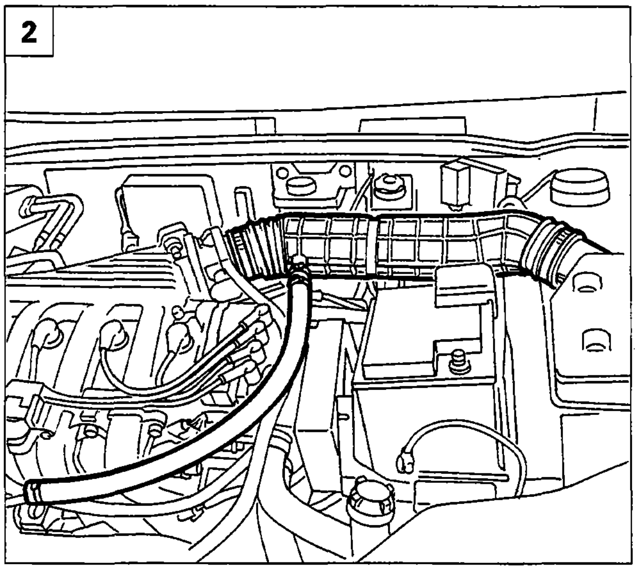
- Remove the gearlever trim;
- disconnect the reverse gear inhibitor cable from the gearlever, after withdrawing the circlip.



P4A019B03

- disconnect the flexible cable from the lever mounting, after r moving the circlip;
- undo the bolt securing the lever to the mounting, then remove it from the car.
- To refit, reverse the procedure for removal.


P4A01CX01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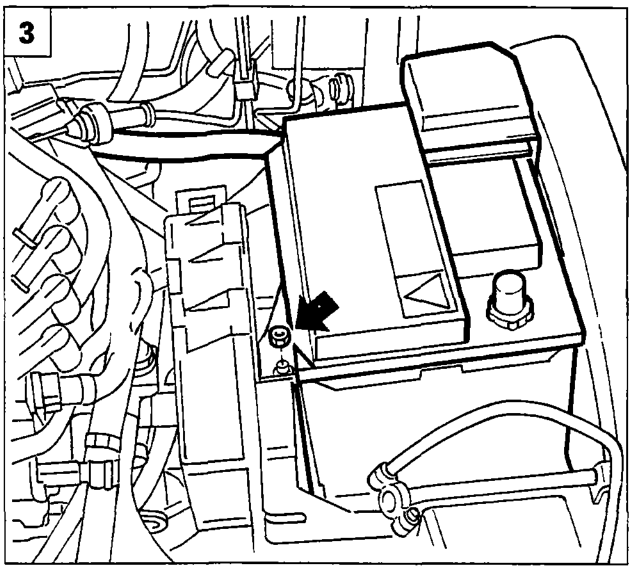
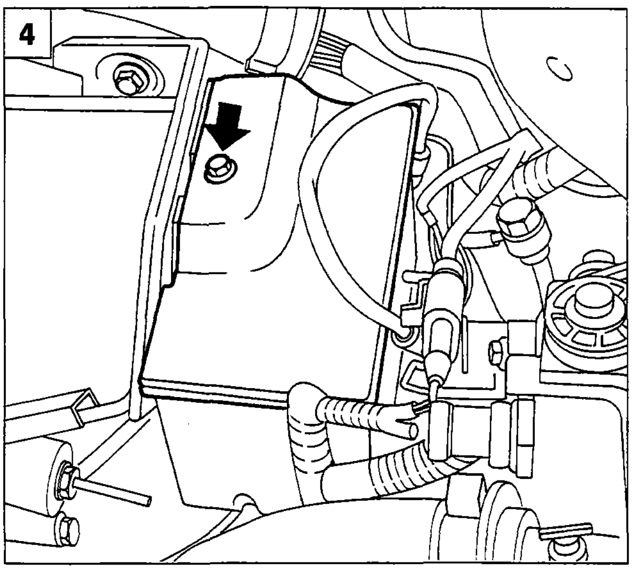

P4A01CX04

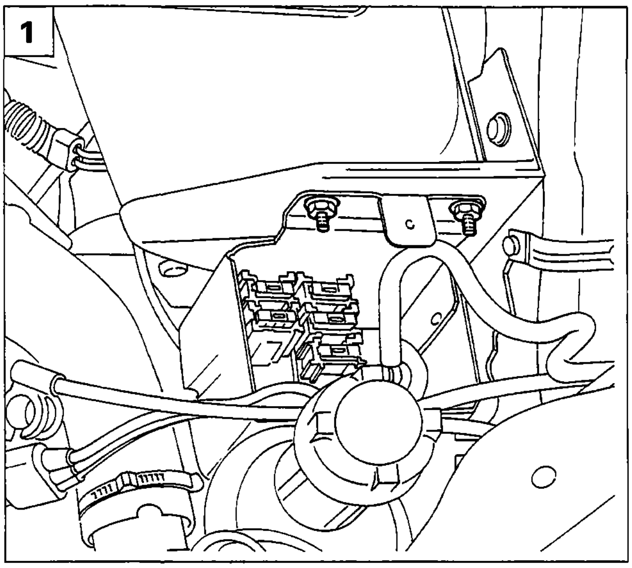

P4A035B03

REMOVING-REFITTING

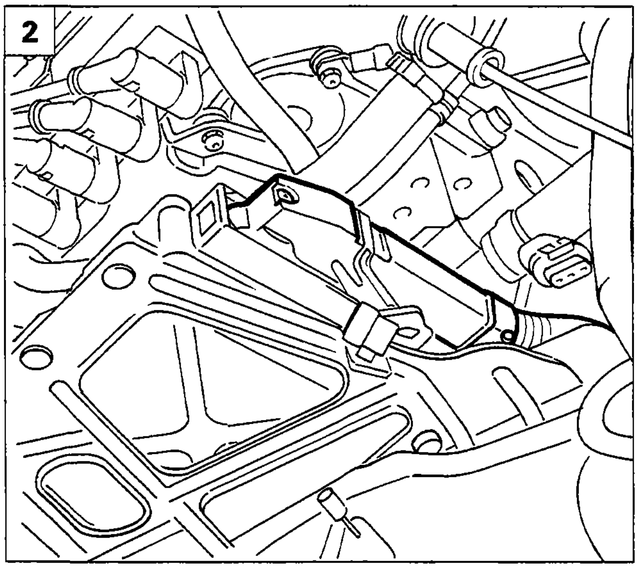
Removing

Place the car on ramps, disconnect the battery's negative terminal and remove the front wheels, then proceed as described below:

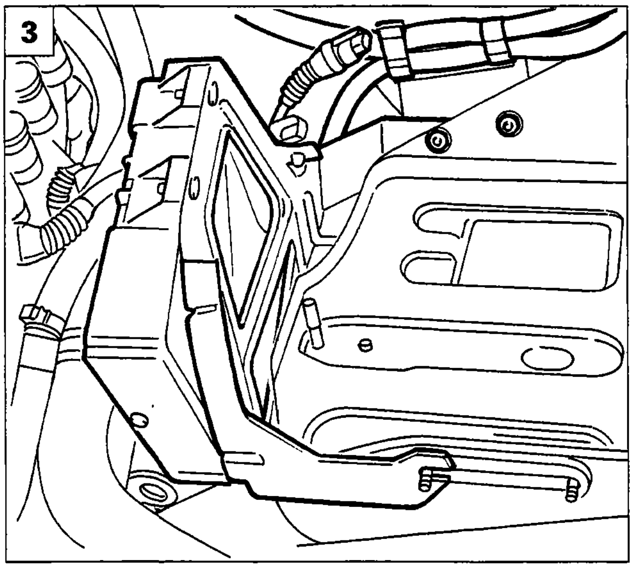
1. Remove the air intake duct by undoing the bolts shown in the figure, securing it to the front crossframe.
2. Remove the air intake duct by undoing the clips shown in the figure, then remove it from the engine compartment complete with oil vapour recovery pipe.
3. Lift the protective cover of the battery's positive terminal and disconnect the relevant cable; undo the nut securing the battery to the cage, then remove it from the engine compartment.
4. Remove the fuse and relay box cover by undoing the bolt indicated.



P4A001B03

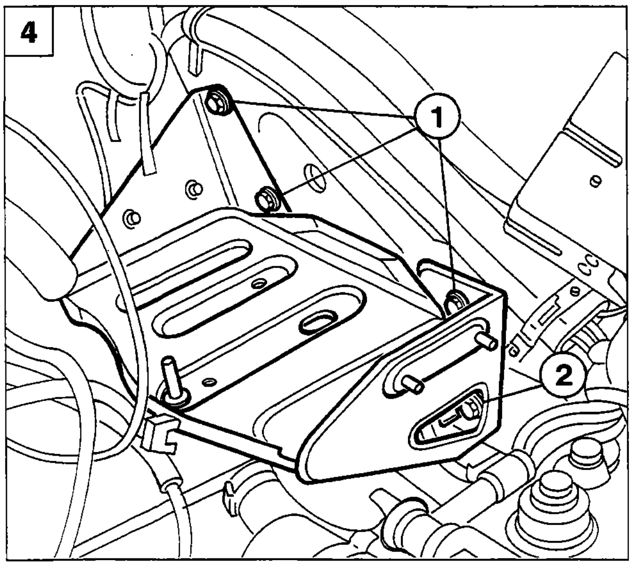


P4A02CX03

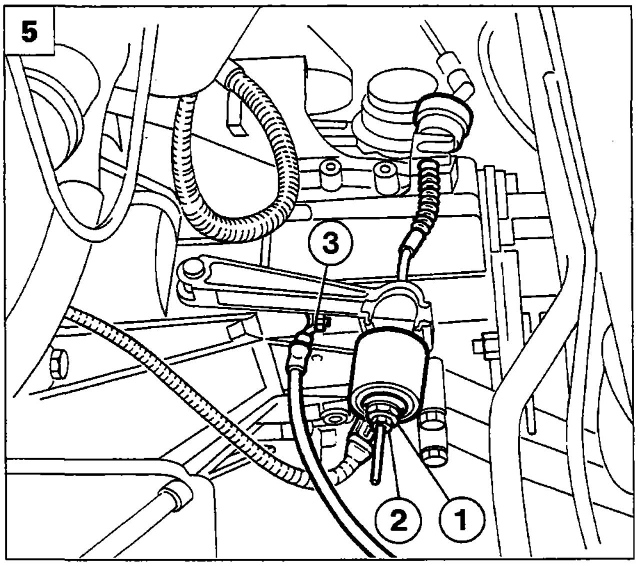


P4A02CX04

1. Remove the nuts securing the fuse and relay box to the battery cage, then move the box over to one side.
2. Disconnect the i.e. control unit supply connector.
3. Remove the nuts securing the i.e. control unit mounting bracket, then remove the control unit from the engine compartment. The nuts indicated also secure the starter motor supply wiring and connection between the front cable and fuel injection cable.
4. Remove the bolts (1) and slacken the bolt (2) securing the battery cage to the bodywork. Before removing the cage, disconnect the cable clip underneath.
5. Disconnect the clutch cable by undoing the nut (1) and lock nut (2) shown in the figure. Also disconnect the earth cable (3) from the gearbox.

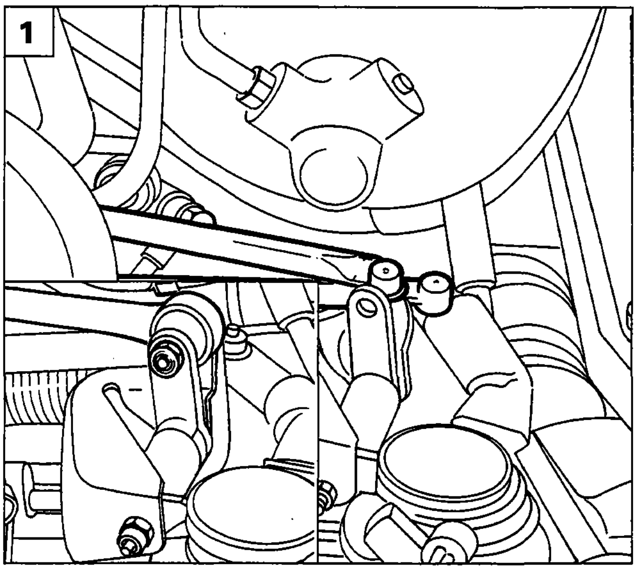


P4A021B01

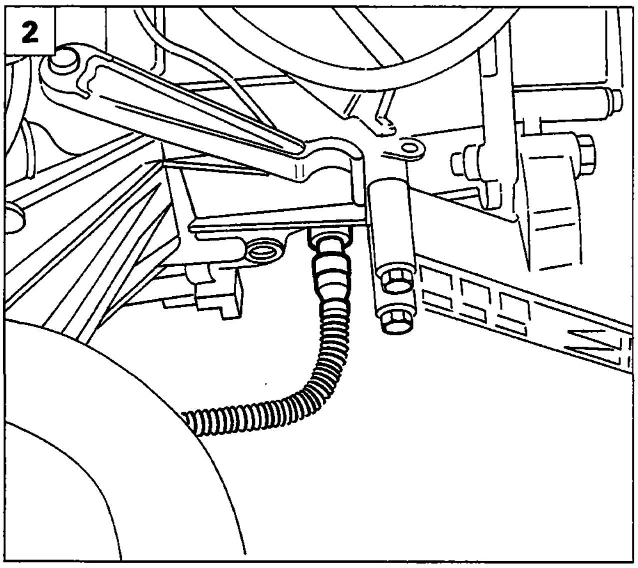


P4A021B02

21-27.



P4A03EX05 P4A040B02



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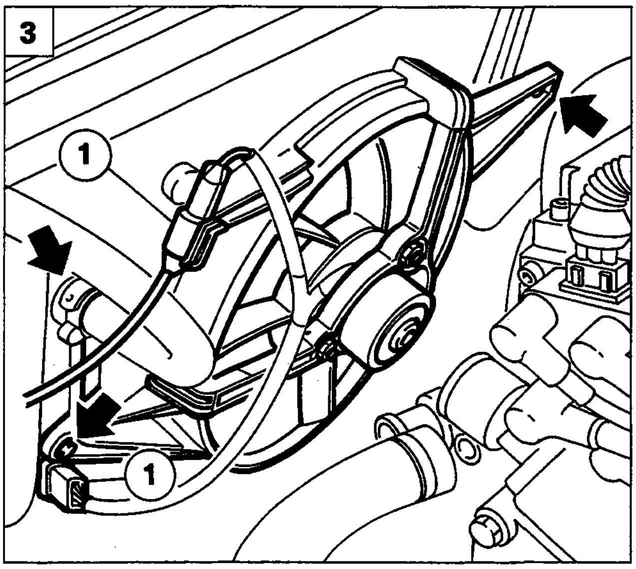
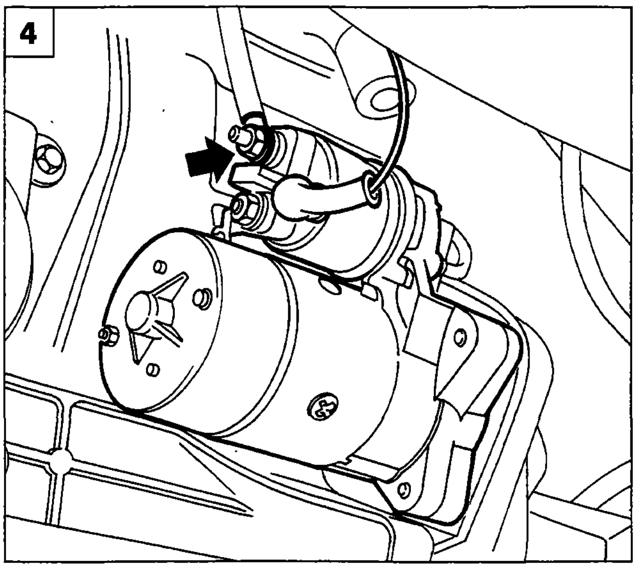


P4A03AX05

1. Disconnect the reaction link shown in the detail and the gear selector and engagement rods from the gearbox; also disconnect the speedometer sensor wiring connector.
2. Disconnect the reversing lights switch connector from the gearbox.
3. Remove the fan by undoing its attachment bolts, making sure to disconnect the supply connections (1).
4. Disconnect the starter motor supply cables.
5. Remove the starter motor by undoing the bolts shown in the figure.



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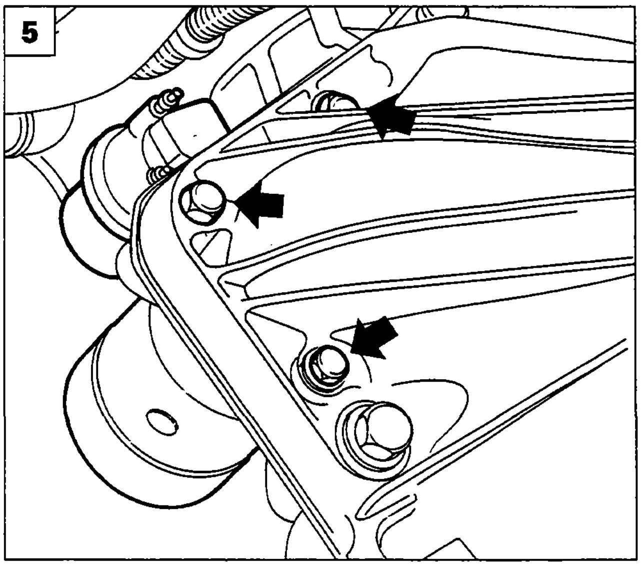

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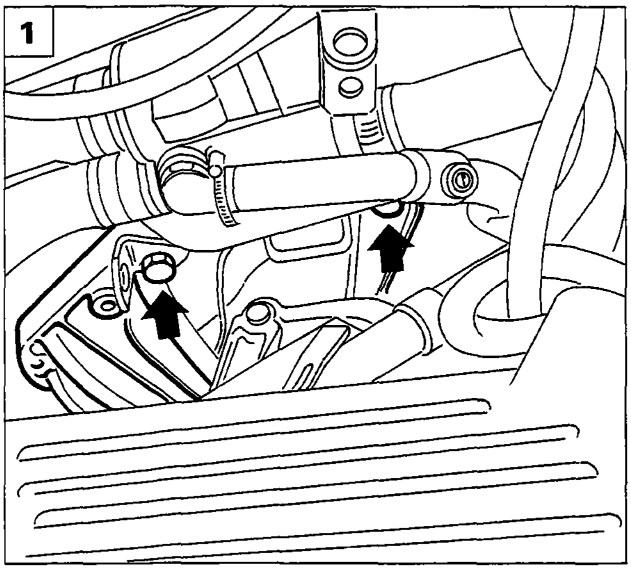
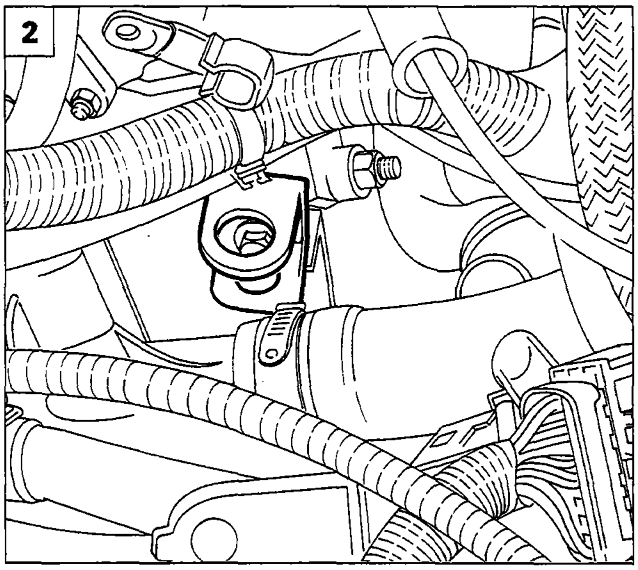


P4A023B01



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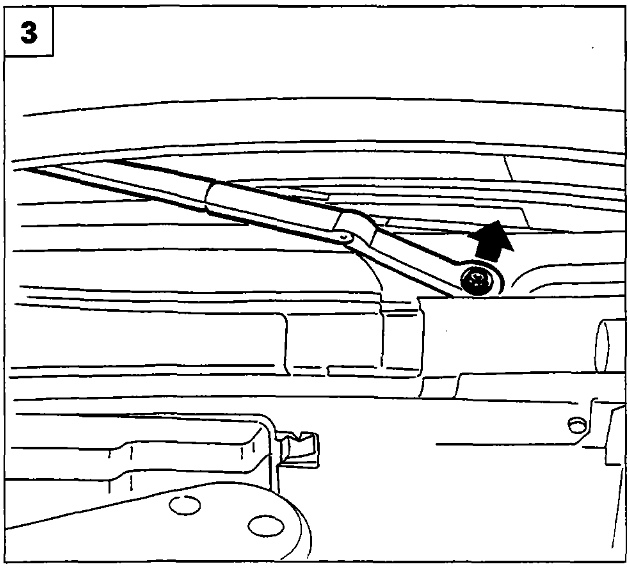
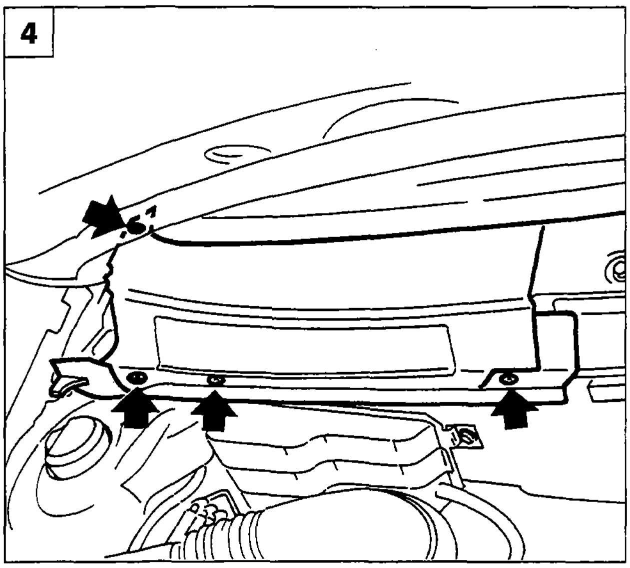


P4A023B03

1. Remove the gearbox top bolts.
2. Fit an appropriate support eyelet at the point shown in the figure, to hook the power unit onto during removal of the gearbox.
3. Undo the nut securing the right windscreen wiper arm after removing the protective cap.
4. Remove the right side cover of the anti-pollen filter by undoing the bolts indicated, while the bolts securing the left cover must be slackened to allow the power unit support stand to be fitted.



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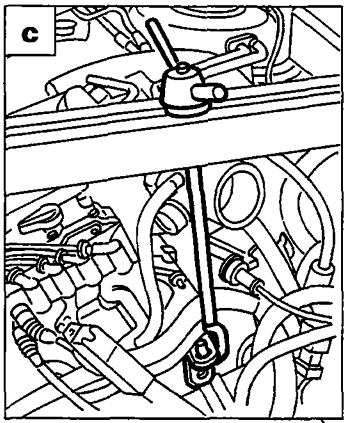
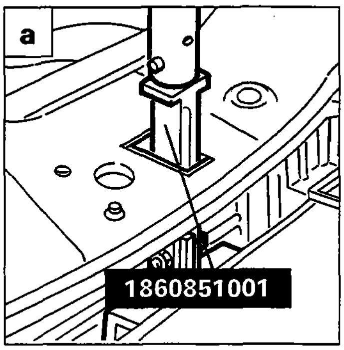
21-27.

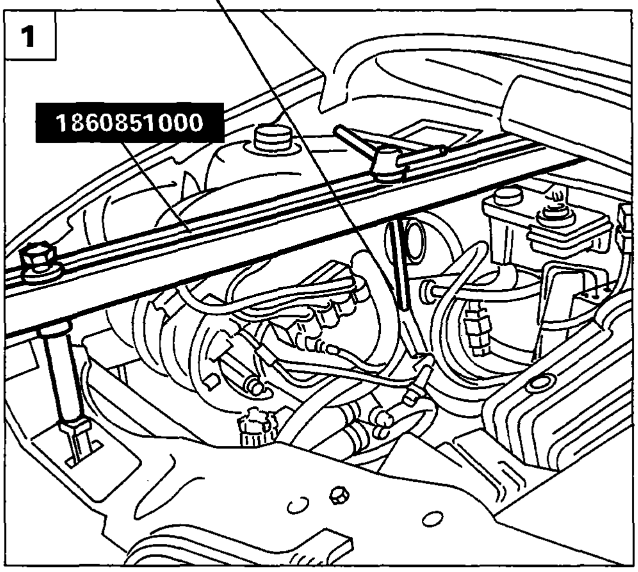


P4A024B02

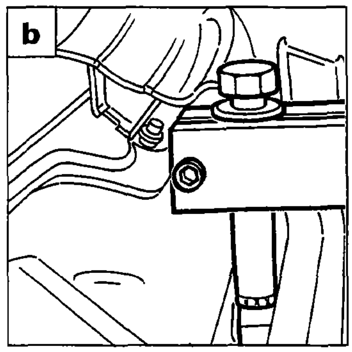
1. Fit the engine support stand 1860851000 and the adaptor 1860851001 in the appropriate mountings.
a. Front mounting: insert the tool in the seat of the bonnet catch so that it rests on the front crossframe.
b. Rear mounting: fit the tool level with the central reinforcement of the fire-proof bulkhead.
c. Secure the hook of the stand to the eyelet previously positioned near the thermostat.



P4A006B05



P4A024B01



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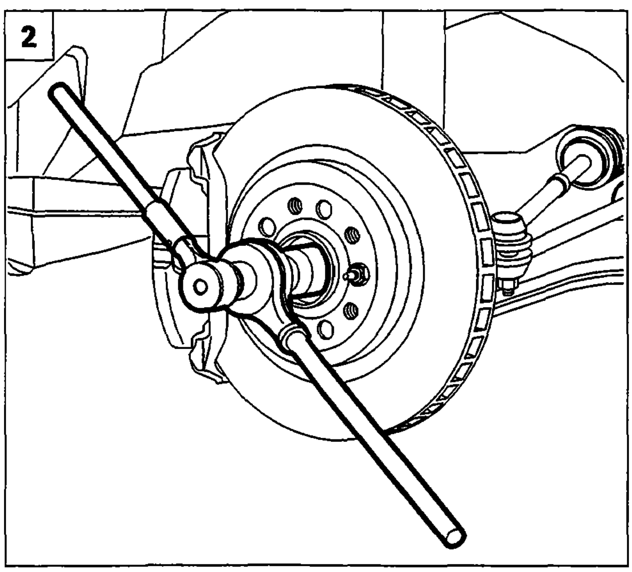
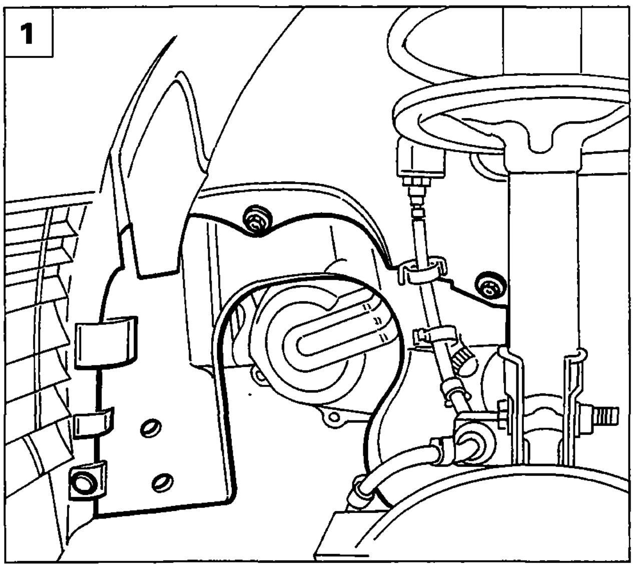
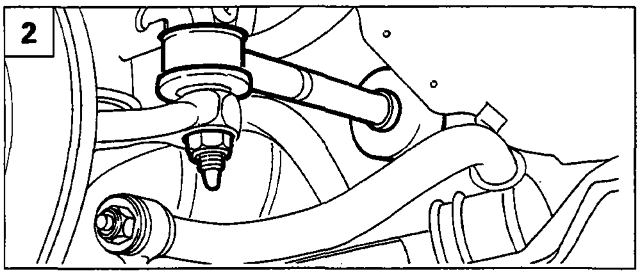


P4A009B02

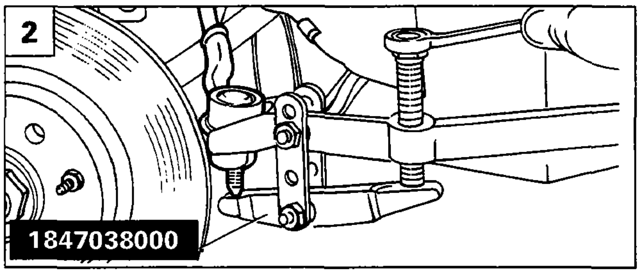
2. Relieve the staking and then remove the hub nut (gearbox side and timing side).



P4A003B01



P4A002B04



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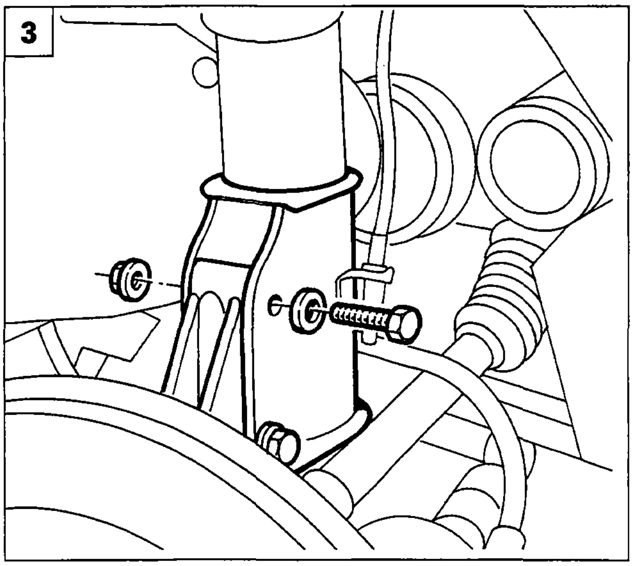

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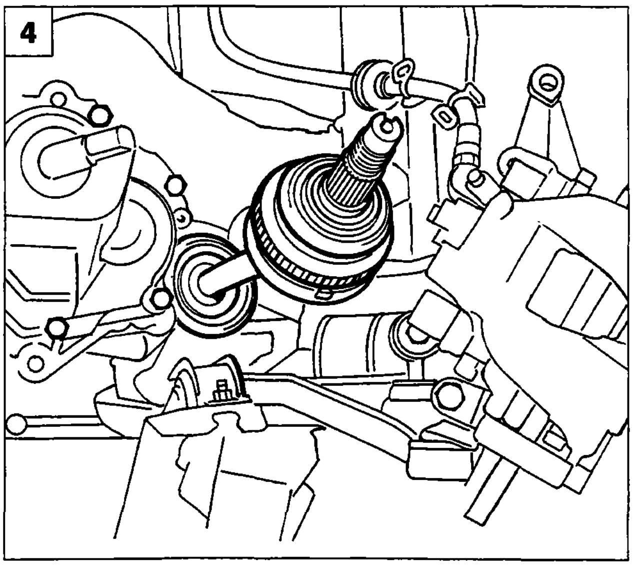
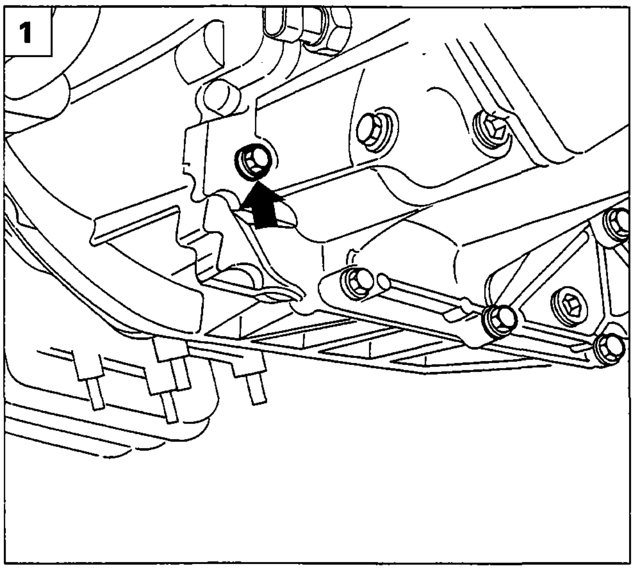


P4A06CX02

1. Remove the plastic wheelarch protection on the gearbox by undoing the bolts and retaining button shown in the figure. To withdraw the protection, it is also necessary to disconnect the brake pad wear sensor connector (repeat the procedure on the other side).
2. Remove the nut securing the steering tie-rod end, then withdraw the latter from the vertical link arm using the puller 1847038000 (repeat the procedure for the other tie-rod end).
3. Remove the nuts securing the vertical link (gearbox and timing side) to the damper.
4. Rotate the vertical link as appropriate so as to withdraw the drive shaft from the wheel hub (repeat the operation for the other drive shaft).

21-27.



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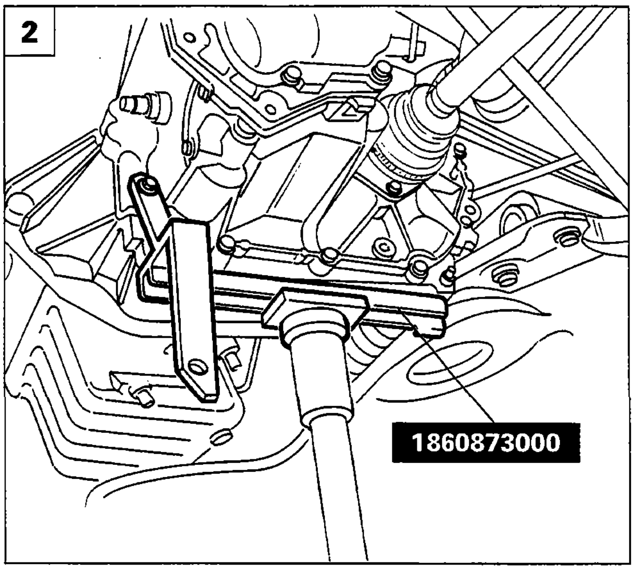

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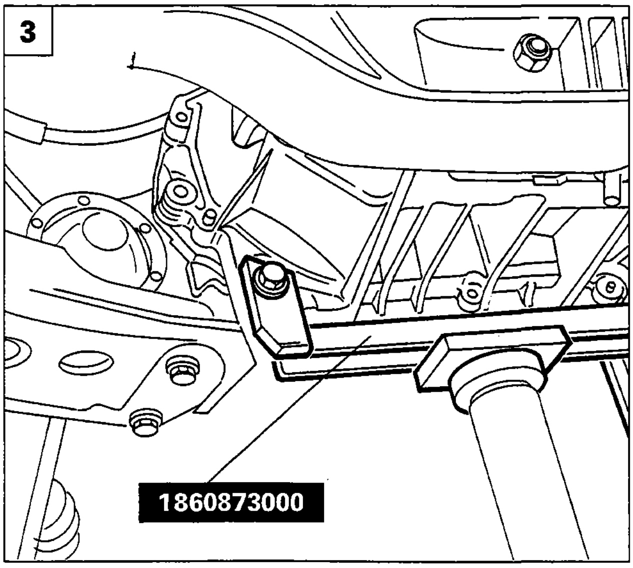

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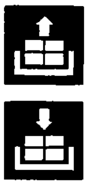
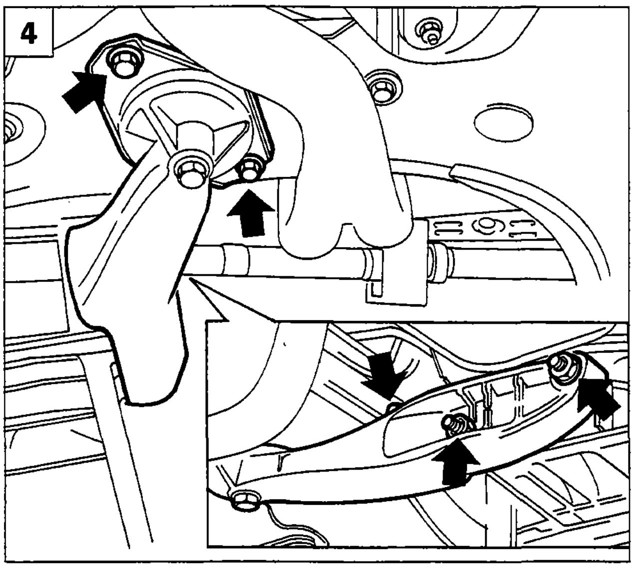


1. Undo the bolt (arrowed) on the bellhousing so that the gearbox support tool can be installed.

2-3. Place the gearbox support tool 1860873000 on a hydraulic jack, then secure it to the gearbox at the points indicated in the figure.

4. Remove the central power unit mounting by undoing the bolts shown in the figure.

5. Remove the cover shown in the figure from the bottom of the gearbox.



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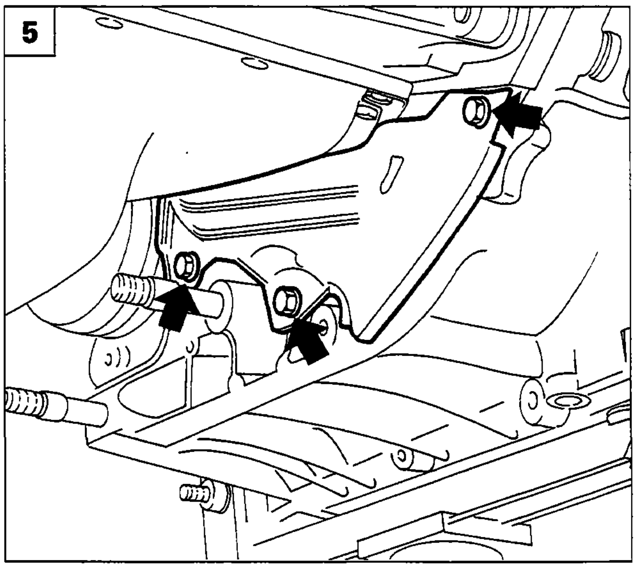

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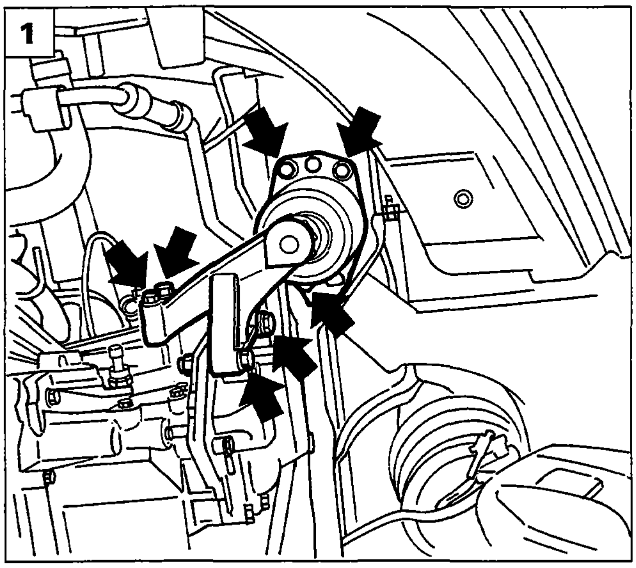
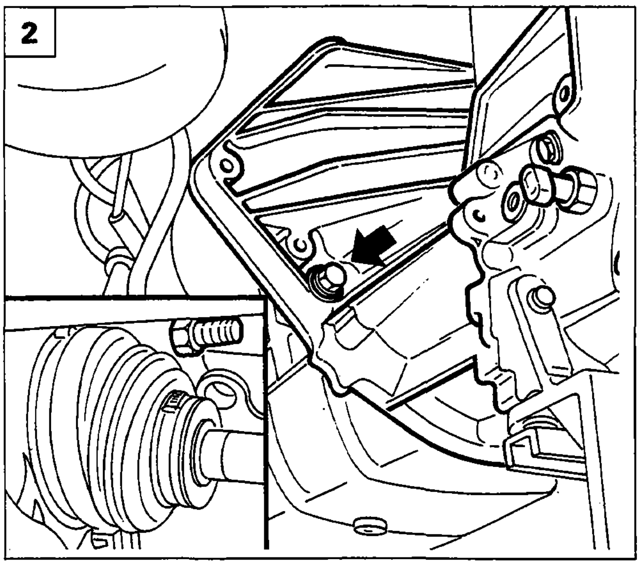
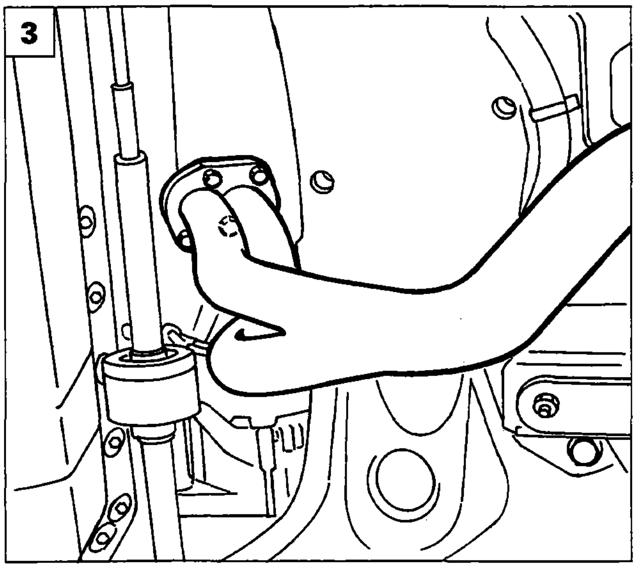


P4A041B04

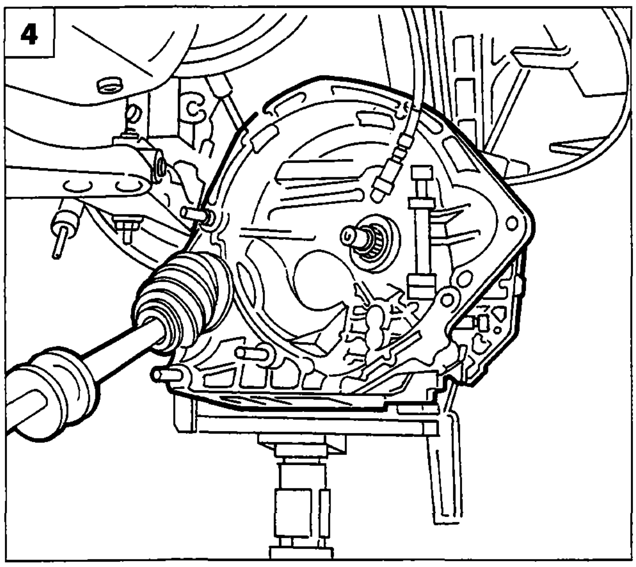


P4A027B01



P4A027B02

1. Remove the engine mounting, gearbox side.
2. Remove the bottom bolts securing the bellhousing to the engine block.
3. Remove the nuts securing the first section of the exhaust pipe to the manifold, to enable the power unit to be moved forwards and so facilitate withdrawal of the gearbox. If this is still not sufficient, disconnect the coolant inlet and outlet pipes from the heater.
4. Manoeuvre the hydraulic jack as appropriate to disengage the gearbox from its attachment studs and the surrounding components. Gradually lower the jack and withdraw the gearbox complete with drive shafts.
5. If the gearbox is to be overhauled, drain the oil by undoing the plug (arrowed) and disconnect the two drive shafts, removing the gaiter retaining clips.



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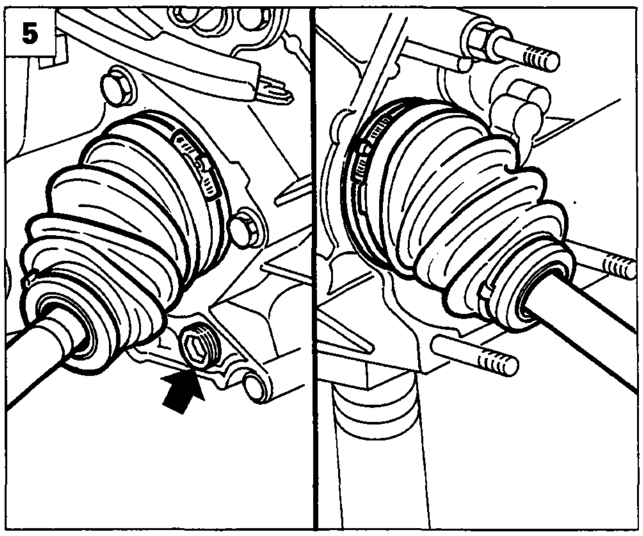
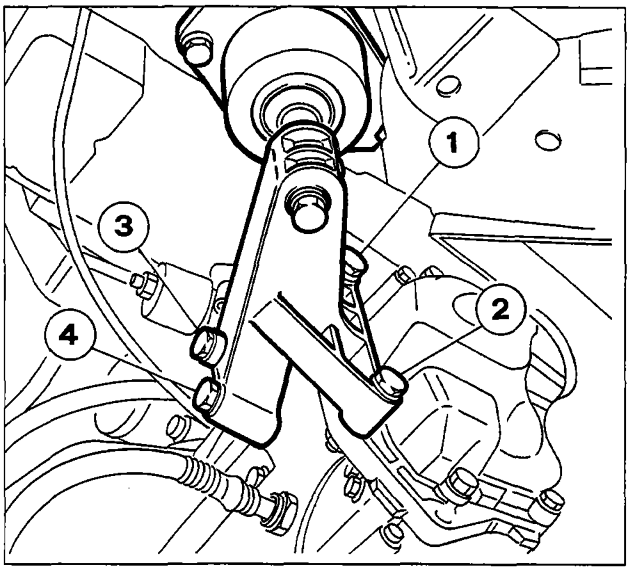


P4A027B04

21-27.



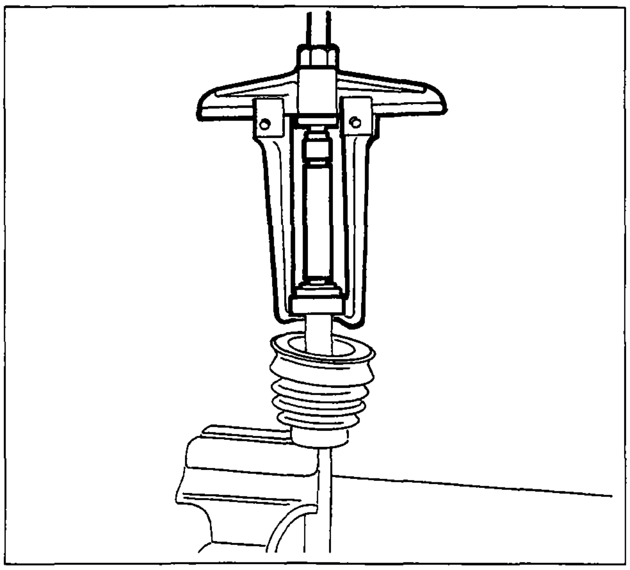
P4A043B01

Refitting

When refitting the engine mounting on the gearbox side, to avoid creating stresses on the gearbox sealing surfaces resulting in deformation and oil leaks, strictly observe the following tightening sequence for the attachment bolts:

- Lightly tighten bolts (1) and (2) to an initial torque of 0.5 daNm;
- Lightly tighten bolts (3) and (4) to an initial torque of 0.5 daNm, then tighten to the specified torque;
- Tighten bolts (1) and (2) to the specified torque.

For the remaining refitting operations, reverse the procedure described for removal. For fitting the clutch release bearing and the bellhousing in the car, refer to the procedure for refitting the gearbox of the 1370 12v engine.



P4A028B02

REMOVING-REFITTING DRIVE SHAFTS

To remove and refit the drive shafts, refer to the procedure described for the 1370 12v engine, with the difference that the drive shafts are secured to the gearbox-differential unit by means of retaining clamps and the tripod joint is inserted directly in the differential.

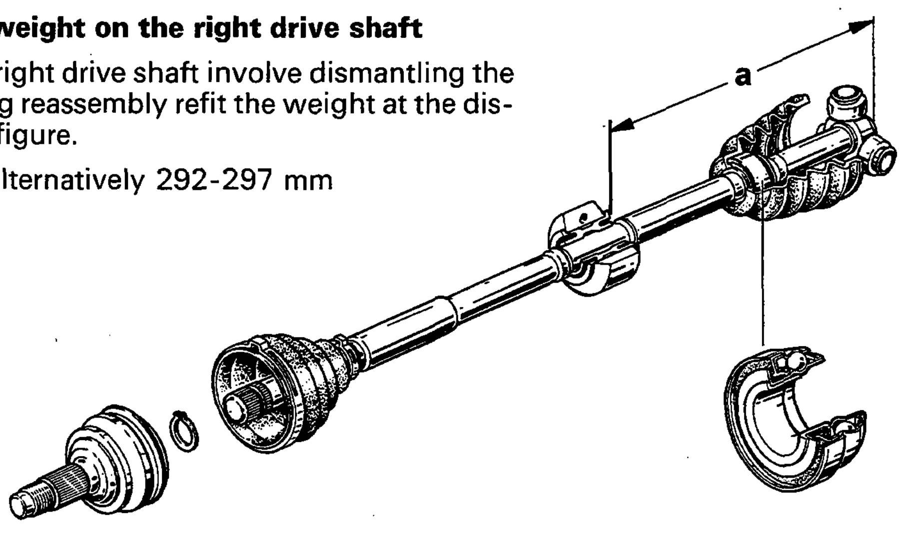
DISMANTLING

Refer to the dismantling of the drive shaft described for the 1370 12v engine, with the difference that on the 1581 engine, to minimise oil leaks, fluid-tight ball bearings have been fitted in the gaiters on the gearbox side. These are installed directly on the drive shafts. Use the general purpose puller to remove these bearings.

Position of damping weight on the right drive shaft

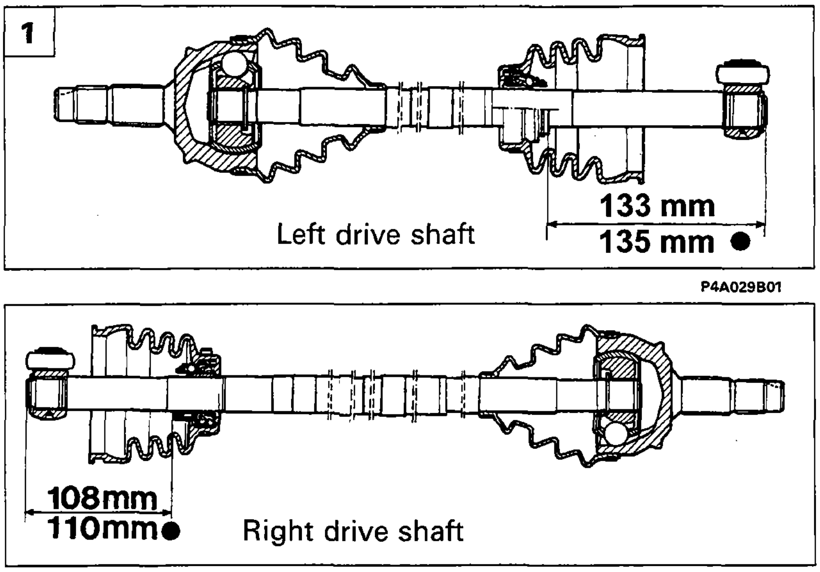
If interventions on the right drive shaft involve dismantling the damping weight, during reassembly refit the weight at the distance specified in the figure.

a = 290-295 mm or alternatively 292-297 mm



P4A028B03

1



P4A029B01

P4A029B02

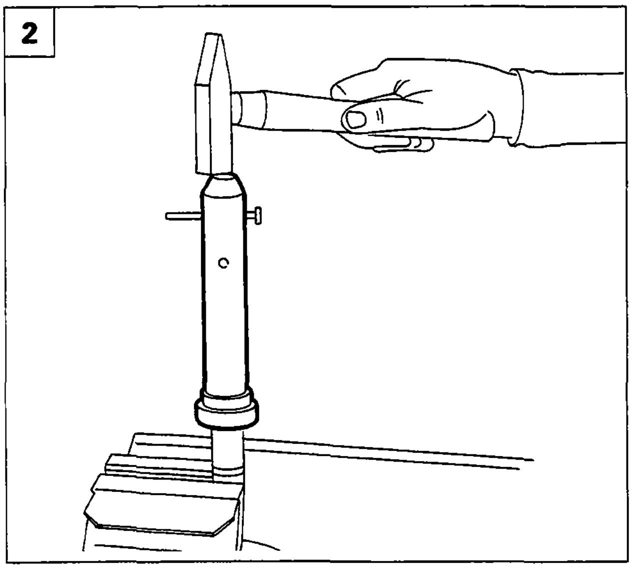
REFITTING

Reverse the procedure described for removal. To refit the differential casing oil seal bearing, refer to the instructions below.

1. Refitting differential casing oil seal bearing.

● Alternative.

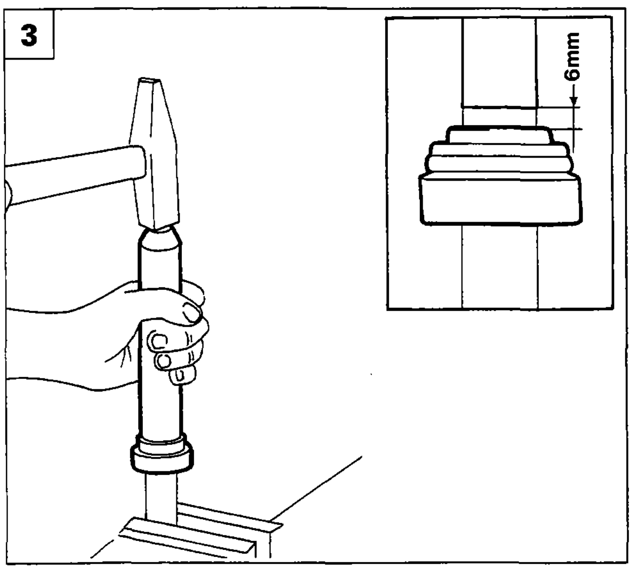
2



P4A029B03

2. Fit and install the INA seal bearing, for the differential casing oil seal gaiter, using the appropriate drift.

3

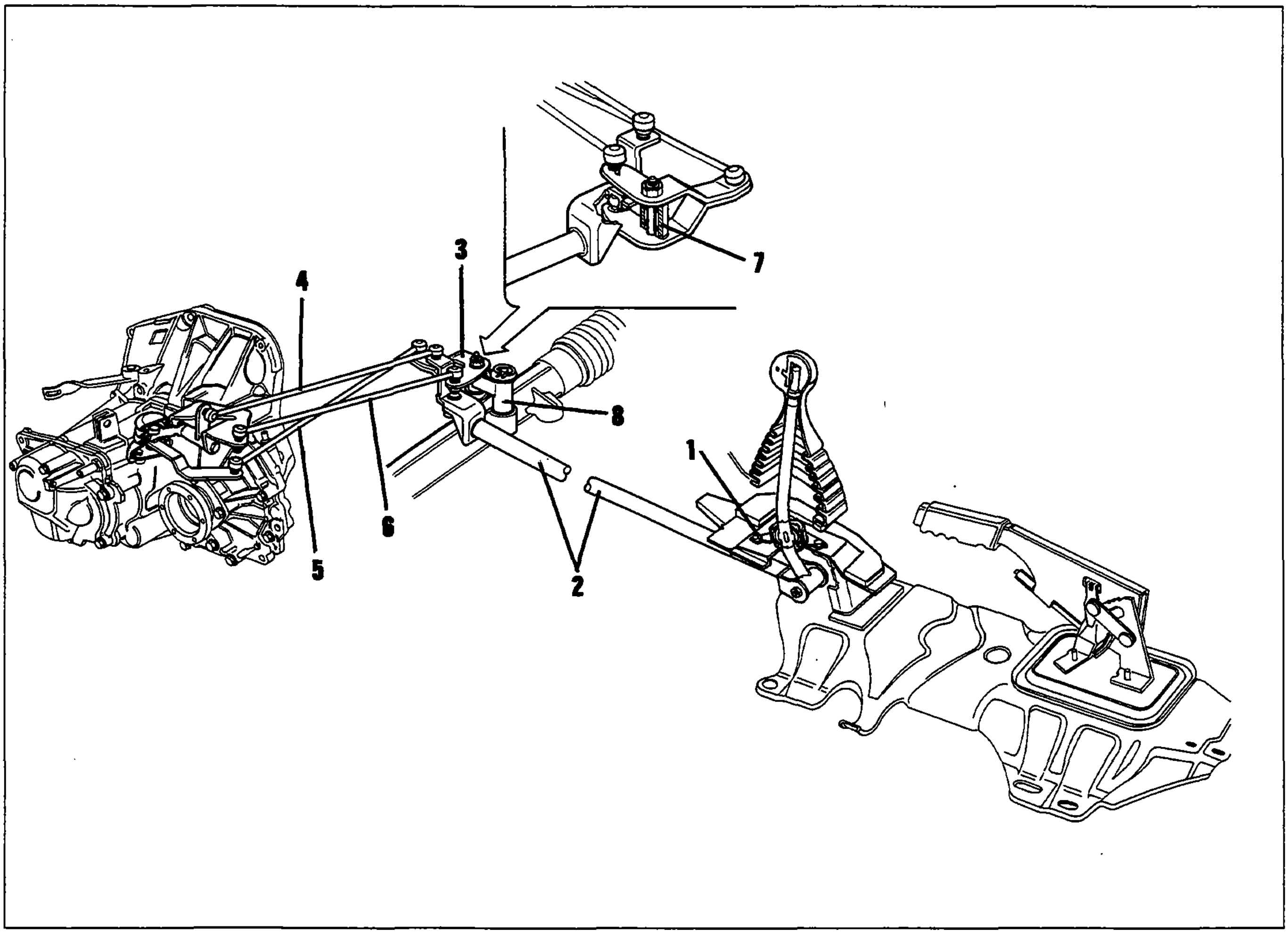


P4A029B04

3. Fit and install the NARDELLA seal bearing, for the differential casing oil seal gaiter, using the appropriate drift. After assembly, the bearing should be in the position shown in the figure.

21-27.

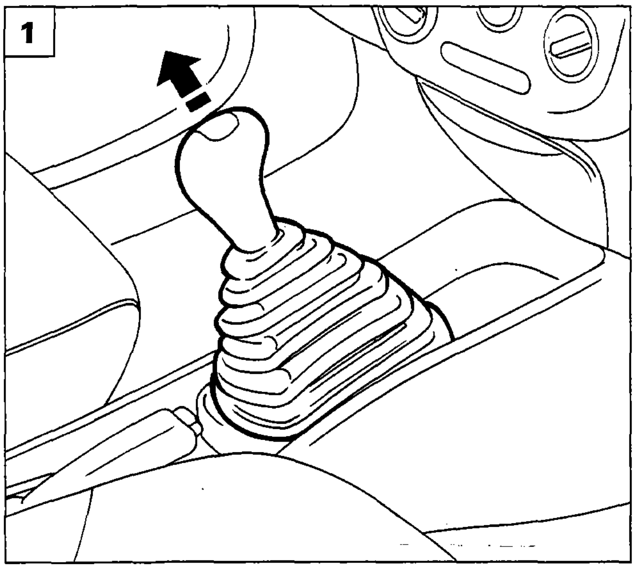
DIAGRAM OF REMOTE CONTROL ASSEMBLY



P4A030B01

Gear engagement and selector linkage

1. Gear selector rod mounting
2. Control rod
3. Relay mounting supporting gear engagement and selector linkage
4. Gear selector rod linkage
5. Gear engagement rod linkage
6. Reaction link
7. Bearings
8. Pin securing relay mounting supporting gear engagement and selector linkage



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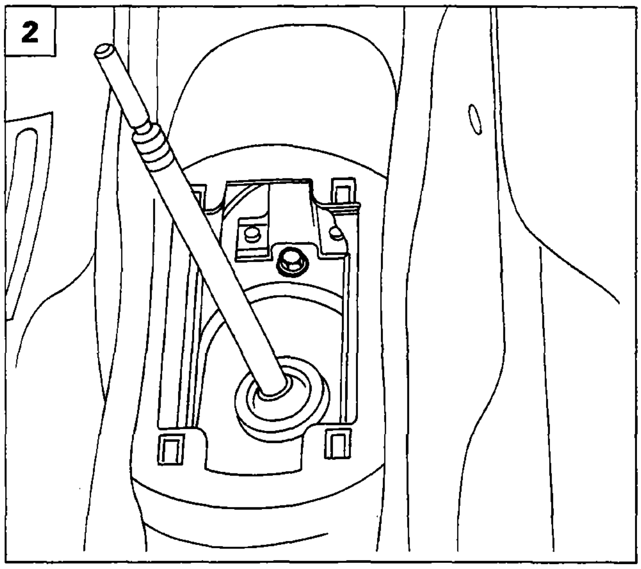

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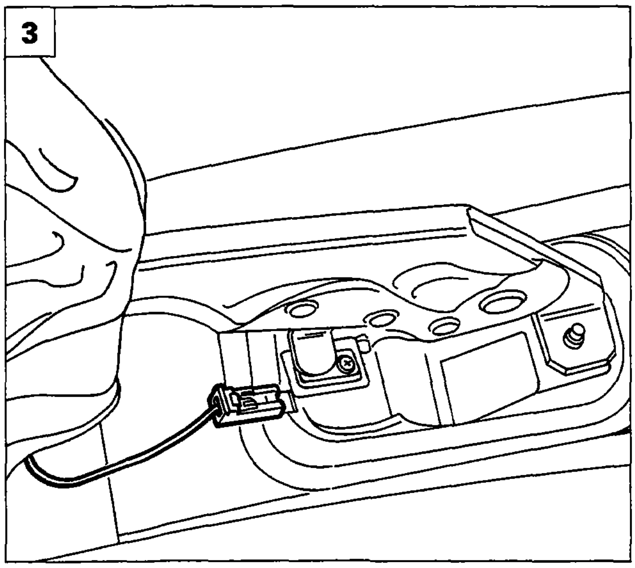
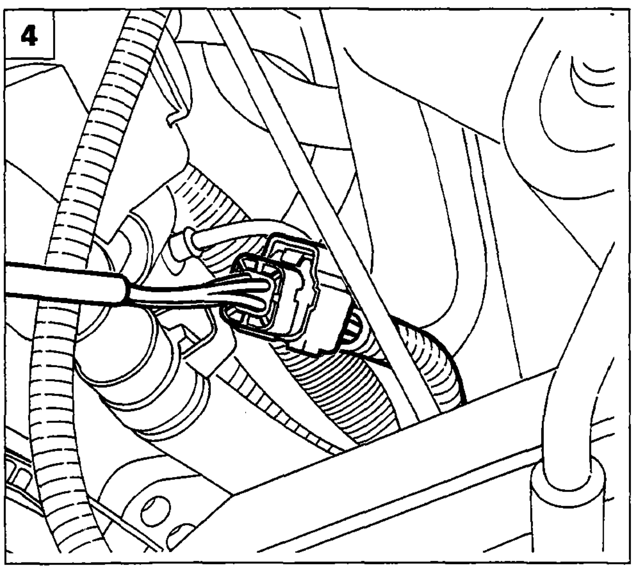


P4A015B02

REMOVING - REFITTING

Disconnect the battery's negative terminal, and dismantle the remote control assembly as described below:

1. Remove the gearlever trim from inside the car.
2. Undo the bolt securing the remote control assembly mounting to the bodywork.
3. Remove the handbrake lever trim and disconnect the electrical connection underneath.
4. Raise the ramps and disconnect the Lambda probe electrical connector.
5. Disconnect the handbrake cables from the mounting and release them from the bracket.



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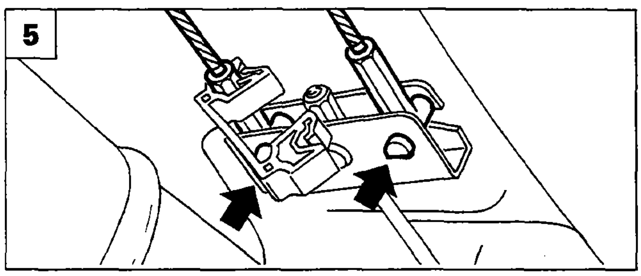

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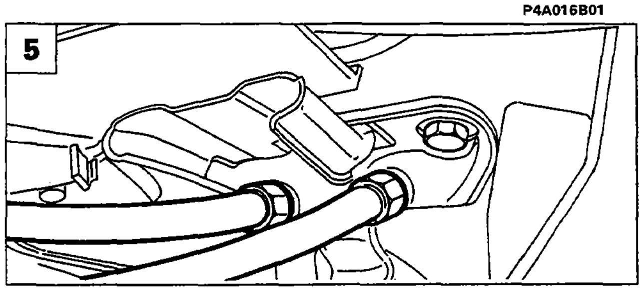

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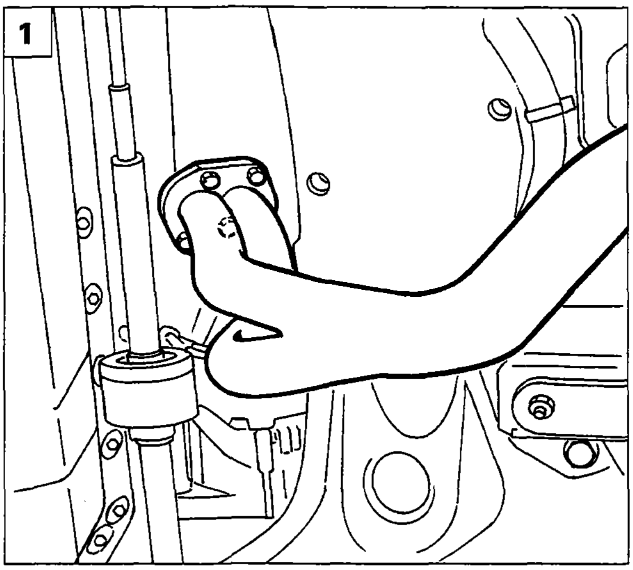
21-27.



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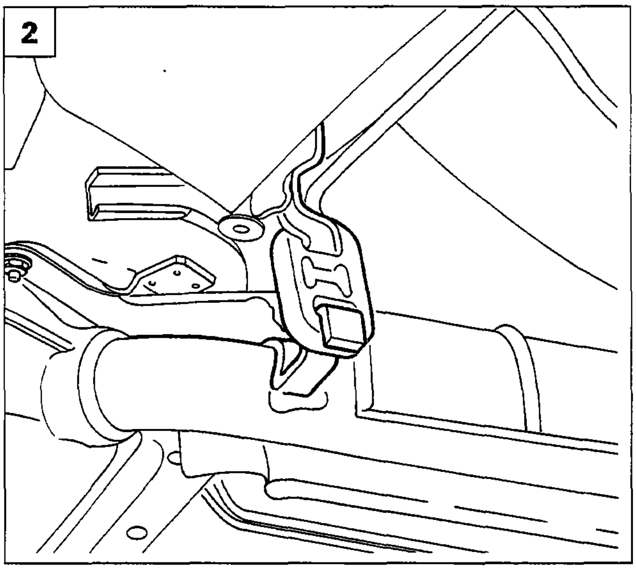

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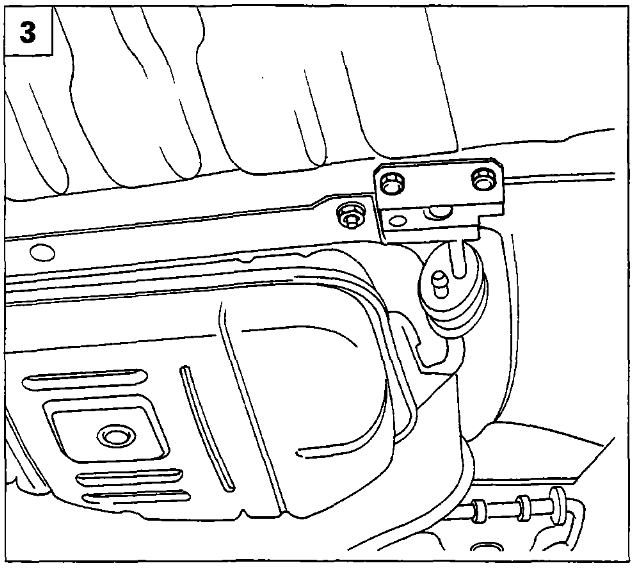
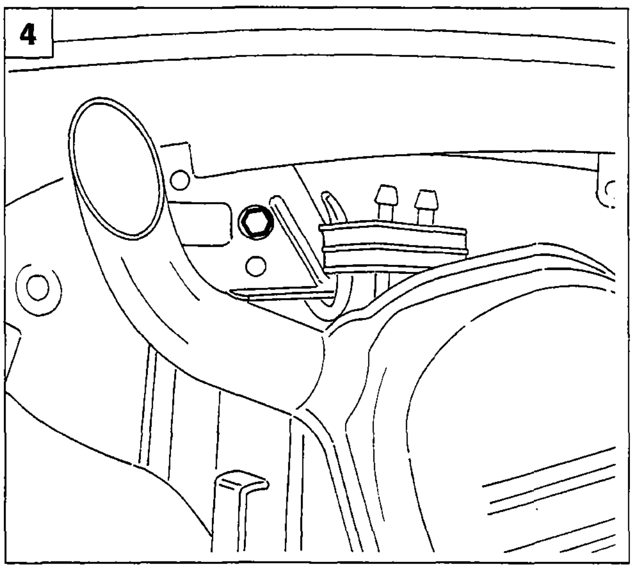


P4A016B06

1. Disconnect the Lambda probe electrical connection and disconnect the first section of the exhaust pipe from the front mountings.
2. Release the exhaust pipe from the rubber mount indicated.
3. Undo the bolts securing the exhaust pipe front mounting.
4. Undo the bolts securing the exhaust pipe rear mounting, then withdraw it from the car.
5. Remove the heat shield by undoing the bolts illustrated.



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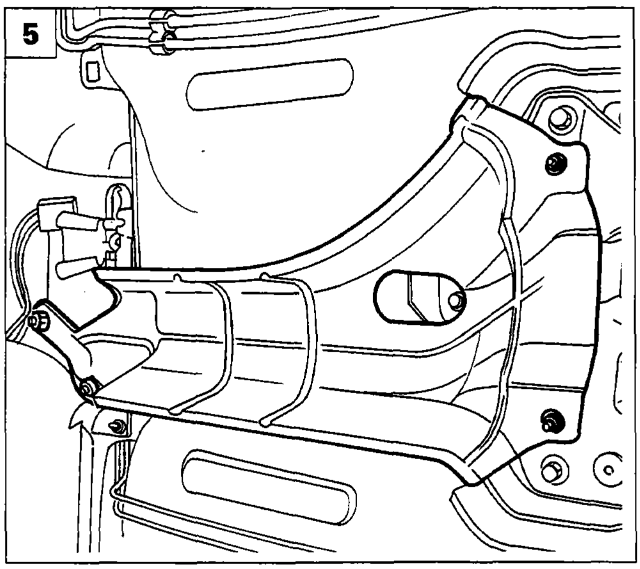
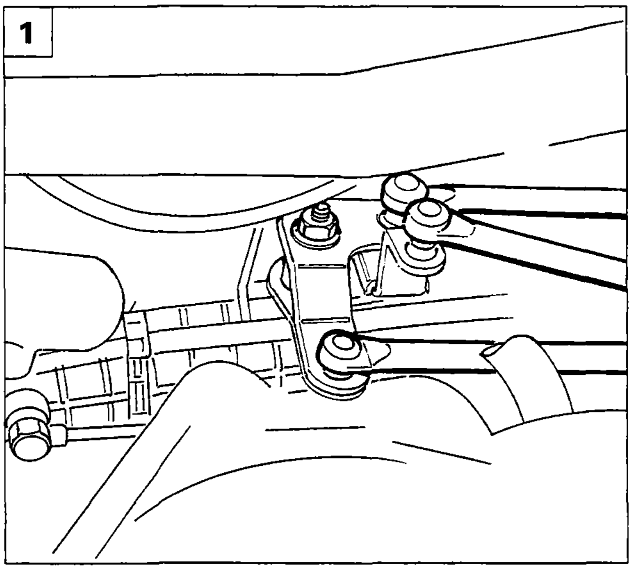


P4A017B02



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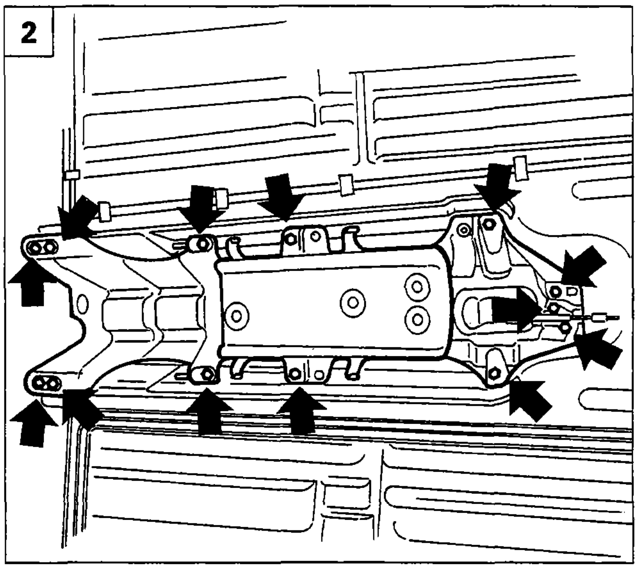

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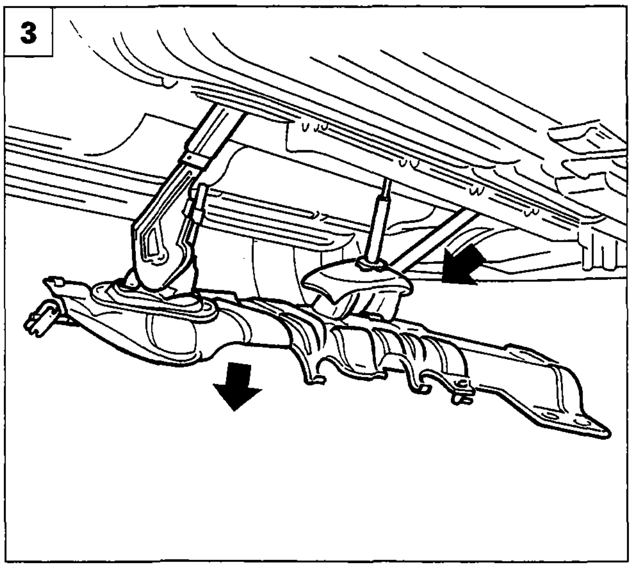

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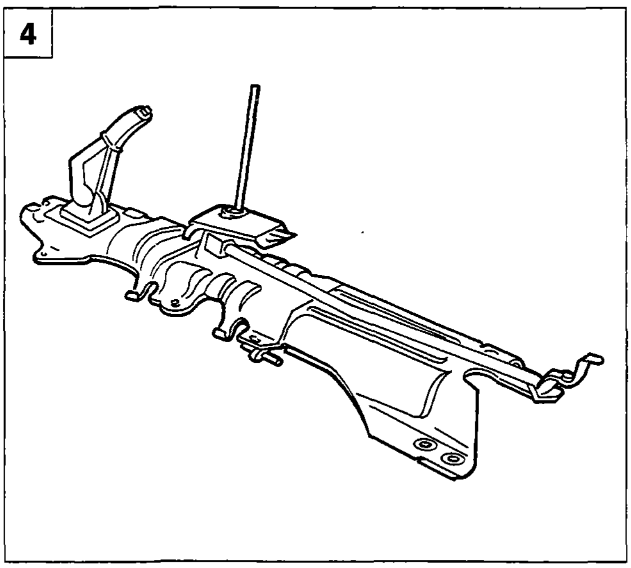


P4A033B03

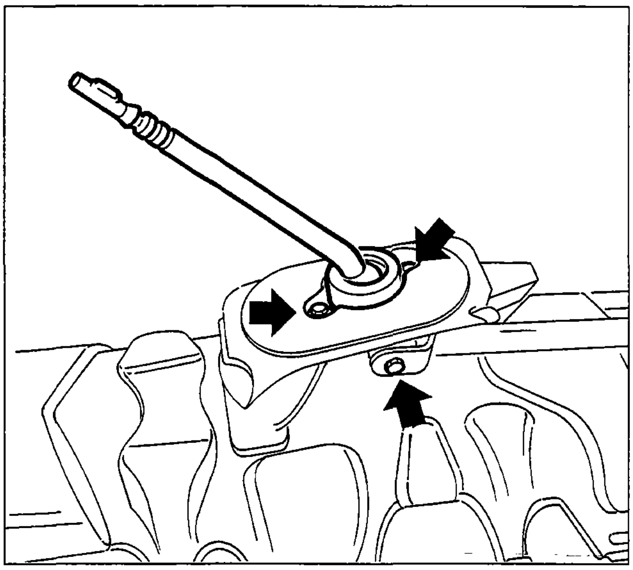
1. Disconnect the gear engagement and selector rods and the reaction link, then undo the nut and disconnect the relay assembly from the control rod.

2. Undo the bolts securing the remote control assembly mounting and handbrake to the bodywork.

3. Withdraw the control rod from the engine compartment, then remove the gearbox remote control assembly.

4. Internal control assembly

21-27.

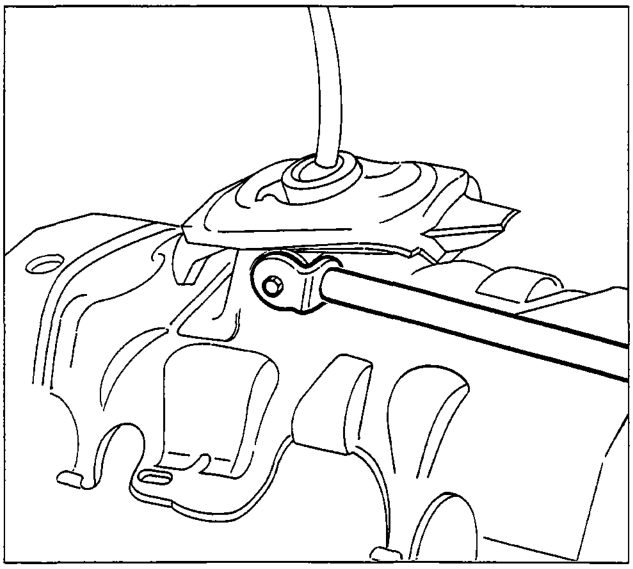


P4A034B01

DISMANTLING AT THE BENCH

Dismantling - refitting gearlever

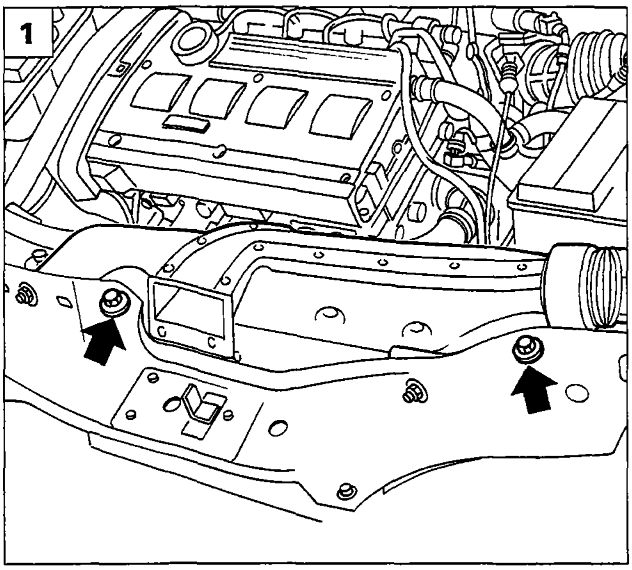
- Undo the bolts securing the gearlever to the mounting and the bolt securing the control rod to the gearlever, then disconnect it from the assembly.



P4A034B02

Dismantling - refitting control rod

- Undo the bolt securing it to the gearlever, then disconnect the control rod from the assembly.



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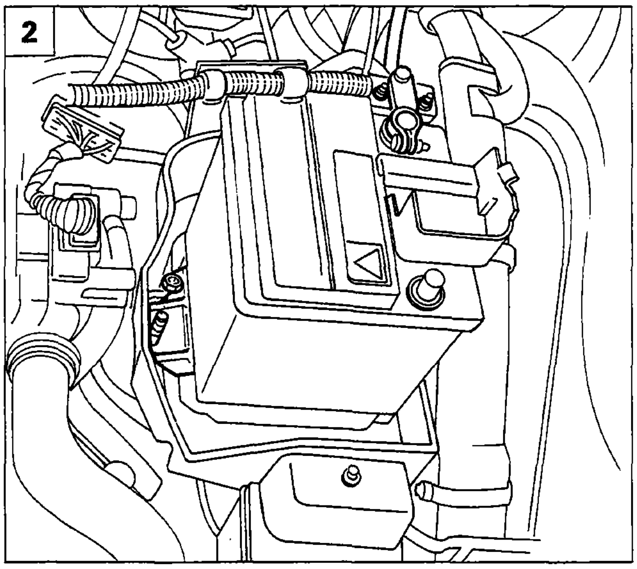

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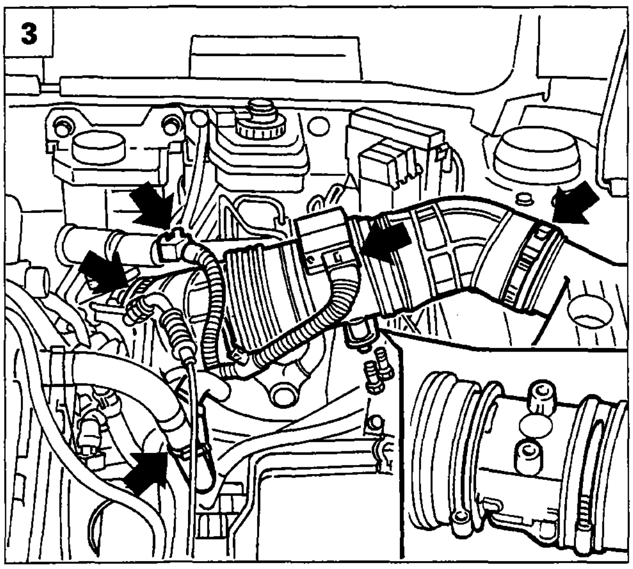

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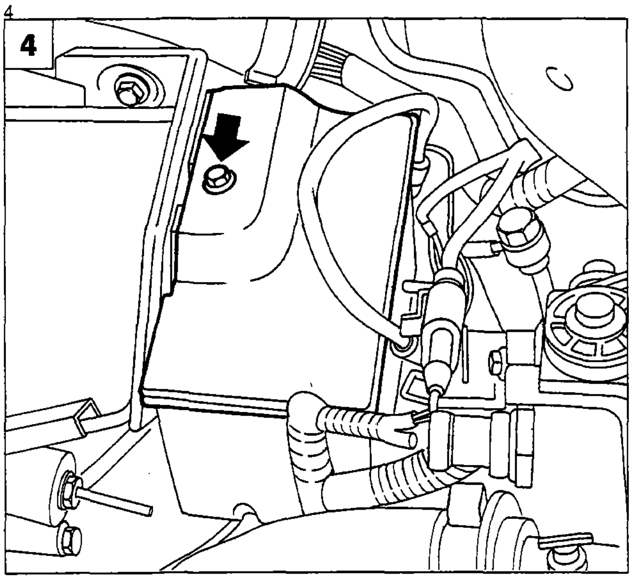


P4A035B03

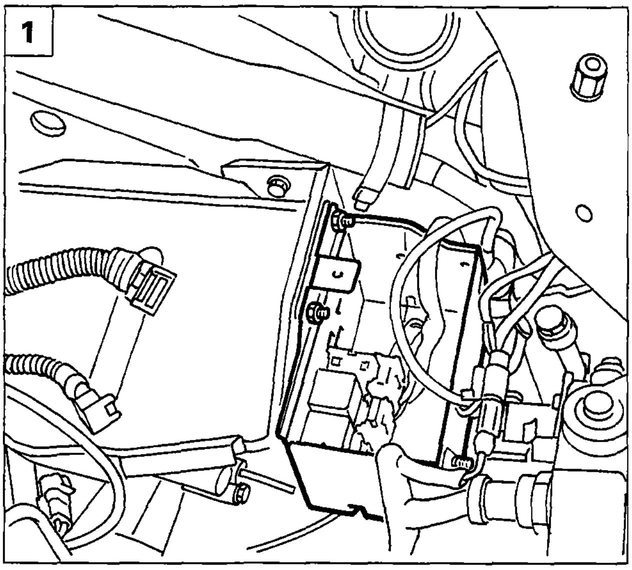
REMOVING - REFITTING

Removing

Place the car on ramps, disconnect the battery's negative terminal and remove the front wheels.

1. Remove the air inlet duct by undoing the bolts illustrated.
2. Lift the protective cover on the positive terminal, disconnect the positive terminal, then undo the nut securing the battery to the cage and remove the battery.
3. Disconnect the electrical connections indicated, unscrew the bolts from the bracket, then remove the complete inlet duct.
4. Undo the bolt indicated and remove the cover of the relay box.

21-27.



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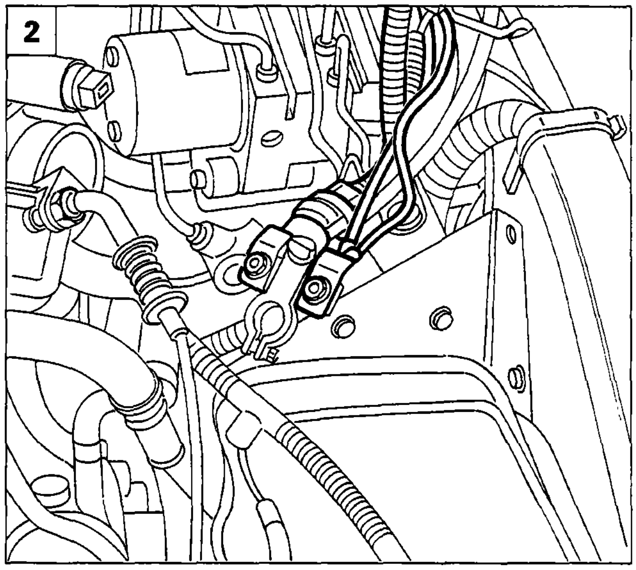

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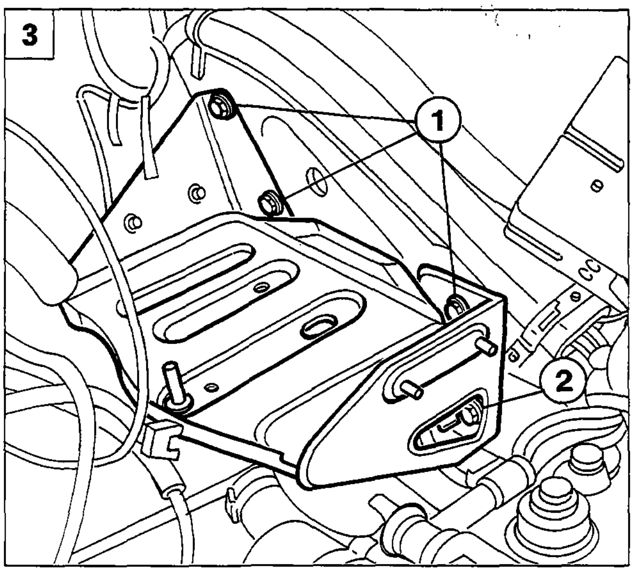

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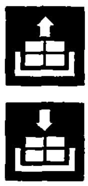
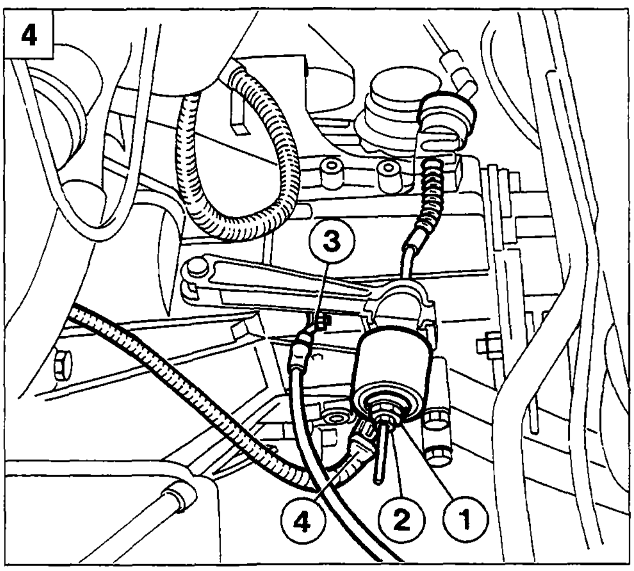


1. Undo the bolts securing the relay box to the battery cage, then move it over to one side.
2. Disconnect the cables indicated from the wiring on the battery's positive terminal.
3. Remove the screws (1) and slacken the bolt (2) securing the battery cage to the bodywork. Before removing the cage, disconnect the cable clip underneath.
4. Disconnect the clutch cable by undoing the nut (1) and locknut (2) shown in the figure. Also disconnect the earth cable (3) from the gearbox and the electrical connector for the reversing lights switch (4).
5. Disconnect the reaction link.



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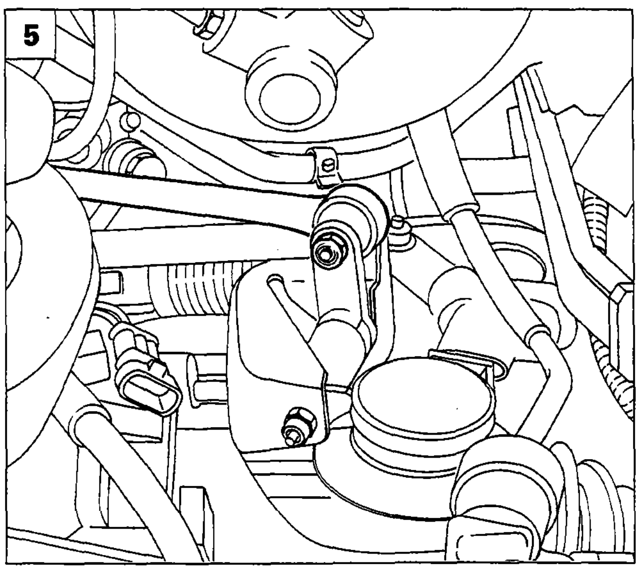

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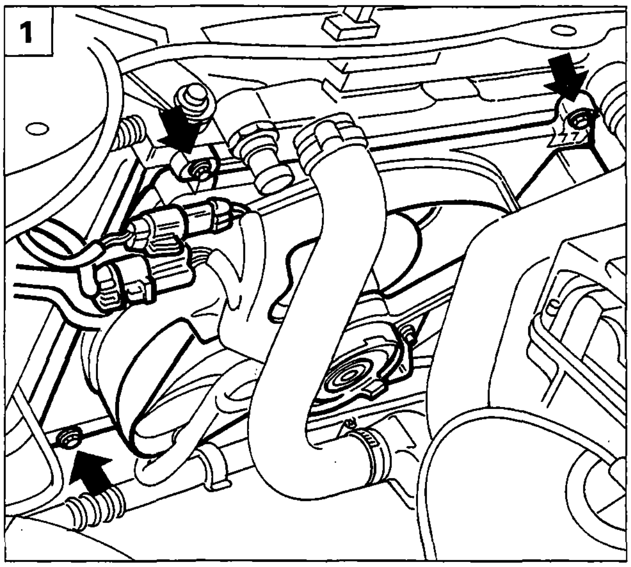

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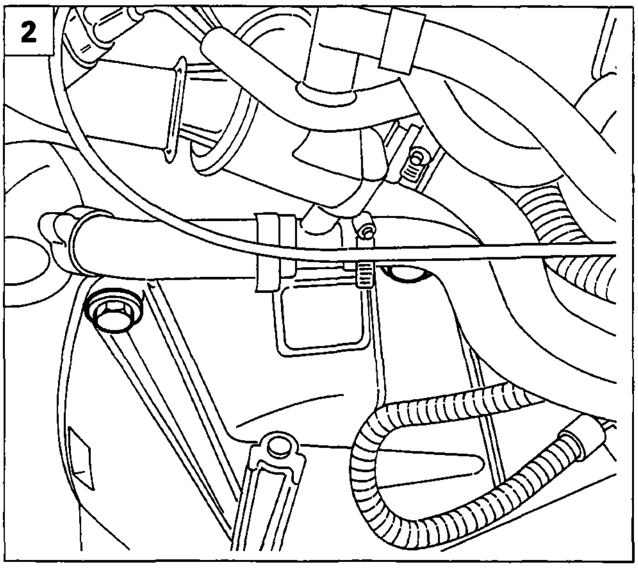

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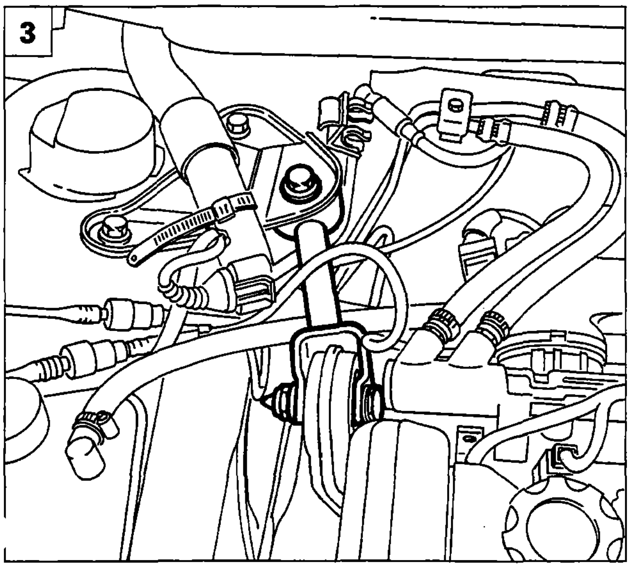


P4A037B03

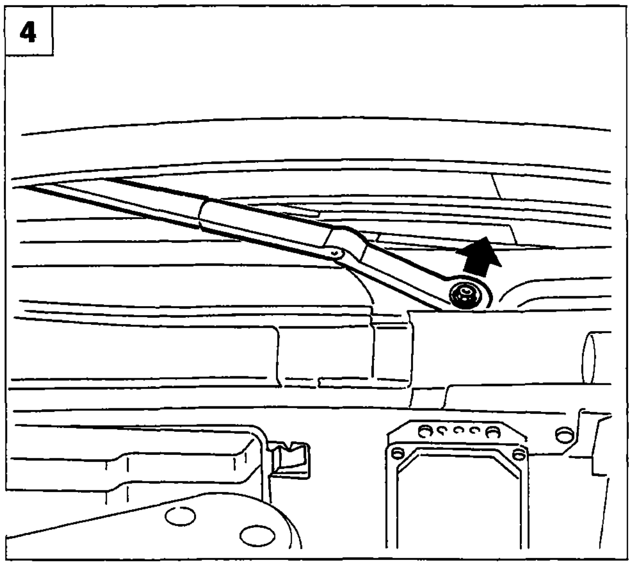
1. Disconnect the fan's supply connecctions. Undo the bolts securing it to the radiator, then remove it from the car.

2. Undo the top bolts securing the gearbox to the power unit.

3. Remove the engine reaction link.

4. Remove the left windscreen wiper arm by undoing the nut.

5. Remove the left side cover from the anti -pollen filter.



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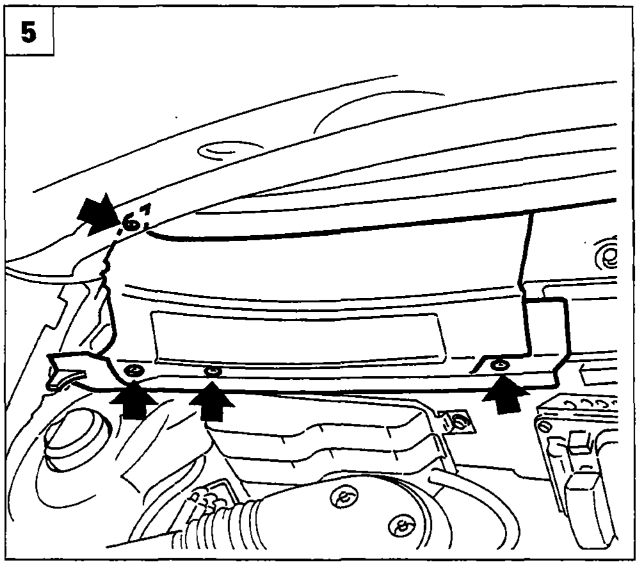

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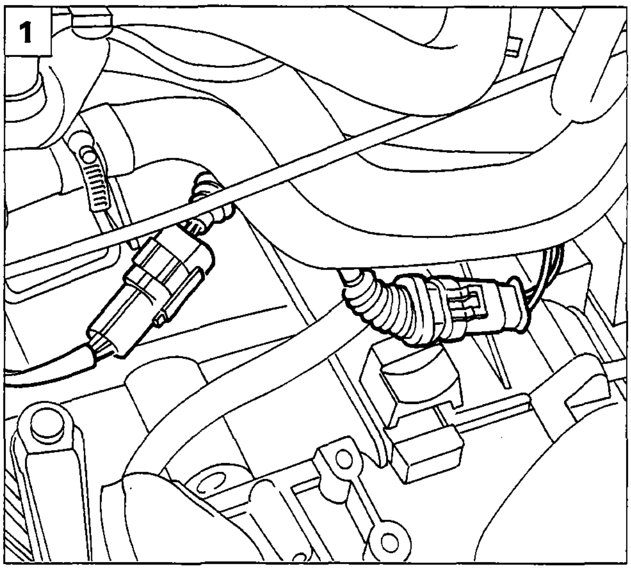
21-27.



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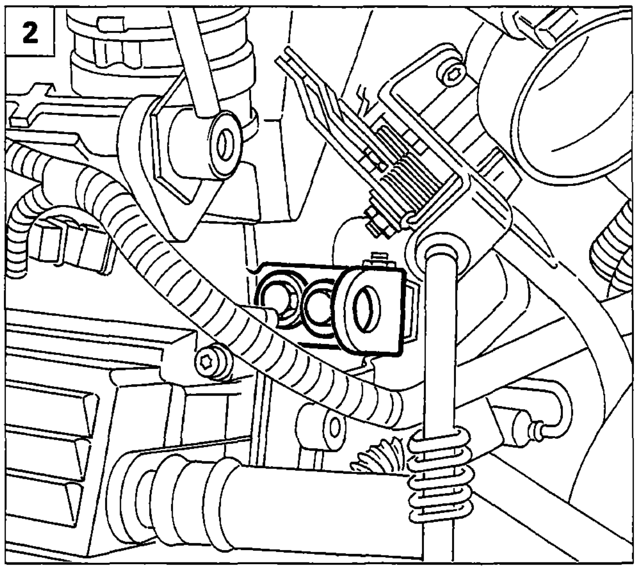
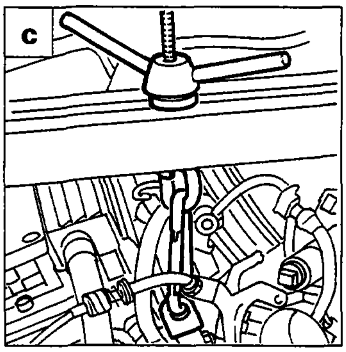


P4A038B02

1. Disconnect the electrical connector of the odometer signal and the Lambda probe connector.
2. Using two ordinary bolts, install a suitable supporting eyelet for hooking the power unit support stand.
3. Fit the engine support stand 1860851000 and adaptor 1860851001 in the appropriate mountings.

a. Front mounting: place the tool in the seat of the safety catch so that it rests on the front crossframe.
b. Rear mounting: fit the tool level with the central reinforcement of the fire-proof bulkhead.
c. secure the hook of the crossbeam to the previously secured bracket.



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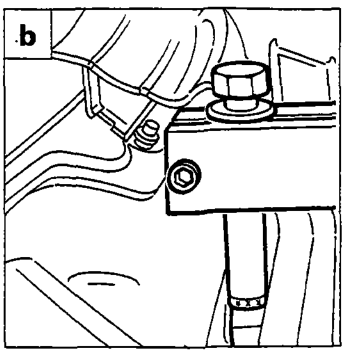

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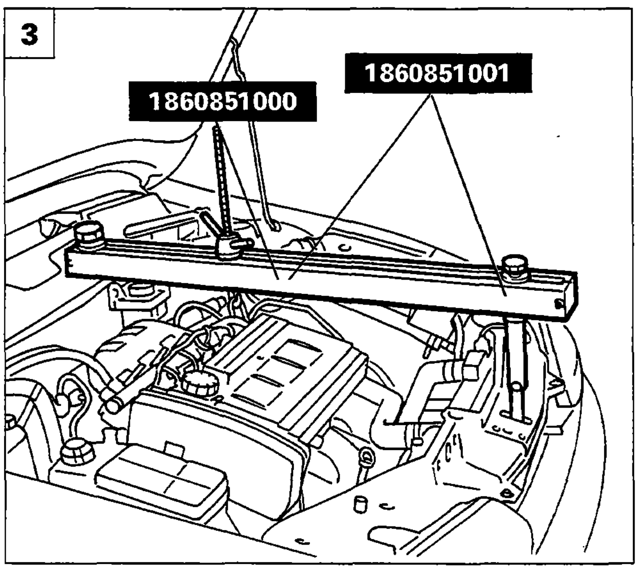

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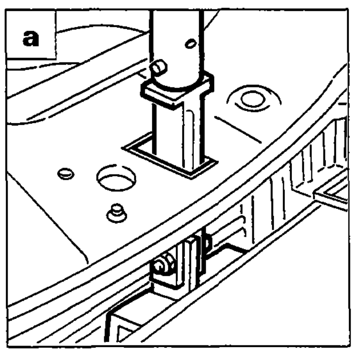

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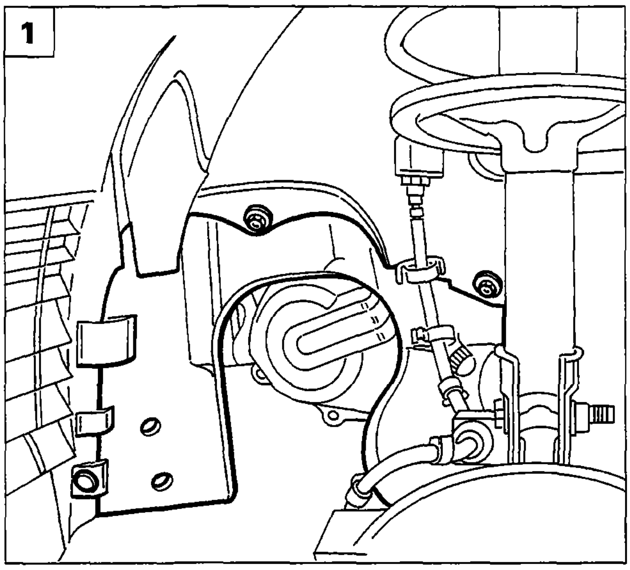

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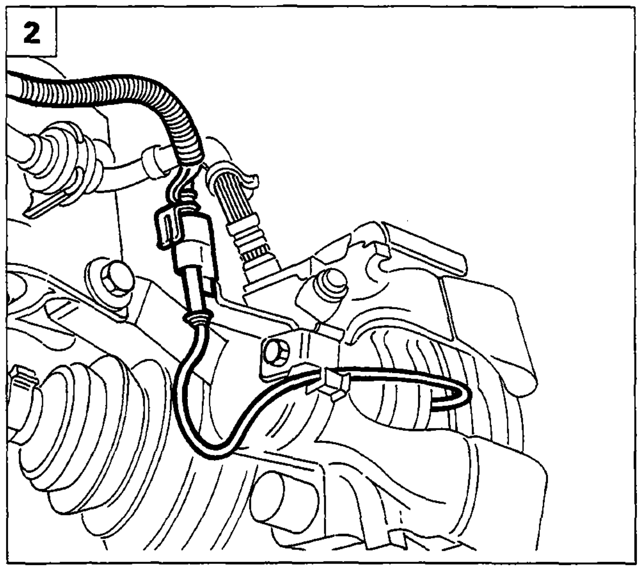

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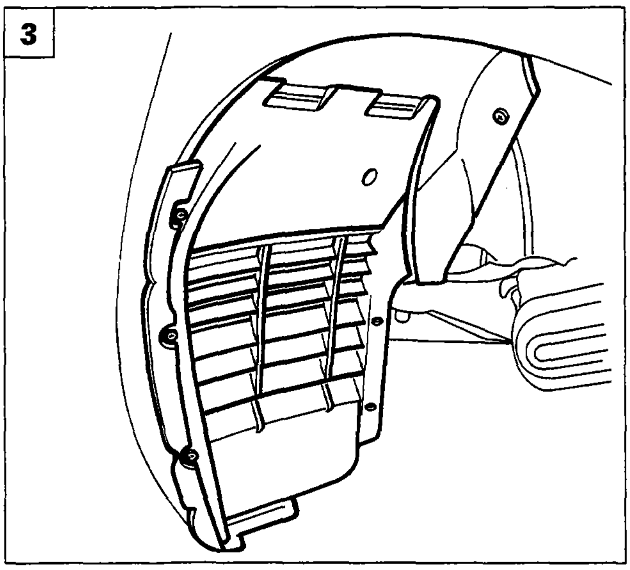
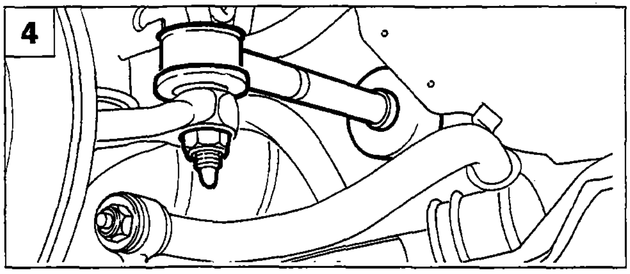


P4A003B03

1. Using tool 1878077000, remove the button securing the dust guard to the bodywork, then undo the bolts and release the dust guard from its seating.
2. Disconnect the brake pad connection then withdraw the central dust guard from the car.
3. Remove the front dust guard by undoing the screws illustrated.
4. Undo the nut securing the tie-rod end, then using tool 1847038000 disconnect the latter from the vertical link.
5. Undo the vertical link bolts, then remove it.



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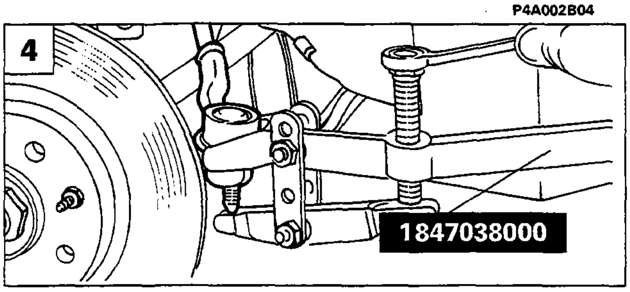

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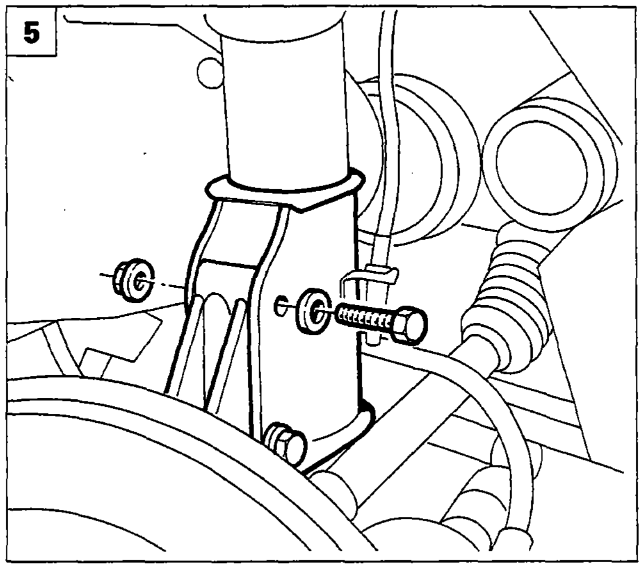

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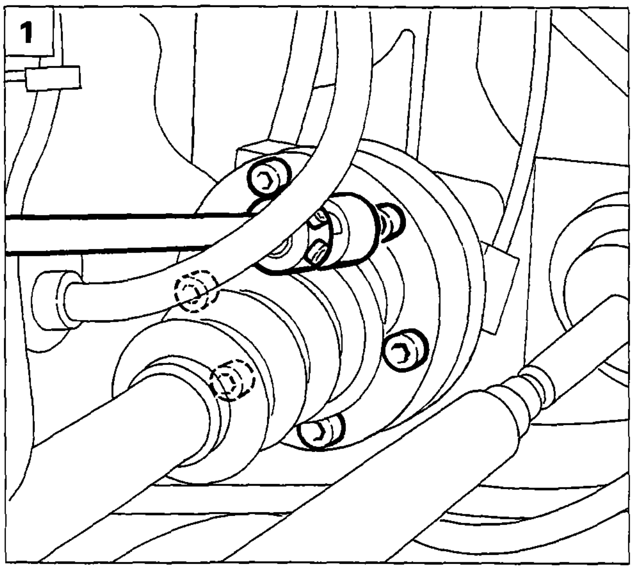
21-27.



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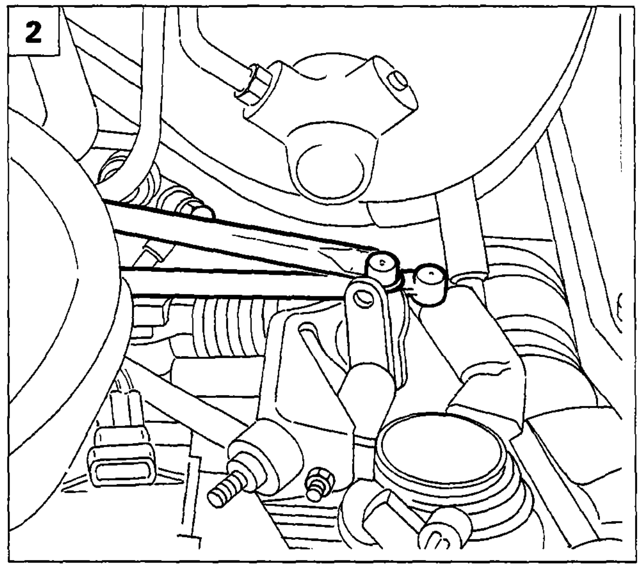
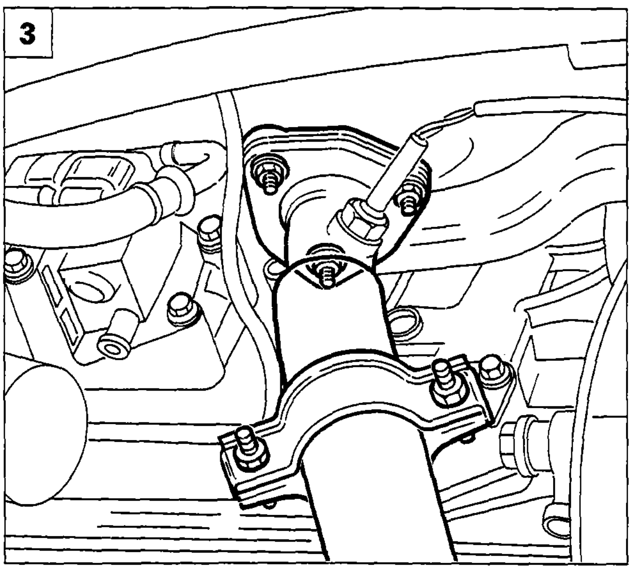


P4A040B02

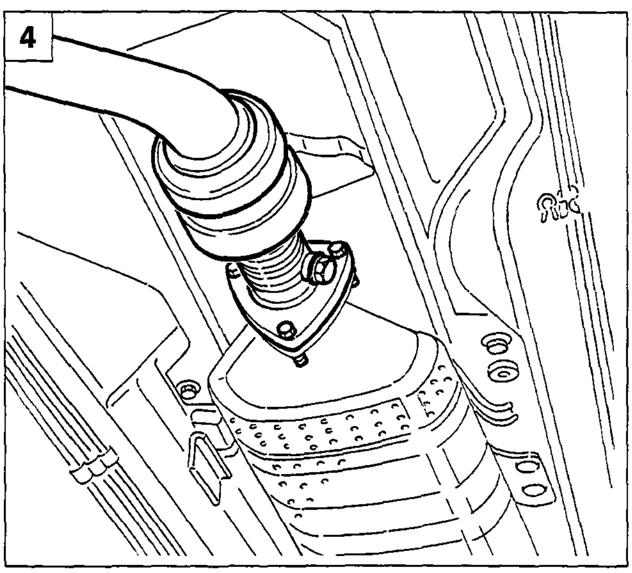


P4A040B03

1. Disconnect the drive shaft by undoing the bolts securing the constant velocity joint to the gearbox flange.

Operations to be repeated on the other side

2. Disconnect the gear engagement and sector rods from the gearbox.
3. Raise the car and remove the front bolts securing the first section of the exhaust pipe.
4. Remove the rear bolts and remove the first section of the exhaust pipe from the car.
5. Remove the bracket indicated to permit insertion of a spanner to remove the bolt securing the gearbox to the power unit.



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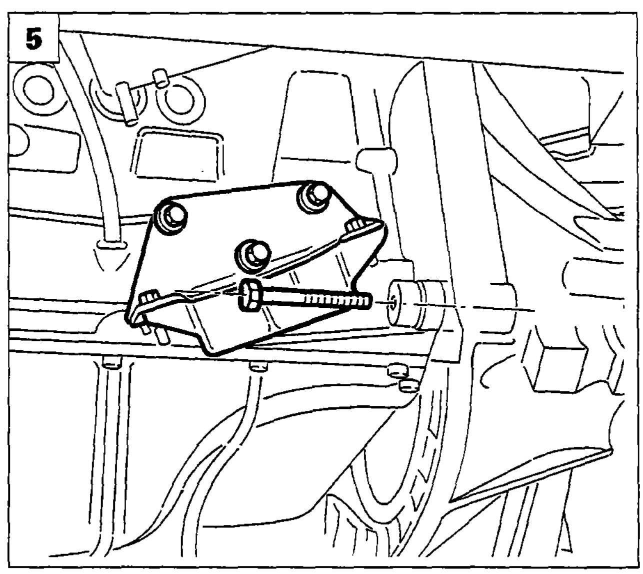

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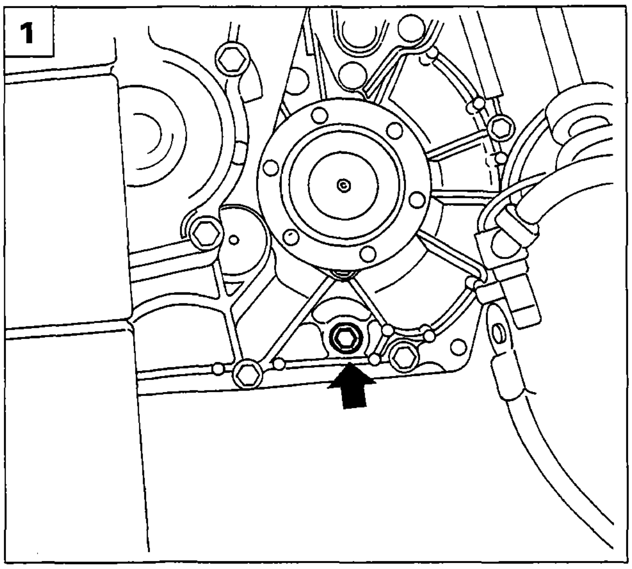
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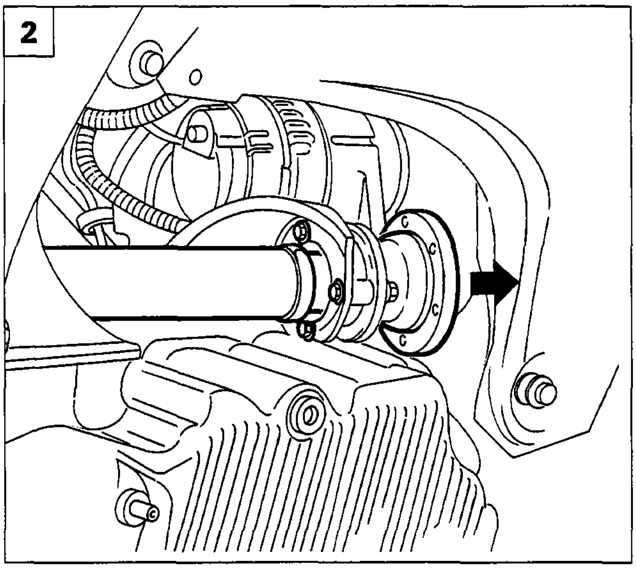
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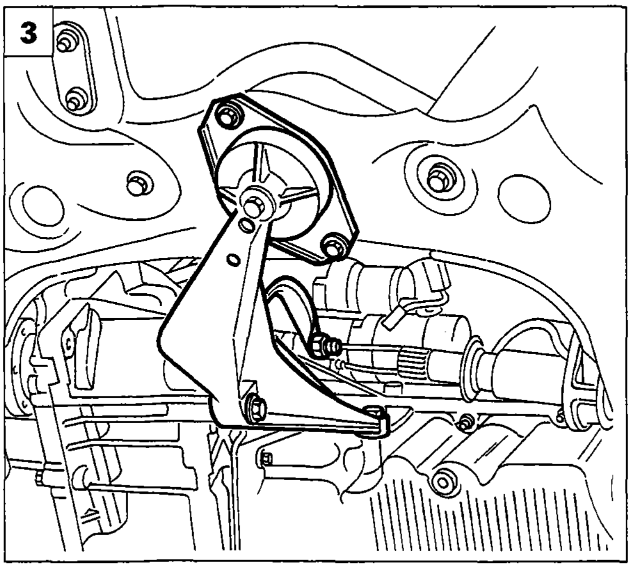
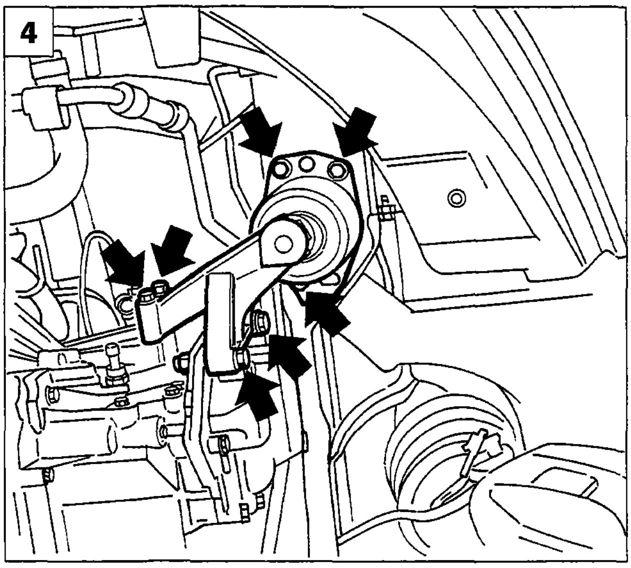

P4A041B03

1. Drain the gearbox oil, undoing the bolt indicated.
2. Undo the bolts securing the intermediate shaft to the engine, release it from the gearbox and move it away from the working area, securing it in an appropriate manner.
3. Remove the power unit's central mounting.
4. Remove the power unit mounting on the gearbox side.
5. Lower the car and manoeuvre the power unit as appropriate to make it perform the maximum permissible travel towards the front of the engine compartment.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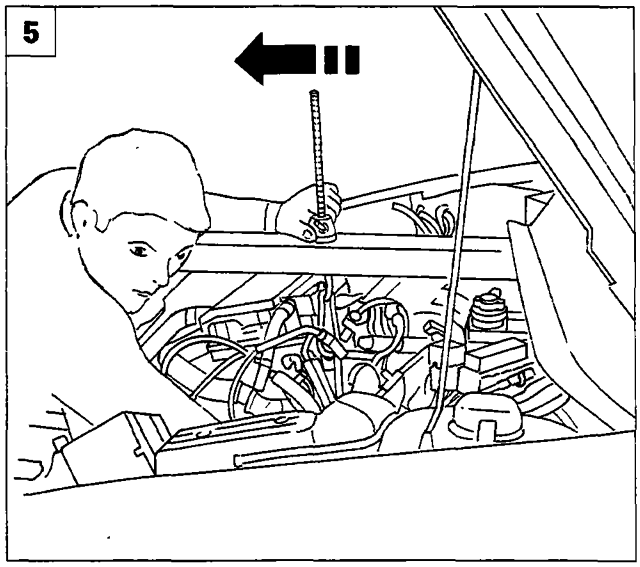
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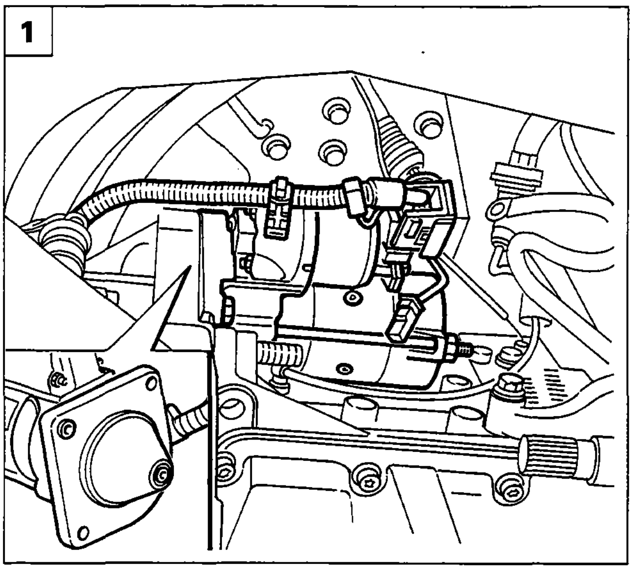
21-27.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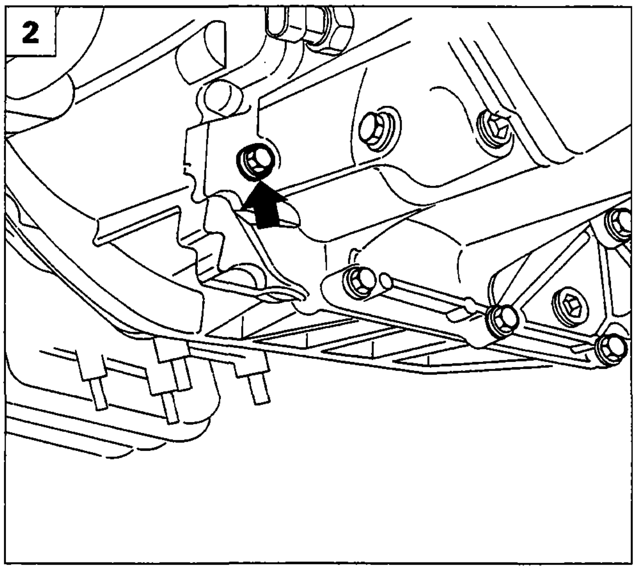
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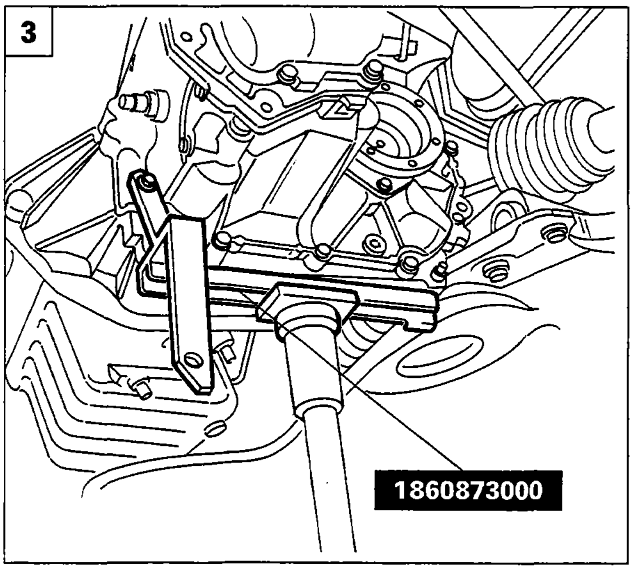


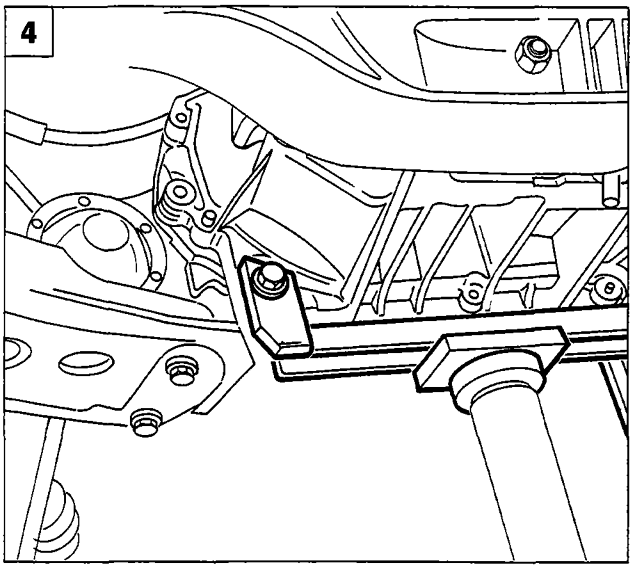
P4A007B02

1. Raise the ramps and remove the starter motor complete with wiring.

2. Undo the bolt illustrated securing the gearbox to the power unit, and unscrew the gearbox bolt illustrated in order to then be able to secure the supporting tool for removing the gearbox-differential unit.

3.4 Fit the tool 1860873000 for manoeuvring the gearbox-differential unit.

5. Undo the rear bolts securing the gearbox to the power unit.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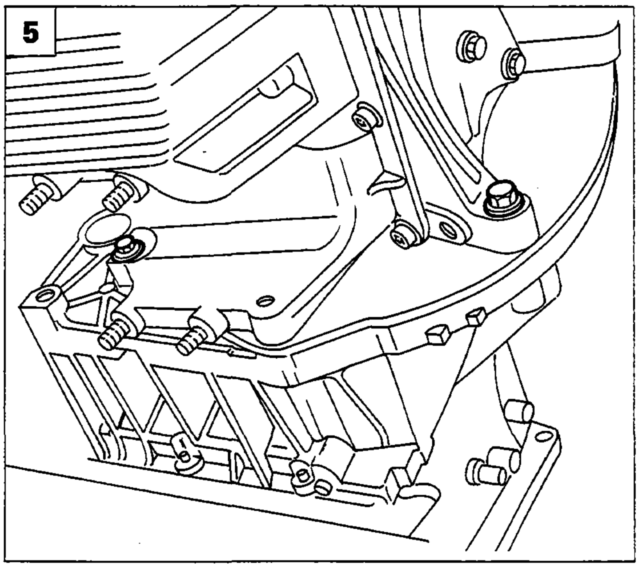
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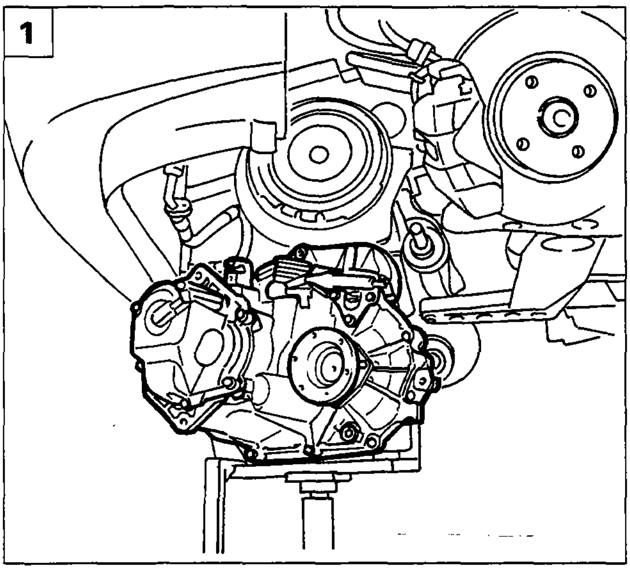

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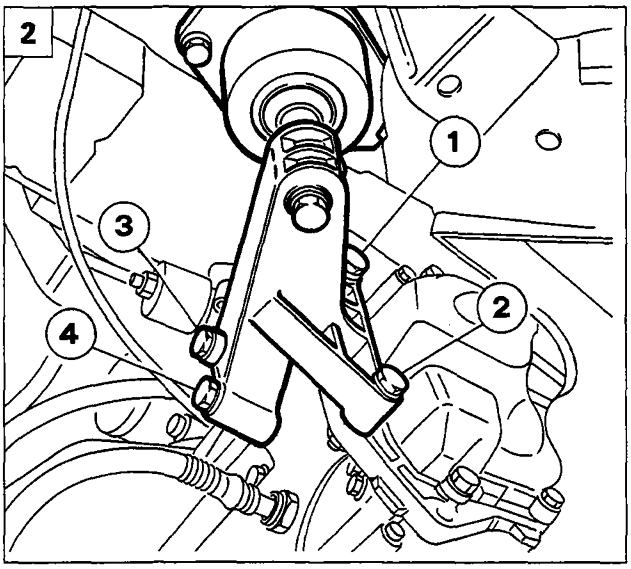


P4A043B01

1. Manoeuvre the hydraulic jack as appropriate to withdraw the gearbox from the centring studs, then withdraw the gearbox from the engine compartment, slowly lowering the jack.

Refitting

2. When refitting the engine mounting on the gearbox side, in order to avoid creating stresses on the gearbox sealing surfaces resulting in deformation and oil leaks, strictly observe the following tightening sequence for the bolts:
   - Lightly tighten bolts (1) and (2) to a torque of 0.5 daNm;
   - Lightly tighten bolts (3) and (4) to a torque of 0.5 daNm, then tighten them to the specified torque;
   - Tighten bolts (1) and (2) to the specified torque.

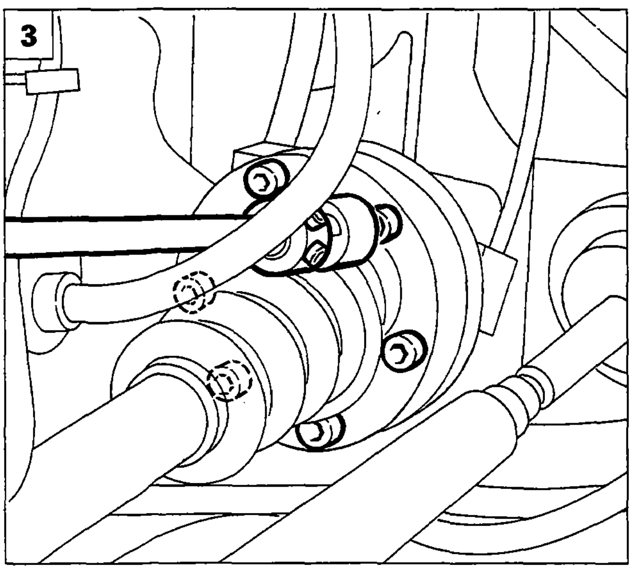
To refit, reverse the procedure described for removal.

REMOVING - REFITTING DRIVE SHAFTS

Place the car on ramps, disconnect the battery's positive terminal and remove the front wheels, then carry out the operations described below:

3. Disconnect the drive shaft by undoing the screws illustrated.
4. Withdraw the drive shaft from the wheel hub and withdraw it from the engine compartment.

NOTE *To refit, reverse the procedure for removal, tightening the hub nut to the specified torque.*



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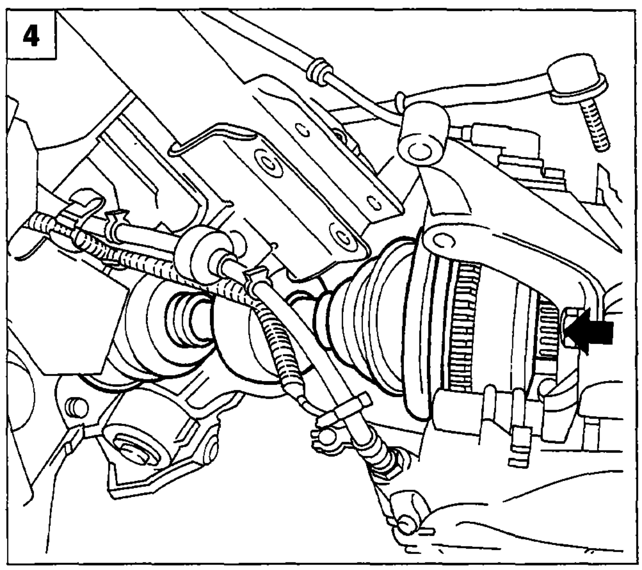

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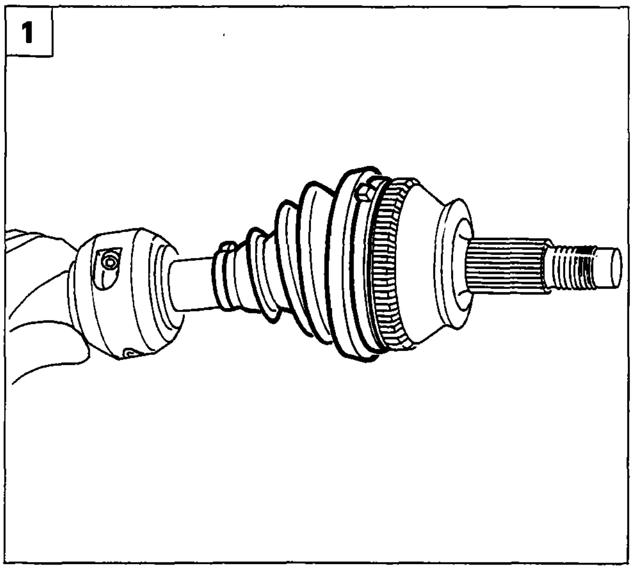
21-27.



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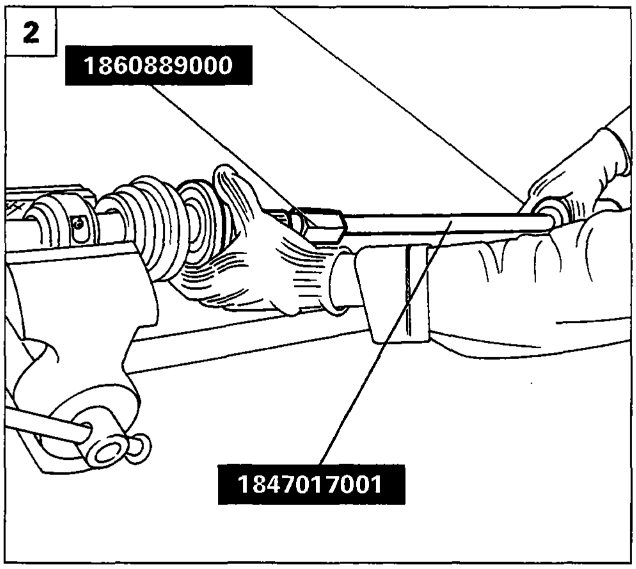

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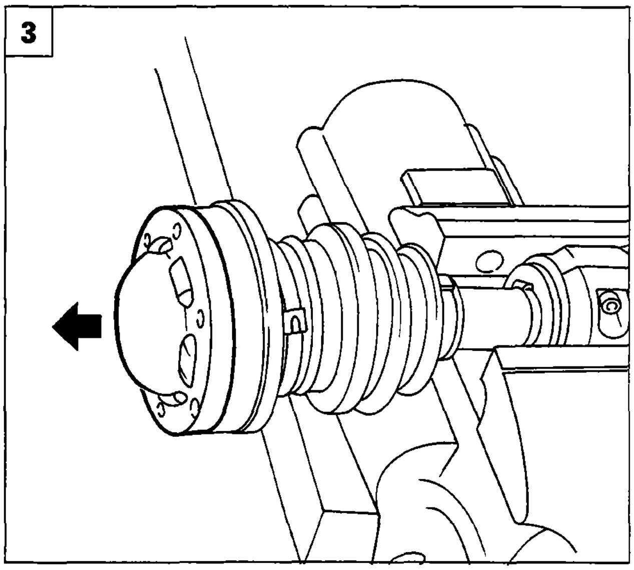


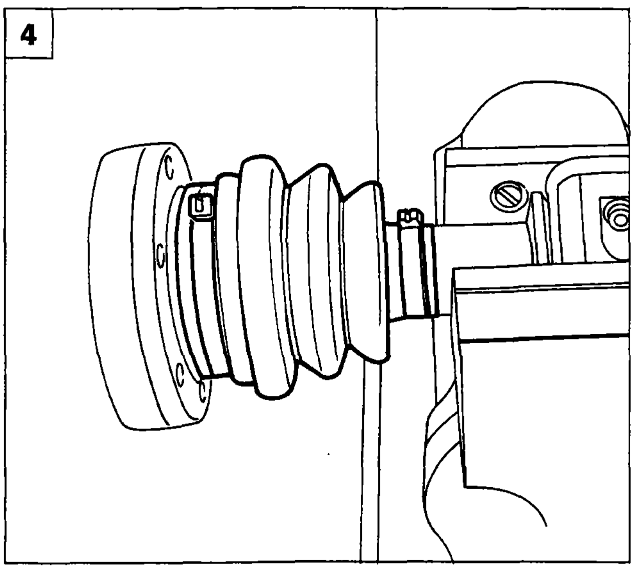
P4A044B03

DISMANTLING

1. Remove the clip and the protective gaiter on the constant velocity joint, wheel side.

During assembly, it is advisable to replace the protective gaiter.

2. Clean the grease off the inside of the constant velocity joint and, using tools 1847017001 and 1860889000, remove the constant velocity joint and then withdraw the protective gaiter, previously moved aside, from the drive shaft.
3. Remove the protective cover from the constant velocity joint, gearbox side.
4. Remove the two clips securing the protective gaiter on the gearbox side, then remove it.
5. Clean the grease off the inside of the constant velocity joint and remove the circlip from its seating.



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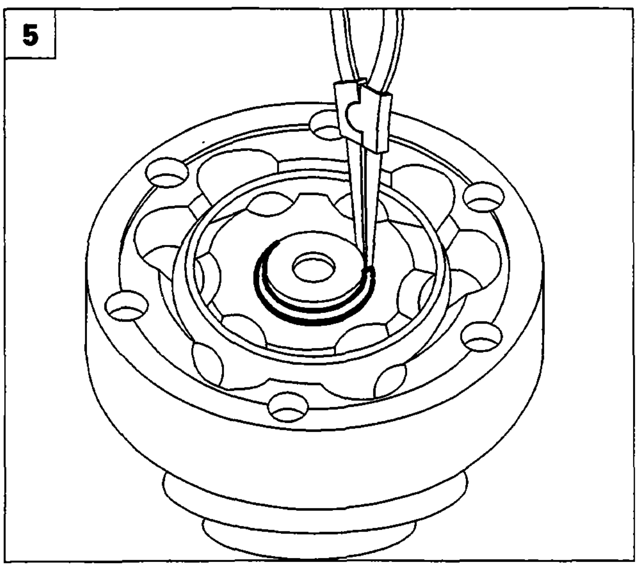

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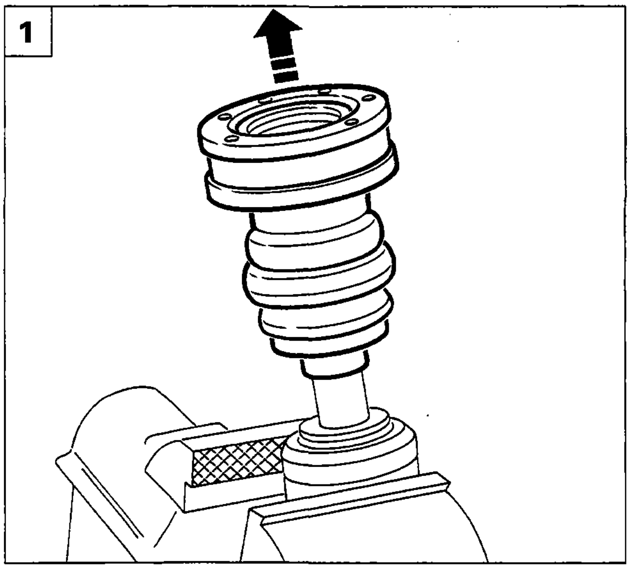
1



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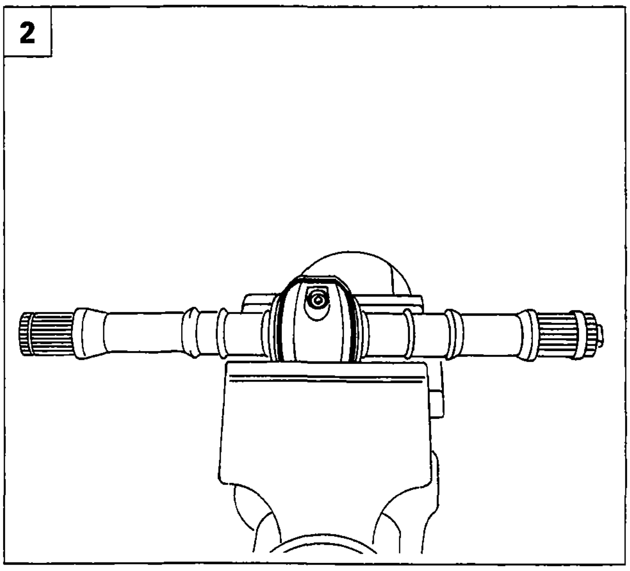

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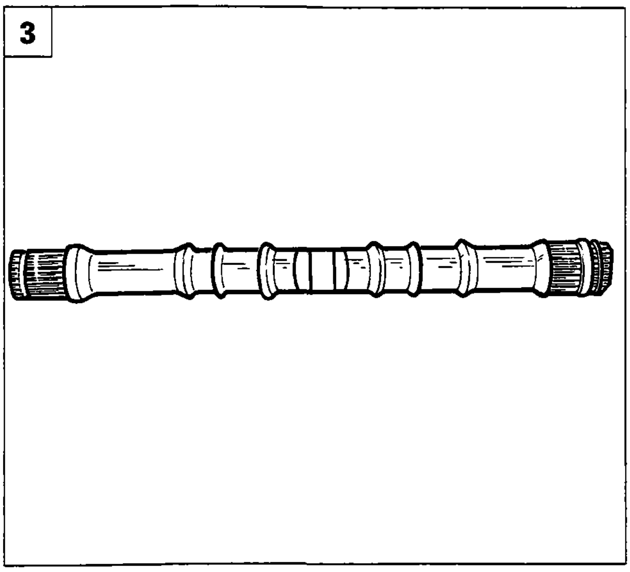
3



P4A045B03

1. Withdraw the joint from the drive shaft and then withdraw the protective gaiter.

It is advisable to renew the protective gaiter whenever it is removed.

2. Undo the two screws, one of which is not in view, and remove the two half shells and the rubber buffer which constitute the damping weight.

When refitting, the damping weight must be returned to the same seating, recognizable on the shaft by a marked reduction of the outer diameter and by two thrust washers which define the outside dimensions of the damping weight.

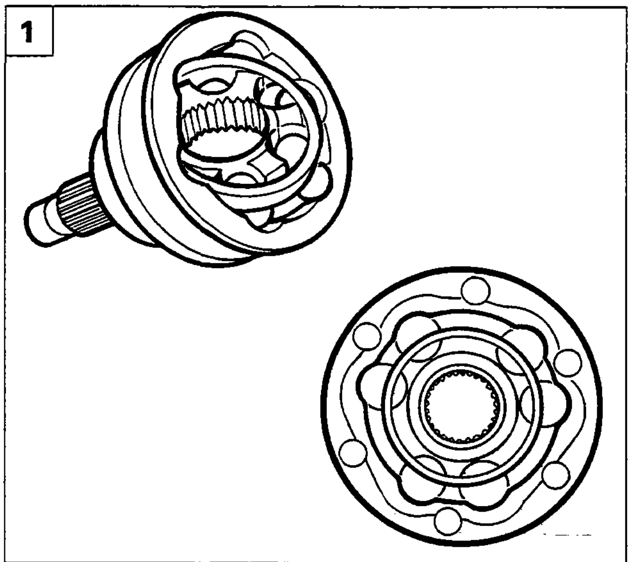
3. Check that the drive shaft is not deformed or out of true, and that the surface in contact with the seal is not worn.

REFITTING

During reassembly, the constant velocity joints must be coupled to the shaft in accordance with the table. Category B joints match both categories of drive shaft; carry out a further check on the joint to make sure that there are no signs of seizure or scoring.

Shaft-joint coupling, wheel side			
Shaft classification		Joint classification	
Category	Colour	Category	Colour
A	Blue	A	Blue
		B	White
B	Red	C	Red

1



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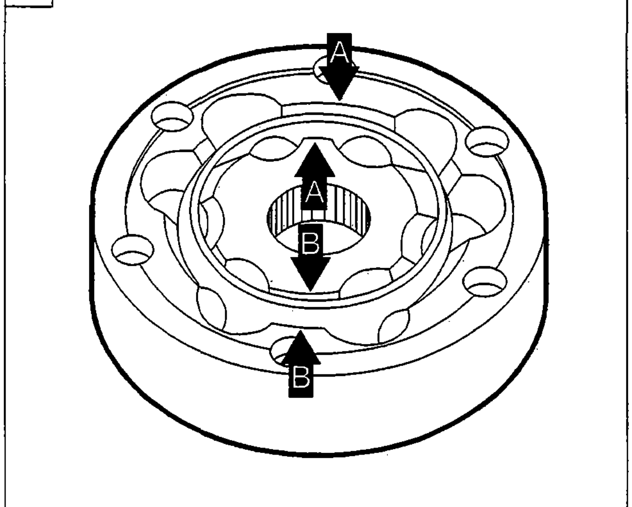
2



P4A046B02

1. Wash the constant velocity joints thoroughly with naphtha or petrol, and visually check that the balls and their seatings mirror each other perfectly and have no signs of seizure or scoring.

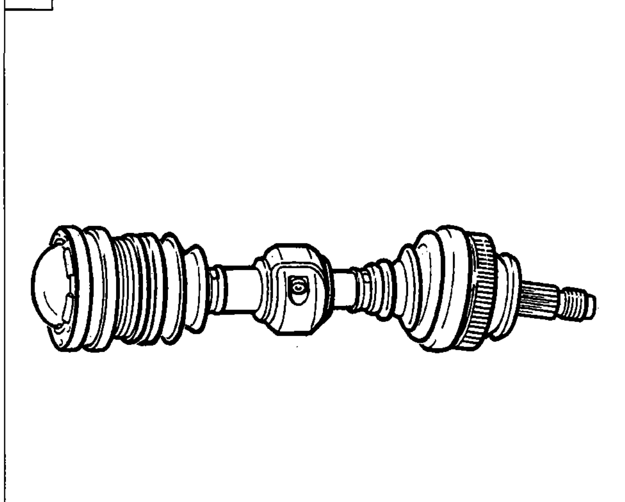
2. If the balls fall out of their seatings during withdrawal of the joints, for correct reassembly, follow the references given in the figure, i.e. "A" must line up with "A" and "B" with "B", otherwise the joint will remain jammed.

3. After carrying out the following checks, refit the parts reversing the procedure for removal, bearing in mind that the bolts securing the two half shells of the damping weight must first be tightened lightly and then tightened to a torque of no more than 0.7 daNm.

it is advisable to renew the protective gaiters whenever they are removed, and it is important to fill both constant velocity joint and gaiter with TUTELA MRM2 grease.

4. General view of drive shaft-constant velocity joint couplings.

3



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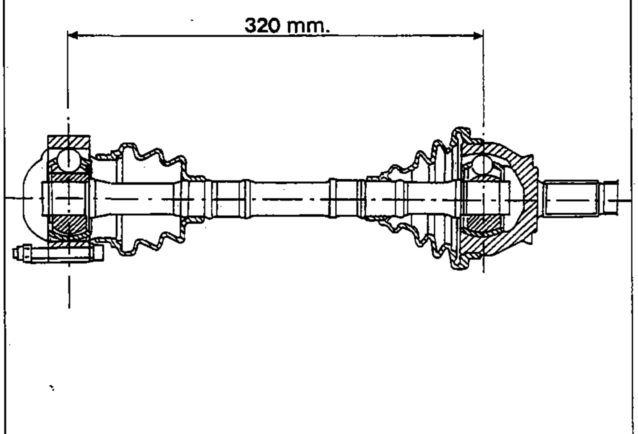

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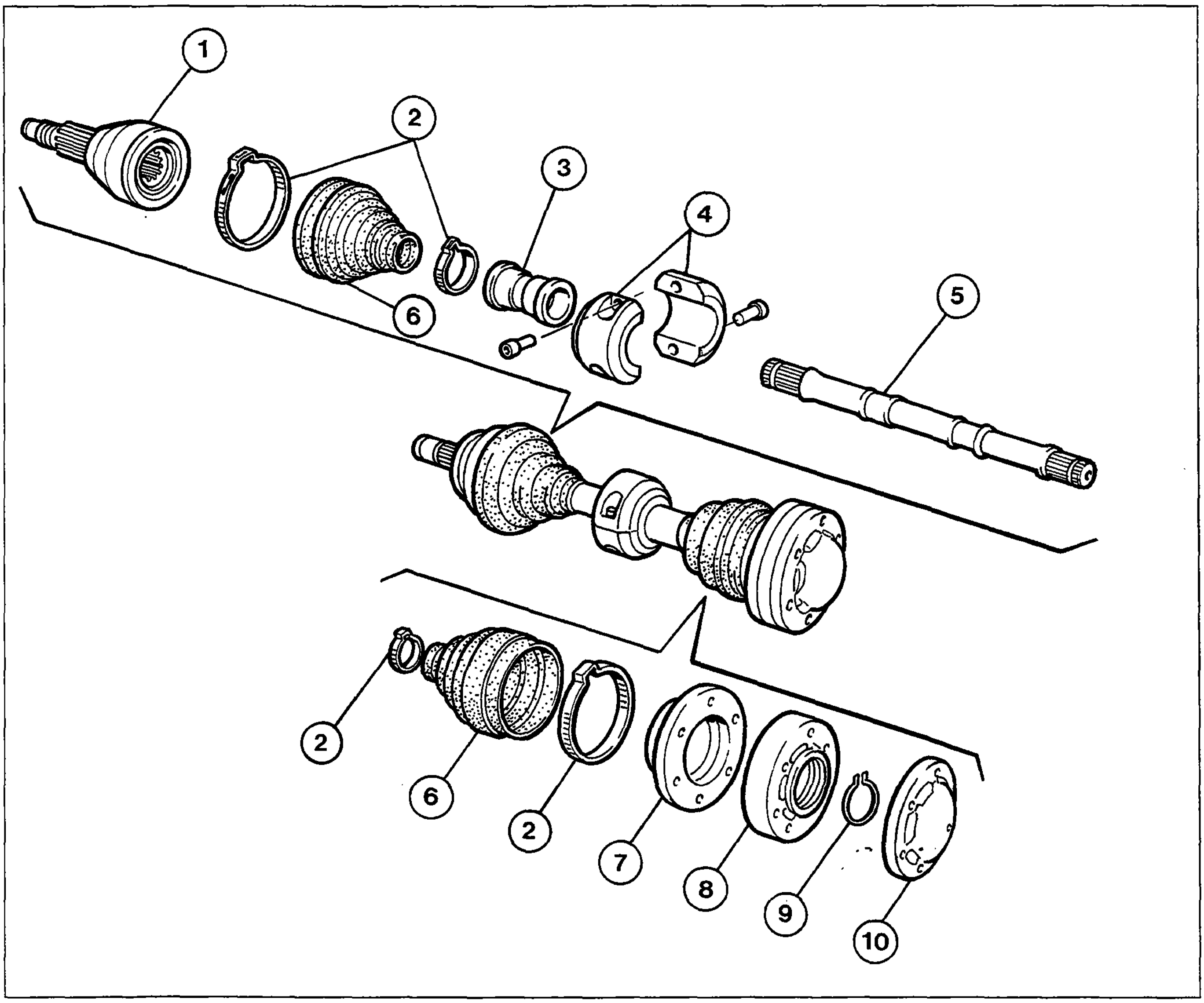
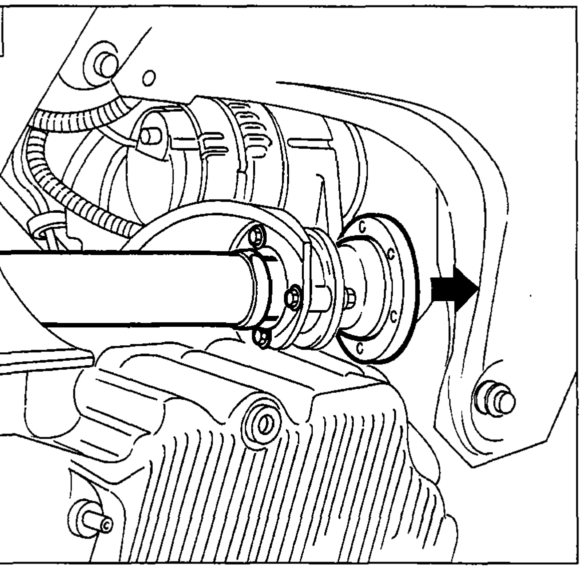
Drive transmission components



1. Constant velocity joint, wheel side
2. Retaining clips
3. Rubber buffer
4. Damping half shells
5. Drive shaft
6. Protective gaiter
7. Flange for constant velocity joint, gearbox side
8. Constant velocity joint, gearbox side
9. Circlip
10. Protective cover

21-27.

1



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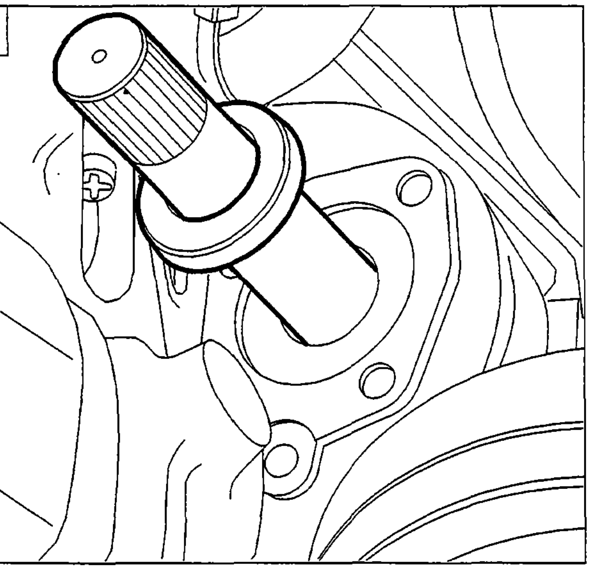

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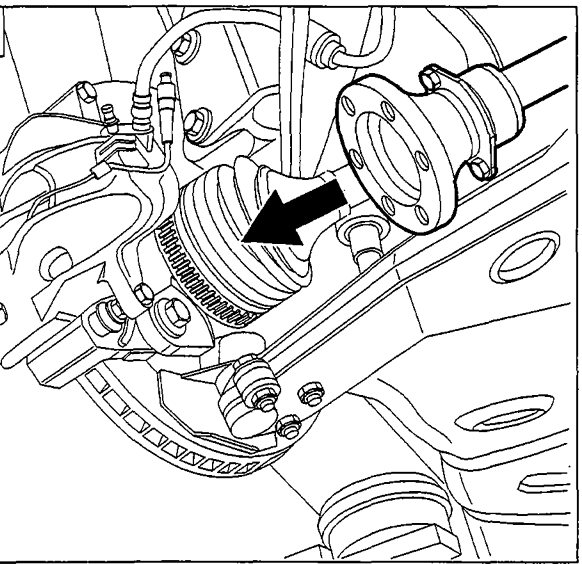

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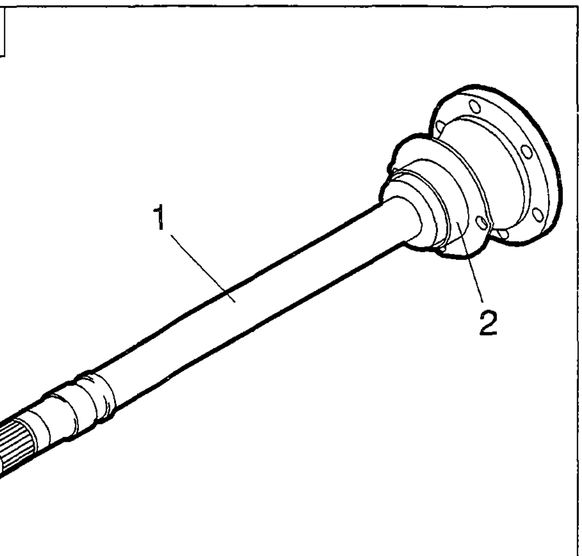


P4A048B03

REMOVING - REFITTING

Place the car on ramps, remove the front right wheel, drain the gearbox oil and carry out the operations listed below, which have already been described above:

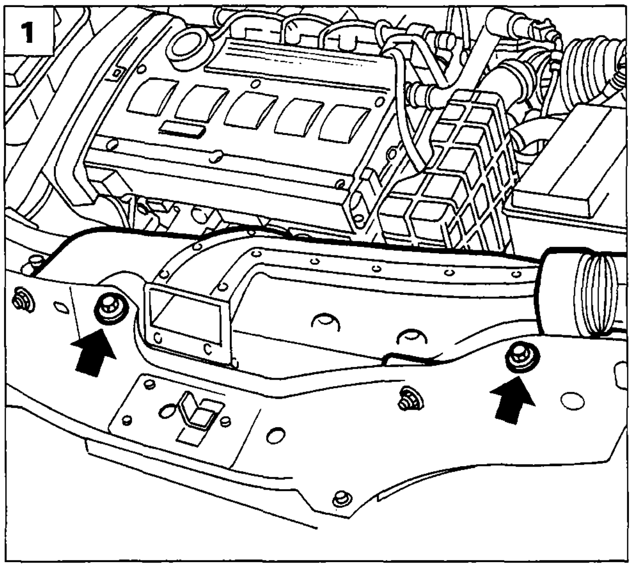
- Remove the right wheelarch cover
- Disconnect the right tie-rod end
- Disconnect the vertical link and drive shaft from the joint.

1. Undo the bolts securing the intermediate shaft to the mounting.
2. Withdraw the intermediate shaft from its seating, then remove the dust excluder.
3. Withdraw the intermediate shaft from the engine compartment.
4. Check that the intermediate shaft (1) is not deformed or out of true; check that the bearing (2) does not show signs of over-heating, scoring or excessive wear.

NOTE *The bearing is not supplied as a spare part, so if it is faulty, the complete intermediate shaft must be replaced.*

REMOTE CONTROL ASSEMBLY

To remove and refit the remote control assembly, refer to the "Remote control assembly" section for the 1581 16v engine.



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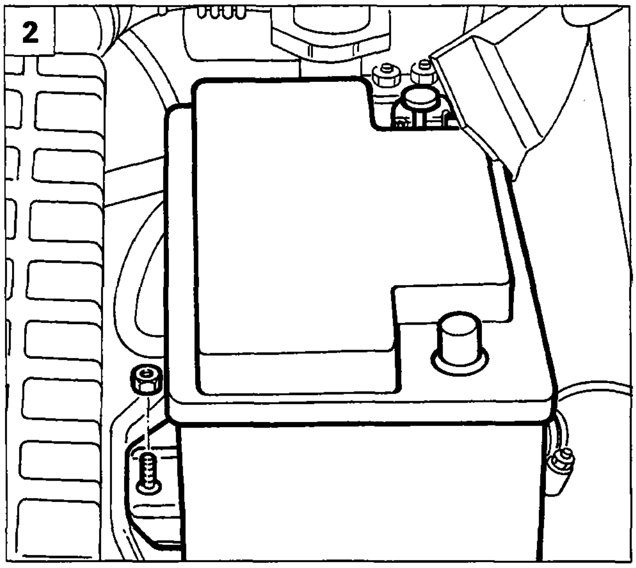

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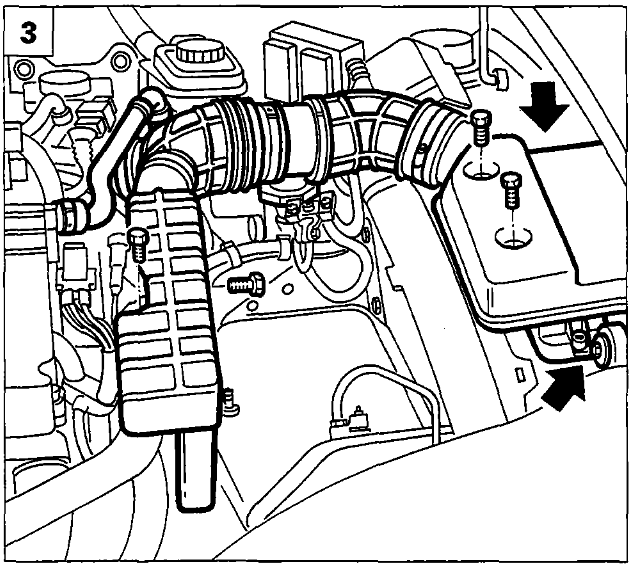


P4A01DX04

REMOVING-REFITTING

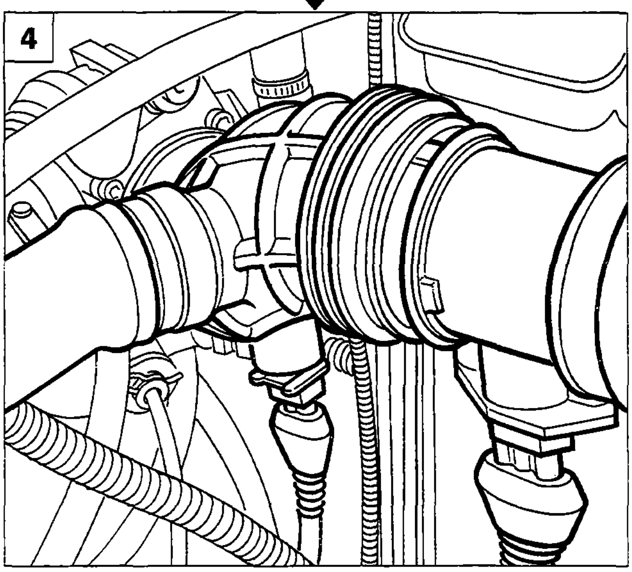
Removing

Place the car on ramps, disconnect the battery's negative terminal and the front wheels, then proceed as described below:

1. Remove the air intake duct by undoing the bolts shown in the figure.
2. Disconnect the battery's positive terminal, then remove the battery from the engine compartment by undoing the nut securing the retaining bracket.

3-4. Disconnect the pipe connecting the air cleaner to the throttle body by undoing the clips indicated, and disconnect the connections under the pipe; also remove the resonator.

5. Remove the relay box cover.



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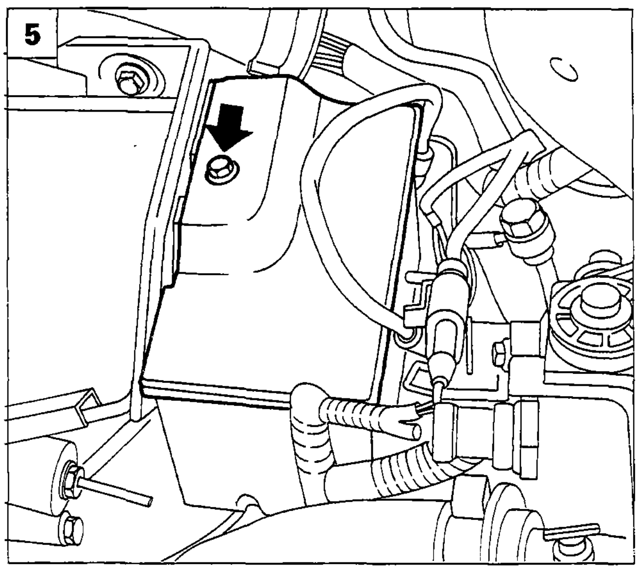

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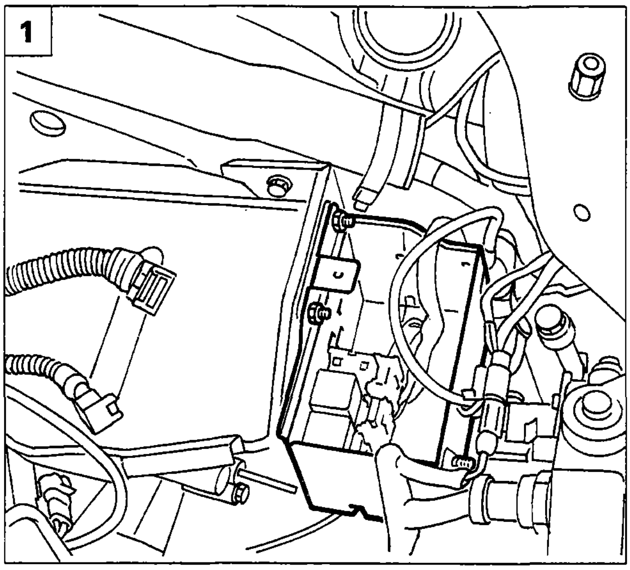

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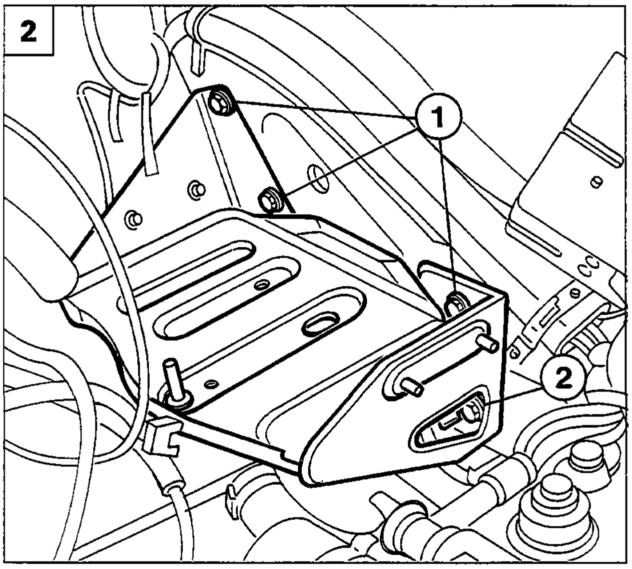

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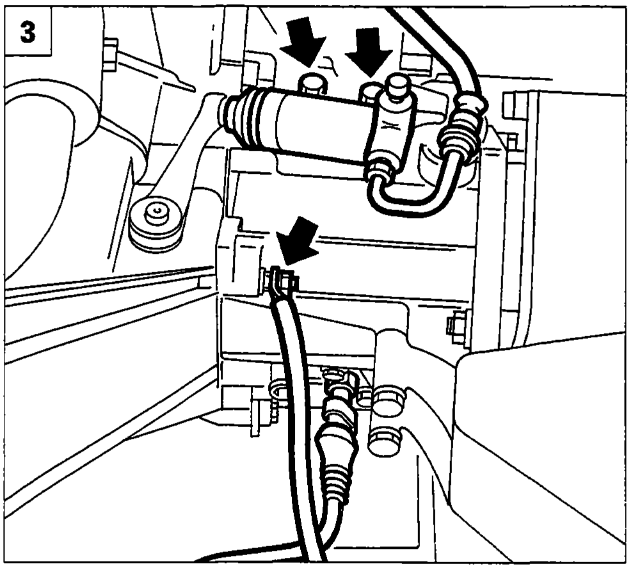
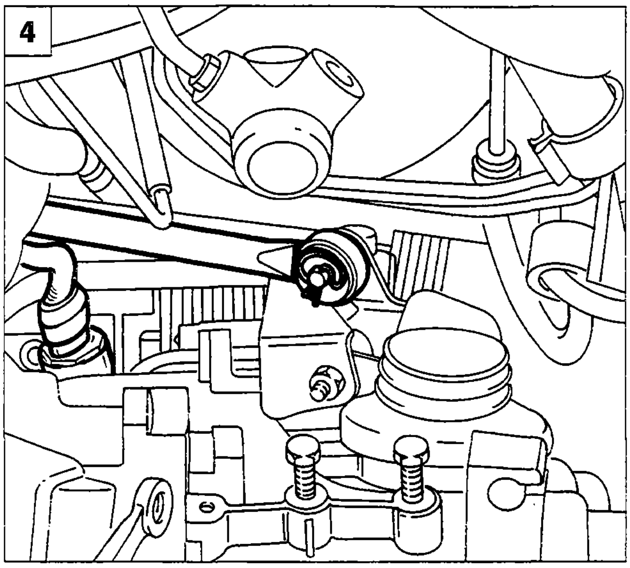


P4A050B01

1. Remove the nuts securing the relay box to the battery cage, then move it over to one side.
2. Remove the battery cage by undoing the bolts shown in the figure; also disconnect the electrical wiring clips indicated.
3. Disconnect the hydraulic clutch actuating cylinder from the gearbox, the earth cable and reversing lights switch.
4. Disconnect the gear selector rod by removing the split pin shown in the figure. Also disconnect the speedometer sensor connection.
5. Undo the nuts securing the cables shown in the figure to the battery's positive terminals.



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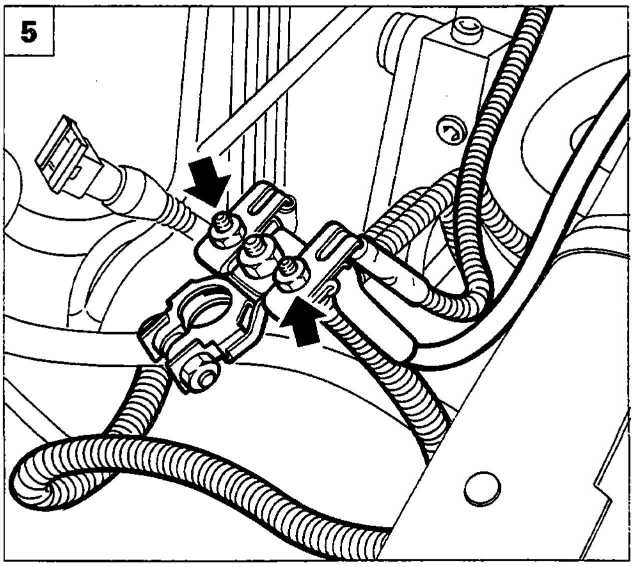

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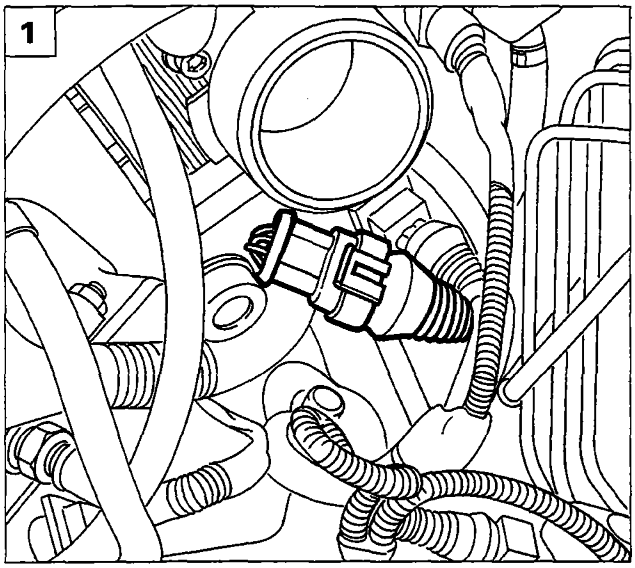

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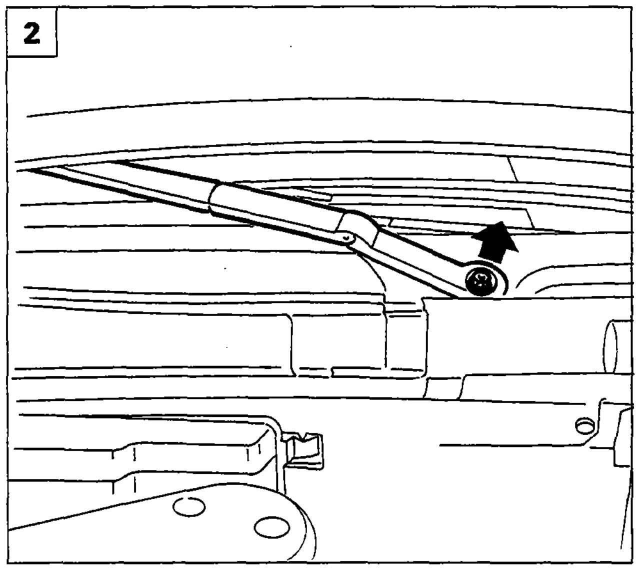

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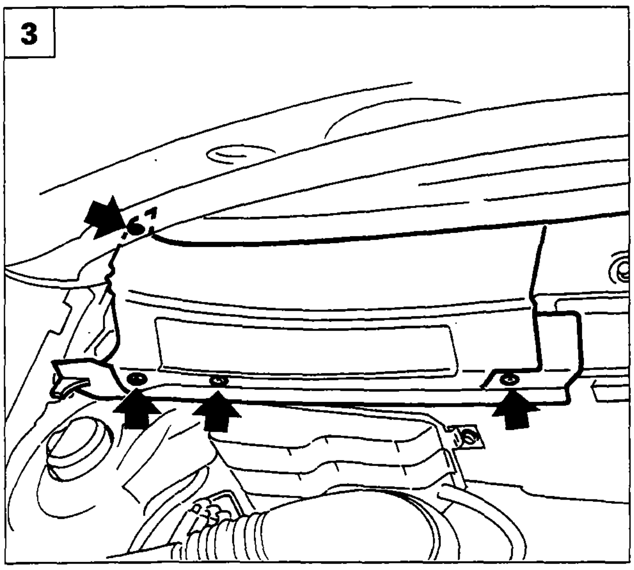

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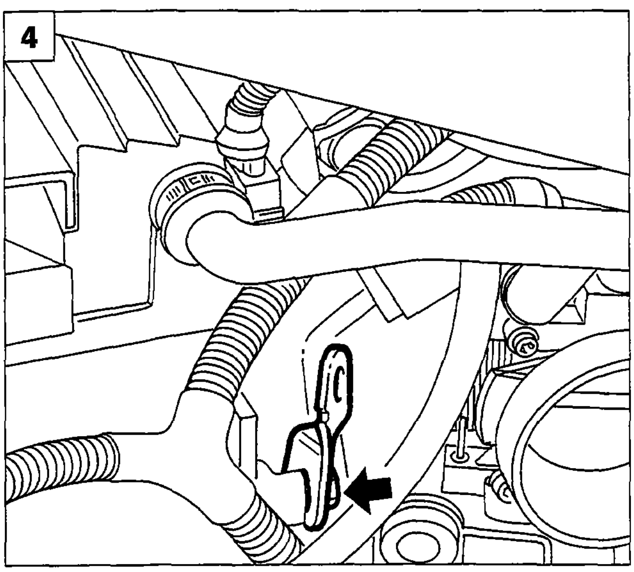
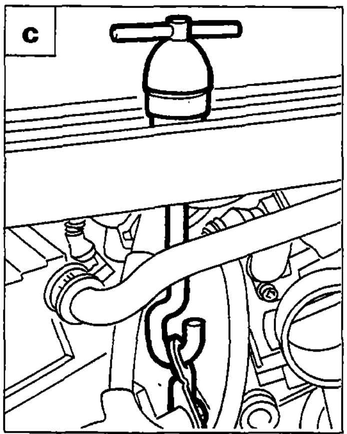


P4A051B01

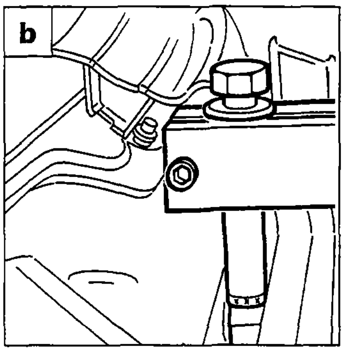
1. Disconnect the Lamba probe connection.
2. Lift the protective cover, then remove the windscreen wiper arm by undoing its attachment nut.
3. Remove the right side cover from the antipollen filter; to facilitate removal, undo the screws of the left side cover.
4. Place a suitable supporting hook at the point shown in the figure, to hook the power unit on to during removal of the gearbox.



P4A052B02

1. Position the engine support stand 1860851000 and adaptor 1860851001 in the mounting points.

   a. Front mounting: insert the tool in the seat of the safety catch so that it rests on the front crossframe.
   b. Rear mounting: position the tool level with the central reinforcement of the fire-proof bulkhead.
   c. Secure the hook of the support stand to the eyelet previously fitted level with the thermostat.



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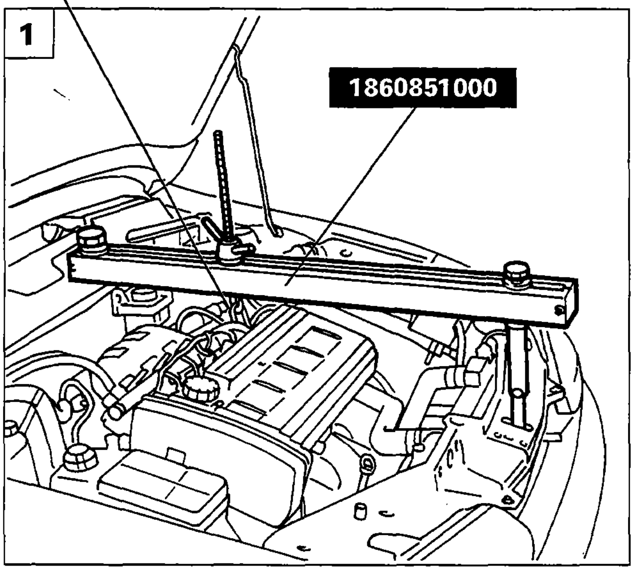

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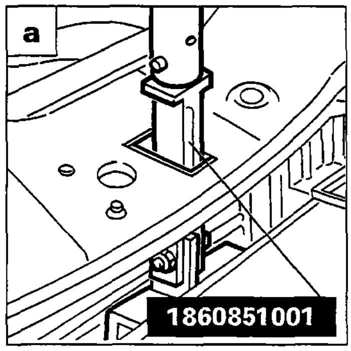

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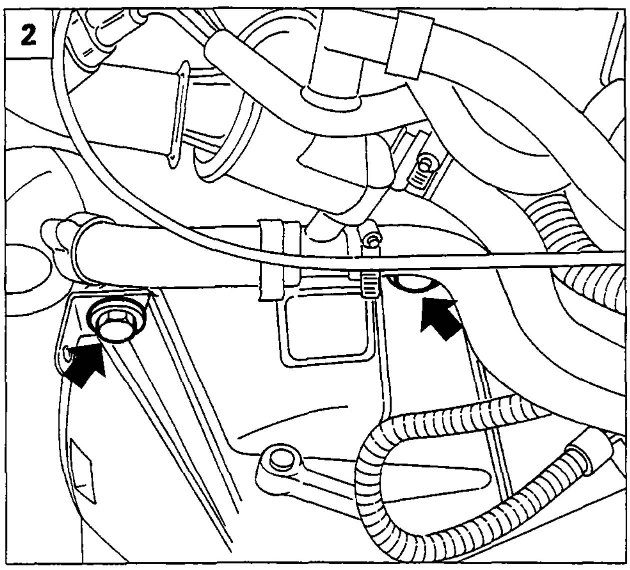
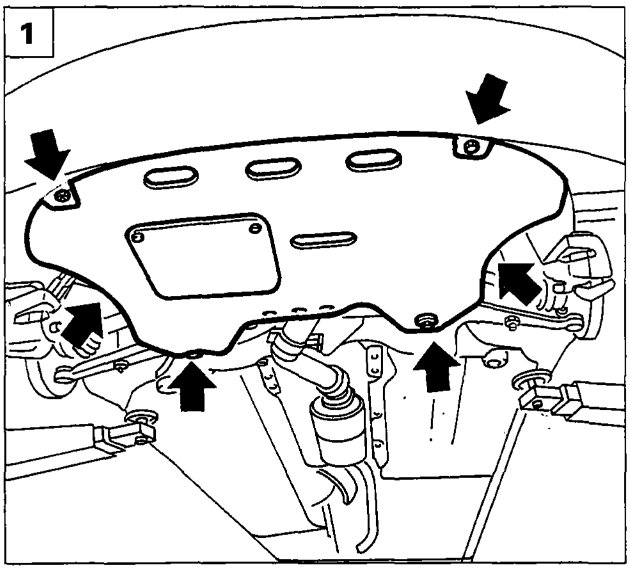


P4A052B03

2. Remove the gearbox top bolts.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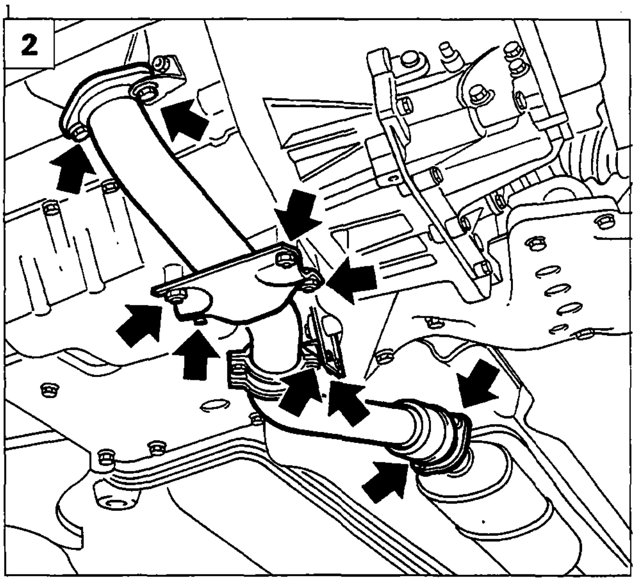
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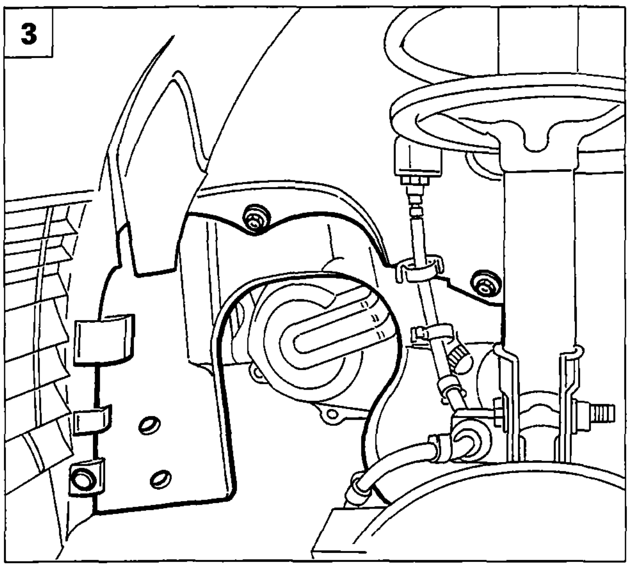
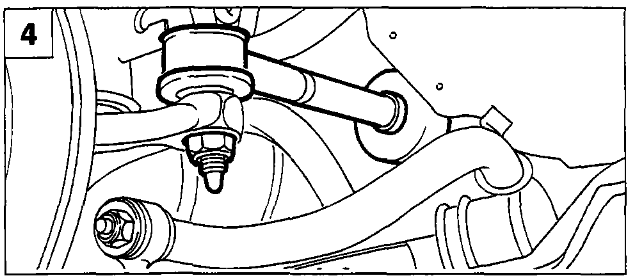

P4A003B01

1. Remove the engine bay bottom guard.
2. Disconnect the first section of the exhaust pipe by undoing the attachments shown in the figure.
3. Remove the wheelarch trim on the gearbox side and timing gear side.
4. Disconnect the tie-rod end from the vertical link (gearbox side and timing gear side) using the puller 1847038000.
5. Undo the bolts securing the left drive shaft flange.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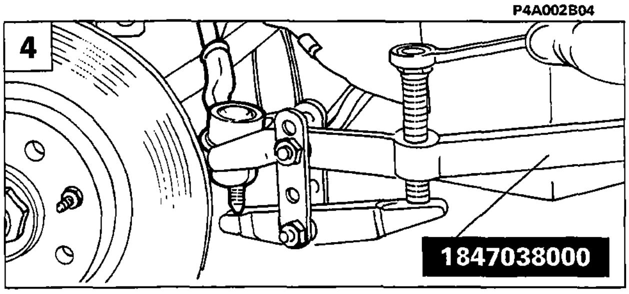

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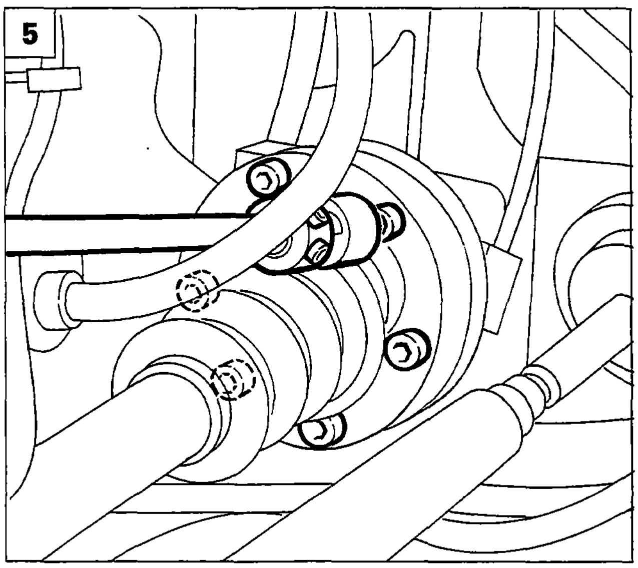
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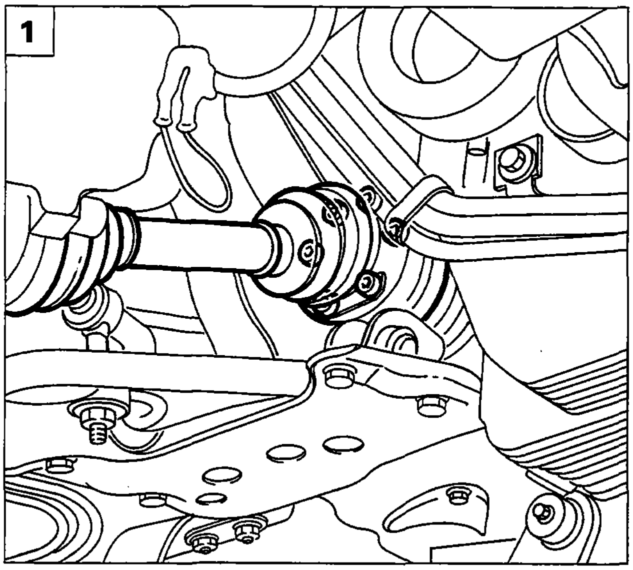
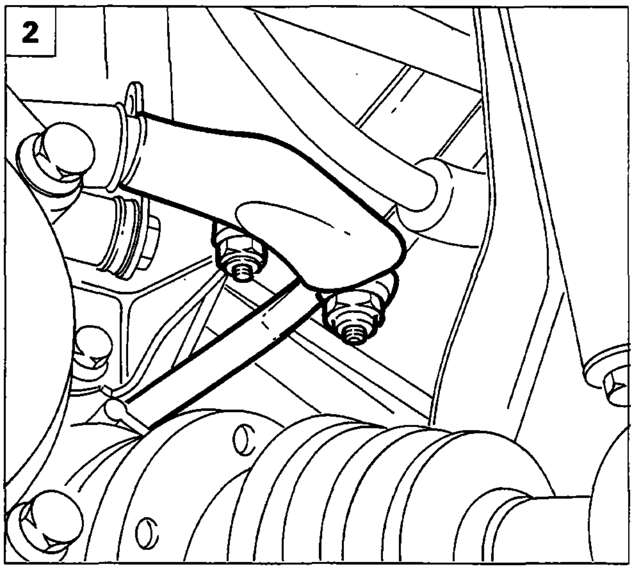
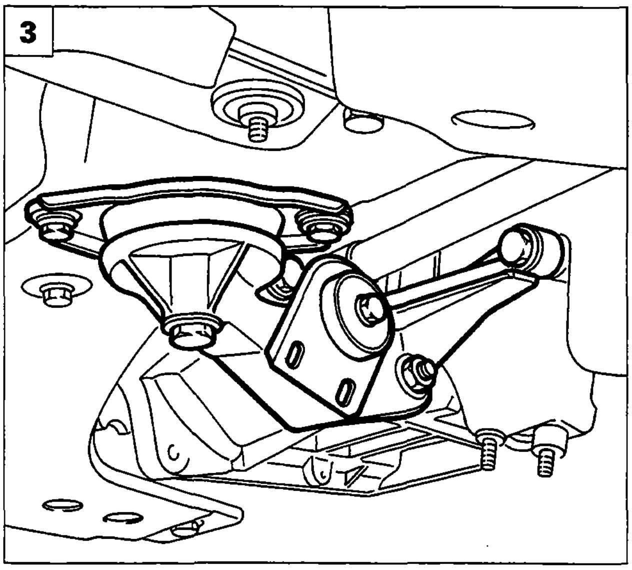


P4A08DX04

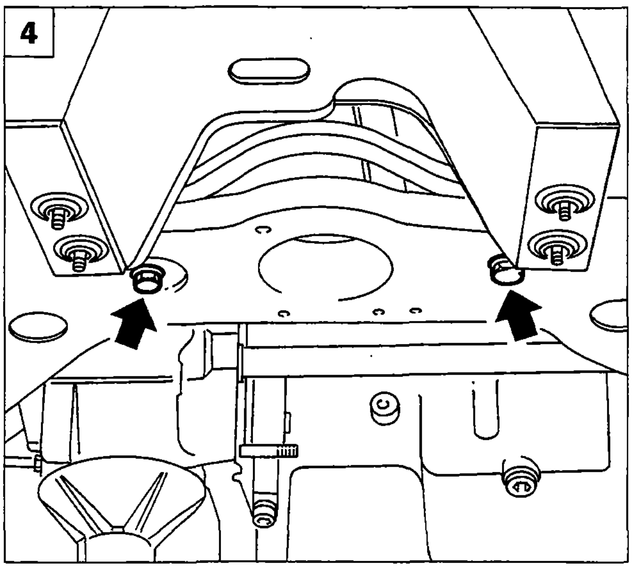


P4A07BX03



P4A09DX02

1. Undo the bolts securing the right drive shaft flange.
2. Disconnect the gear selector and engagement rods accessible from the wheelarch on the gearbox side.
3. Remove the power unit central mounting.
4. Remove the bolts securing the power steering gear to the crossframe. Secure the steering gear to the body shell.
5. Disconnect the links between the anti-roll bar and wishbone (left and right sides) to permit the subsequent removal of the front crossframe.



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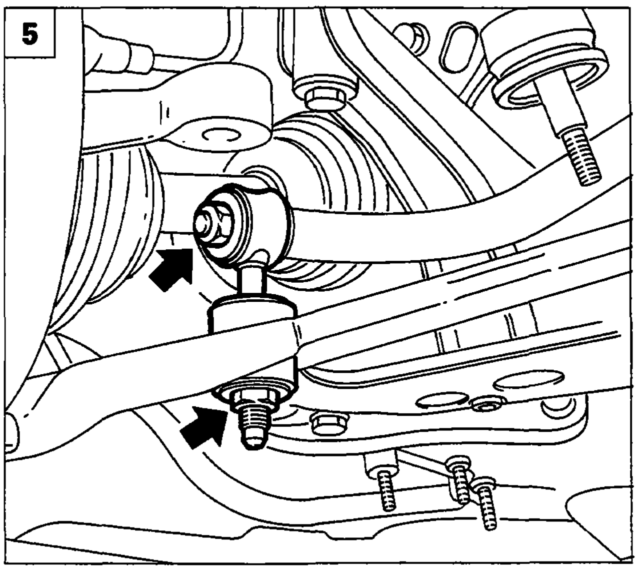

P4A09DX04

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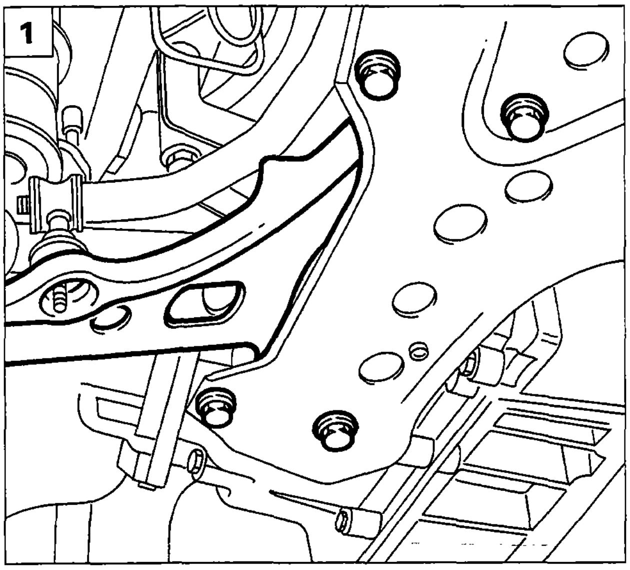
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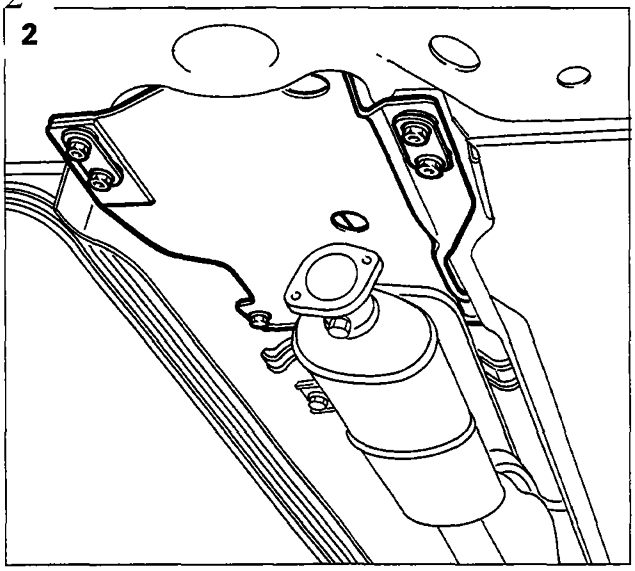
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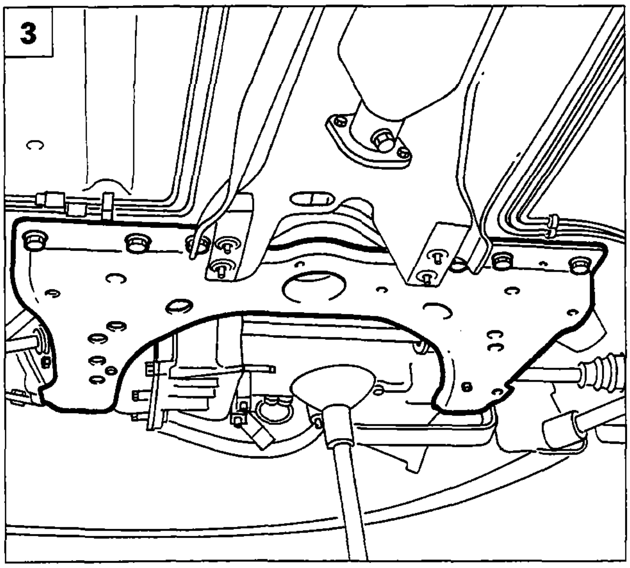
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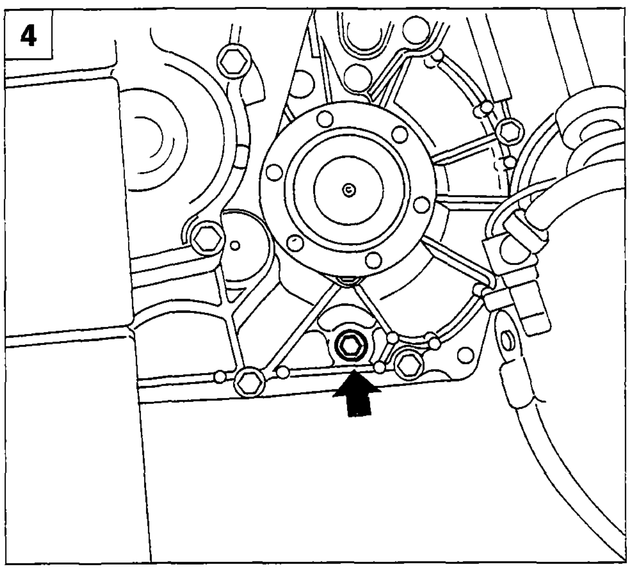
4

P4A041B01

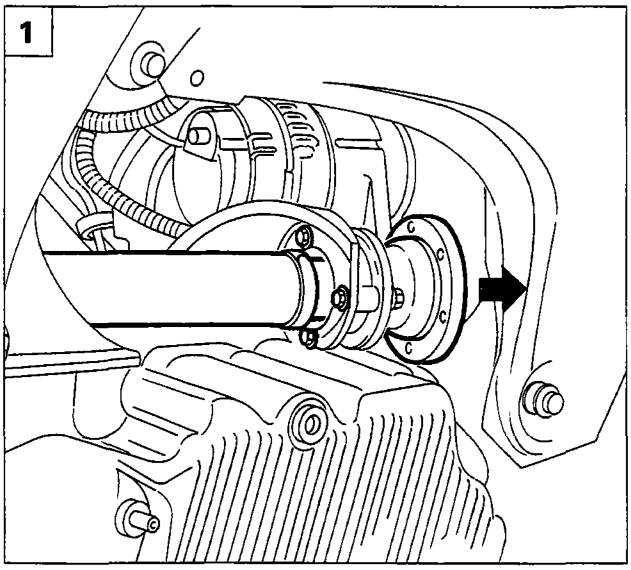
1. Undo the bolts securing the wishbone (right and left sides) to the front crossframe; rotate the wishbone as appropriate to release it from the crossframe.

2. Remove the nuts shown in the figure on the heat shield to permit the subsequent withdrawal of the front crossframe. If necessary, shim the shield to keep it raised off the bodywork and so facilitate the withdrawal of the crossframe.

3. Undo the bolts securing the front crossframe to the body shell; first remove the rear bolts and then the side bolts with the help of an assistant, and finally withdraw the crossframe complete with anti-roll bar.

4. Drain the gearbox oil then by undoing the plug shown in the figure.

21-27.



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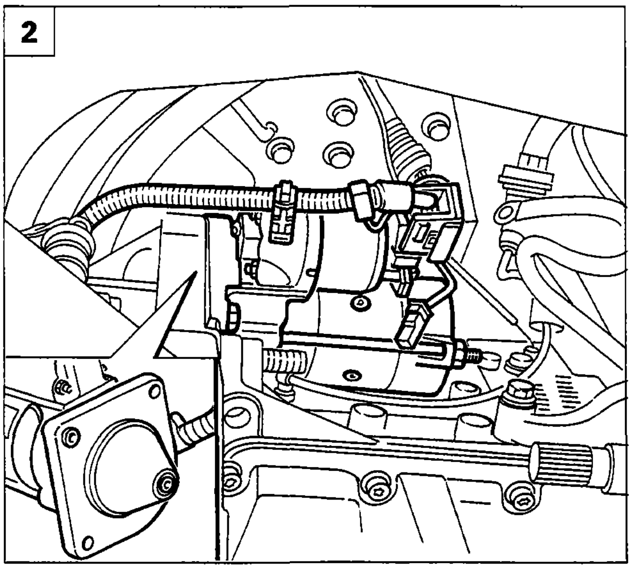

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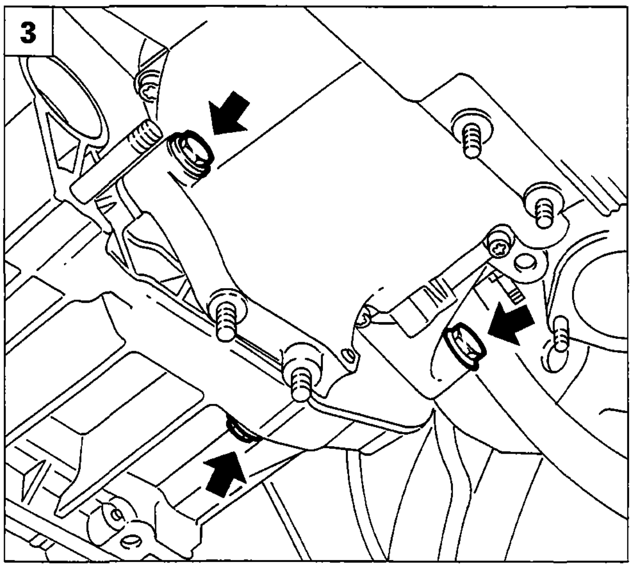
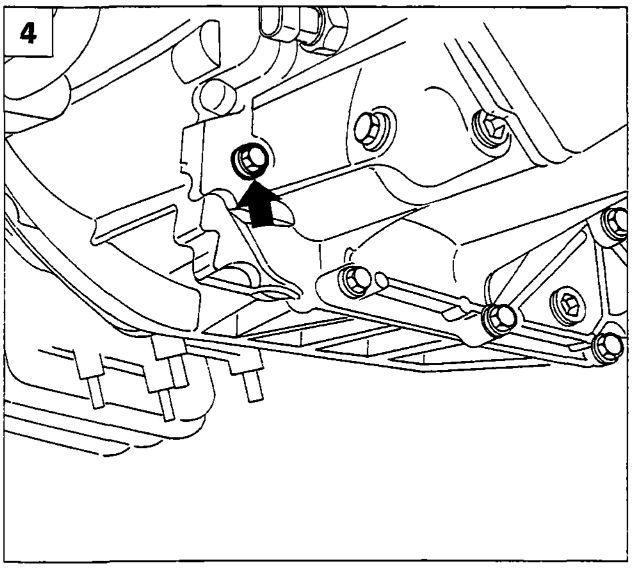
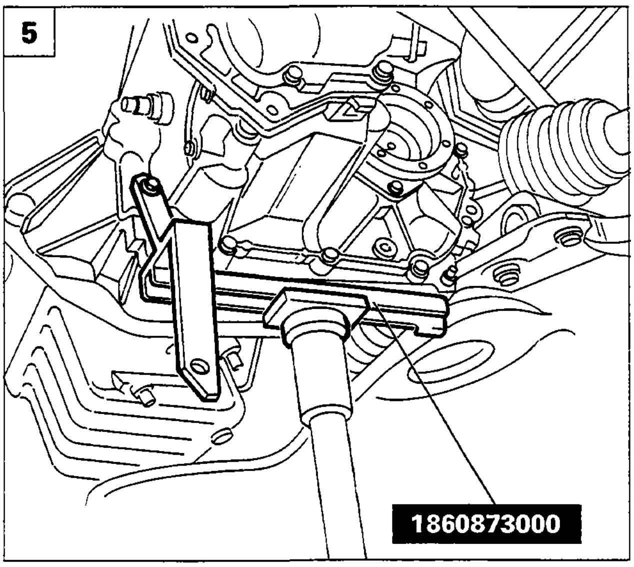


P4A056B01

1. Undo the bolts securing the intermediate shaft to the engine, release it from the gearbox and move it away from the working area, securing it in an appropriate manner.
2. Remove the starter motor by undoing its bolts.
3. Remove the bottom bolts securing the gearbox to the power unit.
4. Undo the bolt shown in the figure from the bellhousing, to permit installation of the gearbox support tool.
5. Place the gearbox support tool 1860873000 on a hydraulic jack, then secure it to the gearbox as shown in the figure.



P4A026B01



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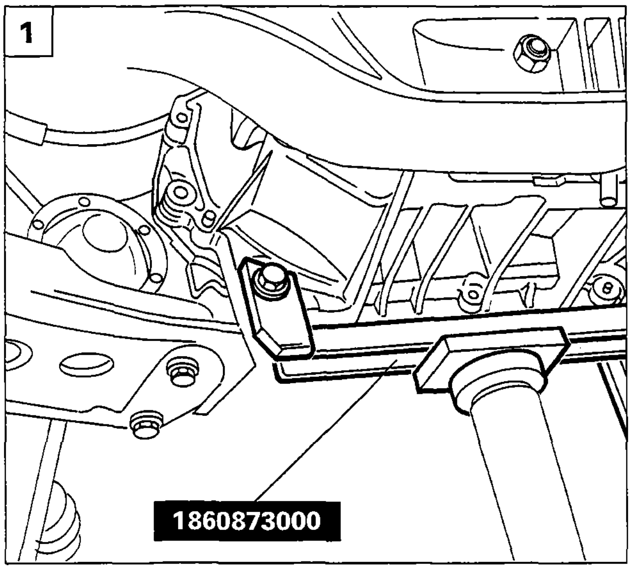

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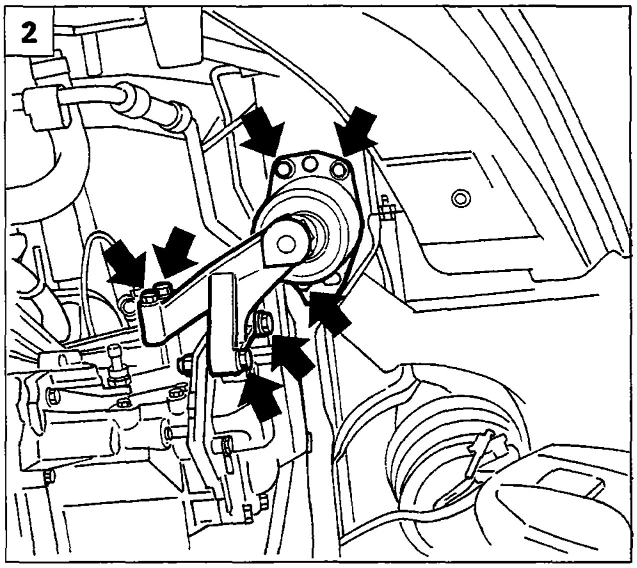
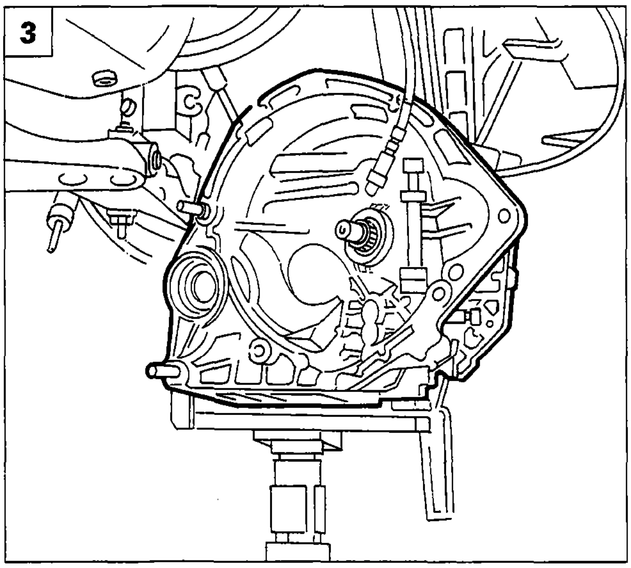
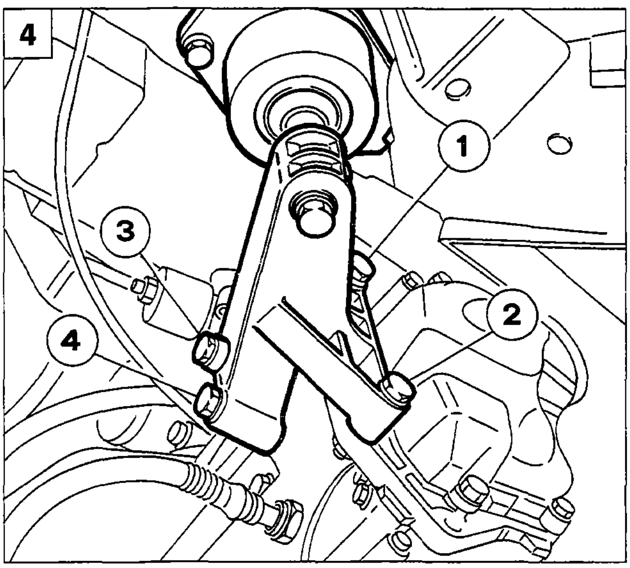


P4A041B04



P4A057B01



P4A043B01

1. Rear attachment of gearbox support tool 1860873000.
2. Remove the engine mounting, gearbox side.
3. Manoeuvre the hydraulic jack as appropriate in order to disengage the gearbox from the attachment studs and surrounding parts. Gradually lower the jack and withdraw the gearbox.

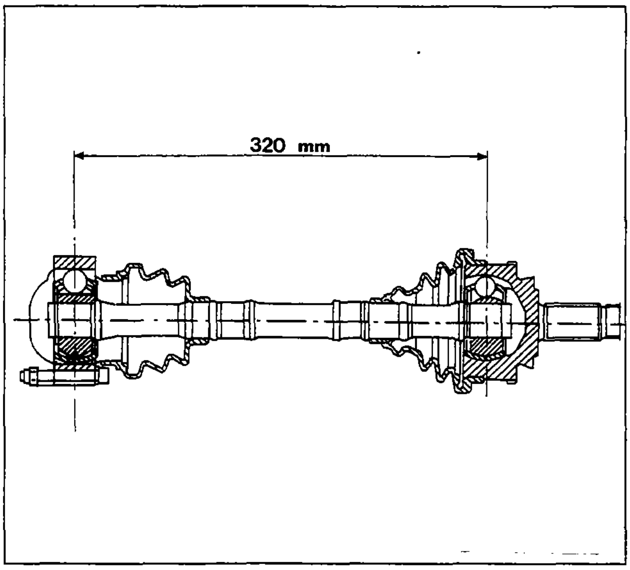
Refitting

4. When fitting the engine mounting, gearbox side, to avoid creating stresses on the sealing surfaces between the mounting and the gearbox, resulting in deformation and subsequent oil leak, closely follow the bolt tightening sequence below:
   - Tighten bolts (1) and (2) to a preliminary torque di 0.5 daNm;
   - Tighten bolts (3) and (4) to a preliminary torque of 0.5 daNm, then tighten to the specified torque;
   - Tighten the bolts (1) and (2) to the specified torque.

   For the remaining refitting operations, reverse the procedure described for removal. Before fitting the bellhousing in the car, check that the clutch release bearing is positioned correctly on the gearbox mainshaft.

The oil level in the gearbox must be 9 mm below the oil filler plug hole.

21-27.



P4A058B01

REMOVING-REFITTING AND DISMANTLING DRIVE SHAFTS

To remove/refit and dismantle the drive shafts, refer to the procedure described for the 1747 16V engine, with the difference that drive shafts on the 1998 20V engine do not have the damping weight.

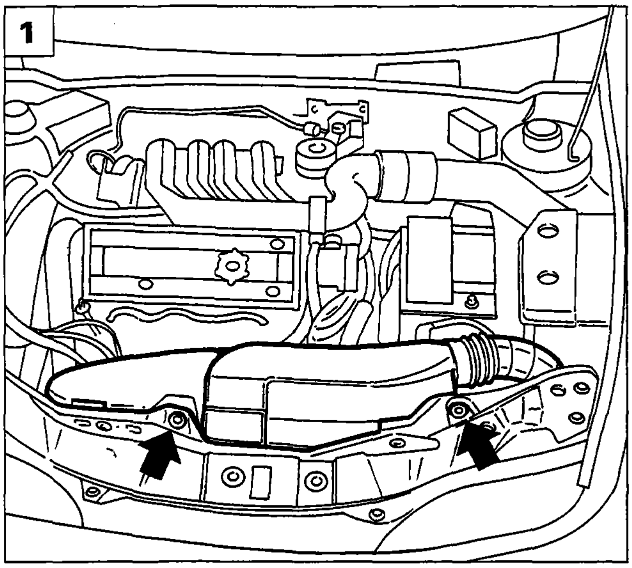
General view of drive shaft - constant velocity joint couplings and distance between the joint centres.

REMOVING-REFITTING INTERMEDIATE SHAFT

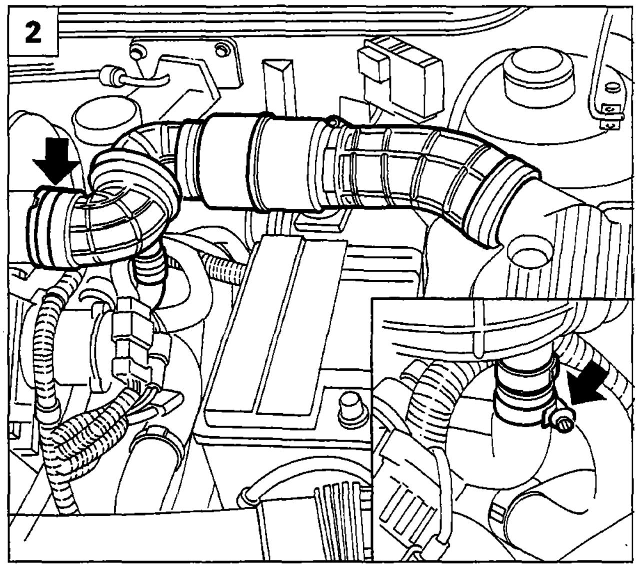
To remove and refit the intermediate shaft, refer to the instructions given for the 1747 16v engine.

REMOVING-REFITTING REMOTE CONTROL ASSEMBLY

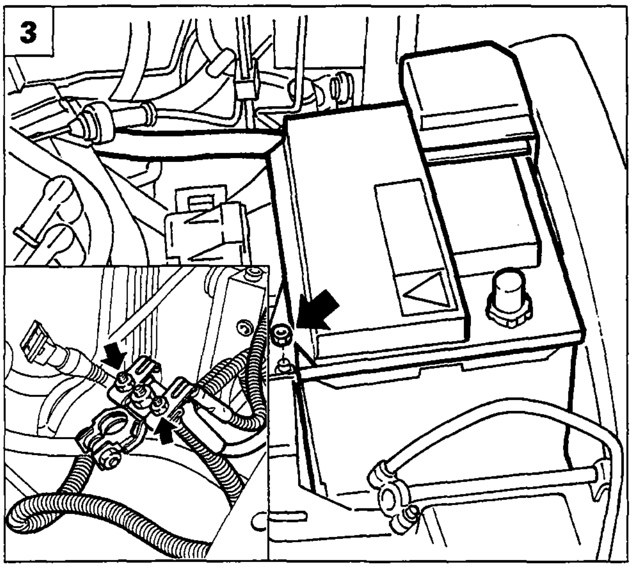
To remove and refit the gearbox remote control assembly, refer to the instructions given for the 1581 16V engine.



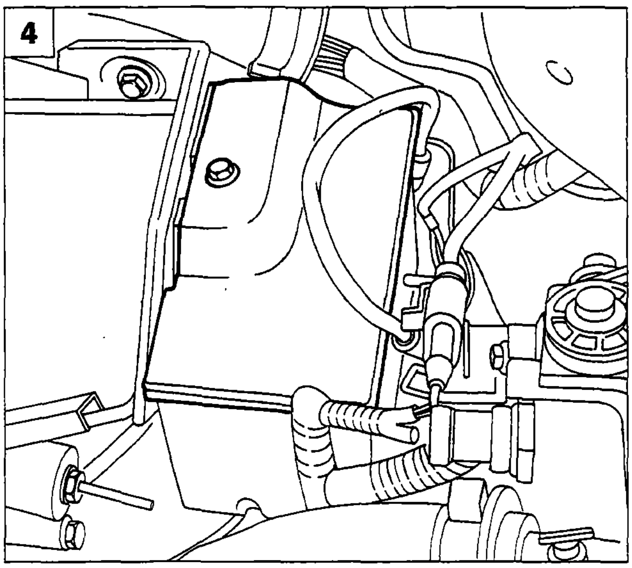
P4A01DJ01



P4A01EX02



P4A01CX04



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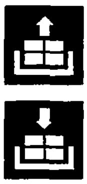
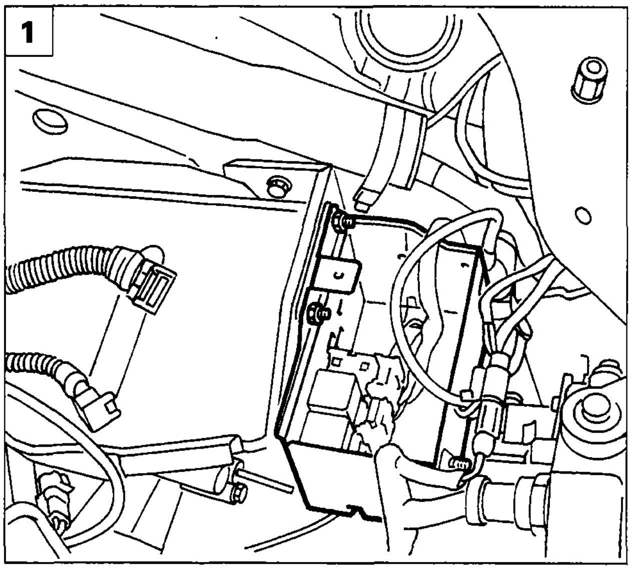


REMOVING-REFITTING

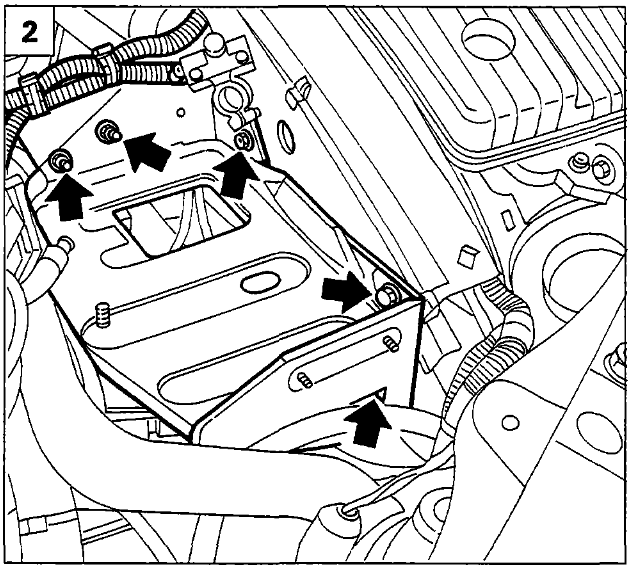
Place the car on ramps, disconnect the battery's negative terminal, remove the front wheels and then proceed as described below:

1. Disconnect air inlet duct by undoing the bolts shown in the figure, securing it to the front crossframe.
2. Remove the air inlet duct complete with resonator by undoing the clips shown in the figure, making sure to disconnect the pipe shown in the detail.
3. Lift the protective cover from the battery's positive pole and disconnect it, then remove the battery by undoing the nut and the attachment bracket shown in the figure. Also undo the nuts securing the cables shown in the detail, leading to the positive terminal.
4. Remove the fuse and relay box cover by undoing the bolt indicated.

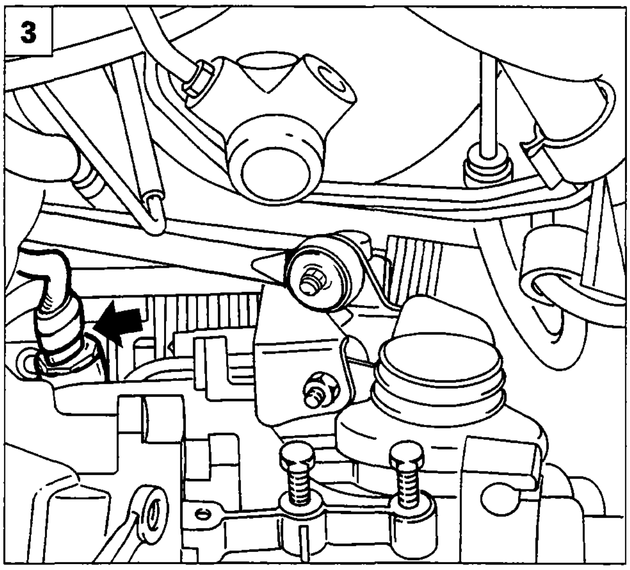
21-27.



P4A02EX01

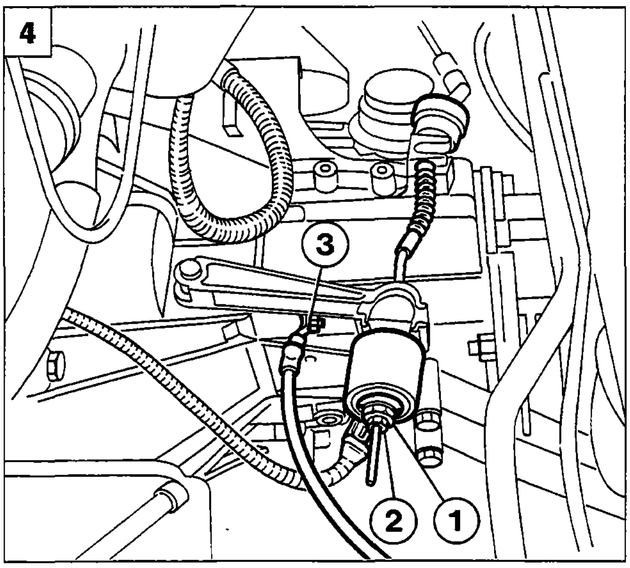


P4A02EX02



P4A060B01

1. Remove the nuts securing the fuse and relay box to the battery cage, then move the box over to one side.
2. Remove the battery cage by undoing the bolts shown in the figure; also undo the nuts securing the mounting bracket for the starter motor supply cables.
3. Disconnect the speedometer sensor connector.
4. Disconnect the clutch cable by undoing the nut (1) and locknut (2) shown in the figure. Also disconnect the earth lead (3) from the gearbox.
5. Disconnect the reaction link shown in the detail and the gear selector engagement rods from the gearbox.



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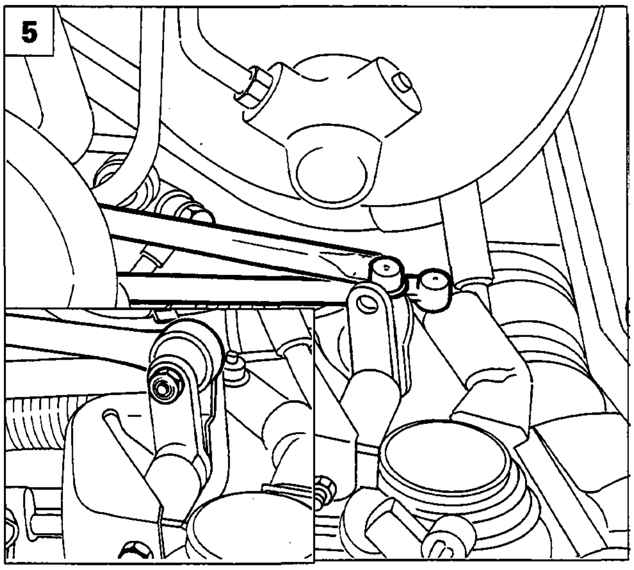

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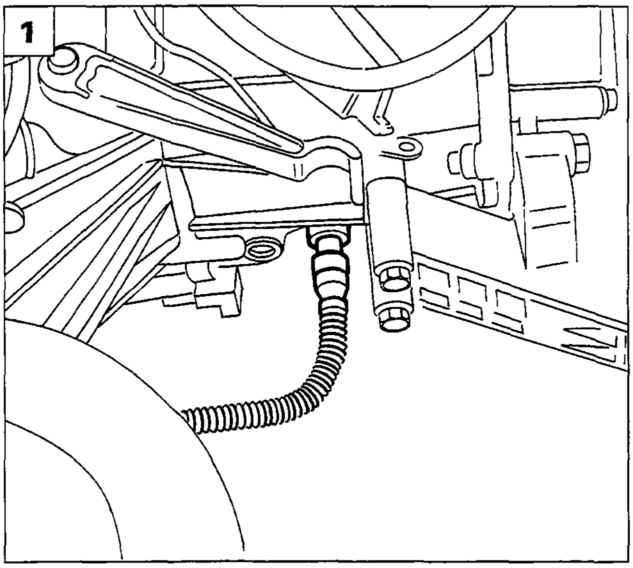
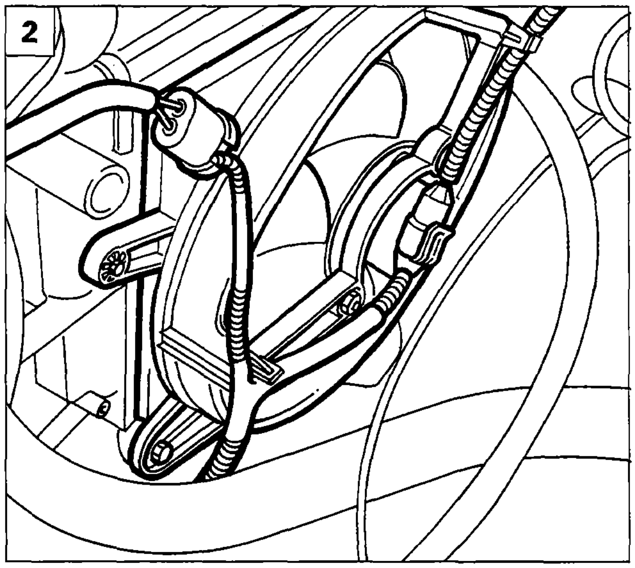


P4A022B01



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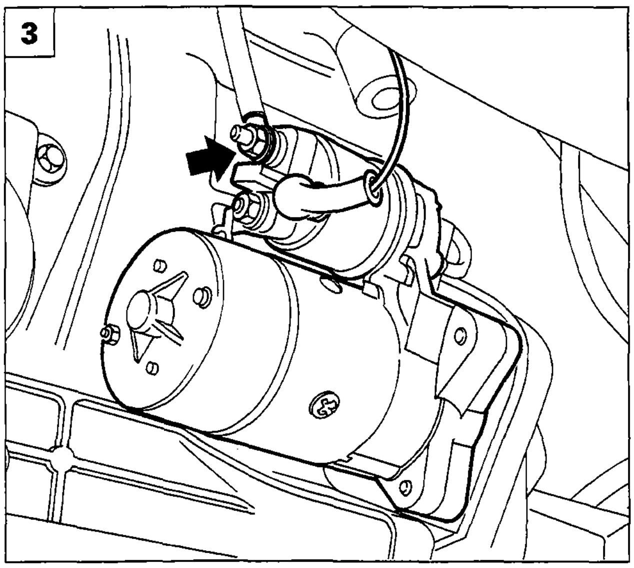
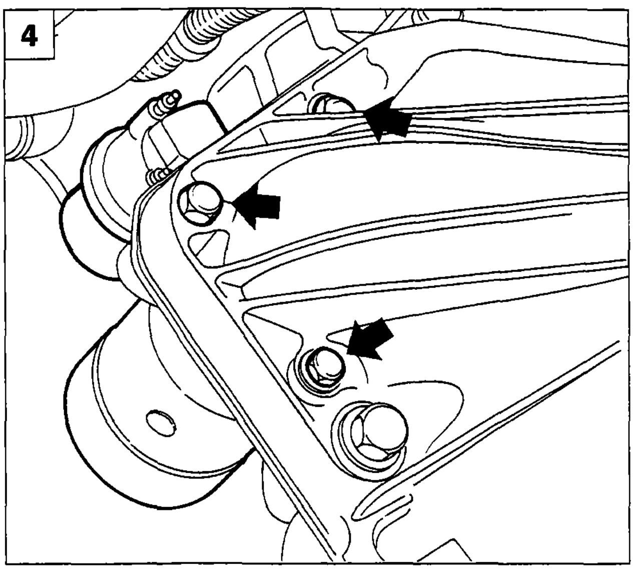


P4A022B02

1. Disconnect the reversing lights switch connector from the gearbox.
2. Disconnect the fan supply connections, then remove the fan by undoing its attachment bolts.
3. Disconnect the starter motor supply cables.
4. Remove the starter motor by undoing the bolts shown in the figure.
5. Remove the gearbox top attachments.



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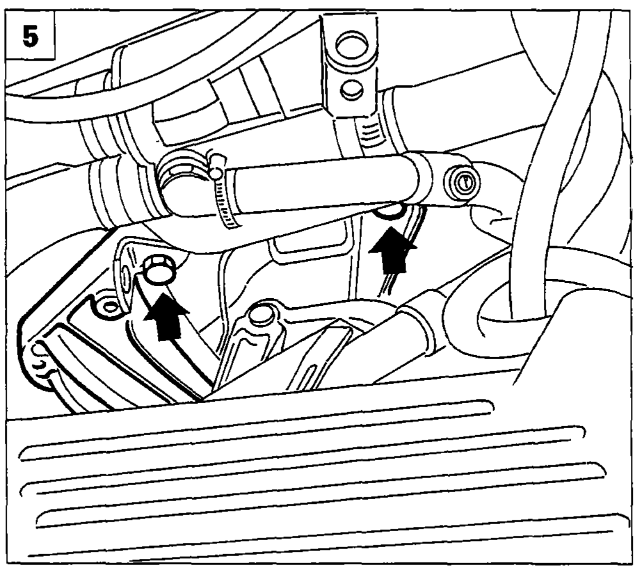
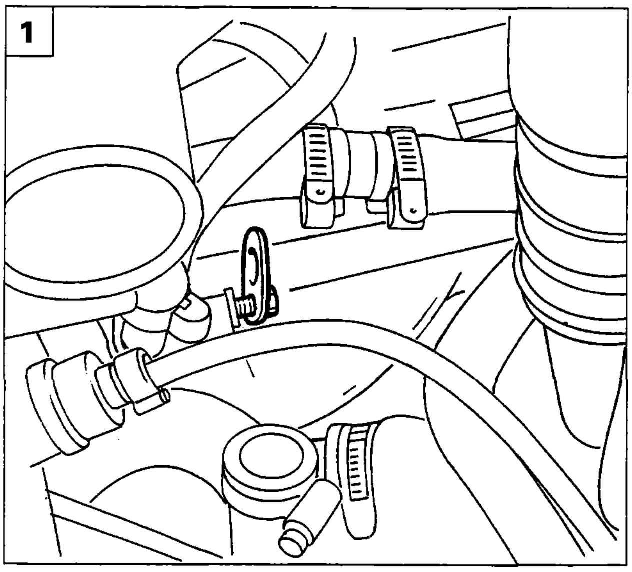


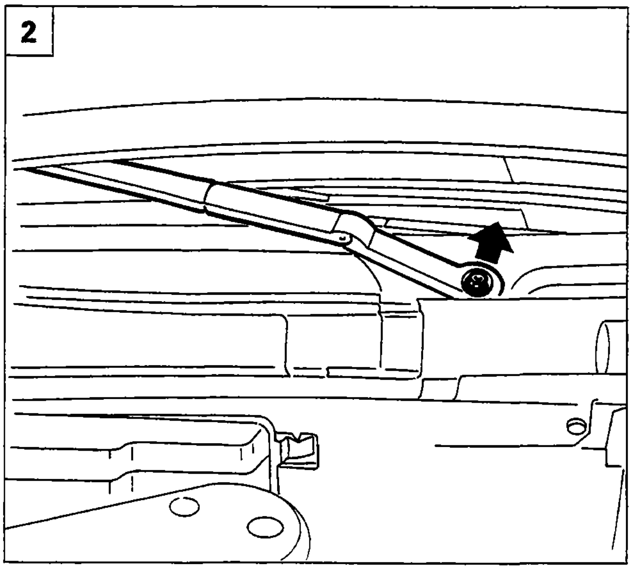
P4A023B01

21-27.



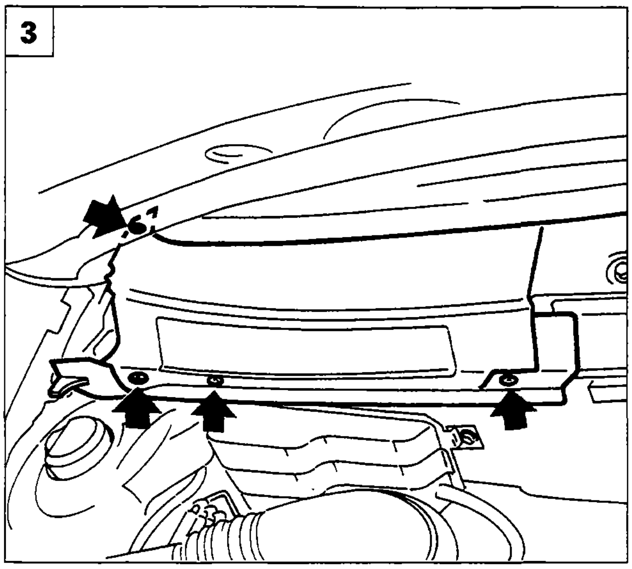
P4A062B01

1. Remove one exhaust manifold nut and fit a suitable hook for supporting the power unit during removal of the gearbox.



P4A023B03

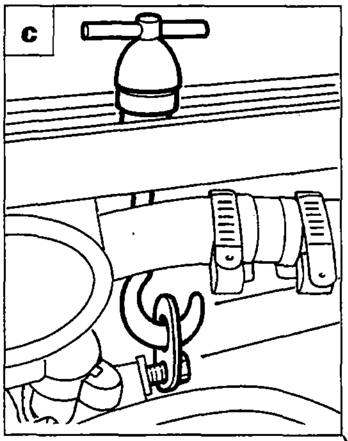
2. Remove the nut securing the right windscreen wiper arm after removing its protective cover.



P4A023B04

3. Remove the right side cover from the antipollen filter by undoing the screws illustrated, and slacken the screws on the right side cover to allow the power unit support stand to be installed.

1. Position the power unit support stand 1860851000 and the special adaptor 1860851001 in the appropriate mounting points.
   a. Front mounting: insert the tool in the seating of the bonnet catch, so that it rests on the front crossframe.
   b. Rear mounting: position the tool level to the central reinforcement of the fire-proof bulkhead.
   c. Secure the hook of the stand to the eyelet previously installed level with the exhaust manifold attachments.



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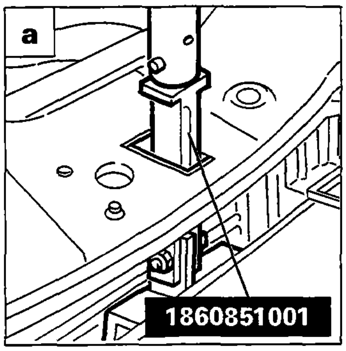
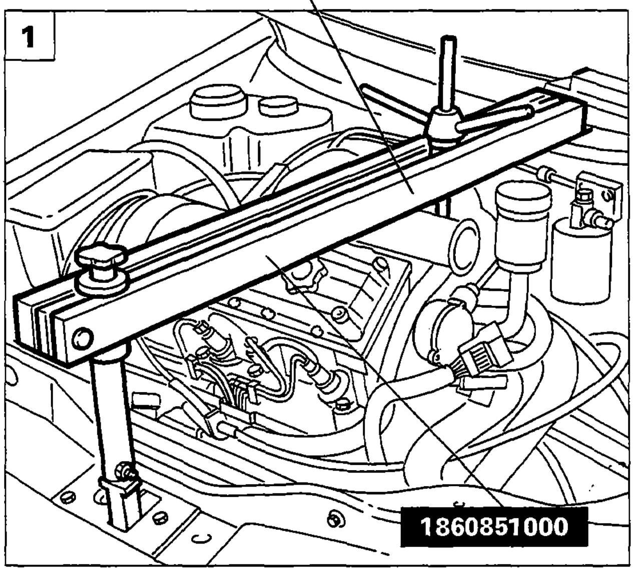


P4A006B05



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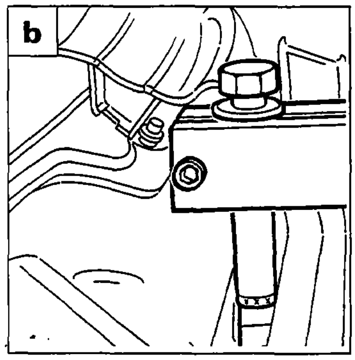
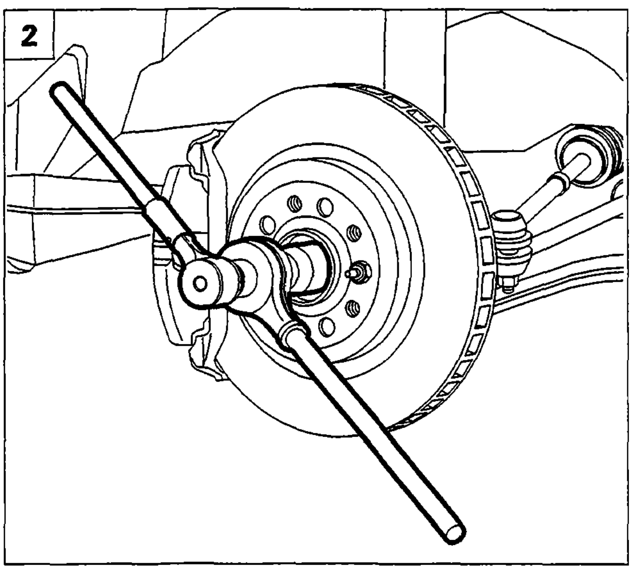


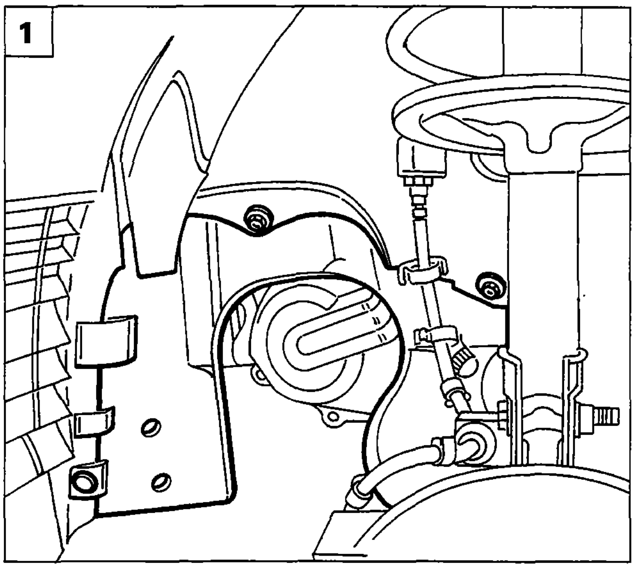
P4A006B06



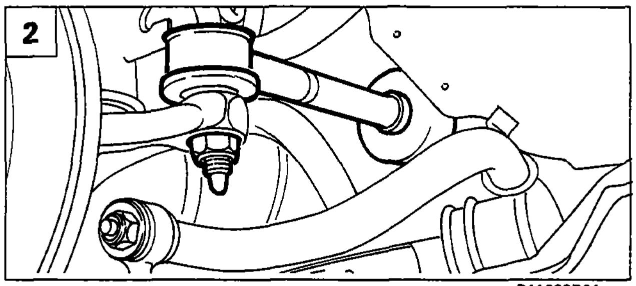
P4A009B02

2. Relieve the staking and then remove the hub nut (gearbox side and timing gear side).

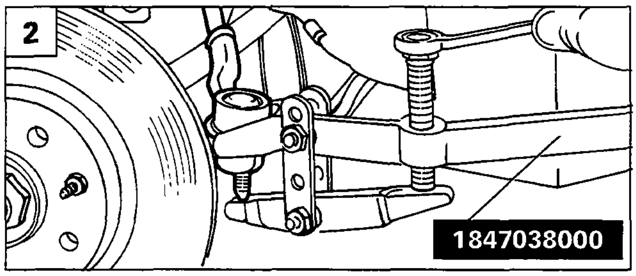
21-27.



P4A003B01



P4A002B04



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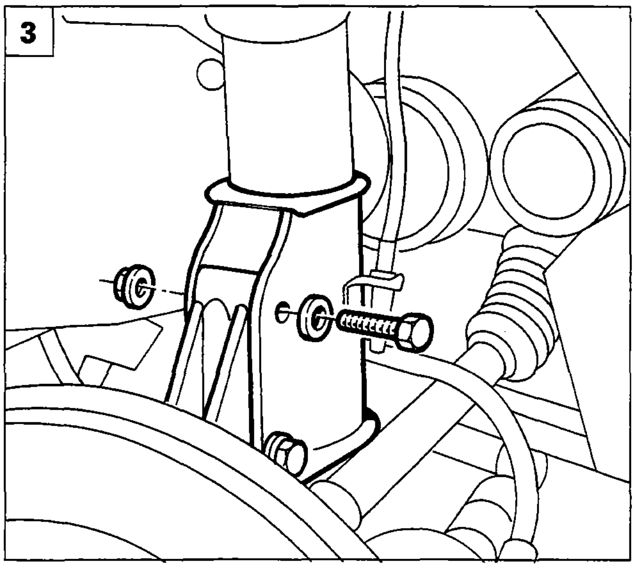

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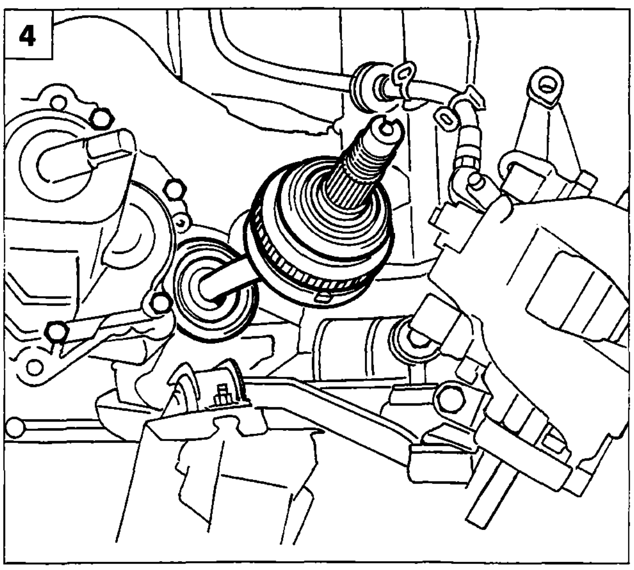
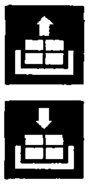
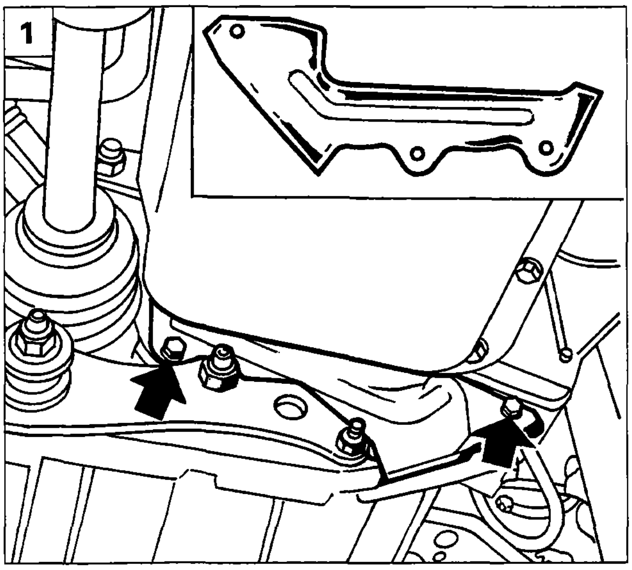


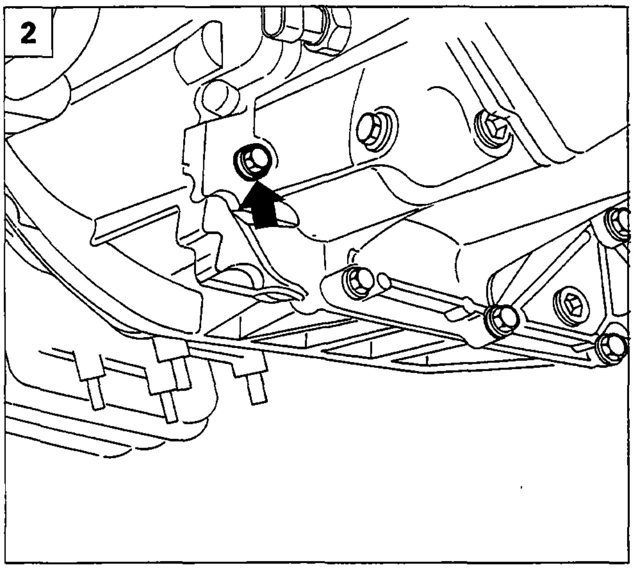
P4A06CX02



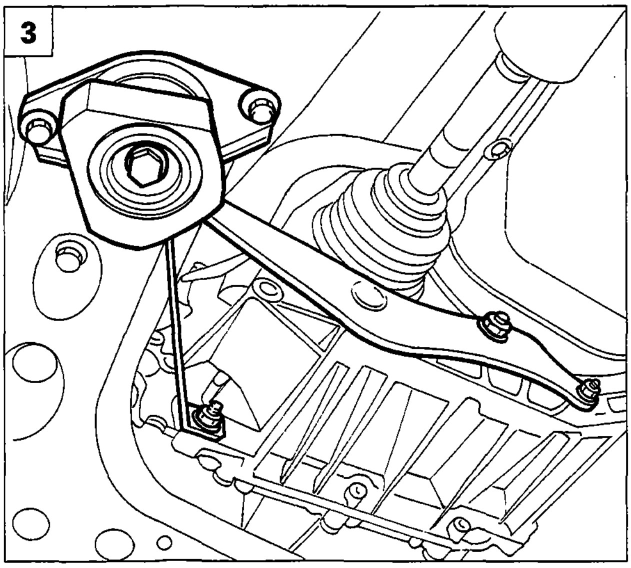
1. Remove the plastic protection from the wheelarch on the gearbox side by undoing the bolts and the button shown in the figure. To withdraw the protection, also disconnect the brake pad wear sensor connection (repeat the procedure on the other side).
2. Remove the nut securing the tie-rod end to the vertical link, then withdraw the tie-rod end from the vertical link arm using puller 1847038000 (repeat the procedure for the other tie-rod end).
3. Remove the bolts securing the vertical link (gearbox side and timing gear side) to the damper.
4. Rotate the vertical link as appropriate to withdraw the drive shaft from the wheel hub (repeat the procedure for the other drive shaft).



P4A11EX04



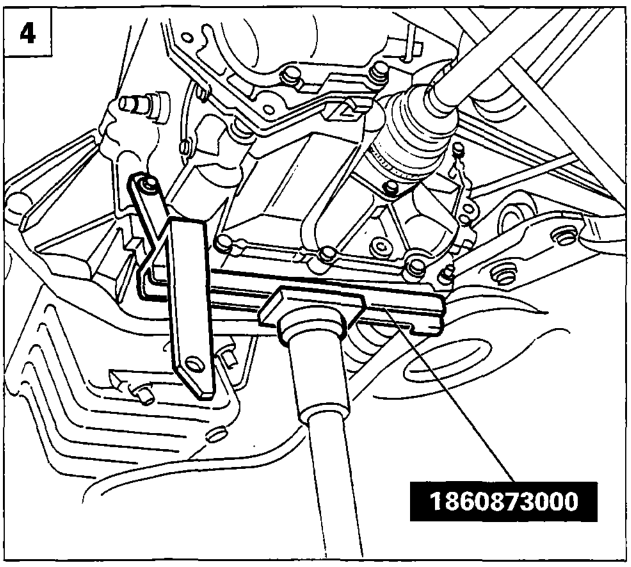
P4A026B01



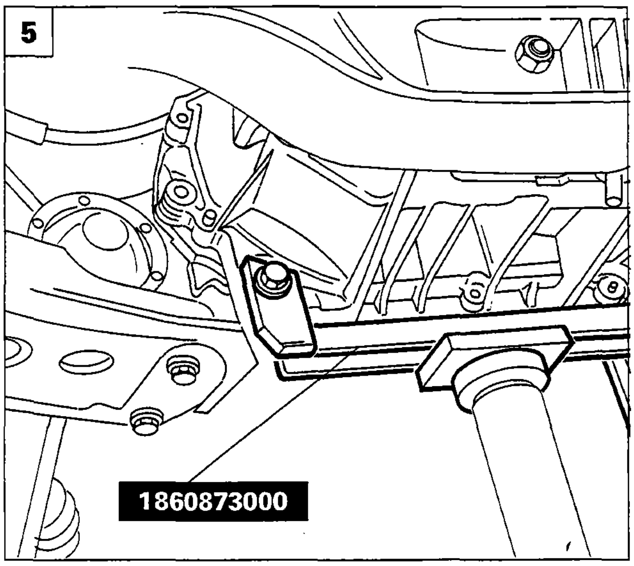
P4A07EX01

1. Remove the bottom flywheel guard from the bellhousing.
2. Undo the bolt shown in the figure on the bellhousing, to enable the gearbox support tool to be installed.
3. Remove the power unit central mounting to enable the gearbox support tool to be subsequently installed.

4-5. Place the gearbox support tool 1860873000 on the hydraulic jack, then secure it to the gearbox at the points shown in the figure (front view and rear view).

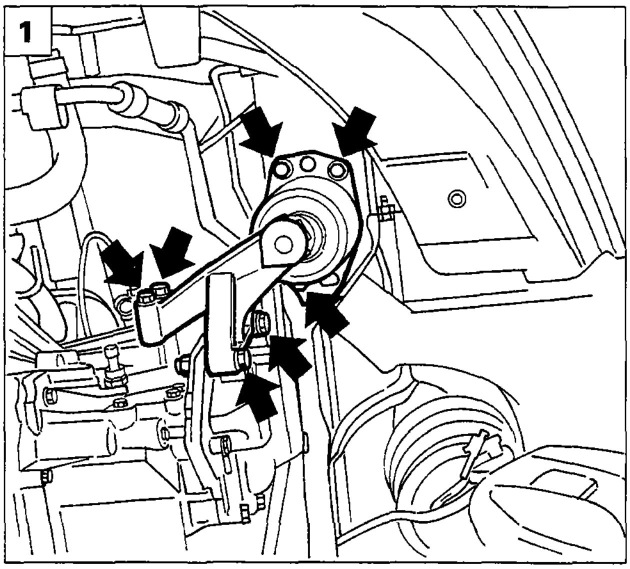


P4A026B02

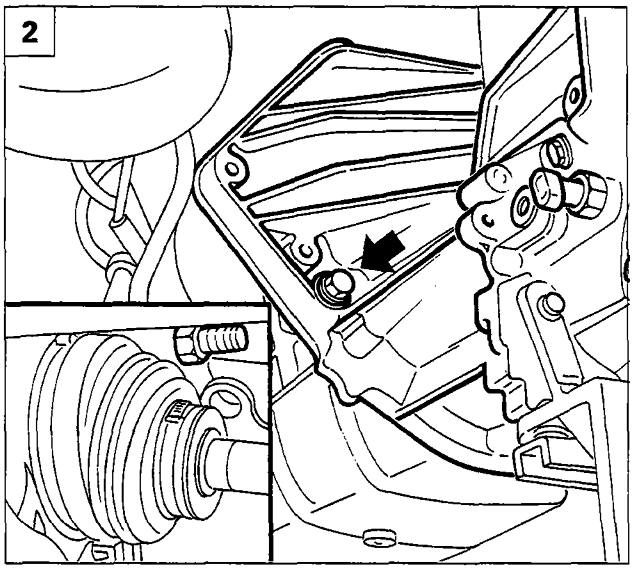


P4A026B03

21-27.



P4A041B04



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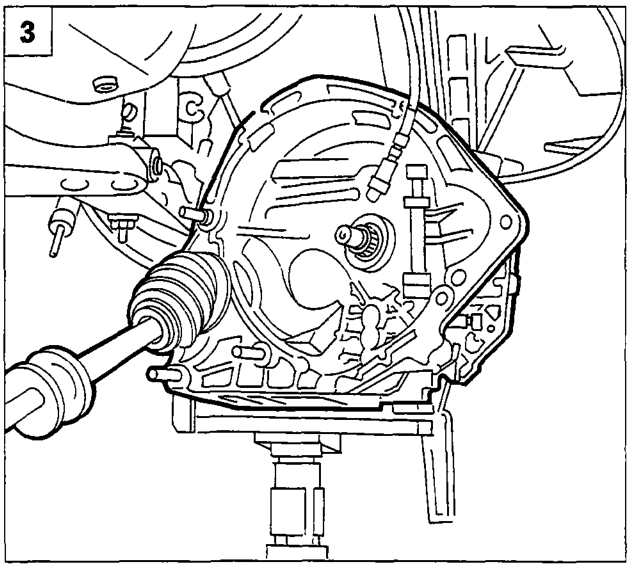
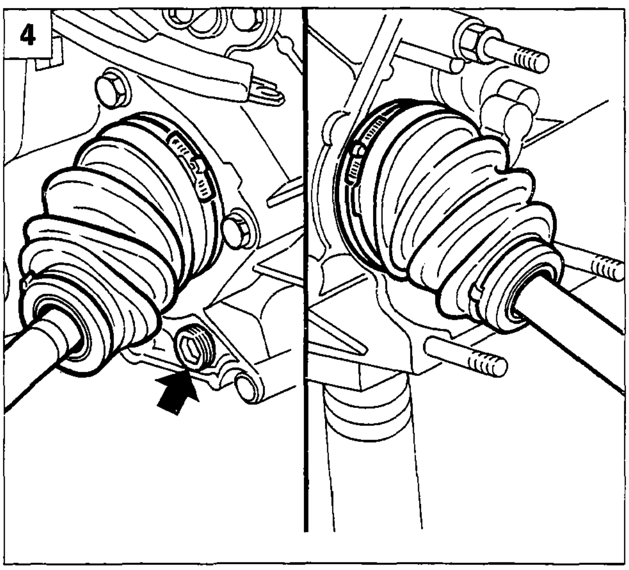
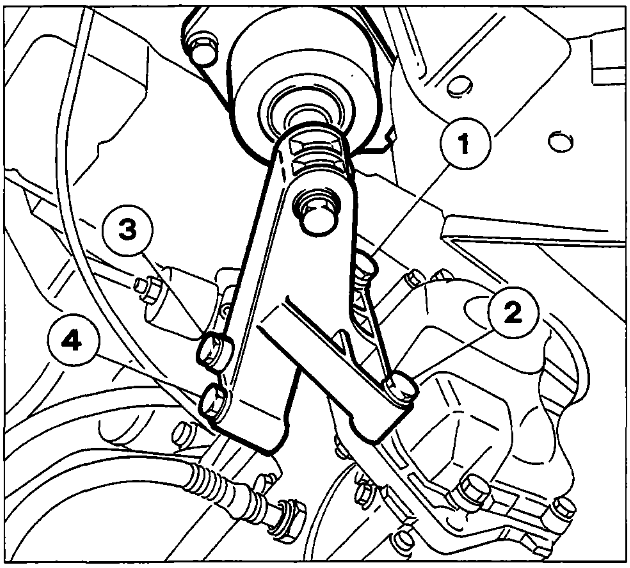


P4A027B03



P4A027B04

1. Remove the engine mounting, gearbox side.
2. Remove the bottom bolts securing the bellhousing to the engine block.
3. Manoeuvre the hydraulic jack to disengage the gearbox from the attachment studs and surrounding components. Gradually lower the jack and withdraw the gearbox complete with drive shafts. If this operation proves difficult, remove the attachments securing the first section of the exhaust pipe to the manifold, to allow the engine to move forwards and so facilitate withdrawal of the gearbox.
4. If the gearbox has to be overhauled, drain the oil by undoing the plug indicated, and disconnect the two drive shafts by removing the gaiter clips.



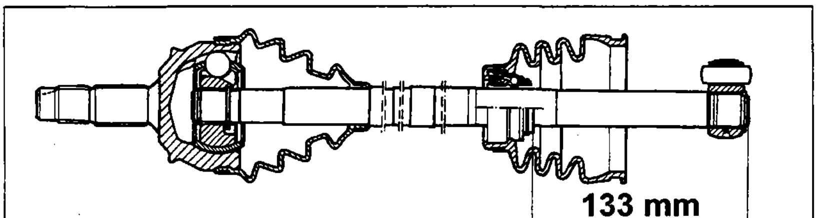
P4A043B01

Refitting

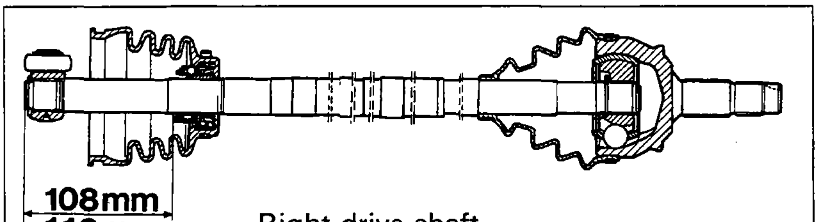
When refitting the engine mounting on the gearbox side, to avoid creating stresses on the gearbox sealing surfaces resulting in deformation and oil leaks, strictly observe the following tightening sequence of the attachment bolts:

- Lightly tighten bolts (1) and (2) to an initial torque of 0.5 daNm;
- Lightly tighten bolts (3) and (4) to an initial torque of 0.5 daNm, then tighten them to the specified torque;
- Tighten bolts (1) and (2) to the specified torque.

For the remaining refitting operations, reverse the procedure described for removal. To fit the clutch release bearing and bellhousing to the car, refer to the instructions for refitting the gearbox of the 1370 12V engine.



● alternative Left drive shaft
P4A029B01



Right drive shaft ● alternative
P4A067B01

REMOVING-REFITTING DRIVE SHAFTS

To remove and refit the drive shafts, refer to the procedure described for the 1370 12V engine, with the difference that the drive shafts are secured to the gearbox-differential unit by retaining clips and the tripod joint is inserted directly in the differential.

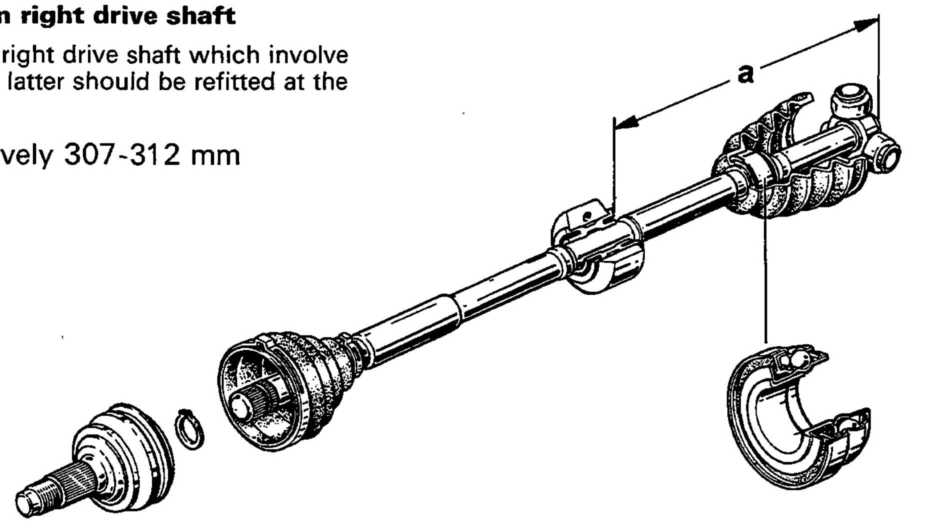
DISMANTLING-REASSEMBLY

Refer to the dismantling of the drive shaft described for the 1581 16V engine. To fit the differential casing oil sealing bearing, refer to the figure opposite.

Position of damping weight on right drive shaft

In the case of interventions on the right drive shaft which involve removing the damping weight, the latter should be refitted at the distance specified in the figure.

a = 305-310 mm or alternatively 307-312 mm



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BOSCH MOTRONIC M 2.10.4 M.P.I. INTEGRATED INJECTION/IGNITION SYSTEM

Introduction

The Bosch Motronic system fitted on the 1998 5 cylinder 20valve engine belongs to the category of digital, inductive discharge, static advance electronic ignition systems integrated with sequential, timed type electronic injection.
This system has only one electronic control unit, a single set of wiring and one set of common sensors.
Its function is to inject the exact quantity of petrol into the engine inlet manifold, upstream of the inlet valves, to mix with the air introduced into the cylinder so that the correct mixture strength is obtained.

The Motronic M 2.10.4 system ensures efficient operation making it possible to achieve optimum performance and fuel consumption and to reduce harmful emissions through a response to the different engine operating conditions.

General description of the injection system

The essential conditions which always have to be satisfied in the preparation of the air/fuel mixture for the smooth running of ignition engines are basically two:

1. the metering (air/fuel ratio) should be kept as constant as possible and close to the stoichiometric value, in order to ensure the rapid combustion required to prevent unnecessary fuel consumption;
2. the mixture should be composed of petrol vapours atomized as finely and as uniformly as possible in the air.

In the Bosch Motronic M 2.10.4 system the injector nozzles carry out the task of atomizing the petrol into minute droplets.
Since the absolute pressure of the air drawn may vary, it is necessary to adjust the quantity of petrol to be injected so as not to alter the weight ratio between the air and the petrol.
The constancy of this ratio is obtained by varying the supply pressure of the fuel, by means of a regulator, according to the valueof the vacuum of the air in the inlet manifold, so that the difference between the two pressures is constant at all engine operating conditions.

As far as the optimum metering, on the other hand, is concerned, it is calculated according to the following measurements:

- exact quantity of air drawn in by the flow meter (air flow meter);
- engine rotation speed by means of the rpm sensor;
- acceleration required by means of the butterfly valve position sensor;
- temperature of the engine coolant by means of the sensor on the thermostat mounting;
- measuring the oxygen content of the exhaust gases via the Lambda sensor.

This information is processed by a micro-processor in the injection/ignition electronic control unit which determines the basic injection time using values, obtained experimentally, which are stored in a special memory in the above mentioned control unit.

General description of the ignition system

The ignition system is the static advance, inductive discharge type (i.e. without a high tension distributor) with power modules inside the electronic control unit.
The system has a single coil for each spark plug; the advantages of this solution are:

- less electrical overloading
- guarantee of constant discharge at each spark plug

The electronic control unit memory contains the entire series of optimum advance values which the engine can adopt for its operating range according to the engine speed and load conditions.

These values have been obtained experimentally, by means of a long series of practical tests carried out on prototypes at the engine test bench to identify the advances at which it is possible to achieve the best compromise between the conflicting requirements of maximum power and low consumption and harmful exhaust emissions.
The optimum advance values have then been memorized in the system control unit. During the operation of the engine, the control unit is constantly informed of the engine speed and load conditions and, on this basis, it "selects" the advance value from its memory to strike the spark at the spark plug for the cylinder during the explosion stroke with the optimum advance.

In addition the control unit corrects this value depending on further factors such as engine coolant temperature, intake air temperature, detonation and position of the butterfly valve, so that the ignition point is always optimum.

The information required by the control unit to operate the single coils is transmitted by means of electrical signals emitted by the following sensors:

a. **An rpm sensor** which generates a single phase alternating signal, whose frequency indicates the engine rpm.

b. **An air flow meter** which, on the basis of the quantity of air drawn in by the engine, transforms this value into an electrical signal, sending it to the electronic control unit.

c. **An air temperature sensor** which transforms the value of the intake air temperature into an electrical signal, sending it to the electronic control unit.

d. **Two detonation sensors** which are positioned in the upper part of the crankcase, one between cylinders 1 and 2 and the other between cylinders 4 and 5, allowing the control unit to recognize the cylinder which is detonating (or is in the early stages of detonation) and to correct the ignition advance for the spark plug for the cylinder involved only.

e. **A butterfly valve position sensor** which transforms the angular value of the actual butterfly into an electrical signal allowing the control unit to recognize the conditions of minimum, partial or full load.

Functions of the system

In addition to electronically controlling the moment of ignition and the air flow rate during idling in order to allow the engine to run smoothly when the environment parameters and the load conditions vary, the control unit must also control and manage the injection in such a way that the stoichiometric ratio (air/-fuel) is always within the optimum values.
The electronic control unit establishes the «time» for the injectors following a relatively simple rule which can be summed up as follows.

Taking the physical characteristics of the fuel (viscosity and density) and the difference in pressure between the fuel and the pressure in the inlet manifold as constant, the quantity of fuel injected depends only on the «opening time» of the injector.

The functions carried out by the injection/ignition system are basically as follows:

- adjusting the injection times;
- adjusting ignition advances;
- checking cold starting;
- checking the enrichment during acceleration;
- fuel cut off during deceleration (Cut-off);
- checking and managing engine idle speed;
- limiting the maximum number of revs;
- checking combustion via the Lambda sensor;
- fuel vapour recovery;
- checking detonation
- checking the phase transformer
- connection with the climate control system (where fitted);
- self-adjustment of the system
- connection with the engine starting immobilizing device (Fiat CODE);
- autodiagnosis.

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SYSTEM MANAGEMENT STRATEGIES

Adjustment of the injection times

Digital technology has made it possible to obtain optimum fuel consumption and performance by using programmed maps, stored inside the electronic control unit memory, dependent on the engine speed and load conditions.
The control unit controls the injectors with extreme speed and precision, calculating the opening time on the basis of the load on the engine (number of revs and air flow rate) also taking into account the battery voltage and the temperature of the engine coolant.
The injection is sequential and timed for each cylinder (the moment of injection is not simultaneous for all the cylinders) and takes place corresponding to the optimum injection point.

Adjustment of ignition advances

Thanks to a map memorized inside the electronic control unit it is capable of calculating the advance according to the engine load (minimum, partial, full, on the basis of the number of revs and air flow rate), the temperature of the intake air and the temperature of the engine coolant.
It is possible to delay the ignition selectively for the cylinder requiring it, which can be recognized via the combination of the values recorded by the detonation and cam angle sensors.

Checking cold starting

Under these circumstances there is a natural weakening of the mixture as a result of the poor turbulence of the particles of fuel at low temperatures, reduced evaporation and condensation on the inner walls of the inlet manifold, all of it exacerbated by the increased viscosity of the lubrication oil.

The electronic control unit recognizes this condition and corrects the injection time on the basis of the coolant temperature signal, the temperature of the intake air, the battery voltage and the engine speed.

The ignition advance is only dependent on the number of revs and the temperature of the engine coolant.

During starting the control unit controls an initial simultaneous injection for all the injectors (full-group injection) and after the reference on the flywheel is recognized, it switches to the normal sequential timed operation.

Whilst the engine is warming up, the electronic control unit controls the idle speed actuator which determines the quantity of air required to ensure that the engine does not cut out.

The rotation speed is made to decrease proportionally as the temperature increases until the nominal value is obtained when the engine has reached operating temperature.

Checking acceleration enrichment

When there is a request for acceleration, if the air flow meter signal variation exceeds a pre-set increase, the control unit not only adjusts the injection to the new requirements, but also increases it further through rapidly reaching the speed required.

When approaching the pre-set speed, the injection increase is gradually eliminated.

NOTE *The request for acceleration is also detected by the potentiometer on the butterfly; this makes it possible to ensure optimum running if there is a failure in the air flow meter until a Service Dealer can be reached.*

Fuel cut off during deceleration

The fuel cut off during deceleration is the modified type.

When the closed butterfly condition is recognized and the engine speed is greater than 1700 rpm (for engine speeds below 1700 rpm the cut off function is not operational to maintain optimum "driveability") the injection of fuel is deactivated.

With no fuel supply, the engine speed starts to decrease more or less quickly depending on the vehicle driving conditions.

Before the idle speed is reached the dynamics of the engine speed decrease are checked.

If they exceed a certain value, the fuel supply is partly reactivated on the basis of a logic which involves the "soft accompaniment" of the engine at idle speed.

When this condition is reached the normal idle functions are reactivated and the cut off during deceleration is only reactivated if the fuel cut off level is exceeded to ensure that the engine runs smoothly. The levels at which the fuel supply is restored and the cut off activated depend on the temperature of the engine.

Another fuel cut off logic is developed in the engine which intervenes during partial deceleration, i.e. when lower engine loads are required.

The function is only activated if the new condition persists for a pre-set time and after the ignition advance angle has been adjusted to the new situation.

Checking and managing engine idle speed

The adjustment of the idle speed is controlled in all operating conditions by means of the idle speed actuator which acts on the butterflyl by-pass.

In addition to controlling the actual idle speed it also carries out the functions of a supplementary air valve and regulator for switching on the various consumers (e.g. the climate control compressor); with the butterfly in the end of travel position, in effect the actuator regulates the by-pass opening compensating for the power required by the consumers to ensure an engine idle speed of 750 rpm.

The actuator fitted on this version guarantees great responsiveness to adjustment because the opening and the closing of the by-pass are both operated by magnetic windings.

The correction of the idle is carried out not only by the actuator but also by the adjustment of the ignition (advance) angle because it has a more rapid effect.

NOTE *The self-adjustment function makes it possible to dispense with all idle speed adjustments with the butterfly casing sensor recognizing the "butterfly in the end of travel" position and correcting any wear which occurs in time and is detected by the butterfly closure position.*

Limiting maximum number of revs (protection outside of revs)

When the engine speed exceeds 6,800 rpm, the electronic control unit reduces the injector operating times so that this value is not exceeded.

If the engine speed exceeds 7,013 rpm, the control unit activates the "fuel cut off" strategy restoring the operation of the injectors when the speed goes below 6,800 rpm.

Checking combustion via the Lambda sensor

The Lambda sensor informs the control unit of the quantity of oxygen present at the exhaust and therefore the correct air/fuel metering.

The optimum mixture is obtained with a Lambda coefficient of 1 (optimum stoichiometric mixture). The electrical signal which the sensor sends to the control unit undergoes a sharp variation when the composition of the mixture differs from Lambda= 1. When the mixture is "lean" ($\lambda > 1$) the control unit increases the quantity of fuel, when the mixture is "rich" ($\lambda < 1$) it decreases it: in this way the engine operates as close as possible to the ideal Lambda value.

The Lambda sensor signal is processed, inside the control unit, by a special integrator which prevents sharp variations in the injection times to correct the mixture strength.

The sensor is heated by an electrical resistance in order to be able to reach the correct operating temperature of around 300 °C rapidly.

By using this sensor it is possible to regulate the engine carburation with precision. This makes it possible, amongst other things, to operate at the limits laid down for emissions.

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Fuel vapour recovery

The (pollutant in terms of the regulations) fuel vapours are sent to an active charcoal filter and from there towards the engine where they are burnt; this takes places by means of a solenoid valve which is operated by the control unit only when the engine is in a load condition which allows the correct combustion without the operation of the engine being "disturbed": in effect, the control unit compensates for this quantity of petrol entering with a reduction of the supply to the injectors.

Checking detonation

The function has the task of detecting the presence of the phenomenon of detonation (engine knocking) by processing the signal coming from the relevant sensors. The control unit constantly compares the signals coming from the sensors with a threshold value which, in turn, is continuously updated, to take into account background noise and the ageing of the engine.

The control unit is therefore capable of detecting detonation (or the early stages of detonation) and makes provisions to reduce the ignition advance (from 3° up to maximum of 9.7°), until the phenomenon disappears. Afterwards the advance is gradually restored until the basic value is reached.

In acceleration conditions, a higher threshold is used, to take into account the greater noise produced by the engine in these circumstances. The detonation control strategy is also equipped with a self-adjustment function which ensures the memorizing of the advance reductions which should be constantly repeated to adapt to the different conditions in which the engine finds itself.

Checking phase transformer

The control unit controls the solenoid valve which controls the phase transformer depending on the engine load conditions. When the temperature of the coolant exceeds 40 °C and when the engine speed is higher than the idle speed and lower than 4,800 rpm with the butterfly angle greater than about 8°, the control unit sends a signal to the solenoid valve which is activated and allows the transformer to decrease the timing diagram for the inlet stage by 18° (torque operation).

When the engine is idling or the speed exceeds 4,800 rpm, the control unit deactivates the solenoid valve and the transformer restores the inlet timing to the previous basic values.

Obviously the control of the phase transformer operates with a hysteris field, i.e. the activating level for the solenoid valve is always higher than the deactivating level; this is designed to prevent balance conditions and a consequent too rapid succession passing from one timing diagram to another with obvious operating problems.

Connection with the climate control system

When the climate control is switched on the compressor absorbs power from the engine which, when idling, tends to cut out. To prevent this problem the control unit adjusts the air flow rate to the new power requirements, controlled by the appropriate actuator (this adjustment also takes place during usage conditions to maintain optimum "driveability"). Another function of the system is that of momentarily interrupting the supply to the compressor in the case of high power requirements by the engine (strong acceleration).

System self-adjustment

The control unit is equipped with a self-adjustment function which has the task of recognizing the changes which take place in the engine due to the settling processes which take place over a period of time and the ageing of both the components and the engine itself.

These changes are stored in the memory in the form of modifications to the basic map and have the task of adpating the operation of the system to the gradual alterations to the engine and the components in relation to the characteristics when new.

This self-adjustment function also makes it possible to compensate for the inevitable differences (due to production tolerances) of any components which may have been replaced. This allows the best possible results for all vehicles with special adjustment or checking operations.

The self-adjustment parameters are lost if the control unit is disconnected.

Connection with engine starting immobilizing device (Fiat CODE)

To increase protection against theft attempts, the vehicle has been equipped with an engine immobilizing device (Fiat CODE) which only allows the activation of the injection/ignition control unit by means of an electronic code.

Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the injection/ignition control unit.

When the ignition key is turned from the OFF position to the ON position the following operations take place in the order given:

1. The injection/ignition control unit sends the Fiat CODE control unit a request for the secret code in order to deactivate the functions lock.
2. The Fiat CODE control unit responds by sending the secret code only after it, in turn, has received the recognition code transmitted by the ignition key, which contains a special transponder inside.
3. The recognition of the secret code allows the de-activation of the functions lock and the injection/ignition control unit can activate the normal system management programme.

A special two directional serial line allows the exchange of information between the injection/ignition control unit and the Fiat CODE control unit.

If there is a failure in the Fiat CODE system it is, however, still possible to start the engine via an emergency procedure.

Control units must not, under any circumstances, be exchanged between different vehicles to check if they are working properly.
During the fault diagnosis, before replacing the control unit, make sure that it really is not working properly, because when a new control unit is supplied the secret code is memorized making it completely unusable on other vehicles.

Autodiagnosis

The Motronic M 2.10.4 injection/ignition system is also equipped with an "**autodiagnosis**" function which memorizes any problems with the sensors and actuators, making it easier to detect and correct them. Any problem is signalled by the appropriate warning light in the instrument panel.

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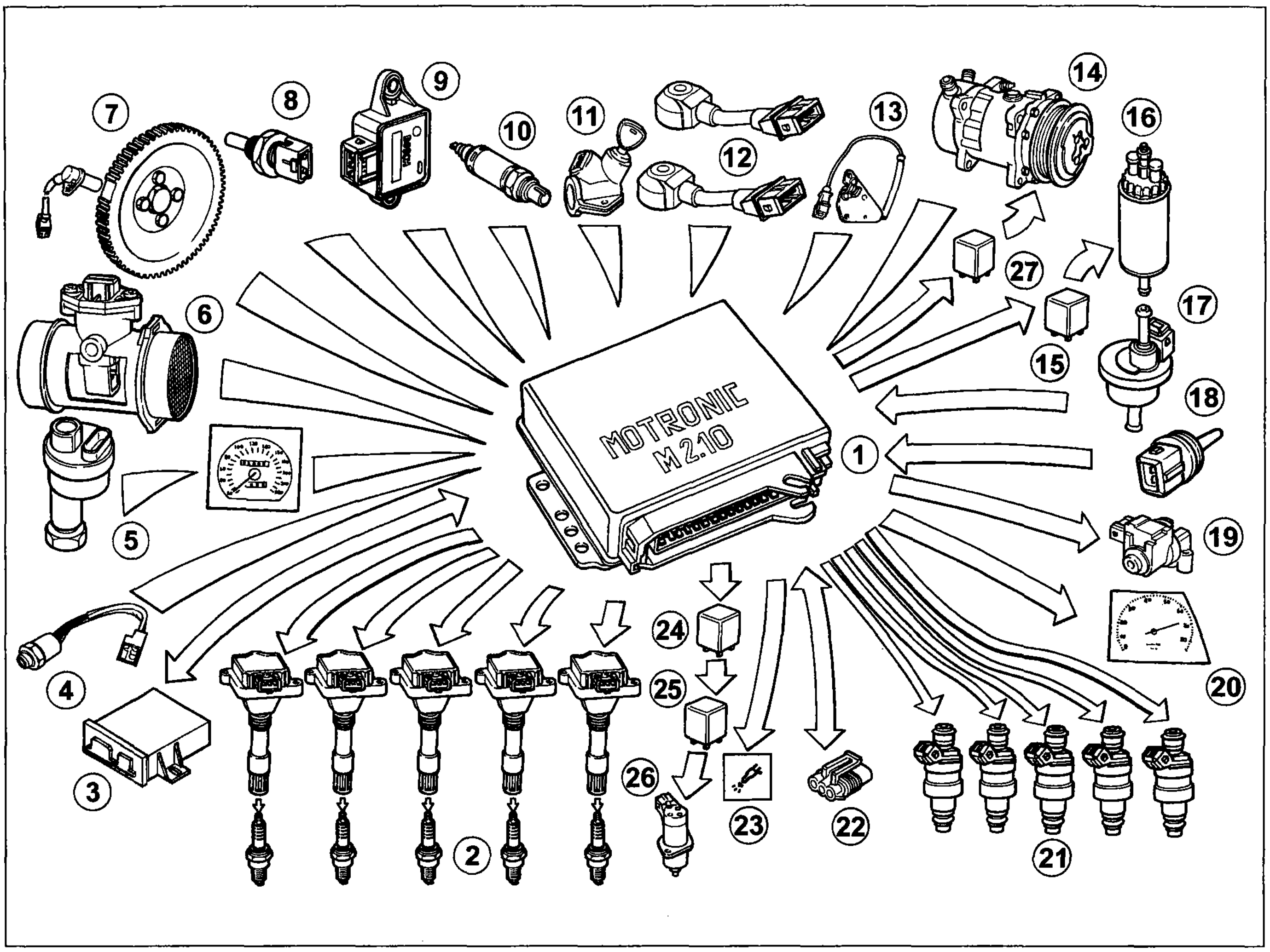
DIAGRAM SHOWING INFORMATION ENTERING/LEAVING THE INJECTION/IGNITION SYSTEM CONTROL UNIT AND SENSORS/ACTUATORS



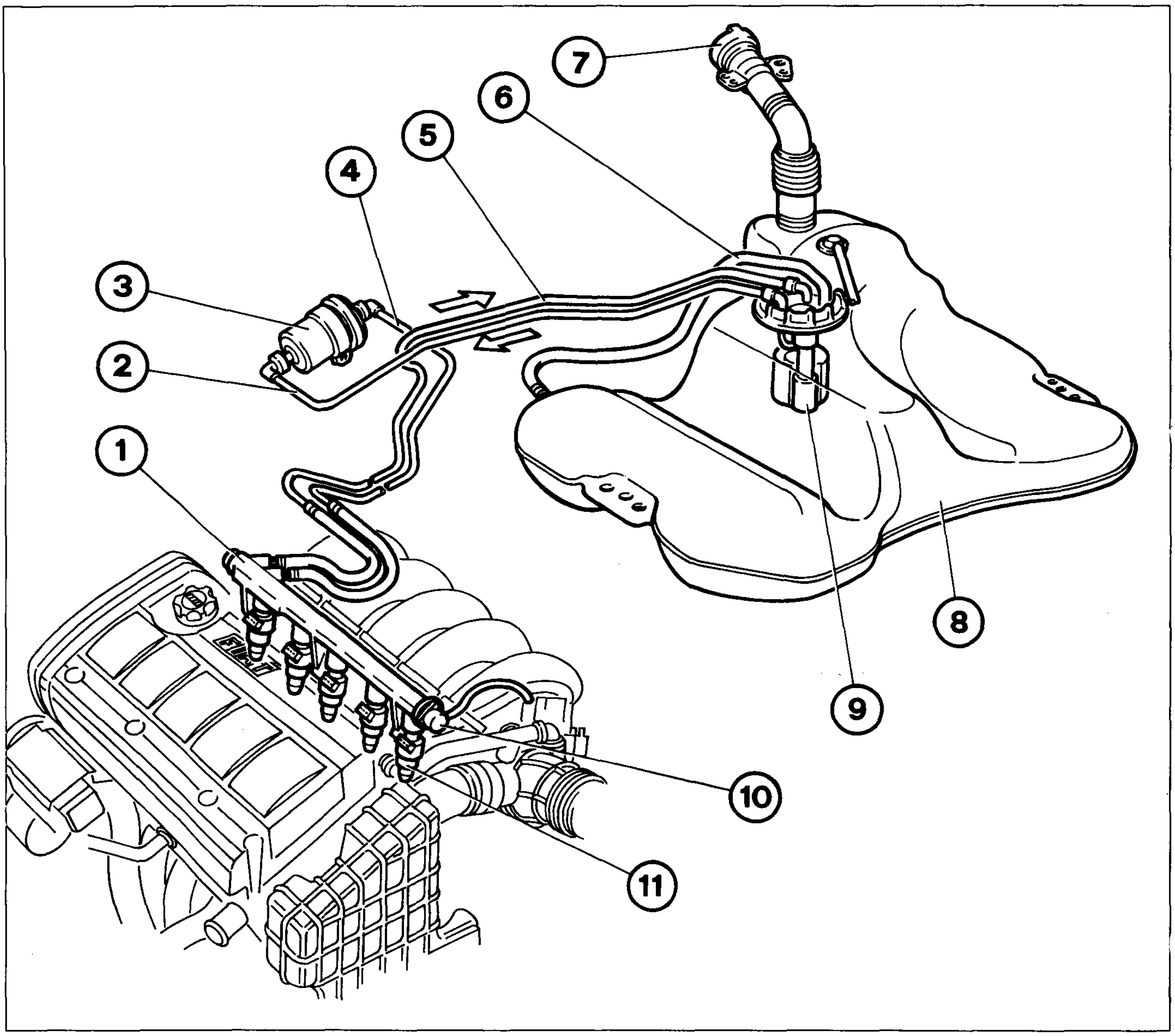
P4A07FJ02

Components key

1. Electronic control unit
2. Coils and spark plugs
3. Fiat CODE control unit
4. Three stage pressure switch
5. Speedometer sensor
6. Flow meter
7. Rpm sensor
8. Coolant temperature sensor
9. Butterfly potentiometer
10. Lambda sensor
11. Ignition switch
12. Detonation sensors
13. Timing sensor
14. Climate control system signal
15. Electric fuel pump and Lambda sensor relay
16. Electric fuel pump
17. Petrol vapour inlet solenoid valve
18. Intake air temperature sensor
19. Engine idle speed actuator
20. Rev counter signal
21. Injectors
22. Diagnostic socket
23. I.E. system failure warning light
24. I.E. system relay.
25. Relay for phase transformer
26. Phase transformer solenoid valve
27. Air conditioning relay feed

10.

DIAGRAM SHOWING FUEL SUPPLY CIRCUIT



P4A08FJ01

1. Fuel supply manifold
2. Supply pipe from the tank to the filter
3. Filter
4. Supply pipe from filter to injectors
5. Return pipe
6. Breather pipe
7. Filler with ventilation and safety valve
8. Tank
9. Electric pump
10. Pressure regulator
11. Injectors

NOTE *Given the special shape of the tank, when fuel is being introduced an air pocket tends to form in the lower part preventing it from being filled completely; the pipe (6) allows the air to flow from the bottom thereby enabling the tank to be filled completely.*

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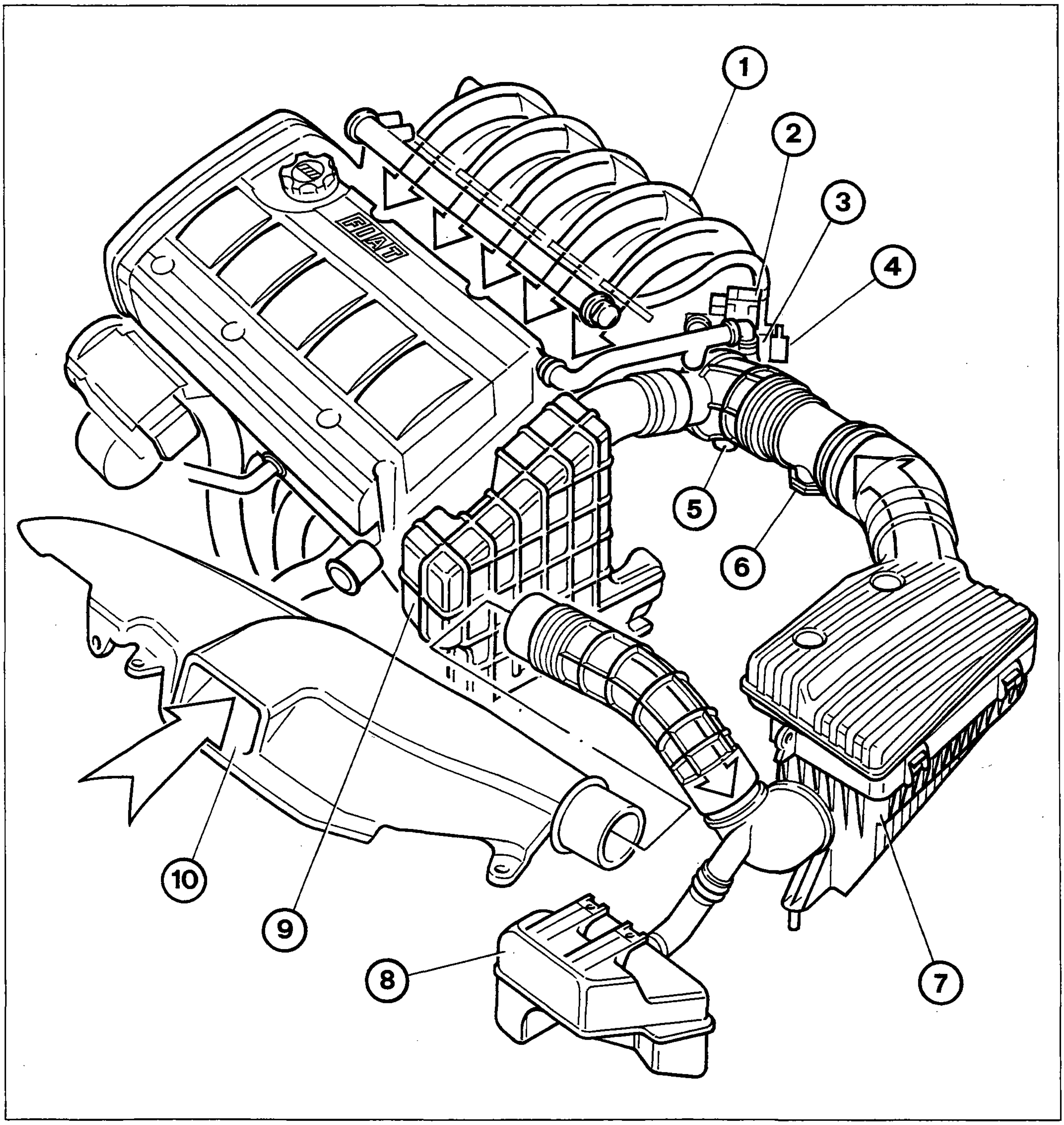
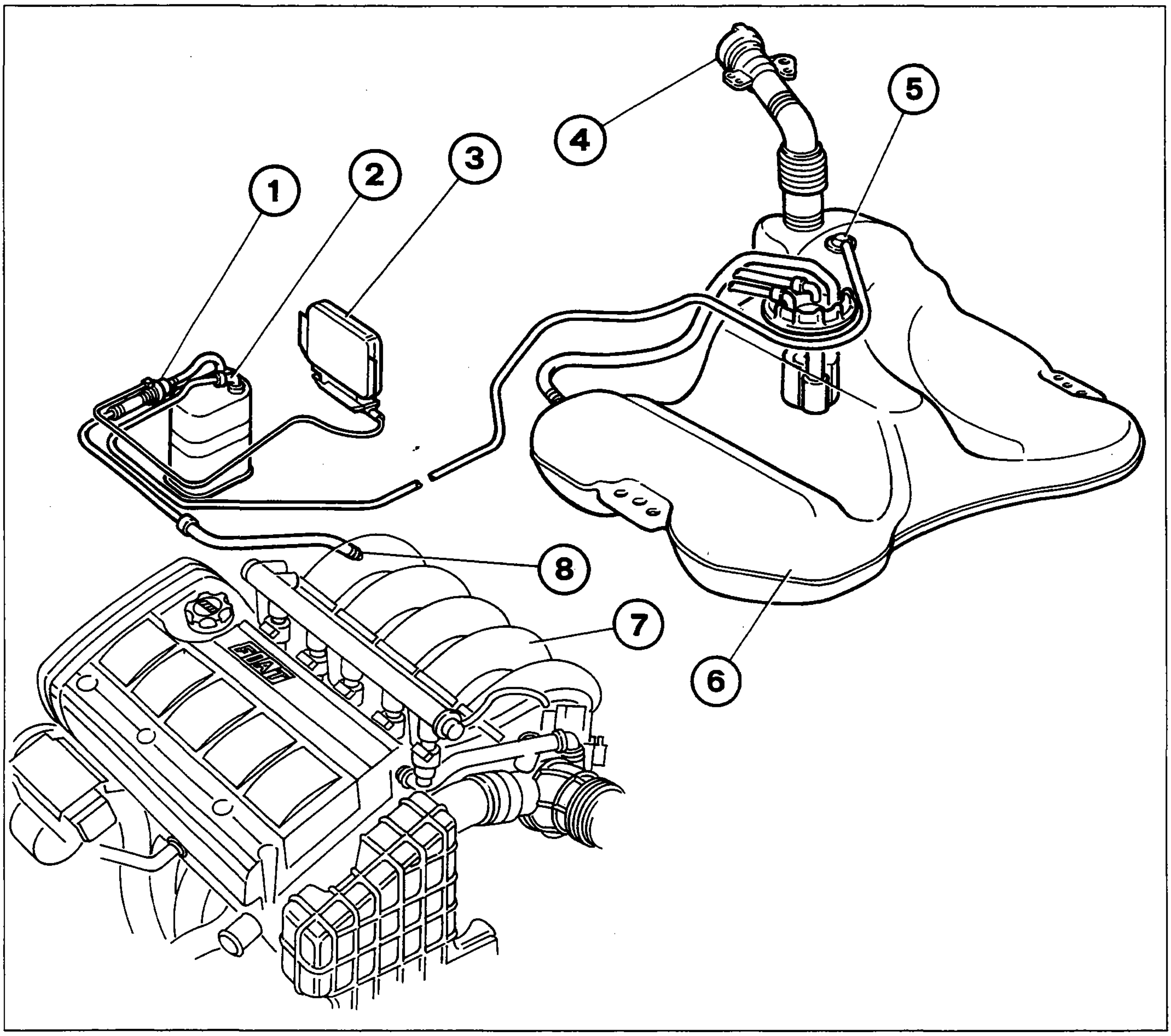
DIAGRAM SHOWING AIR INTAKE CIRCUIT



1. Inlet manifold
2. Engine idle speed actuator
3. Butterfly casing
4. Butterfly valve position sensor
5. Air temperature sensor
6. Flow meter
7. Air filter
8. Lower resonator
9. Upper resonator
10. Inlet opening

10.

DIAGRAM SHOWING FUEL ANTI-EVAPORATION CIRCUIT



P4A10FJ01

The anti-evaporation system has the task of preventing the fuel vapours, made up of the lightest sections of hydrocarbons which form in the tank, from being discharged into the atmosphere.

1. Fuel vapour cut out valve
2. Charcoal filter
3. Injection/ignition control unit
4. Safety and ventilation valve
5. Multi-purpose valve
6. Tank
7. Inlet manifold
8. Fuel vapour intake

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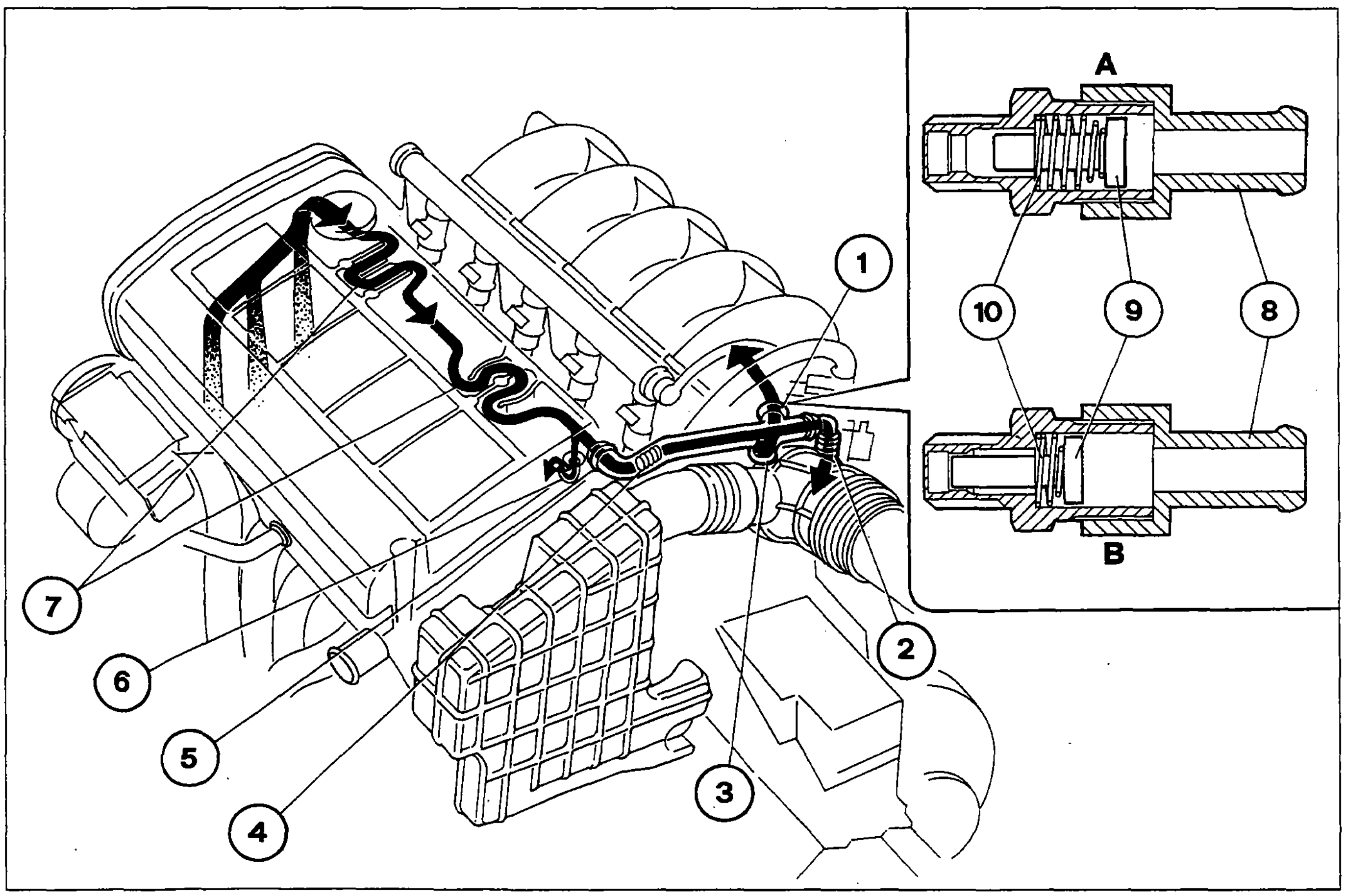
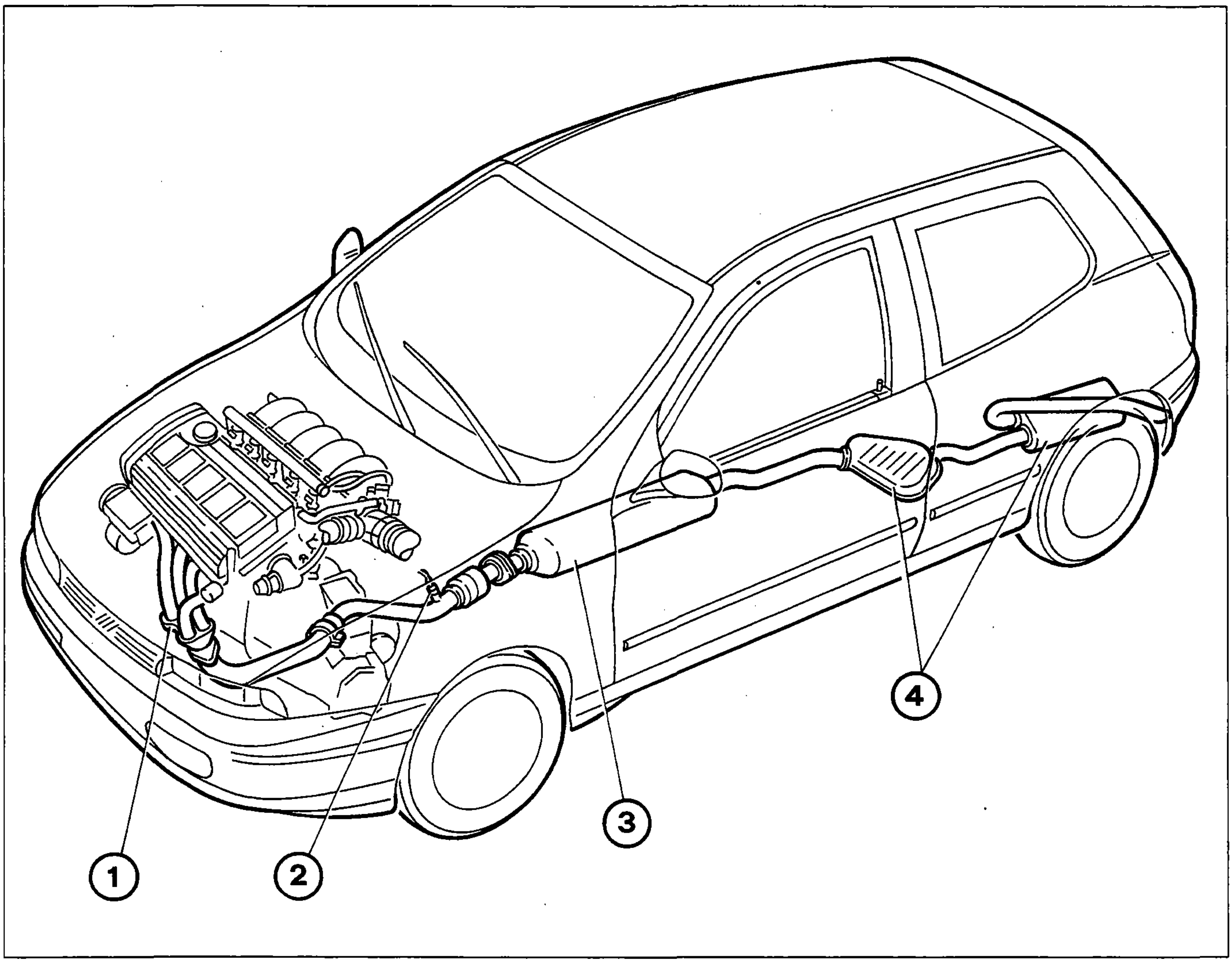
SYSTEM FOR RECIRCULATING GASES COMING FROM THE ENGINE CRANKCASE

This system controls the emissions, from the engine crankcase, of breather gases made up of air/petrol mixtures and burnt gases which escape from the piston seals, in addition to lubricant oil vapours, recirculating them to the inlet.
The breather gases, directedd by special walls, rise by the engine oil filler and then pass through the labyrinth (7), under the tappet cover, where they lose part of the oil which they contain, in the form of droplets, falling on the camshafts through the pipe (6).
The siphon shape of the pipe (6) prevents the breather gases from escaping and only allows the recirculation of the droplets of oil.
The remaining gases escape from the intake (5) inside of which there is a spark out (4) (to prevent the phenomenon of combustion due to flame returns from the butterfly casing).
From the intake (5) the breather gases reach the T union (3).
With the butterfly open, the gases flow through the intakes (1) and (2) to be drawn into the manifold.
With the butterfly closed, the vacuum in the inlet manifold draws in the gases through the intake (1) which contains a PVC restricting valve (8) (Positive Crank Ventilation) which shutters the intake.
The PCV valve can, in effect, be modulated and the quantity of gas which passes through is proportional to the vacuum in the inlet manifold.
When the butterfly valve is completely open (condition A), the vacuum inside the inlet manifold is minimal, the spring (10) is fully extended and the PCV valve allows the maximum flow of breather gases. Viceversa, with the butterfly completely closed (condition B), the vacuum inside the manifold is maximum, this causes the movement of the piston (9) which shutters the section through which the breather gases flow inside the PCV valve thereby restricting the intake of the actual gases in the manifold.



P4A11FJ01

DIAGRAM SHOWING ENGINE EXHAUST ASSEMBLY



P4A12FJ01

Key

1. Exhaust manifold
2. Lambda sensor
3. Catalytic silencer
4. Silencers

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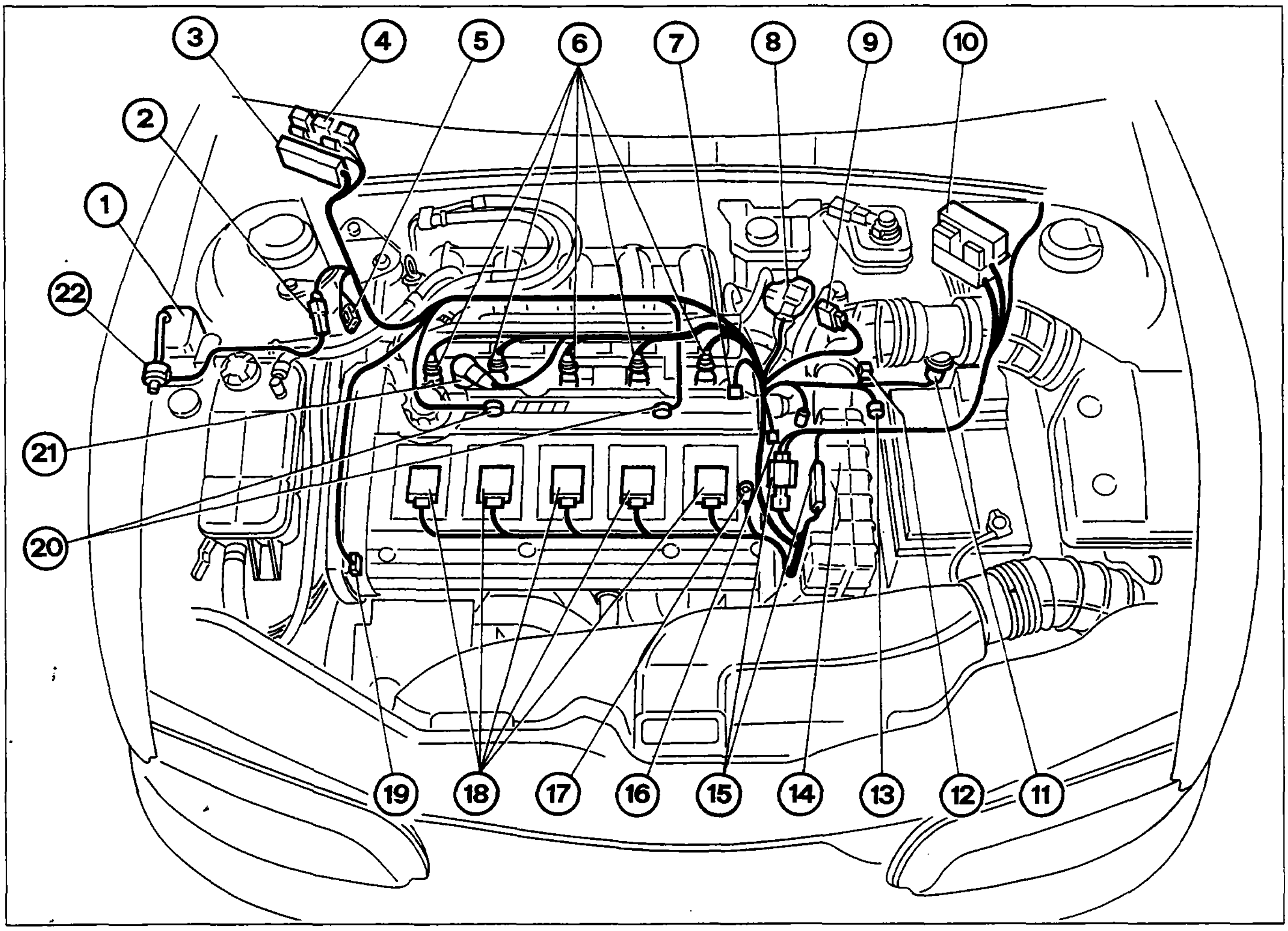
LOCATION OF INJECTION/IGNITION SYSTEM COMPONENTS



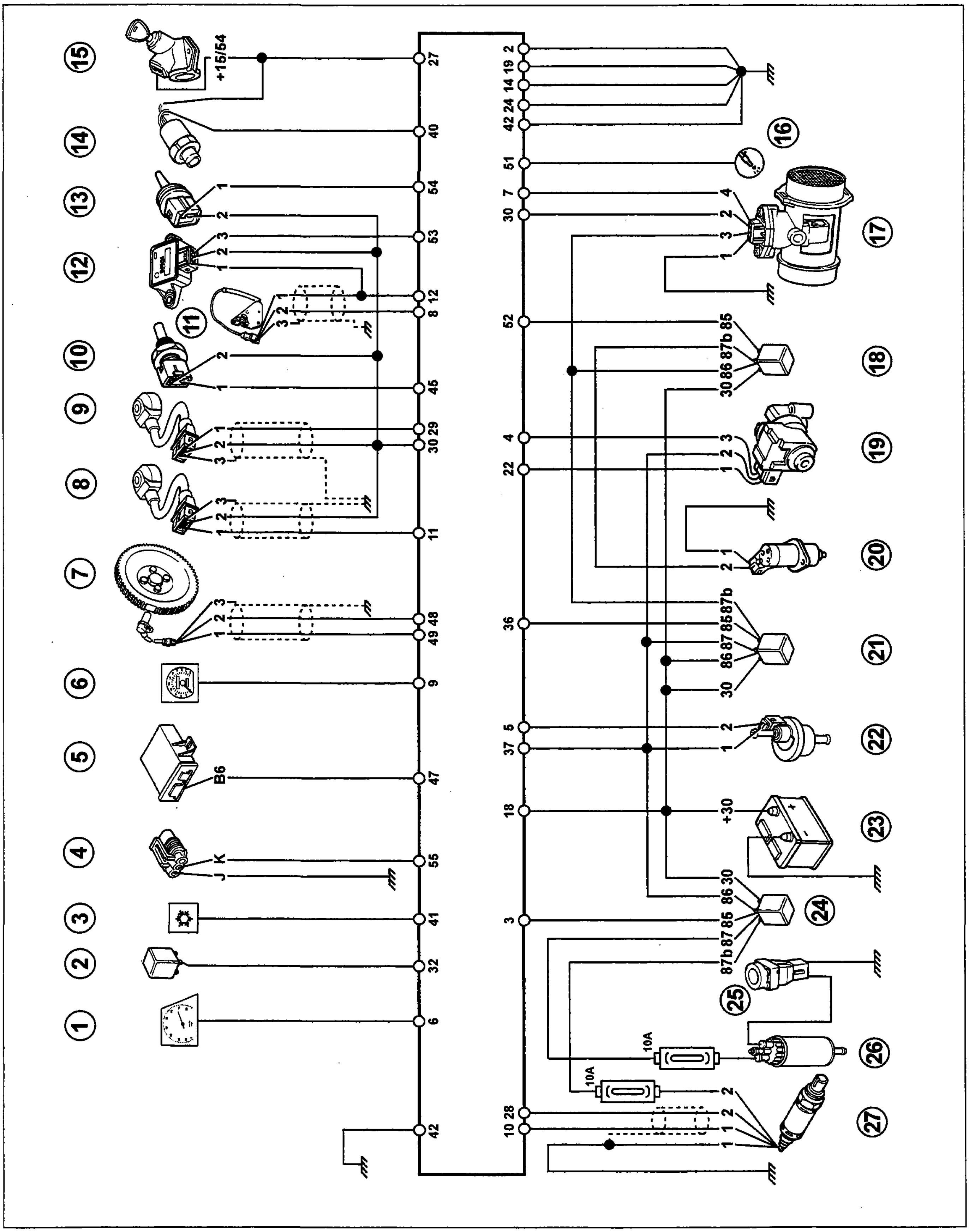
P4A13FJ01

Key

1. Charcoal filter
2. Fuel vapour solenoid valve connection
3. Injection/ignition control unit
4. Fuses and relays
5. Diagnostic socket
6. Injectors
7. Rpm sensor
8. Engine idle speed actuator
9. Butterfly valve position sensor
10. General system protective fuse
11. Flow meter
12. Air temperature sensor
13. Vehicle speed sensor
14. Lambda sensor
15. Join between front cable and injection cable
16. Coolant temperature sensor
17. Earth connection
18. Ignition coils
19. Timing sensor
20. Detonation sensor
21. Phase transformer solenoid valve
22. Fuel vapour solenoid valve

10.

WIRING DIAGRAM SHOWING INJECTION/IGNITION SYSTEM



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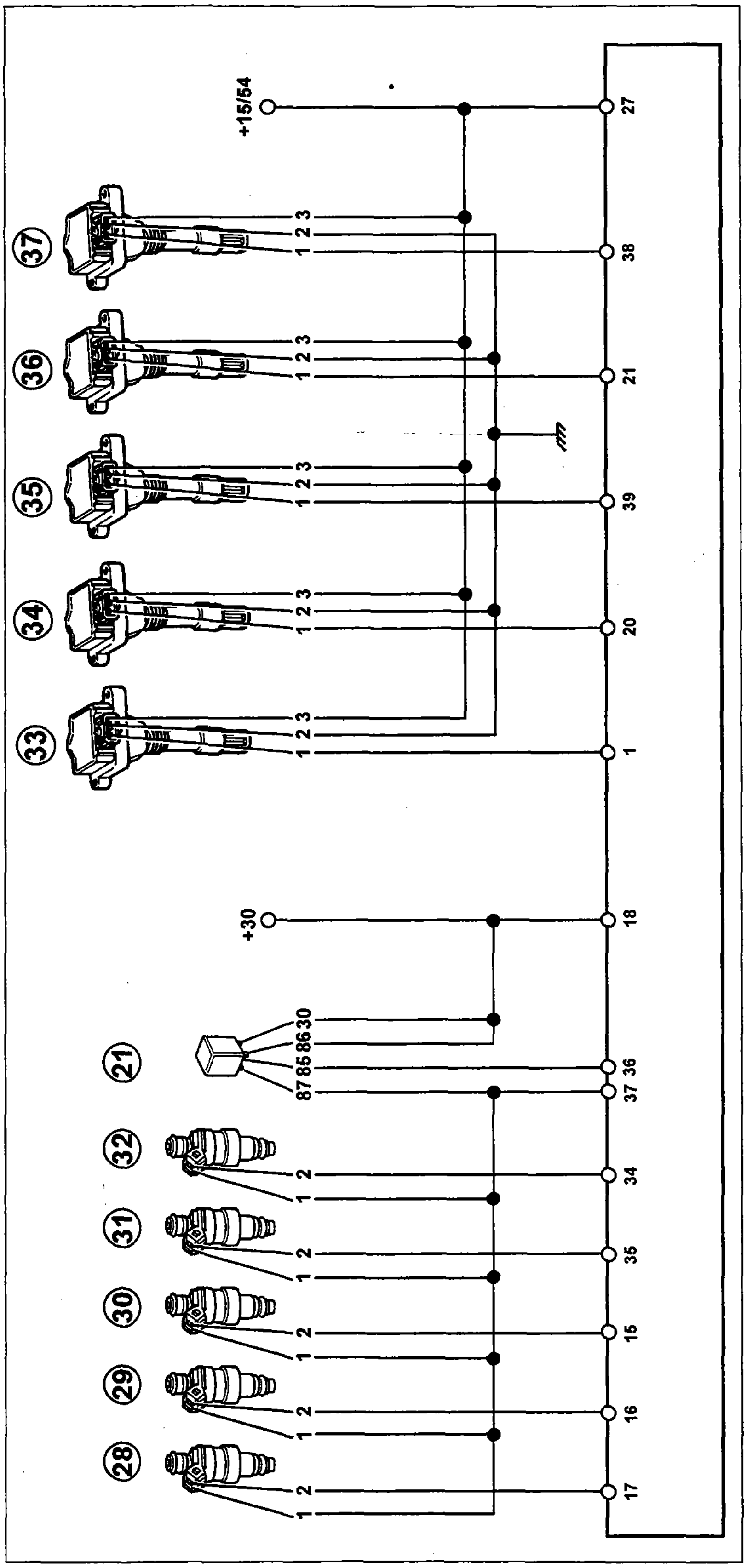
Connection of control unit/ignition coils and injectors

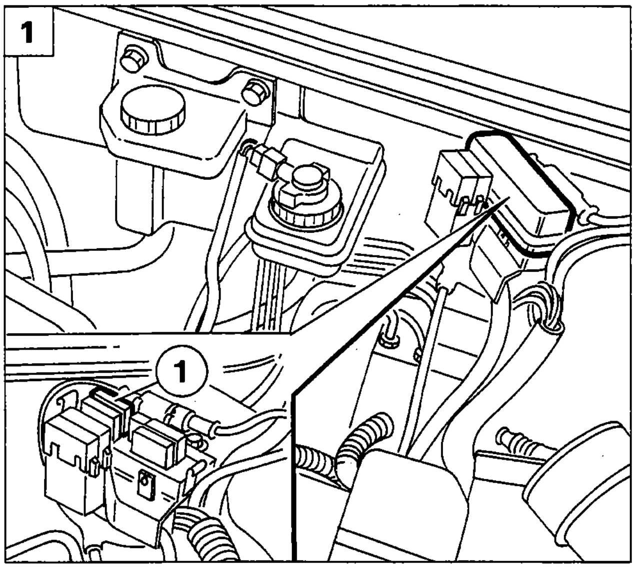


P4A15FJ01

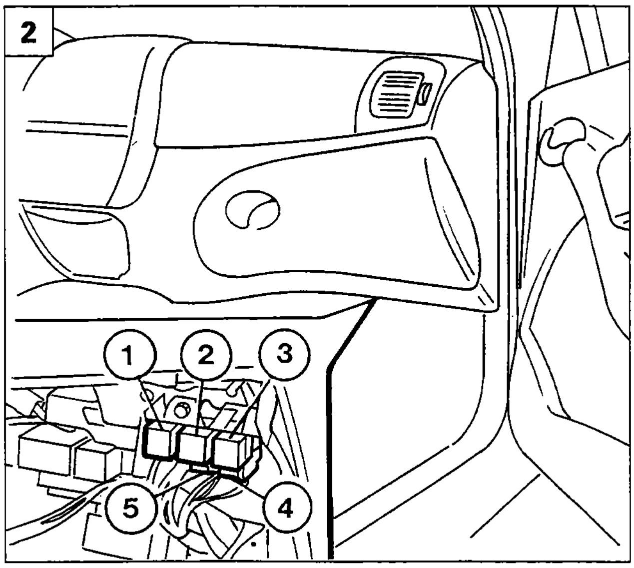
Key:

1. Rev counter signal
2. Climate control relay
3. Climate control on button
4. Fiat/Lancia Tester diagnostic socket
5. Fiat CODE control unit
6. Speedometer signal
7. Rpm and TDC sensor
8. Detonation sensor 1
9. Detonation sensor 2
10. Water temperature sensor
11. Timing sensor
12. Butterfly valve position sensor
13. Intake air temperature sensor
14. Three stage pressure switch
15. Ignition switch
16. I.E. system failure warning light
17. Flow meter
18. Phase transformer solenoid valve relay
19. Engine idle speed actuator
20. Phase transformer solenoid valve
21. I.E. system relay feed
22. Fuel vapour solenoid valve
23. Battery
24. Electric fuel pump relay and Lambda sensor
25. Inertia switch
26. Electric fuel pump
27. Lambda sensor
28. Injector for cylinder N°1
29. Injector for cylinder N°2
30. Injector for cylinder N°3
31. Injector for cylinder N°4
32. Injector for cylinder N°5
33. Ignition coil for cylinder N°1
34. Ignition coil for cylinder N°2
35. Ignition coil for cylinder N°3
36. Ignition coil for cylinder N°4
37. Ignition coil for cylinder N°5

10.



P4A23CJ01



P4A16FJ02

FUSES, RELAYS AND EARTH POINTS

1. General protective fuse

The general protective fuse (EFI-30A) for the injection/ignition system (1) is housed inside a container; to gain access to it, remove the cover releasing the side clips.

2. Fuses and relays

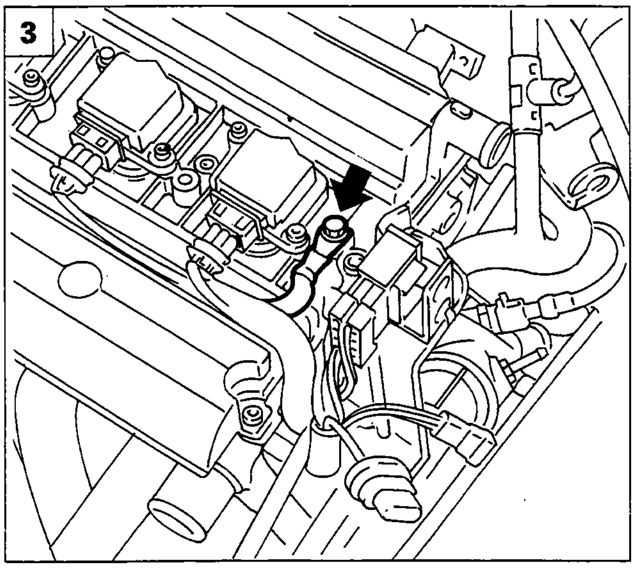
These are located under the glove compartment, in front of the electronic control unit.

1. Phase transformer solenoid valve relay
2. Injection system relay
3. Electric fuel pump relay
4. Lambda sensor fuse (10A)
5. Electric fuel pump fuse (10A)

3-4 Earth points

In order to improve electro-magnetic compatibility and operational reliability special care has been taken over the number and location of the earth points:

3. secondary coils connected below the cylinder head cover;
4. earth control unit (pin 2, 14, 19, 24,42), Lambda sensor heater, flow meter and phase transformer solenoid valve connected to the inlet manifold mounting bracket.



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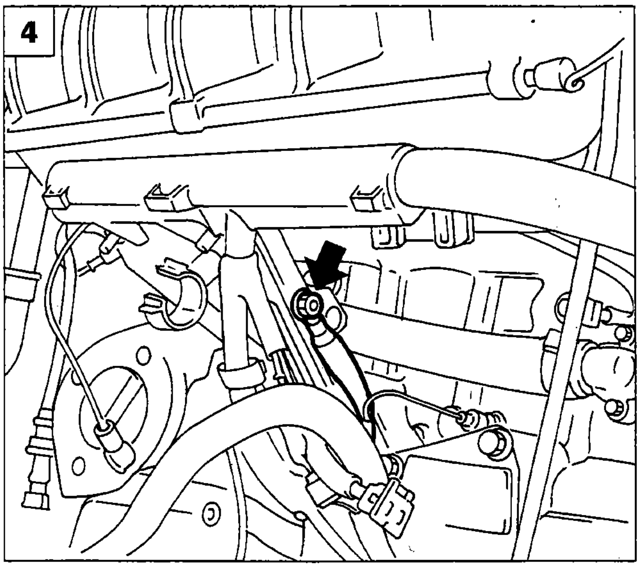

P4A16FJ04

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INJECTION/IGNITION SYSTEM COMPONENTS

The injection/ignition system is basically made up of wiring, an electronic control unit (I.E. control unit) and the following sensors/actuators:

Sensors

- Speedometer sensor
- Rpm and T.D.C. sensor
- Detonation sensors
- Coolant temperature sensor
- Timing sensor
- Butterfly valve position sensor
- Intake air temperature sensor
- Intake air flow rate sensor (flow meter)
- Lambda sensor

Actuators

- Engine idle speed actuator
- Phase transformer solenoid valve
- Fuel vapour cut out solenoid valve
- Electric fuel pump
- Injectors
- Ignition coils
- Spark plugs

INJECTION/IGNITION SYSTEM WIRING

The connection between the different system components is achieved by means of a single set of wiring with various type connectors grouped together in special conduits fitted on the engine.

INJECTION/IGNITION ELECTRONIC CONTROL UNIT

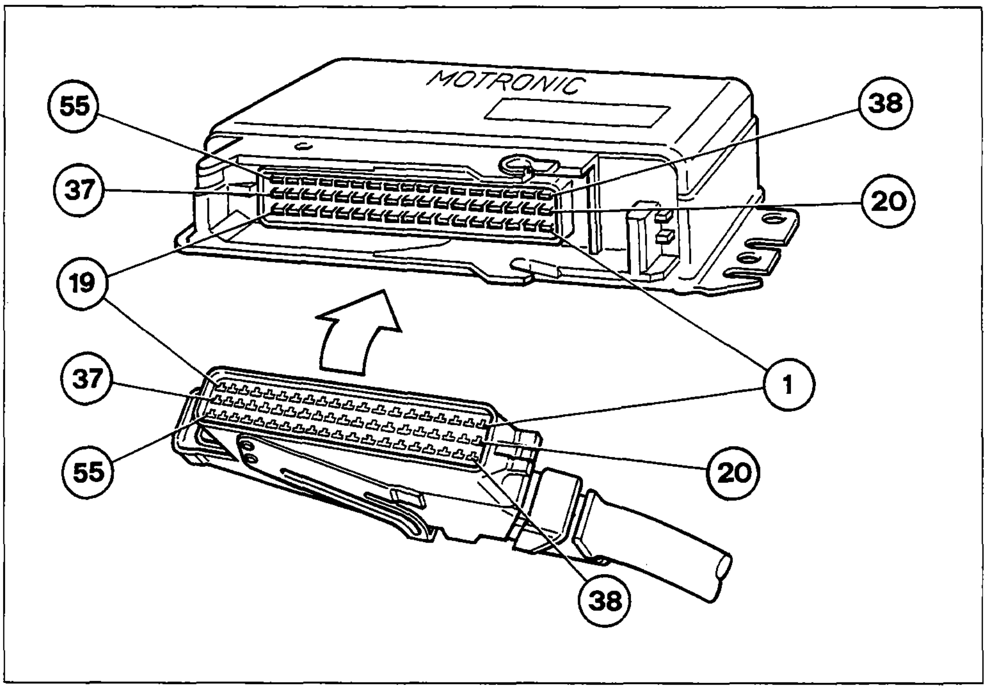
It is made up of thick film hybrid circuits and is connected to the electrical wiring by means of a **55 way** (or pole) multiple connector.

All the information on the engine operating conditions transmitted by the various sensors flows into the control unit.

By means of this data and with the aid of characteristic programmes written indelibly in its memory, the control unit is capable of achieving the following objectives:

1. Managing the injection time and frequency; in other words, it provides the quantity of fuel calculated for each cylinder with a sequential, timed operation (1-2-4-5-3).
   In practice, the air/fuel ratio should always remain within the optimum value, defined during setting up, in order to limit fuel consumption, reduce harmful exhaust emissions and ensure optimum thermodynamic efficiency for the engine.
2. Electronically controlling the moment of ignition (ignition advance)
3. Controlling the air flow rate at the rotation speed through the specific sensor in order to allow the smooth running of the engine as the environmental parameters and loads applied vary.
4. Detecting, by carrying out the programmes, any operating defects for the different sensors recorded in the RAM and replacing the incorect data or data not received with replacement values to ensure the operation of the engine even in emergency conditions (RECOVERY).
5. Supplying the Fiat/Lancia Tester, if connected, via the serial line (diagnostic socket) with the data relating to the operating defects detected and memorized.

IDENTIFICATION OF CONTROL UNIT CONNECTIONS (PIN-OUT)



P4A18FJ01

1. Ignition coil for cylinder N°1
2. Engine earth
3. Electric fuel pump relay feed and Lambda sensor
4. Engine idle speed actuator
5. Fuel vapour solenoid valve
6. Rev counter signal
7. Intake air flow meter
8. Timing sensor
9. Speedometer sensor
10. Lambda sensor
11. Detonation sensor
12. Timing sensor
13. Not connected
14. Engine earth
15. Injector for cylinder N°3
16. Injector for cylinder N°2
17. Injector for cylinder N°1
18. Supply (+30)
19. Engine earth
20. Ignition coil for cylinder N°2
21. Ignition coil for cylinder N°4
22. Engine idle speed actuator
23. Not connected
24. Engine earth
25. Not connected
26. Not connected
27. Supply (+15/54)
28. Lambda sensor
29. Detonation sensor
30. Supply for various sensors
31. Not connected
32. Climate control go ahead relay
33. Not connected
34. Injector for cylinder N°5
35. Injector for cylinder N°4
36. I.E. system relay
37. Supply (+)
38. Ignition coil for cylinder N°5
39. Ignition coil for cylinder N°3
40. Three stage pressure switch
41. Air conditioning on signal
42. Engine earth
43. Not connected
44. Not connected
45. Coolant temperature sensor
46. Not connected
47. Fiat CODE control unit
48. Rpm and TDC sensor
49. Rpm and TDC sensor
50. Not connected
51. I.E. system failure warning light
52. Phase transformer solenoid valve relay
53. Butterfly valve position sensor
54. Intake air temperature sensor
55. Diagnostic socket for Fiat/Lancia Tester

VI-96 - Cancels and replaces

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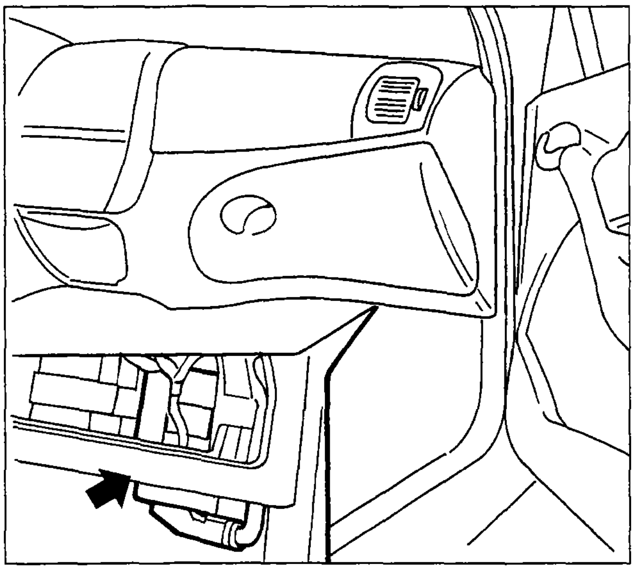


P4A19FJ01

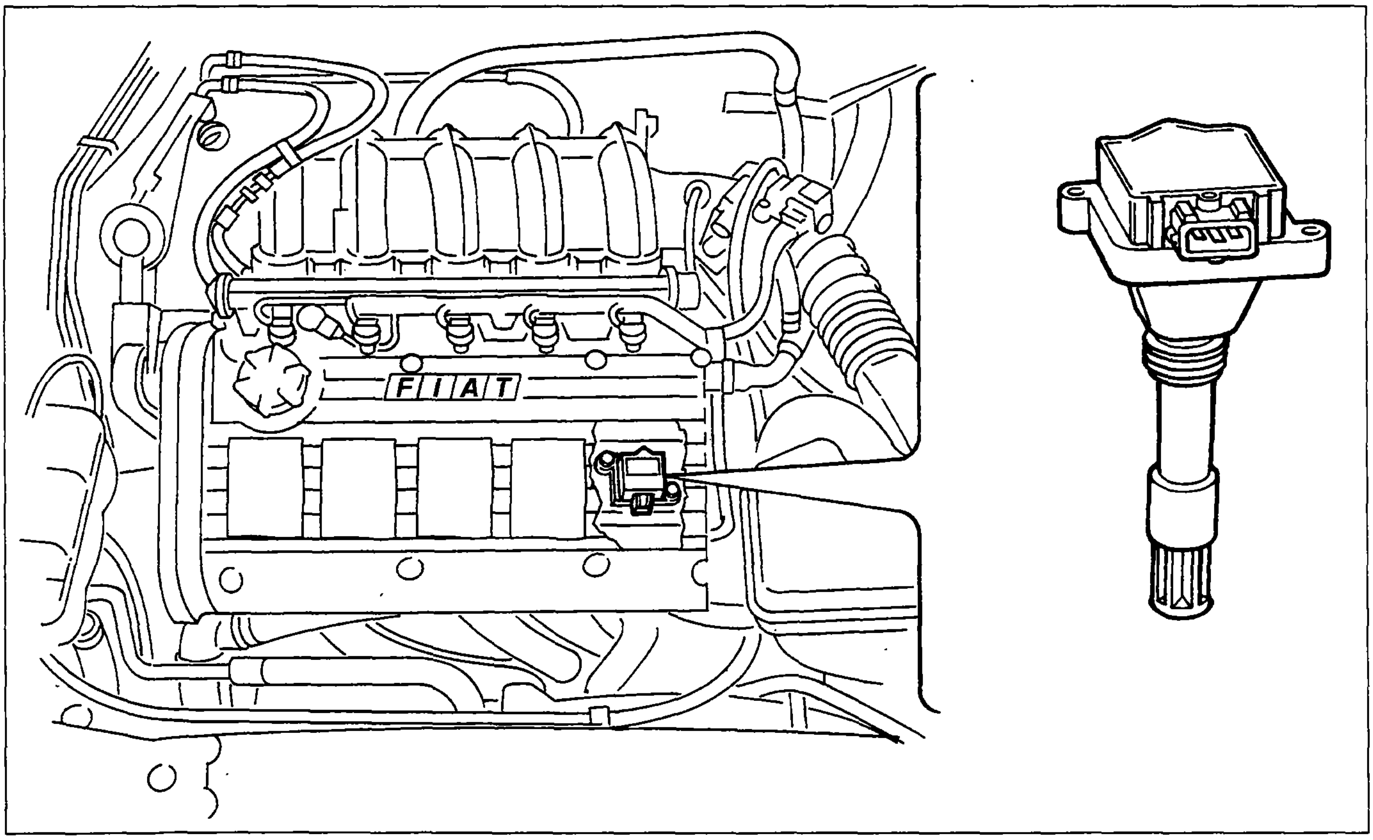
REMOVING-REFITTING ELECTRONIC CONTROL UNIT

The electronic control unit is located under the glove compartment (right hand side). To remove the control unit proceed as follows:

- Undo the bolts fixing the control unit to the mounting bracket.
- To remove the multiple connector, pull the connector clip upwards.

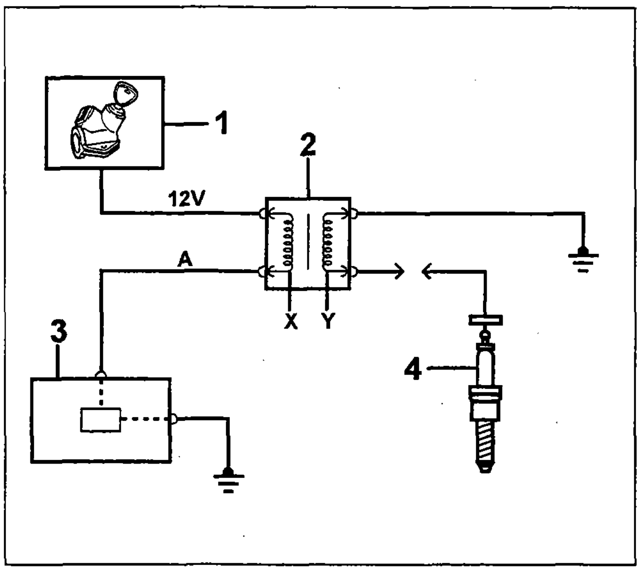
There could be tension at the terminals not connected therefore no connections should ever be made because there is the risk of a short circuit with damage to the control unit.
The operations of fitting and removing the multiple connector should be carried out with the ignition switched off.

IGNITION COILS (0 221 504 006)



P4A19FJ02

The "static advance" electronic ignition has been improved with a single coil for each spark plug (SINGLE COIL); in addition, the power modules are contained inside the control unit; in practice this solution eliminates the H.T. circuit, further increasing reliability and safety and decreasing the risk of interference due to the high tension leads and connections.
They are normal coils which increase the tension of the impulse sent to the spark plugs: each individual coil, located on the cylinder head, directly supplies a spark plug without intermediate H.T. leads.



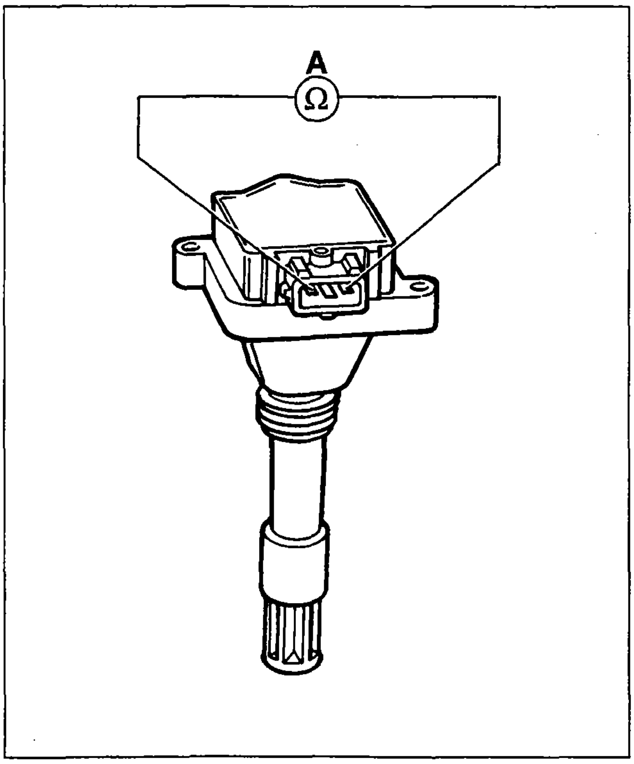
P4A20FJ01

Electrical features

Primary winding inductance .... 3 mH
Primary winding resistance .... 0,4 Ω
Interference resistance .... 1 KΩ

Diagram showing electrical connections

A. Operating signal
X. Primary winding
Y. Secondary winding
1. Supply via ignition switch
2. Single coil
3. Electronic control unit
4. Spark plug



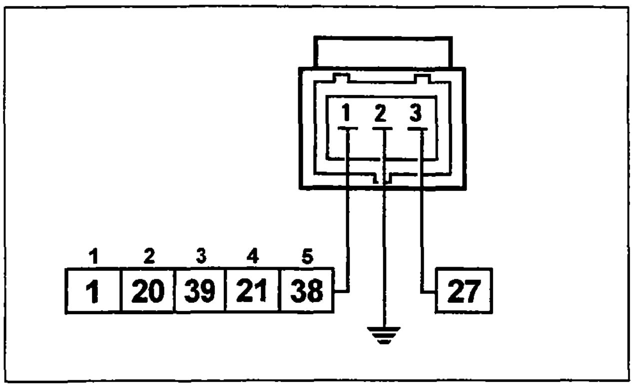
P4A20FJ02

Checking coil circuit resistance

A. Primary circuit

The resistance is checked by connecting an ohmmeter to the connector outer pins, as shown in the diagram.

Primary resistance: 0.4 ohm



P4A20FJ03

Wiring connector

The numbers indicate the corresponding pins for the control unit arranged in the order of the number of cylinders.

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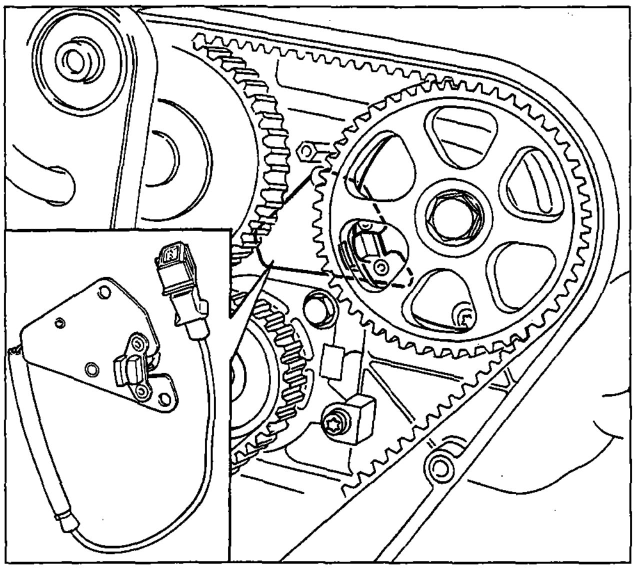
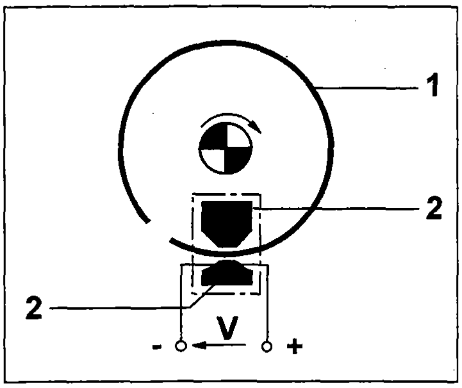


P4A21FJ01

TIMING SENSOR (0.232.101.036)

The Bosch Motronic M 2.10.4 system uses a sequential timed system, i.e. the injection of the fuel takes place in sequence for each cylinder during the inlet stroke.
To achieve this, the electronic control unit also uses a timing signal to determine the injection point in addition to the rpm and TDC signal.
The signal sent to the control unit is produced by a Hall effect sensor fitted by the camshaft drive pulley, exhaust side.

Operating principle



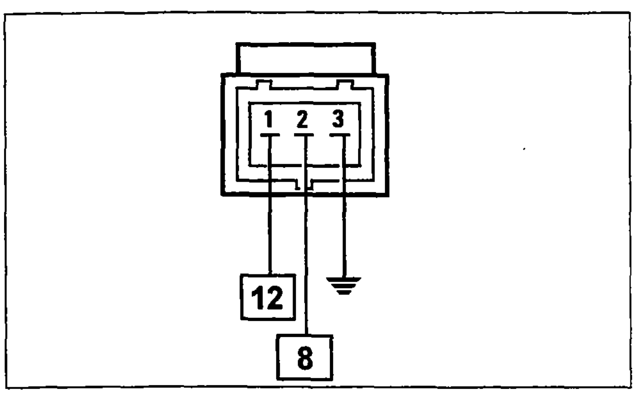
P4A21FJ02

1. Deflector (pulley seal)
2. Magnetic material

A semi-conductor layer with current passing through, immersed in a normal magnetic field (lines of force perpendicular to the direction of the current) generates a difference in power, known as "HALL" tension.
If the intensity of the current remains constant, the tension generated depends only on the intensity of the magnetic field; it is therefore sufficient for the intensity of the magnetic field to be varied periodically to obtain a modulated electrical signal where the frequency is proportional to the speed with which the magnetic field changes.
To obtain this change, a metal ring (inner part of the pulley) with an opening is made to pass through the sensor. When it moves the metal part of the ring covers the sensor blocking the magnetic field with the consequent low output signal; viceversa, by the opening and therefore where the magnetic field is present, the sensor generates a high signal.
As a result the high signal alternates with the low signal once every two revolutions of the engine and precisely when cylinder N°1 is 78° before TDC.
This signal, together with the rpm and TDC signal, allows the control unit to recognize the cylinders and determine the injection point. For each revolution of the engine the control unit checks that the timing signal is present; if this signal is lacking for two consecutive revolutions, the control unit signals the failure (warning light in the instrument panel comes on) and the engine cannot be started up.

Wiring connector

The numbers indicate the corresonding pins for the control unit



P4A21FJ03

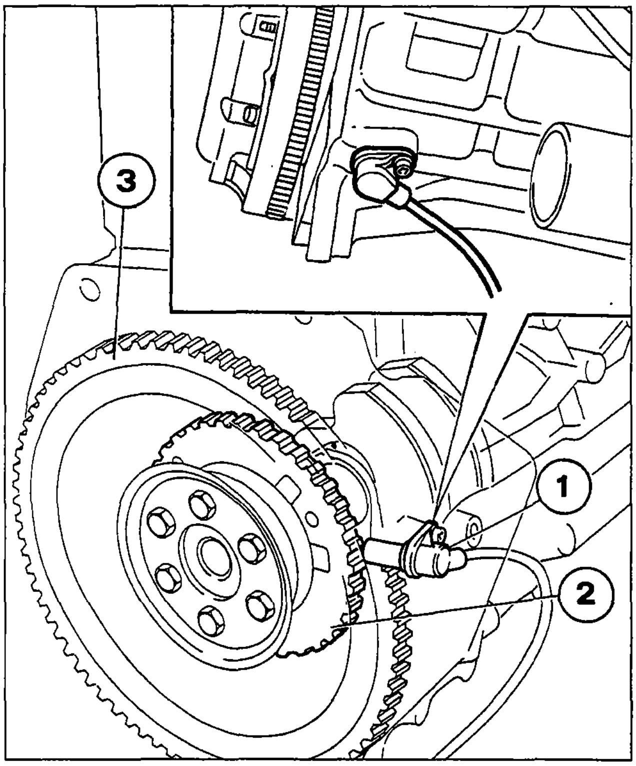
Removing-refitting

This operation involves removing the timing belt and the camshaft pulley, exhaust side.
When these operations have been carried out it is necessary to:
- disconnect the electrical connector;
- Undo the fixing bolts and remove the sensor.

When refitting carry out the procedure in the reverse order, following the instructions for fitting and tensioning the toothed belt.

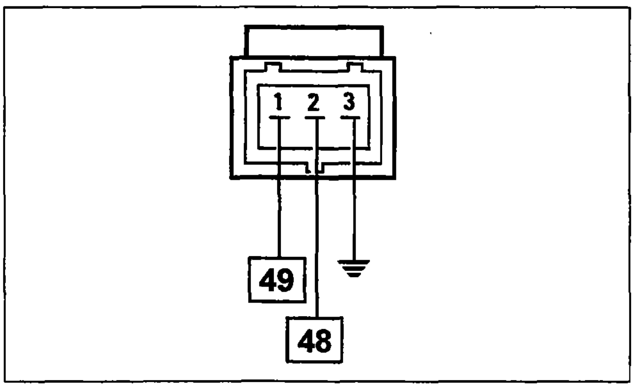
NOTE *The sensor does not require any type of adjustment.*

10.

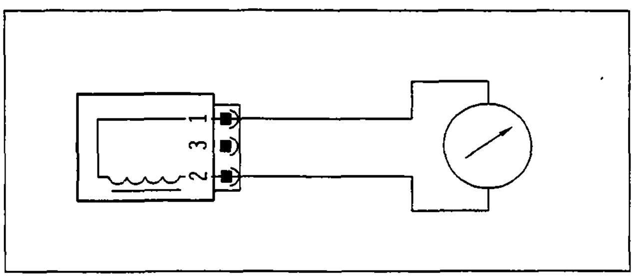


P4A22FJ01

1. Rpm sensor
2. Toothed pulley
3. Engine flywheel



P4A22FJ02



P4A22FJ03

RPM AND TDC SENSOR (0.281.002.102)

The sensor designed to detect the rpm and TDC is the inductive type, i.e. it operates by varying the magnetic field created by the teeth on a toothed pulley (flywheel) inside the crankcase and fixed to the rear counter-weight for the crankshaft. In this way the sensor is fixed to the crankcase and the checks and adjustments of the gap and the angular position are no longer necessary.

The teeth which pass in front of the sensor, alter the gap between the pulley and the sensor; the flow dispersed, which consequently varies, produces an alternating voltage which depends on the number of revs.

The flywheel has 58 teeth plus a space equivalent to the two missing teeth.

The reference defined by the space for the two missing teeth constitutes the basis for detecting the synchronism point (TDC).

For a more detailed description of the operating principle, refer to the Fuel System section for the 1581 16v engine.

Removing-refitting

Position the vehicle on a lift, then working from underneath the vehicle:

- Disconnect the electrical connector;
- undo the bolt fixing the sensor and remove it from its housing.

Wiring connector

The sensor is connected to the electronic control unit (pins 48 and 49) by means of twisted cables covered by a screened anti-interference outer casing connected to earth.

NOTE *The numbers indicate the corresponding control unit pins*

Checking the resistance

The resistance of the sensor can be measured by disconnecting the connector and connecting an ohmmeter to the sensor.

Resistance: 774-946 ohm at 20°C

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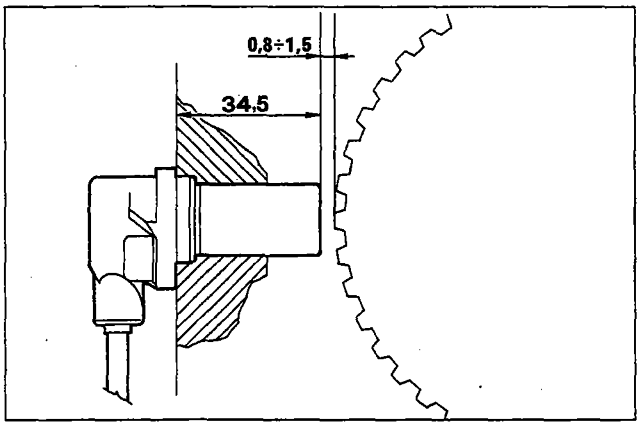
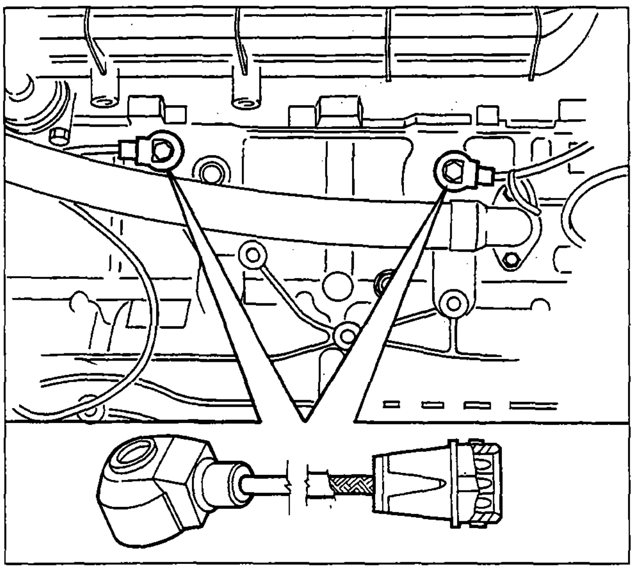


P4A23FJ01

When measuring the distance it is necessary to be sure that you are at right angles with the flywheel and by a tooth and not a hollow.

Checking the gap

The rpm and TDC sensor is fixed directly to the engine crankcase and therefore no adjustments of the gap or the angular position are required. If a problem is suspected it is possible to check the gap, proceeding as follows:
- remove the rpm and TDC sensor;
- check that the distance between the surface of the sensor and the flywheel tooth corresponds to the sum of the length of the sensor probe (34.5 mm) with the gap (0.8 - 1.5 mm).


P4A23FJ02

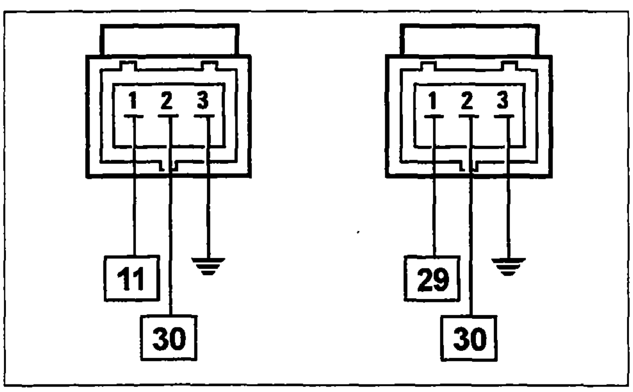
DETONATION SENSORS (0.261.231.095)

The detonation sensors are located in the monobloc below the inlet manifolds and between cylinders 1-2 and 4-5, respectively.

These sensors have a bush to prevent incorrect torque wrench tightening. **If they are replaced, do not place washers or shims between the engine crankcase and sensor contact surfaces.**

When there is engine knocking (detonation) vibrations of a certain frequency are created in the cylinder block/crankcase.

The phenomenon creates mechanical repercussions on a piezoelectric crystal which sends a signal to the control unit which, on the basis of this signal, makes provisions to reduce the ignition advance (from 3° to a maximum of 9.7°) until the phenomenon disappears. Afterwards the advance is gradually restored to the basic value.



P4A23FJ03

Wiring connector

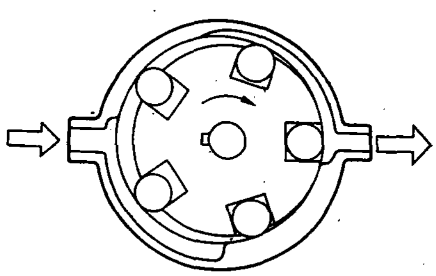
The numbers indicate the corresponding control unit pins.

Recovery

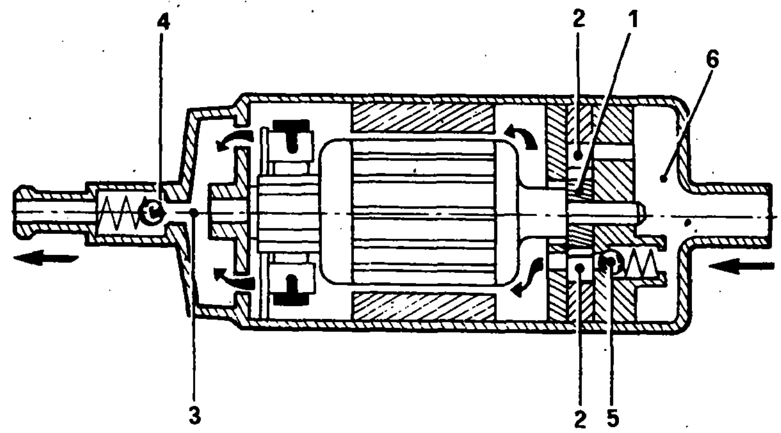
The ignition advance is calculated according to the temperature of the engine coolant and the temperature of the intake air.

ELECTRIC FUEL PUMP (0.580.453.408)

The submerged electric fuel pump is located inside the tank, housed in a mounting also containing the fuel gauge.
The electric pump is the cell type with rollers, operated by an electric motor with permanent magnet windings, immersed in the fuel.
A disc rotor (1) situated eccentrically in the pump casing contains the cells arranged along its circumference and metal rollers (2) which are thrust by centrifugal force against the outer race with the effect of ensuring the hydraulic seal.



Cross section of electric pump

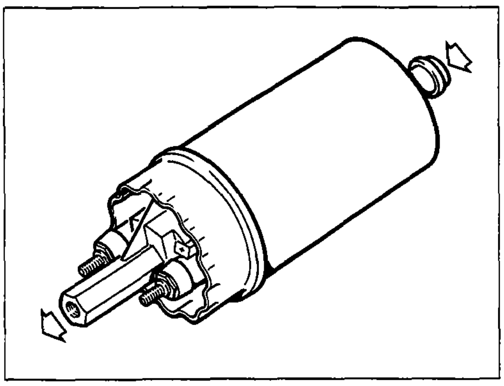


Longitudinal section of electric pump

P4A24FJ01

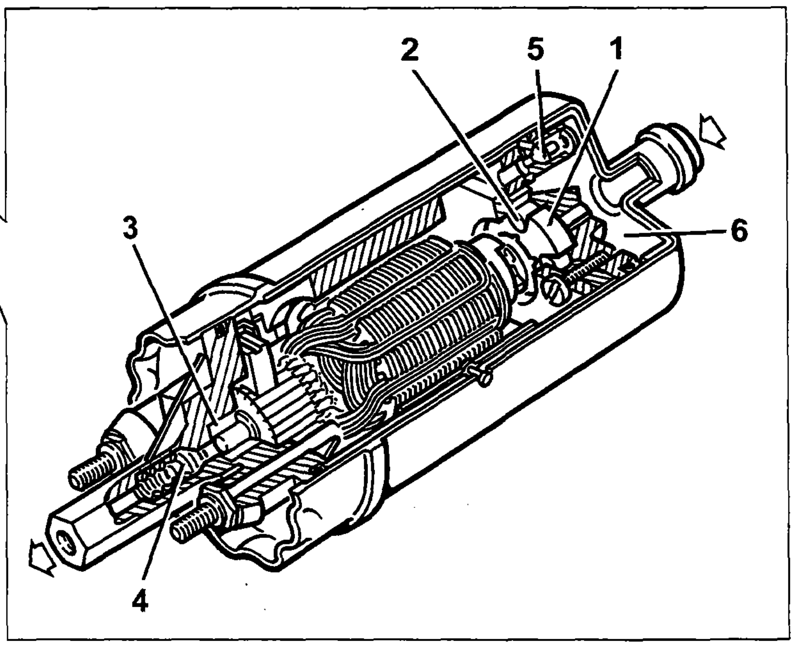
The fuel flows in the empty housings and is compressed in the supply duct (3). A one-way valve (4) prevents the supply pipe from being drained with the engine switched off.
An excess pressure valve (5) short circuits the supply in the inlet chamber (6) when the pressure exceeds 7.5 bar.
The electric pump starts to work when the ignition switch is turned to the starting position. When the starting stage is over, the electric pump continues to operate with the switch in the ON position, unless the engine speed goes below 225 rpm or the ignition switch is turned to the OFF position.
If the engine cuts out for any reason, with the ignition switch in the ON position, the operation of the pump is automatically interrupted, thereby creating a safety condition.

Diagram showing longitudinal cross section and external view of electric fuel pump



P4A24FJ02

NOTE *For the positioning and the removing-refitting procedures, refer to the fuel system section for the 1581 16v engine.*



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FUEL FILTER (A.450.024.262)

The fuel filter is fitted under the floor panel, on the fuel supply pipe. For the removing-refitting procedure, refer to the fuel system section for the 1581 16v engine.

FUEL SUPPLY MANIFOLD AND PRESSURE REGULATOR

The fuel supply manifold, which has the function of distributing the fuel to the injectors, is made from steel and is equipped with housings for the injectors and for the pressure regulator and the fuel inlet and outlet unions.

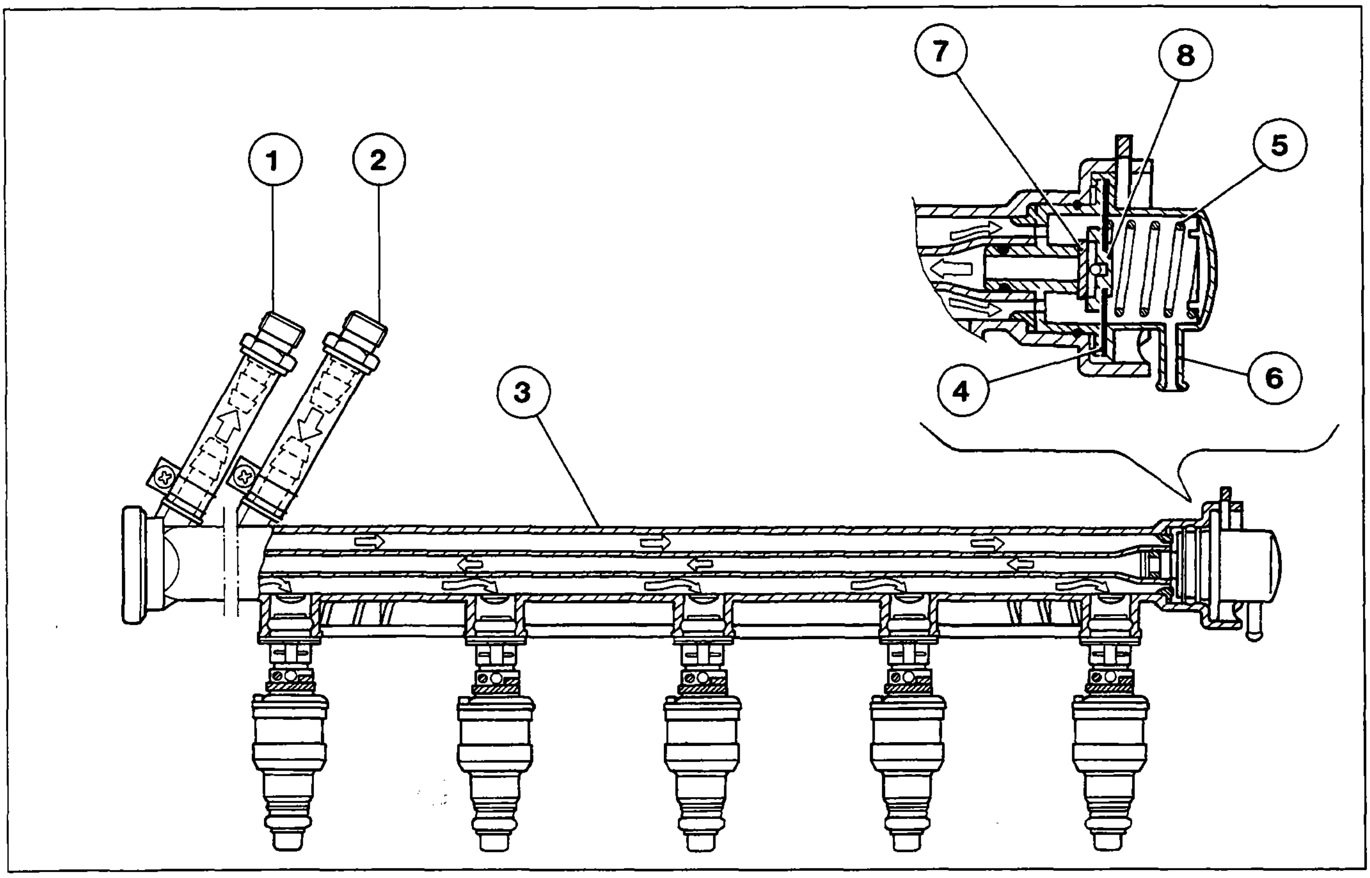
The fuel manifold is fixed to the inlet manifold by four brackets.

The pressure regulator is a necessary element in keeping the rise in pressure at the injectors constant. It is a differential diaphragm type device, regulated at a pressure of around 3 bar.

The pressure regulator is made up of a metal casing which houses a moving element comprising a metal casing (8) and a diaphragm (4) loaded by a spring (5). When the pre-set force, made up of the vacuum in the opposite part of the diaphragm and the spring (5) loading, is exceeded, the fuel thrust by the pump causes the opening of a valve (7) which allows the excess fuel to flow through the pipe to the tank (2).

The chamber housing the spring is in contact with the engine inlet manifold (6) (vacumm signal). The difference between the pressure of the fuel and the vacuum in the inlet manifold is kept constant for all engine operating conditions.

Longitudinal section of fuel supply manifold and pressure regulator



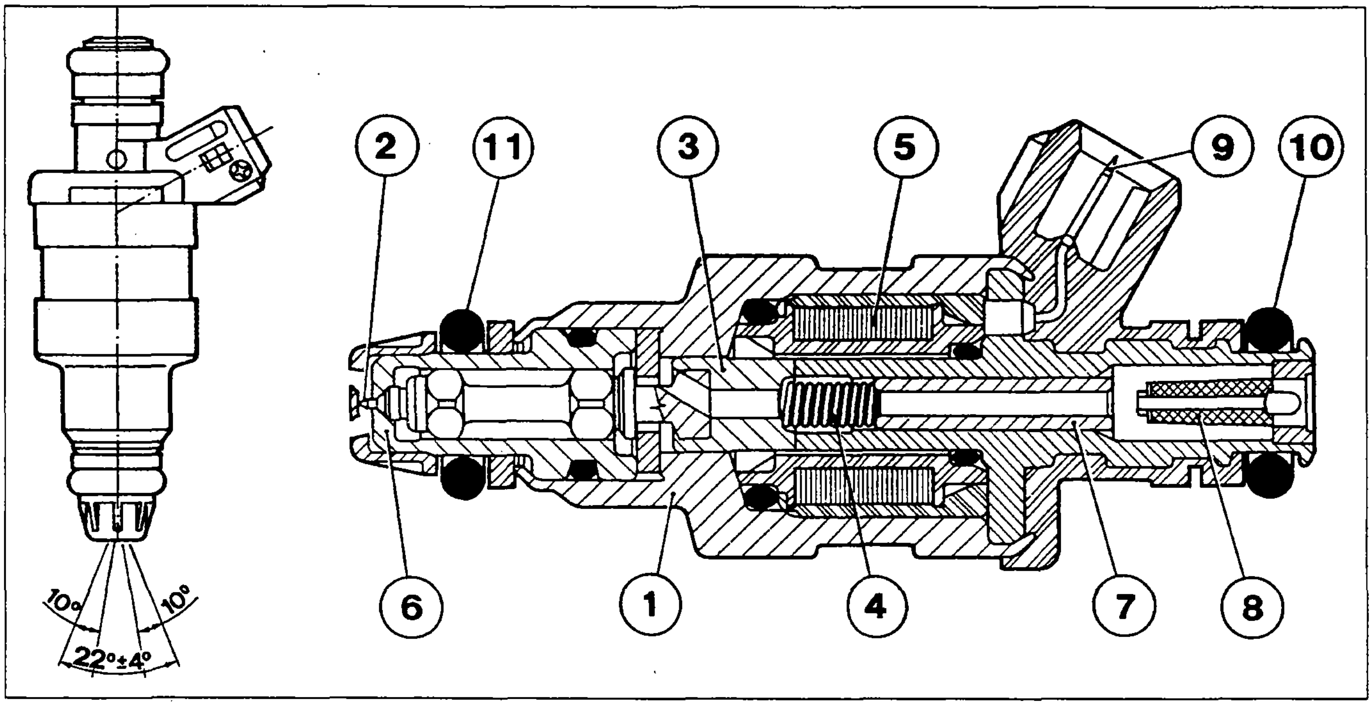
1. Fuel return union
2. Fuel arrival union
3. Injectors mounting and fuel manifold
4. Diaphragm with flow valve
5. Adjustment spring
6. Connection to inlet manifold
7. Flow valve
8. Metal casing

INJECTORS (0.280.150.443)

The double jet type injectors are fitted on the inlet manifolds, immediately before the inlet valve.
These injectors are specifically for engines with 4 valves per cylinder, making it possible to direct the jets towards the two inlet valves.

The jets of fuel at a differential pressure of 3 bar which leave the injector are instantly atomized forming two cones of about 10° each.

The operation of the injectors is the «sequential timed» type, i.e. the five injectors are operated according to the engine cylinder inlet sequence, whilst the supply can already start for each cylinder during the expansion stroke until the inlet stroke has already begun.
The injectors are fixed by the fuel manifold which presses them into their housings in the inlet manifolds. In addition they are anchored to the fuel manifold by means of «safety clips». Two rubber seals (10) and (11) ensure the seal for the inlet manifold and the fuel manifold.

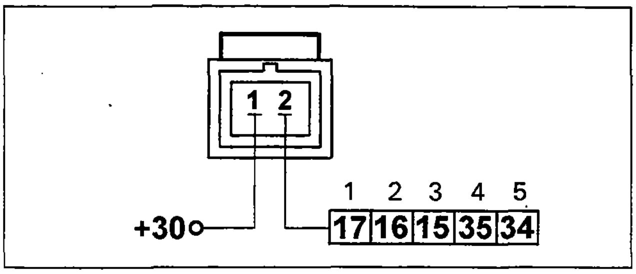


P4A26FJ01

1. Injector casing
2. Needle
3. Magnetic core
4. Coil spring
5. Winding
6. Injector nose
7. Adjustable spring pusher
8. Fuel filter
9. Electrical connection socket
10. Fuel seal
11. Vacuum seal

Wiring connector

NOTE *The numbers indicate the corresponding control unit pins arranged in the order of the number of cylinders.*

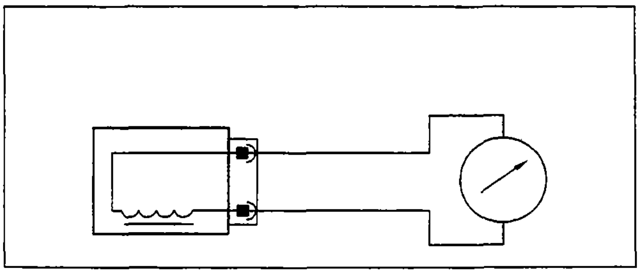


P4A26FJ02

Checking the resistance

The resistance of the injector can be measured by disconnecting the connector and connecting an ohmmeter as shown in the diagram.

Resistance value 16.2 ohm



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BUTTERFLY CASING

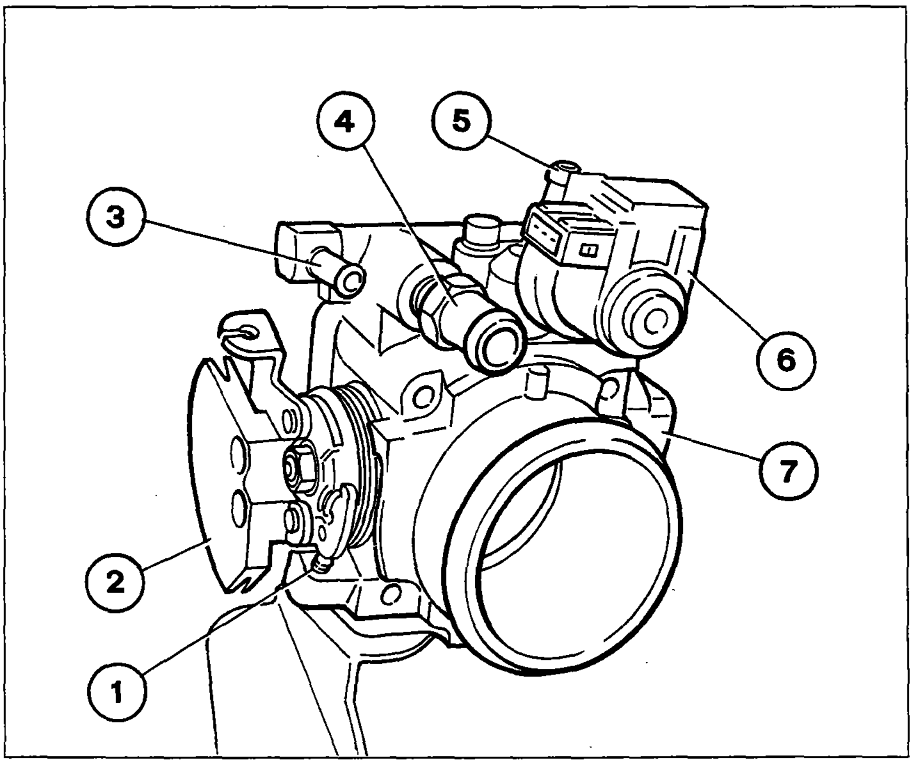
The quantity of air drawn in is determined by the opening of the butterfly located at the start of the inlet manifold. The butterfly casing is fixed to the inlet manifold by four bolts; the butterfly is operated by the accelerator pedal by means of linkage which produces an opening system where in relation to the pedal travel, small butterfly opening angles are produced with the pedal slightly pressed and greater opening angles are produced with the pedal more depressed.

The air required to support the engine during idling and in load conditions with the butterfly valve closed is regulated and by-passed exclusively by the engine idle speed actuator.

A special screw (1), makes it possible to adjust the butterfly closure to prevent interference with the surrounding duct; this screw is not used for adjusting the idle as it is adjusted by fluxing in production and should not be tampered with under any circumstances.

The flow of engine coolant arriving from the thermostat flows through the inlet and outlet ducts (3) and (5) in the area of the butterfly valve has the aim of preventing condensation and the formation of ice which could be produced in particular low external temperature and/or high humidity conditions.

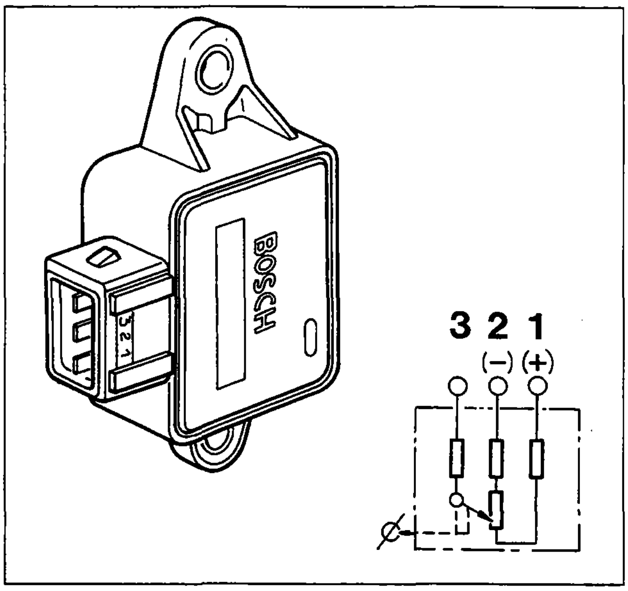
The gases which flow from the engine crankcase are drawn into the inlet manifold downstream of the butterfly through the PCV valve (4).



P4A27FJ01

1. Butterfly valve adjustment and anti-tamper screw **(not to be tampered with)**
2. Butterfly opening control levers
3. Attachment for engine coolant supply pipe
4. Attachment for engine crankcase vapour recovery and recirculation pipe
5. Attachment for engine coolant return pipe
6. Engine idle speed actuator
7. Butterfly valve position sensor

10.



P4A28FJ01

BUTTERFLY VALVE POSITION SENSOR (0.280.122.001)

The sensor is made up of a potentiometer inserted in a plastic container which has two fins, in which there are two openings WITHOUT SLOTS which have the function of ensuring the anchorage and the positionining of the sensor in relation to the butterfly valve.
A three pin socket in the container guarantees the electrical connection with the electronic control unit.
During operation, the injection/ignition control unit provides the potentiometer with a supply of 5 Volts at pins (1) and (2).
There is a voltage at pin 3 which is inversely proportional to the opening position of the butterfly valve. According to the voltage sent by pin 3 the control unit recognizes the opening condition for the butterfly valve and suitably corrects the mixture strength.
With the butterfly closed an elecrical voltage signal of around 0.5 Volts reaches the control unit which recognizes the idle and cut off conditions (distinguishing them on the basis of the engine speed).
The potentiometer automatically recognizes the butterfly idle position by means of a "self--adjustment" function. This eliminates the adjustment operations and makes it possible to allow for any wear which may occur for the butterfly closure position.

Recovery

If the sensor fails, the control unit establishes the following parameters:

Butterfly opening angle = 10°

idle state: air flow rate < 12.8 m3/h;

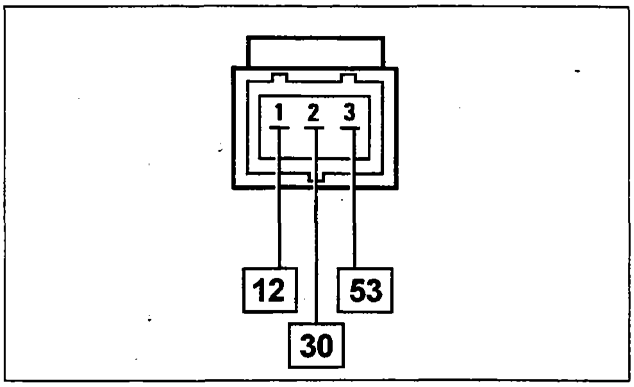
exit from idle state: air flow rate > 8 m3/h;

full load state: engine load > 6,5 ms and simultaneous speed > 2000 RPM;

exit from full load state: engine load < 6,5 ms or speed < 2000 RPM.

Additional provisions

The engine idle speed gradual decrease (dashpot) and idle self-adjustment strategies are stopped.

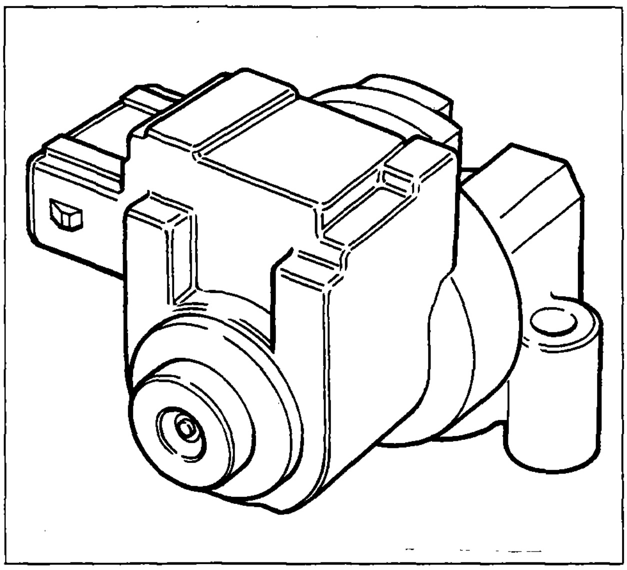


P4A28FJ02

Wiring connector

NOTE *The numbers indicate the corresponding control unit pins*

Print no. 506.670


P4A29FJ01

ENGINE IDLE SPEED ACTUATOR (0.280.140.553)

It is composed of an electric motor which, by opening the flow of supplementary air (in parallel to the flow from the butterfly with the accelerator released) in the butterfly casing more or less, automatically keeps the engine idle speed constant, irrespective of the load conditions (additional consumers switched on or not, engine hot or cold, etc.).
The opening caused by the rotation of the distributor is controlled by electrical' impulses processed by a special section in the injection control unit which causes the distributor to rotate in one direction or the other depending on the speed at which the engine is rotating.

Recovery

If the actuator fails, the control unit activates different recovery strategies depending on the butterfly valve opening angle.

Recovery 1: valve in recovery position, near the idle air flow rate for:
- short circuit battery V at opening or closing winding or opening and closing winding;
- open circuit at opening or closing winding or at opening and closing winding
- short circuit battery V at opening winding and open circuit at opening winding
- short circuit battery V at closing winding and open circuit at opening winding.

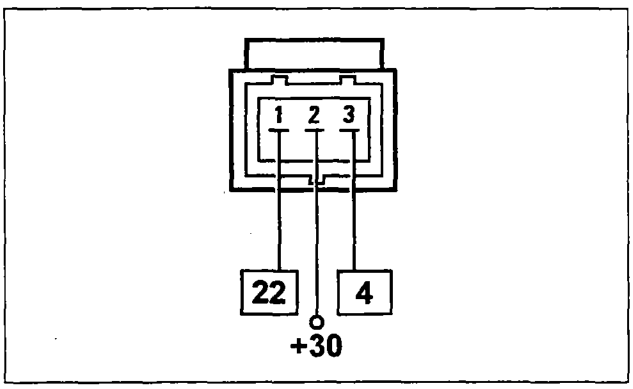
Recovery 2: valve open 0% for:
- short circuit battery V at opening winding and short circuit to earth at closing winding;
- open circuit at opening winding and short circuit to earth at closing winding.

Recovery 3: valve open 50% for:
- short circuit to earth at opening winding or closing winding or opening and closing

Recovery 4: valve open 100% for:
- short circuit battery V at closing winding and short circuit to earth at opening winding;
- open circuit at closing widing and short circuit to earth at opening winding.

Additional provisions

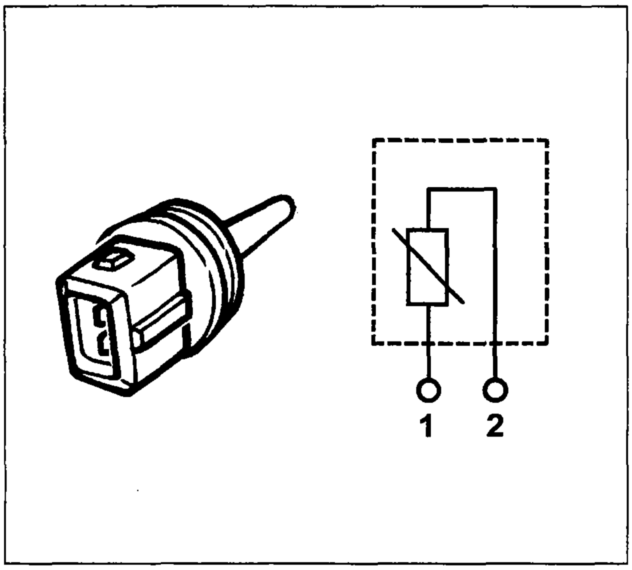
Locking the idle self-adjustment at the current values and locking the idle control.



P4A29FJ02

Wiring connector

NOTE *The numbers indicate the corresponding control unit pins.*

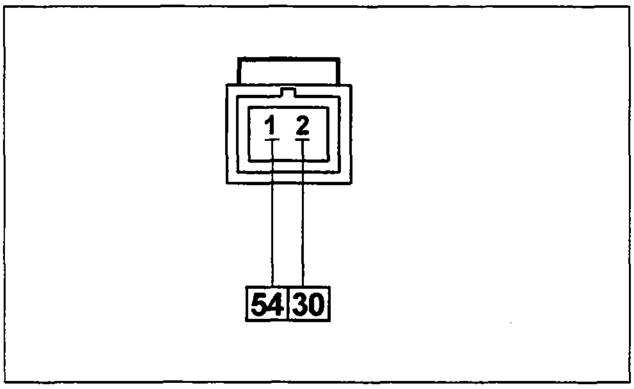


P4A30FJ01

AIR TEMPERATURE SENSOR (0.280.130.073)

The intake air temperature sensor is, in this version, separate from the air flow meter: it is made up of an NTC sensor (Negative Temperature Coefficient) where the electrical resistance decreases as the temperature increases.

Since the control unit input circuit is designed as a tension divider, this tension is divided between a resistance in the control unit and the sensor NTC resistance. As a result the control unit is capable of evaluating the variations in the resistance of the sensor through the changes in voltage and of thereby obtaining the temperature information.



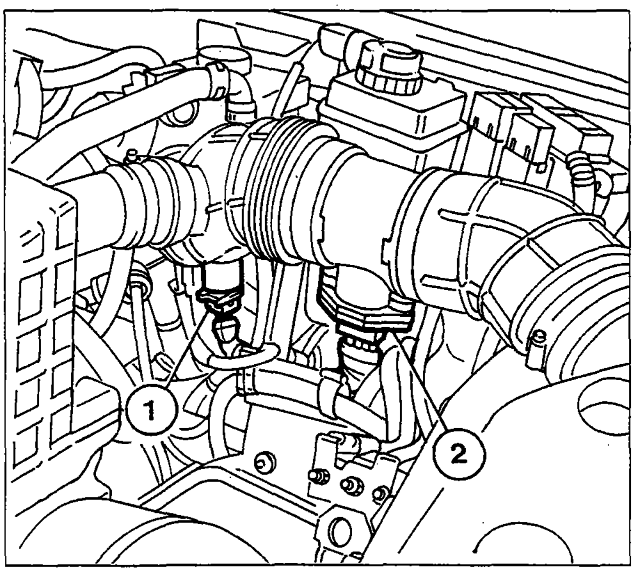
P4A30FJ02

Recovery
If, 3 minutes after starting, the control unit detects a temperature (air T) < -35 °C or > 130 °C for 30 seconds, it assumes air T=20.4 °C as a fixed parameter

Additional provisions
Locking the self-adjustment of the mixture strength at current values

Wiring connector

NOTE *The numbers indicate the corresponding control unit pins.*



P4A30FJ03

1. Air temperature sensor
2. Flow meter

FLOW METER (0.280.217.111)

The air flow meter is the "heated film" type; the operating principle is based on a heated diaphragm which is placed in a measuring duct through which the intake air entering the engine flows.

The film diaphragm is kept at a constant temperature (~120 °C above the temperature of the air) by the heating resistance in contact with it.

The mass of air which passes through the measuring duct tends to remove heat from the diaphragm therefore, to maintain the latter at a constant temperature, a current must flow through the heating resistance; this current is measured by a suitable Wheatstone bridge.

The current measured is therefore proportional to the mass of air flow.

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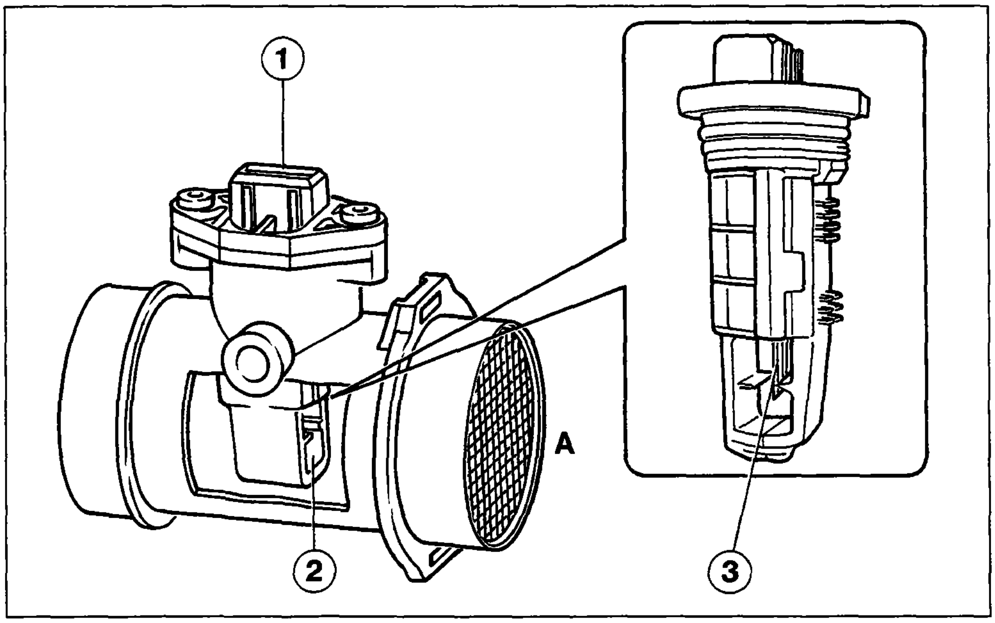


P4A31FJ01

1. Connector
2. Measuring duct
3. Hot film sensor

A= Air intake

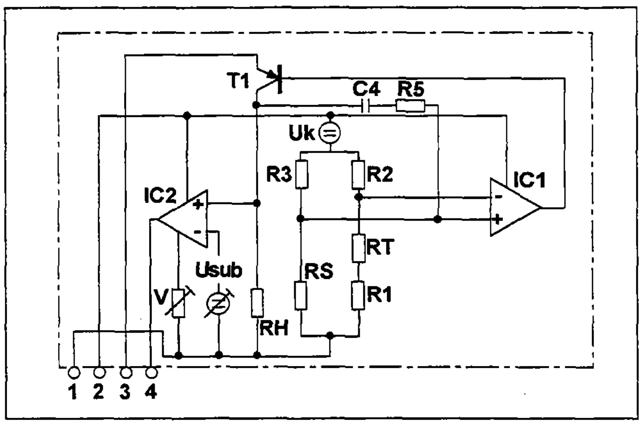
NOTE *This flow meter directly measures the mass of air (and not the volume as on previous versions) thereby dispensing with the problems of temperature, altitude, pressure, etc.*

Description of the operation

The Wheatstone bridge (made up of R3, R2, Rs, Rt+R1) is balanced when the Rs is at about 120 °C above the temperature of the air. The air which passes through the diaphragm removes heat from the Rs, therefore the bridge is unbalanced. This situation is detected by the circuit at IC1 which controls the transistor T1 in a manner which is proportional to the bridge imbalance and as a result more current is passed through Rh to heat Rs and therefore restore the balance for the bridge. The circuit IC2 measures the current which passes through Rh. This current makes it possible to keep the bridge balanced and therefore proportional to the mass of air which passes through the air flow meter.

Recovery

In the absence of a simultaneous error at the butterfly potentiometer, the idle engine load is calculated according to the speed if the engine is idling, otherwise a fixedengine load is allocated. If there is a simultaneous error at the butterfly potentiometer, the engine load and advance values are allocated according to a table depending on the number of revs.



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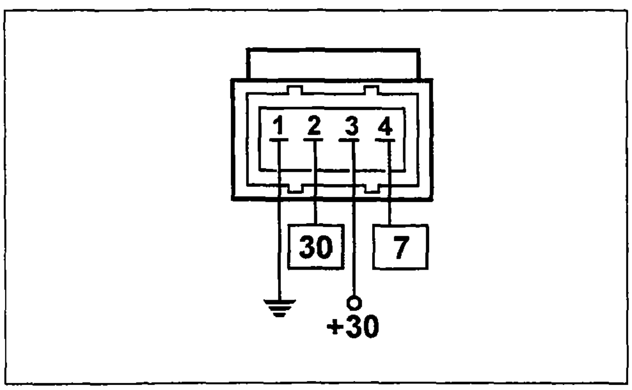


P4A31FJ03

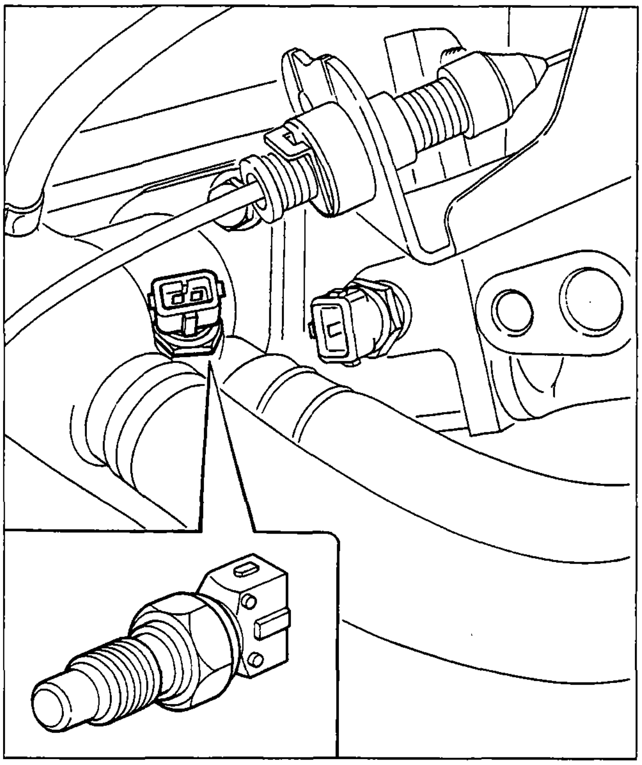
Additional provisions

Locking the self-adjustment of the mixture strength and idle at current values.

Wiring connector

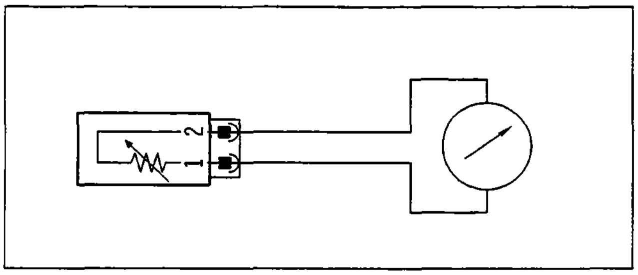
NOTE *The numbers indicate the corresponding control unit pins.*

COOLANT TEMPERATURE SENSOR (0.280.130.026)



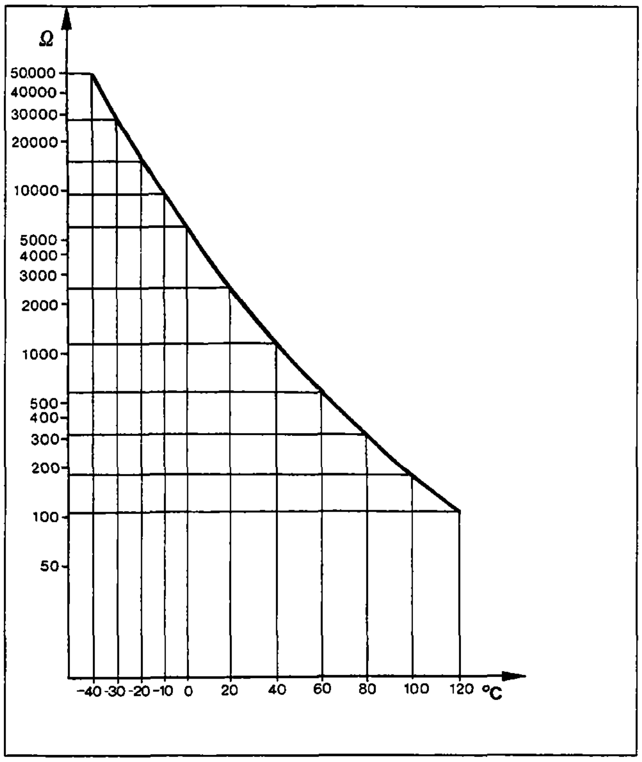
P4A32FJ01

The sensor is fitted near the thermostat casing with the sensitive part in contact with the coolant. It is made up of a brass casing which protects the actual resistive element comprising an NTC (Negative Temperature Coefficient) «thermistor», where the electrical resistance of the sensor decreases as the temperature increases).
It provides the control unit with a voltage which varies according to the temperature of the engine in order to correct the information concerning the air flow rate from the flow meter so that according to the signal received by the sensor the control unit can control the injection of the fuel for a greater length of time, providing the necessary enrichment when the engine is operating at temperatures below operating temperature.



P4A32FJ02

The graph below shows the sensor characteristics which can be measured by disconnecting the connector and connecting an ohmmeter as shown in the diagram at the side.



P4A32FJ03

Recovery

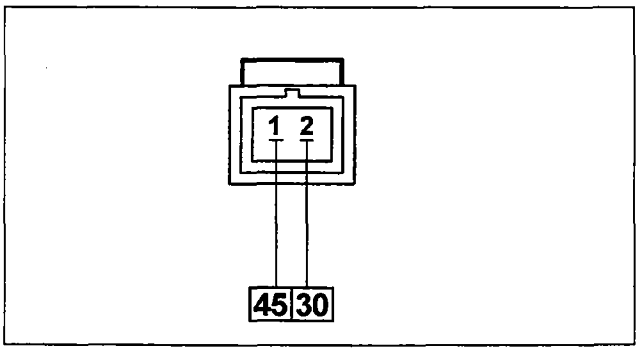
If air T ⩽ 19.9 °C, it is assumed that engine T = air T for three minutes, then it is assumed that engine T = 80 °C. If air T ⩾ 19.9 °C, it is assumed that engine T = 80 °C immediately.

Additional provisions

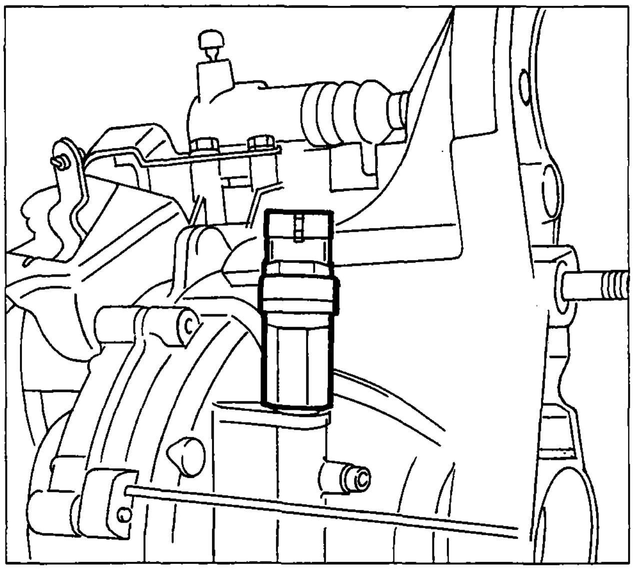
Locking the self-adjustment of the mixture strength and idling at current values.

Wiring connector

The numbers indicate the corresponding control unit pins



P4A32FJ04



P4A33FJ01

SPEEDOMETER SENSOR

The speedometer sensor (vehicle speed sensor) it is composed of a Hall effect sensor and is located at the differential outlet.
The sensor transmits a signal to the control unit where the frequency varies according to the speed of the vehicle.
The control unit uses this information to improve the management of the engine idle adjustment actuator and for the CUT-OFF strategy.

The speedometer sensor signal is also processed to calculate and memorize the mileage travelled in the control unit; this information can be read using the Fiat/Lancia Tester.

PHASE TRANSFORMER

In order to achieve a good compromise between the high performance in terms of power at high speeds and good torque at low speeds, a phase transformer (electronically and hydraulically operated) is fitted for the inlet camshaft.

This device makes it possible to alter the timing diagram (inlet phase) according to the engine load conditions; this parameter is processed by the MOTRONIC control unit on the basis of the electrical signals received by the air flow meter and the rpm sensor and sent to the phase transformer solenoid valve.

The construction of the device involves a main assembly fitted on the inlet camshaft which has the task of altering the angular position of the actual shaft in relation to the drive pulley.

In addition there is a valve, operated by an electro-magnet, both of which are on the inlet manifold and connected hydraulically to the main assembly by appropriate ducts.

The operating principle is as follows:

- with the temperature of the coolant below 40 °C and when the engine is idling or the speed exceeds 4800 rpm, the electro-magnet (1) is de-energized, therefore the valve (2) thrust by the opposing spring (3) remains raised not allowing the oil which is arriving from the duct (A) to reach the transformer.
  In this case the timing of the inlet valves remains unaltered.
  With the temperature of the coolant above 40 °C and with the engine speed above idle and below 4800 rpm with the butterfly angle greater than about 8°, the electro-magnet (1) is energized, thereby thrusting the valve (2) downwards. In this position the oil, coming from the duct (A), enters the piston chamber (B) and from here flows via a special opening into the duct (C) inside the latter.
  The oil can only leave the above mentioned duct via the upper port (in contact with duct (D) supplying oil to the transformer) because with the valve (2) lowered, the lower port is not in contact with the discharge duct (E).

  The oil reaches the chamber (G) through ducts (D) and (F) moving the piston (4) axially towards the engine; because this piston has helical teeth on the outside this axial movement causes it to rotate in a clockwise direction (as seen from the timing side).

  This rotation is transmitted, by means of a straight toothed splied profile, to the pinion (5) which, bolted onto the threaded end of the camshaft (6), transmits the rotation to the shaft, thereby varying the timing of the inlet valves by an advance of 9°.

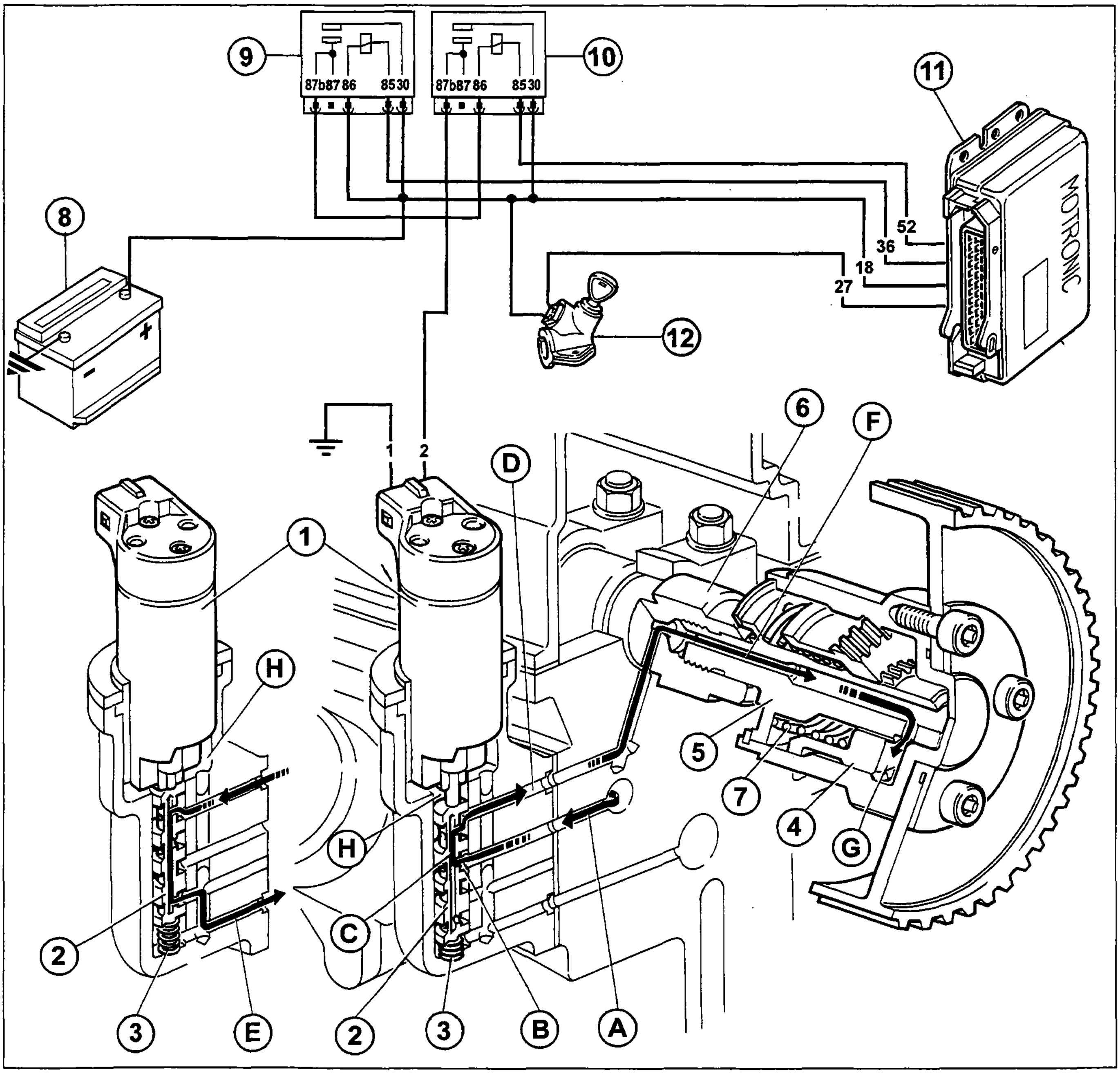
When the electro-magnet is de-energized, the valve (2) returns to the original position, interrupting the flow of oil under pressure to the chamber (G), but allowing the return of the oil to the exhaust, thanks to the force of the opposing spring (7).

10.

An additional duct ensures the lubrication of the bearing on the camshaft even when the device is not activated.
The oil which reaches the chamber (H) for the electro-magnet is discharged through the drainage duct (E).

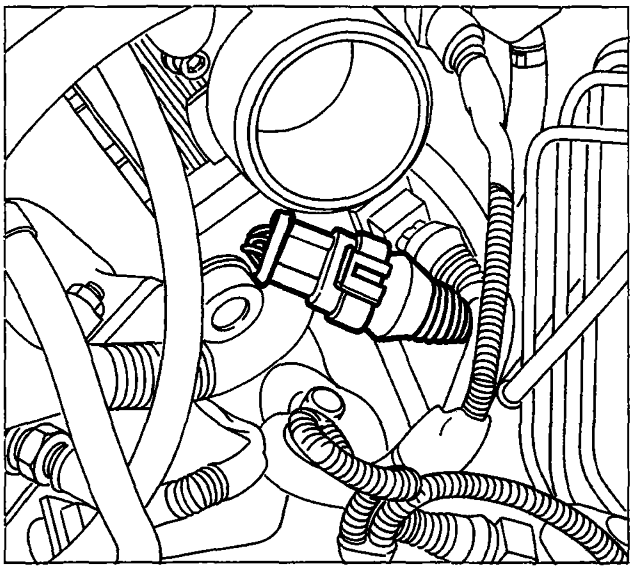
Recovery

If the solenoid valve fails, the final stage (driver) in the control unit is deactivated.



1. Solenoid valve
2. Valve
3. Valve spring
4. Piston
5. Pinion
6. Camshaft end section
7. Piston spring
8. Battery
9. Injection/ignition system relay
10. Phase transformer solenoid valve relay feed
11. Injection/ignition control unit
12. Ignition switch

Print no. 506.670



P4A05DX04

LAMBDA SENSOR (0.258.003.466)

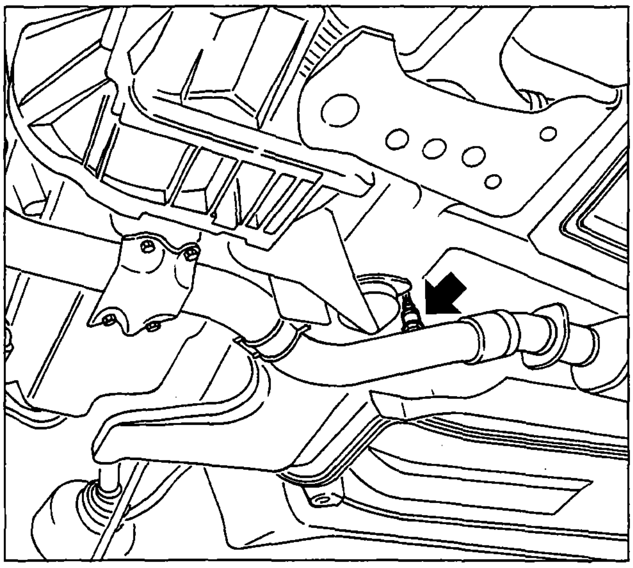
To meet the strict legislation governing the emission of harmful residues from internal combustion engines which require increasingly more precise metering of the air/fuel mixture, the vehicle has been equipped with a heated Lambda sensor with four wires which measures the oxygen content of the exhaust gases. For a complete description of the Lambda sensor, refer to the Fuel System section for the 1581 16V engine.

The sensor can be rapidly put out of action by even the slightest amounts of lead in the fuel.

Removing-refitting

- Position the vehicle on a lift.
- Disconnect the negative lead from the battery.
- Disconnect the electrical connection under the butterfly casing.
- Raise the vehicle.
- Remove the Lambda sensor from its housing.
- When tightening, do not exert force on the component or it will be irreparably damaged.

If the Lambda sensor is being replaced, when refitting smear anti-seize grease on the threaded part (e.g. Bosch VS 14016- FT).



P4A35FJ02

Tightening torque 5 - 6 daNm

Recovery

The Lambda data is ignored (open loop) if the sensor voltage is> 1,099 V or between 0.400 and 0.518 V for more than 2.55 s.

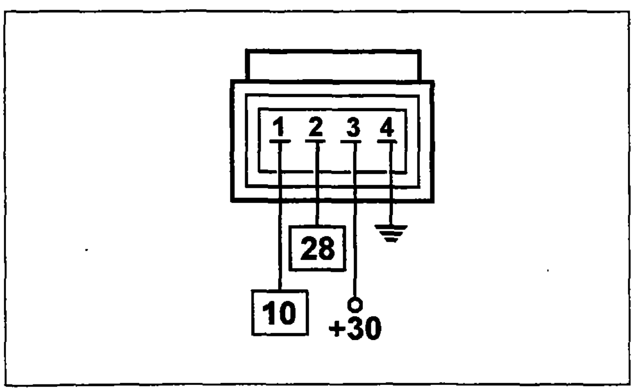
Locking of self-adjustment of mixture strength for sensor voltage < 0,0879 V for more than 2.55 s.

Open loop is considered the maximum Lambda integrator value (FR) for the last good sensor voltage reading < 0.0879 V and simultaneously FR=1.4.

Locking of FR at limit value reached for FR > 1.25 or < 0.75 for at least 15 s.

Wiring connector

The numbers indicate the corresponding control unit pins.



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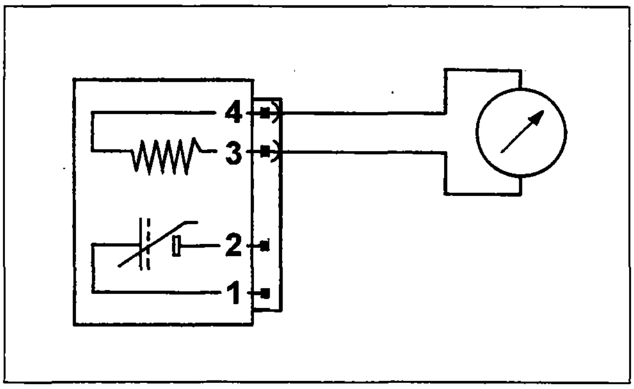
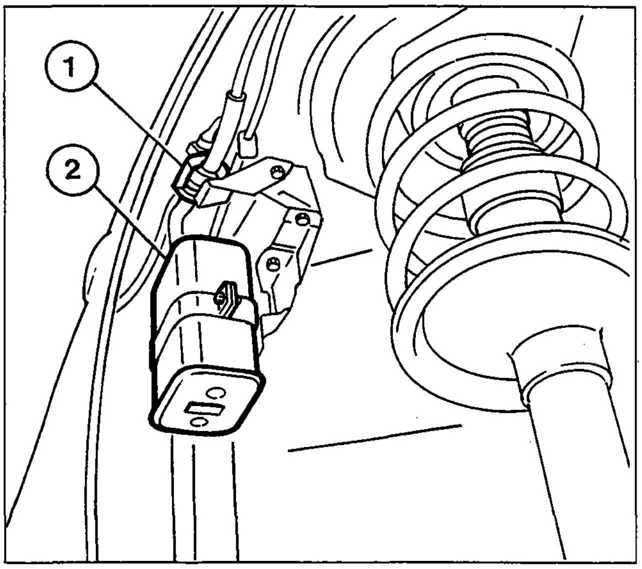
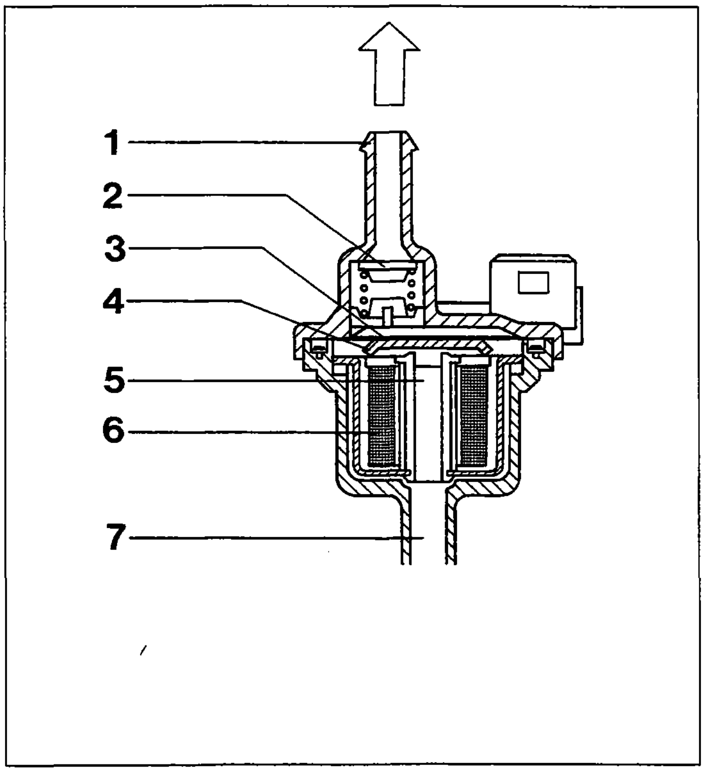


P4A36FJ01



P4A36FJ02



P4A36FJ03

Checking the resistance

The resistance of the sensor heater can be measured by disconnecting the connector and connecting an ohmmeter as shown in the diagram.

Resistance: 4.5 ± 0.5 ohm at 20 °C

CHARCOAL FILTER AND FUEL VAPOUR CUT OUT SOLENOID VALVE

The charcoal filter and the solenoid valve are located in the right wheel arch.

For the description of the charcoal filter refer to the Fuel System section for the 1581 16V engine.

1. Vapour cut out solenoid valve
2. Charcoal filter

Vapour cut out solenoid valve (0.280.142.300)

The function of this valve is to control the quantity of petrol vapours drawn in by the active charcoal filter and directed to the inlet manifold by means of the electronic control unit.

If this valve is not supplied it is in the open position; if the key is turned to the ON position, it closes preparing for operation. In effect, if energized the solenoid valve (6) attracts the shutter (4) which, overcoming the spring (3) loading, closes the port (5) preventing the flow of petrol vapours.

The operation is controlled by the electronic control unit as follows:

- during starting the solenoid valve remains closed, preventing the petrol vapours from excessively enriching the mixture;
- when the engine has been started up, the electronic control unit sends a signal to the solenoid valve which modulates the opening.

In this way the control unit controls the quantity of petrol vapours sent to the inlet, thereby preventing considerable variations (above all during idling) in the mixture strength.

NOTE *The solenoid valve must be fitted correctly: the arrow on its casing should be facing the vacuum inlet on the inlet manifold.*

1. Inlet union
2. One-way valve
3. Spring
4. Shutter
5. Outlet port
6. Solenoid valve
7. Outlet union

Print no. 506.670

Removing-refitting

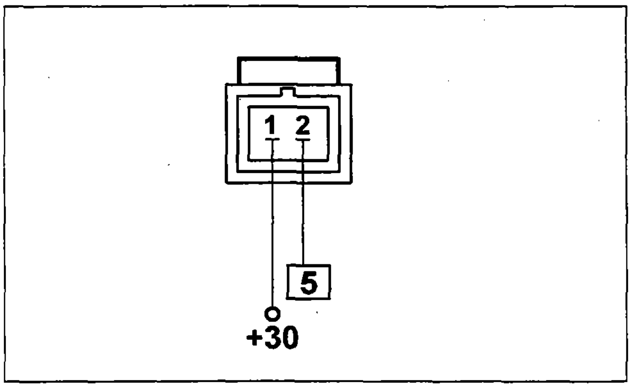
The procedure is valid for both the charcoal filter and the vapour cut out solenoid valve. .

- Raise the vehicle;
- remove the right front wheel;
- remove the rear liner for the right front wheel arch;
- undo the bolt which fixes the component concerned to the mounting bracket;
- remove the electrical connection and the pipes connected;
- remove the component concerned.

Recovery

Locking self-adjustment of mixture strength.

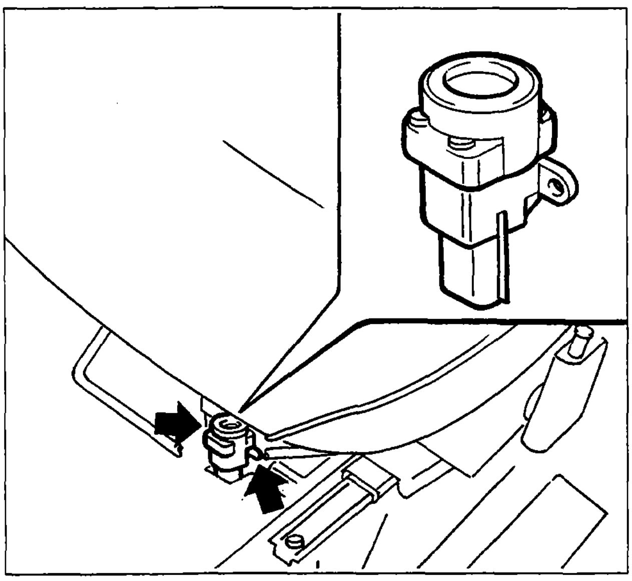
Locking the self-adjustment of the fuel anti-evaporation system.



P4A37FJ01

Wiring connector

NOTE *The numbers indicate the corresponding control unit pins.*



P4A48CJ02

INERTIA SWITCH

In order to increase the degree of safety for the occupants of the vehicle in the case of an impact, the vehicle is equipped with an interia switch located inside the passenger compartment, under the driver's seat.

This sensor reduces the possibility of fire (as a result of fuel escaping from the injection system) by de-activating the electric pump which supplies the injection circuit.

For the complete description and the removing-refitting procedure, refer to the Fuel System section for the 1581 16V engine.

After even a slight impact, if there is a smell of fuel or there are leaks from the fuel system, do not turn the switch back on, but search for the problem and correct it to prevent the risk of fire.

MULTI-PURPOSE VALVE AND SAFETY AND VENTILATION VALVE

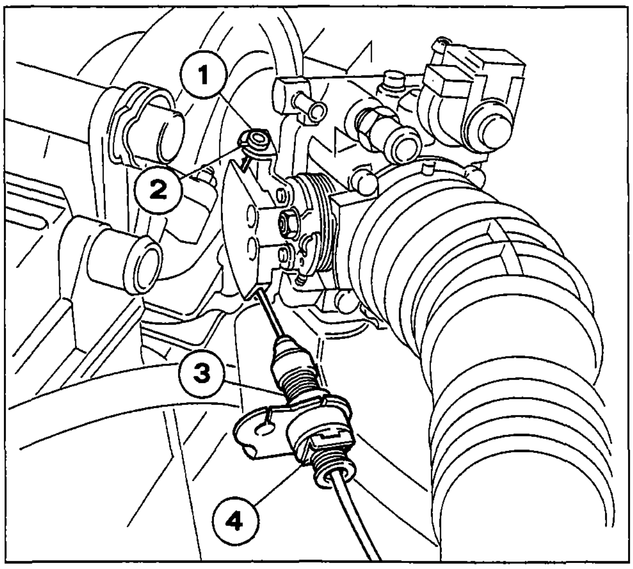
These valves belong to the fuel vapour anti-evaporation and recirculation system. For their description refer to the Fuel System section for the 1581 16V engine.

CHECKS/ADJUSTMENTS AND REPAIR OPERATIONS TO BOSCH MOTRONIC M 2.10.4 INJECTION/IGNITION SYSTEM APART FROM FAULT DIAGNOSIS WITH THE FIAT/LANCIA TESTER

WHEN WORKING ON A VEHICLE EQUIPPED WITH A MOTRONIC INJECTION/IGNITION SYSTEM THE FOLLOWING PRECAUTIONS MUST BE OBSERVED:

- *do not start up the engine with the electrical connection terminals not properly connected or slack at the battery poles;*
- *never use a rapid battery charger to start the engine;*
- *never disconnect the battery with the engine running;*
- *to rapidly charge the battery it must be disconnected first from the vehicle's electrical system;*
- *if the vehicle is going in a drying oven after painting where the temperatures are in excess of 80 °C, it is necessary to remove the injection/ignition electronic control unit;*
- *never attach or disconnect the electronic control unit multiple connector with the ignition switch in the ON position;*
- *always disconnect the negative battery lead before carrying out electrical welding on the vehicle.*

Remember that this system has a memory which is always supplied (stand-by memory) wherethe self-adjustment values are memorized. The operation of disconnecting the battery results in this information being lost but it can be acquired again after a certain mileage; this operation should therefore be restricted.



P4A38FJ01

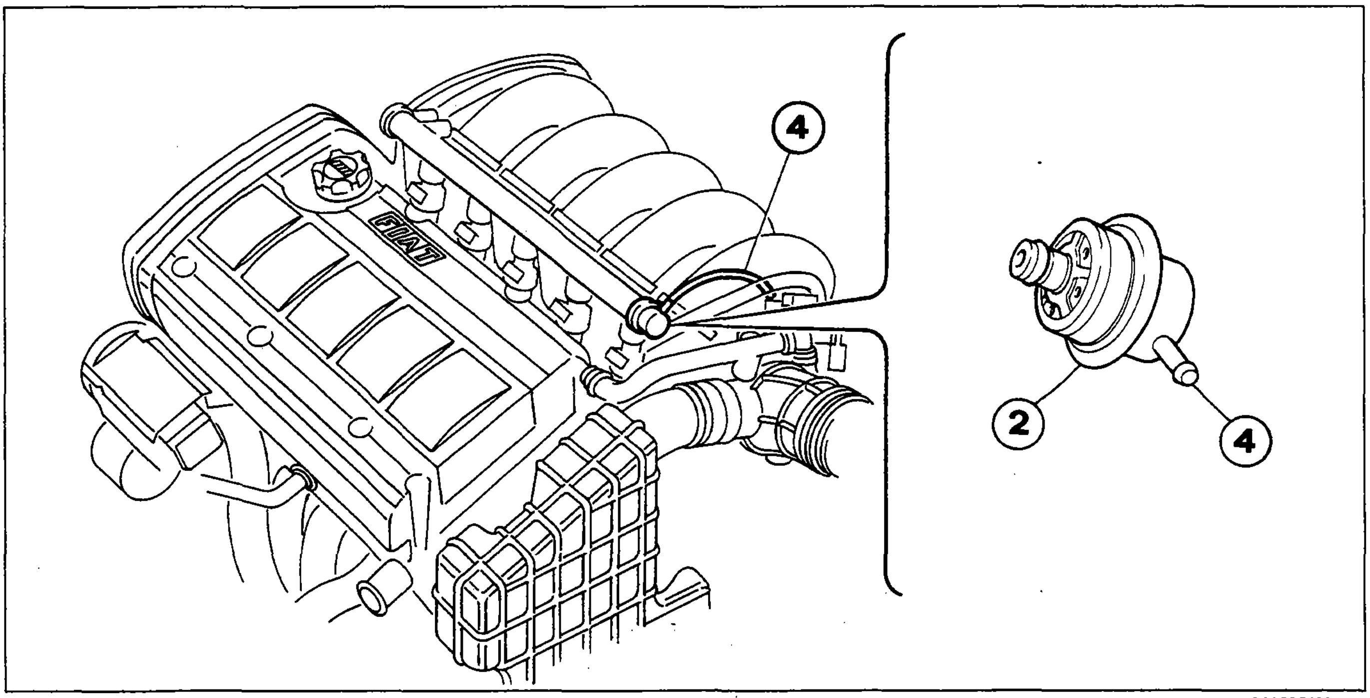
ADJUSTMENT OF ACCELERATOR CONTROL CABLE

The adjustment of the accelerator cable is obtained by moving the clip (4) in the different bush (3) splines.

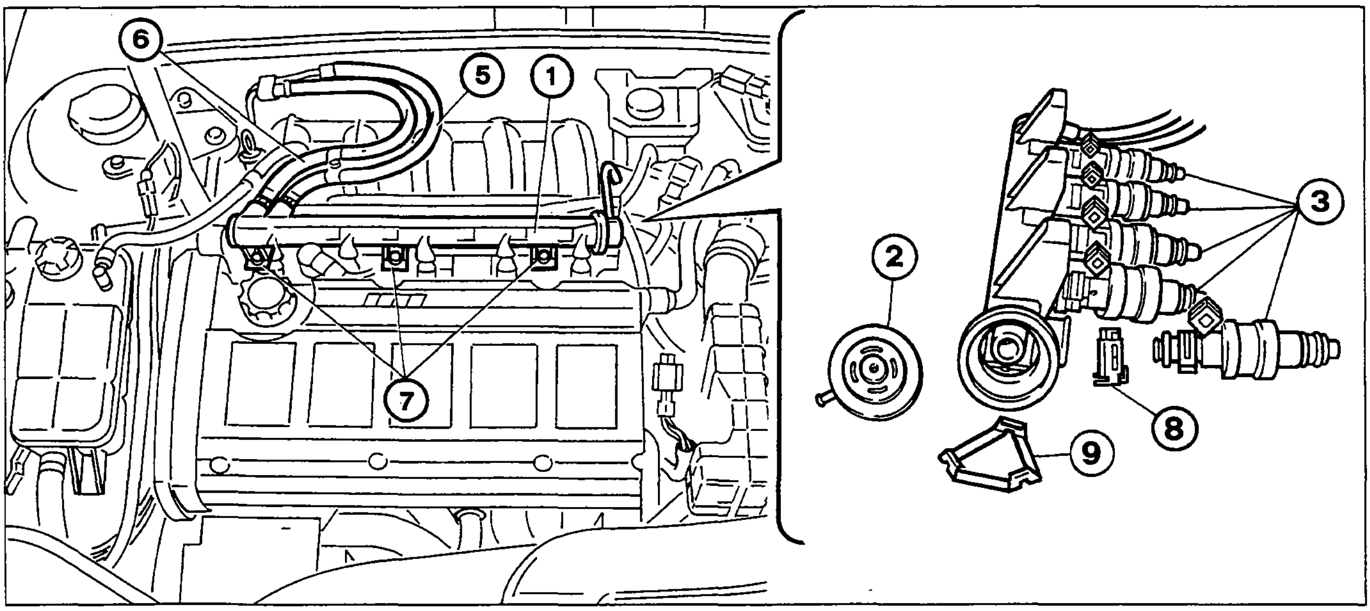
Position the clip in such a way that the head (1) of the accelerator cable freely enters the slot (2) without altering the engine idle speed.

Print no. 506.670

REMOVING-REFITTING FUEL MANIFOLD COMPLETE WITH INJECTORS AND PRESSURE REGULATOR



P4A39FJ01



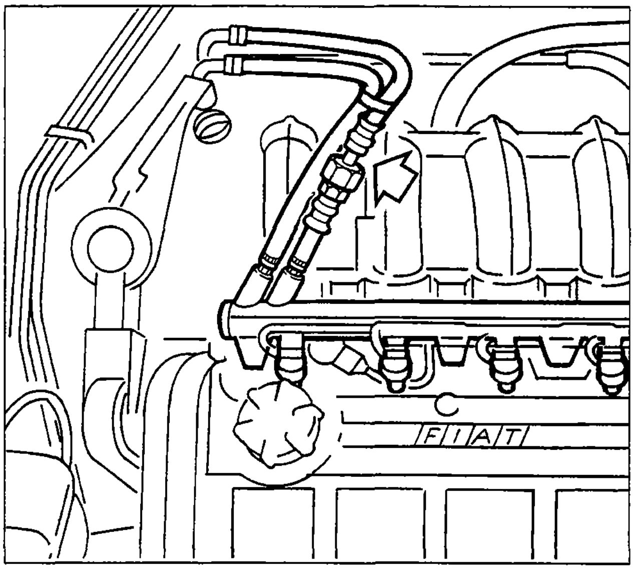
P4A39FJ02

Proceed as follows:

- Disconnect the fuel supply pipe (5) from the union.
- Loosen the band for the return pipe and disconnect the flexible rubber pipe from the rigid pipe.
- Disconnect the electrical connectors from the injectors.
- Undo the fixing bolts (7).
- Extract the injector manifold assembly..
- To remove the injectors from the fuel manifold, remove the clip (9).

1. Fuel manifold
2. Fuel pressure regulator
3. Injectors
4. Vacuum pick up from engine inlet manifold
5. Fuel supply pipe from the electric pump
6. Fuel return pipe to the tank
7. Bolts fixing fuel manifold and injectors
8. Pressure regulator clip on fuel manifold
9. Injector clip on fuel manifold

10.



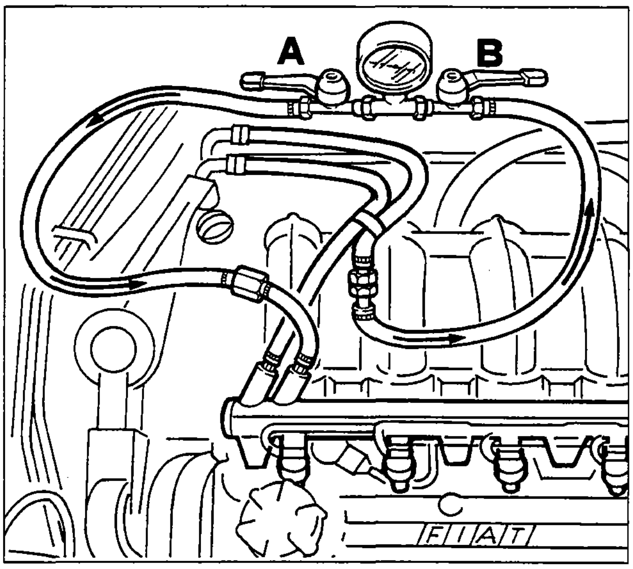
P4A40FJ01

CHECKS ON FUEL SUPPLY CIRCUIT

1st Test

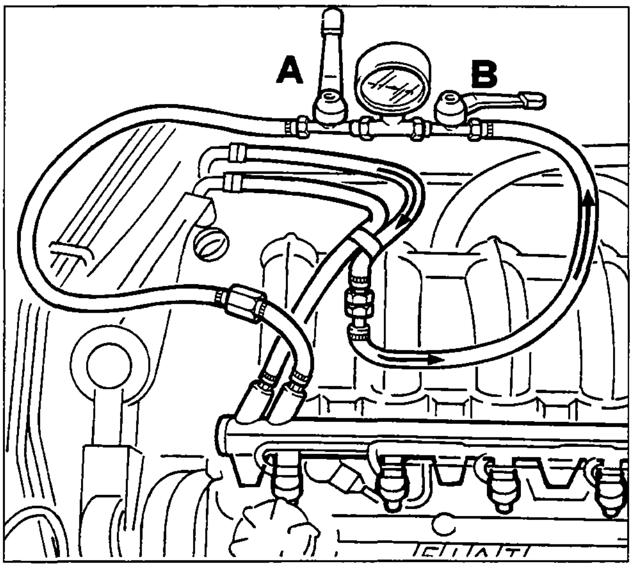
Checking fuel regulation pressure

- Disconnect the fuel supply pipe to the manifold from the union shown by the arrow;
- Place pressure gauge 189589000 with both taps A and B in the open position between the end of the pipe disconnected and the fuel manifold;



P4A40FJ02

- operate the electric fuel pump with the engine switched off with the help of the Fiat/Lancia Tester activating the "fuel pump" test;
- the pressure reading on the pressure gauge should stabilize in these test conditions at around 3 bar. If the pressure is insufficient, carry out the 2nd test.



P4A40FJ03

2nd Test

Checking maximum fuel supply pressure (or electric pump efficiency)

The same connections as for the previous test apply.

- Close lever A for the fuel tap (downstream of the pressure gauge);
- operate the electric pump with the engine switched off, as described in the previous test: the pressure should reach 6 bar and not exceed 7.5 bar (pump safety valve calibration). If this is not the case, replace the electric pump because it is defective.

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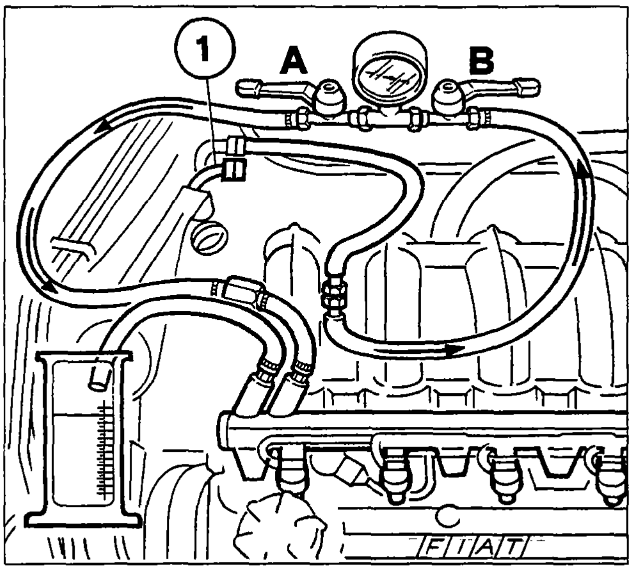
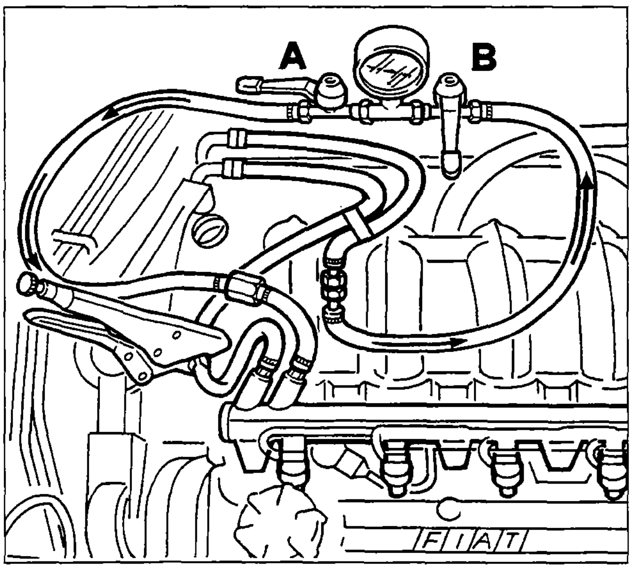


P4A41FJ01

If in the 1st test (see previous page) the pressure value was more than three bar it is necessary to:
- disconnect the fuel return pipe (at the connection point (1) with the rigid fuel return pipe to the electric pump) and place it in a suitable container for collecting the fuel.
- place both taps A and B in the open position;
- operate the electric pump with the engine switched off, as described on the previous page, then read off the value reached on the pressure gauge:
  a. if it reaches 3 bar, check the fuel return pipe to the tank because it is obstructed or bent;
  b. if it exceeds 3 bar, then the pressure regulator must be replaced because it is defective.



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3rd Test

Checking injectors seal

To check whether the injectors are dripping, simply implement the connections for the 1st test (checking regulation pressure), then operate the electric pump with the engine switched off. When the regulation pressure is reached, close the control lever B and, at the same time, restrict the fuel return pipe to the tank; a pair of pliers should be used so as not to damage the pipe.
This operation is necessary to distinguish between a real leak from the injectors and the imperfect seal of the fuel pressure regulator flow valve.

Then:
- switch off the electric pump;
- observe whether the pressure remains constant for around 60 seconds as soon as it stabilizes (i.e. decreases slightly).

If this is not the case, there is a leak from one or more injector or from a union.
- If this is the case, remove the fuel manifold from the inlet manifold, keeping the connection with the pressure guage.
- Repeat the previous test leaving the pressure gauge tap open.
- After having operated the electric pump with the engine switched off, visually inspect for drips from the injectors or from any connecting sections.

Replace any injector which is dripping and/or renew the defective seal which is leaking.

CHEKCING ENGINE IDLE SPEED

If the engine idle speed is not 750 ± 50 rpm and the injection/ignition control unit is the self-adjusting type, it is not possible to adjust it, therefore it is necessary to check that the accelerator linkage is correctly adjusted and to then search for the cause of the problem by carrying outa complete fault diagnosis using the Fiat/Lancia Tester.

CHECKING CONCENTRATION OF POLLUTANT EMISSIONS

The Motronic M 2.10.4 system ensures a constant check on the idle speed and the CO percentage through the self-adjustment of the system, thereby making any outside adjustments superfluous (there are no adjustment screws). However, a check on the content of the exhaust gases downstream of the catalyzer can provide precious indications on the operation of the injection/ignition system, the engine parameters and the catalyzer.

Checking idle concentration of CO and HC

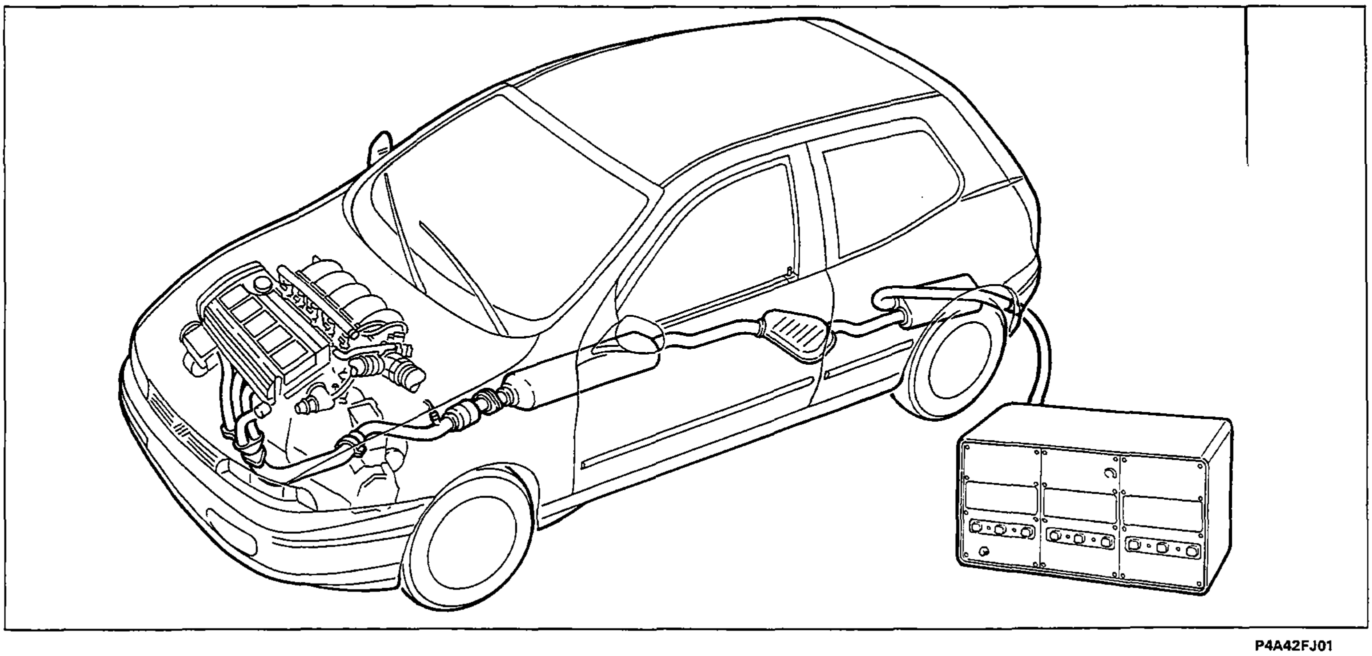
The concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) is measured with the catalyzer at operating temperature (300 - 350 °C) (it is advisable to drive "hard" for around 5 - 10 minutes to make sure that the catalyzer reaches operating temperature), then insert the suitably tester probe at least 30 cm into the end of the exhaust pipe as shown in the diagram.

If the shape of the end section of the exhaust pipe is such that the sensor cannot be completely introduced, a special extension pipe must be added which ensures the seal in the join area.

1. Check that the CO and HC concentrations are within the values given in the table;
2. If the CO value is not within the recommended figures, it is necessary to check:
   - the correct operation of the Lambda sensor, using the Fiat/Lancia Tester;
   - the presence of air penetration in the area surrounding the Lambda sensor housing;
   - the injection and ignition system **(in particular the state of wear of the spark plugs).**
3. If the HC value is outside of the recommended limits, the cause of the problem should be sought in the incorrect engine timing or the decreased efficiency of the catalyzer.

CO (%)	HC (p.p.m.)	CO_2 (%)
$\leqslant$ 0,35	$\leqslant$ 90	$\geqslant$ 13

Table summarizing pollutant emission tolerances downstream of the catalyzer



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DIAGNOSIS

The complete diagnosis of the system is possible through active dialogue with the Fiat/Lancia Tester.

If a failure is detected for the sensors the electronic control unit replaces the information coming from the faulty sensor with information memorized **(recovery)** so that the engine can still operate. The detection of the problem involves it being memorized permanently and the exclusion of the sensor from the system until the signal is compatible once again.

The same procedure is applied if the problem involves an actuator or its control holder. The detection of the problem and the replacement with recovery data involves signalling the problem by the special warning light in the instrument panel coming on.

The parameters which can, in the case of a breakdown, be managed by the control unit are: flow meter, idle adjustment actuator, coolant temperature sensor, butterfly valve position sensor, Lambda sensor, air temperature sensor, battery voltage and detonation sensors. If there are problems with the control unit, the timing sensor or the injectors, the system does not detect the problem and the vehicle breaks down. The problems can be read by an operator on the control unit using the Fiat/Lancia Tester.

Detecting problems

This is carried out during the basic function which manages the sensor/actuator.

Memorizing the error and the structure of the errors memory

The errors are memorized in the control unit in the order in which they occur in the RAMS. For each of them the location and type of error, 2 environmental conditions (specific to each type of problem) measured the moment in which the problem is detected and a frequency counter is memorized.

Classification of the defect

If a defect is recognized for the first time and the error state persists for a time t > 0.5s, the defect is memorized as "permanent". If this defect then disappear, it is memorized as "intermittent" and "not present". If it then reappears, it remains memorized as "intermittent", but becomes "present".

The classification of a problem as "permanent" activates the recovery functions; when the problem disappears the normal function of reading or implementation is restored.

Certain types of problem are classified as "important", i.e. in terms of anti-pollution regulations. The presence of these problems is signalled to the user by means of the failure warning light in the instrument panel coming on.

Frequency counter

For each error there is a frequency counter, which is used to determine the moment in which a problem which is no longer present has been memorized. The first time the problem is detected, the counter is set at 10. If the fault disappears, the counter remains at the current value. If it reappears, it is increased by 1 (to an upper limit of 50).

The counter is decreased each time the engine is started up without the fault reappearing. If the counter reaches zero then the fault is automatically cancelled from the memory.

If after having decreased the counter the fault should reapper, the counter returns to a value of 10 (if, however, it is greater than 10, it is not altered).

Signalling failures

The failure warning light comes on when there is a defect memorized as "present" and "important".

The delay time between detecting the problem and the warning light coming on is 0.1 seconds; the delay time between the disappearance of the problem in the memory and the warning light going out is 4 seconds.

The warning light comes on each time the ignition key is turned to the ON position. If there are "important" problems already present, the warning light goes out after 4 seconds.

Cancelling the error

When the frequency counter reaches the value 0, the error is cancelled and so are the parameters associated with it.

The immediate cancelling of the entire errors memory takes place in the following cases:

- by means of the "cancel errors memory" command sent by the tester;
- by interrupting the supply to the injectors control unit (disconnecting the battery or the connector for the control unit).

Fault diagnosis with the Fiat/Lancia Tester

On the right hand side of the engine compartment (near the engine oil dip stick) is the diagnostic socket to which the Fiat/Lancia Tester is connected.

The exchange of data between the control unit and the Tester takes place via a two direction serial line (line K) using the standard Bosch communication protocol.

The Tester can supply the following information:

- display of the errors;
- display of engine parameters;
- active diagnosis.

List of errors

Rpm sensor	Loss of signal
Butterfly potentiometer	C.C.
Air temperature sensor	C.C.
Coolant temperature sensor	C.A-C.C.
Battery	Supply> 16,01V. Supply< 10V.
Lambda sensor	C.A-C.C.- Incorrect CO value
Injector	C.C
Idle speed actuator	C.C.
Petrol vapour solenoid valve	C.C.
Actuator relays	C.C.
Control unit	Operating problems for the micro-processor or control unit memories are signalled.
Flow meter	C.C.
Timing sensor	Signal missing or not plausible
Detonation sensor	Signal missing or not plausible
Speedometer sensor	Signal missing or not plausible
Phase transformer	C.C.
Electric fuel pump	C.C.
Fiat CODE	Code not recognized or not received

Print no. 506.670

Parameters displayed

Engine rpm
Injection time
Advance
Intake air temperature
Coolant temperature
Butterfly valve opening angle
Battery voltage
Lambda sensor
Self-adjustment
Flow meter
Engine knocking (detonation)
Vehicle speed
Petrol vapour cut out solenoid valve
Fiat CODE
Mileage travelled

Active diagnosis

The following active tests can be carried out using the Fiat/Lancia Tester:
- Phase transformer
- Injector
- Failure warning light
- Petrol vapour solenoid valve
- Air conditioning
- Idle speed actuator
- Cancelling errors.

Recovery

If there are problems with the sensors, the control unit replaces the value transmitted by the sensor with a so called Recovery value which, depending on the different problems, is stored in the control unit memory or is specially reconstructed from the other information available, in order to allow the vehicle to reach a service centre.
This value is also transmitted to the Fiat/Lancia Tester, therefore, during the fault diagnosis it is worth bearing in mind that in the case of problems the Fiat/Lancia Tester will signal the error for the sensor concerned and the Recovery value will be displayed.

Permanent memory

The control unit is equipped with a «permanent» type errors memory (EEPROM), i.e. the error indication is preserved even if the cause of the problem no longer exists and the key has been turned to the OFF position; it also has a «volatile» type memory (RAM) which, on the other hand, loses the error information as soon as the cause disappears.
This also allows the more effective detection of errors of an occasional nature.
Before ending the fault diagnosis the contents of the «permanent» memory should be cancelled using the Fiat/Lancia Tester in Active Diagnosis.

The contents of the «permanent» errors memory can be cancelled in the following ways:

1 - Using the Fiat/Lancia Tester in active diagnosis.

If this is not the case, when the Fiat/Lancia Tester is reconnected the errors already examined are signalled.

2 - If the cause of the error is no longer present and the engine has been started up 5 times (working for at least 20 minutes) with a gap of at least 2 minutes between one starting and the next.

Disconnecting the control unit from the system, even for long periods of time, does not cancel the contents of the «permanent» memory.

FUEL SYSTEM

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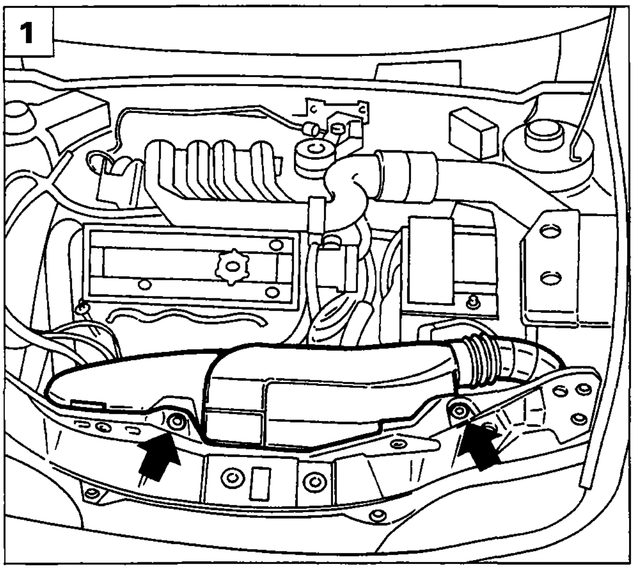

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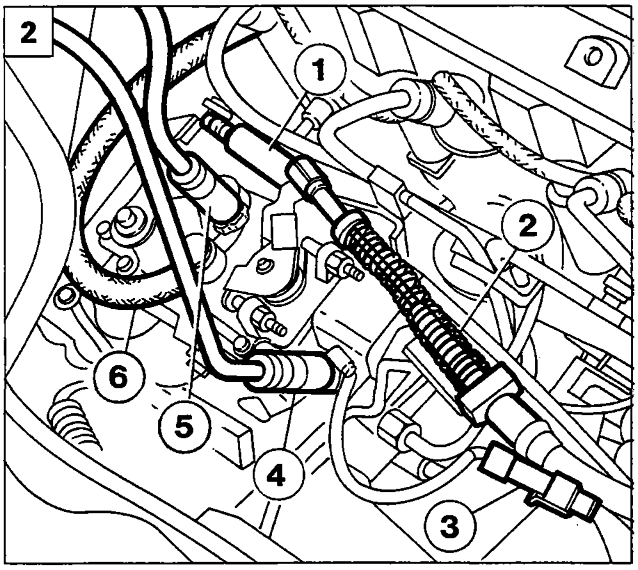

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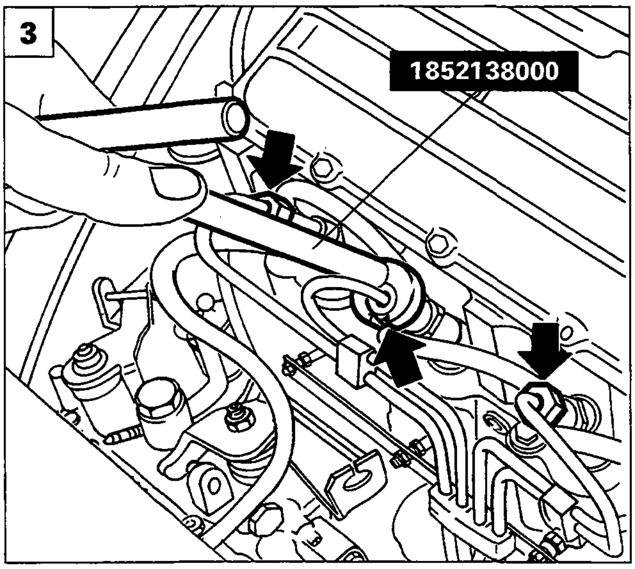

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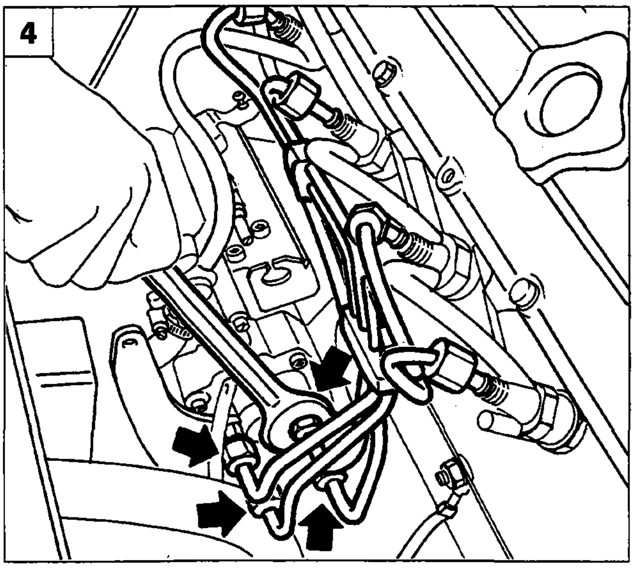

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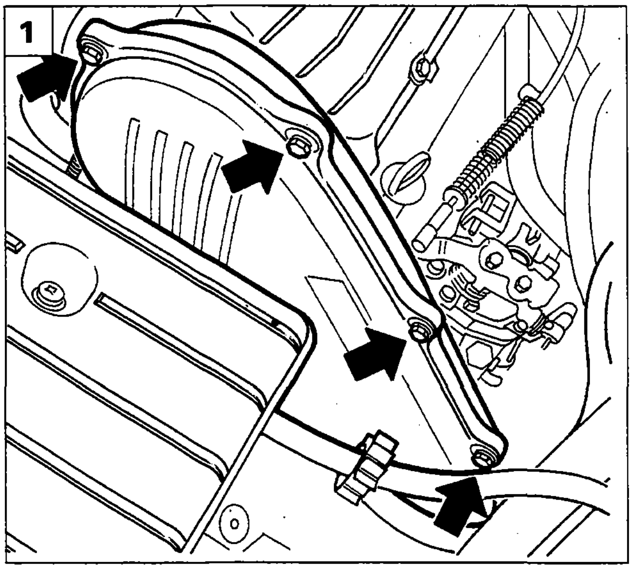
REMOVING-REFITTING INJECTION PUMP ON VEHICLE

Removing injection pump

1. Unscrew the bolts indicated and remove air intake assembly with connection sleeve to air cleaner container.
2. Remove the following parts from the pump:
   1. Fast idle cable.
   2. Accelerator cable.
   3. Electrical connection for engine stop solenoid (electrostop).
   4. Fuel delivery line.
   5. Fuel return line to tank.
   6. Fuel return line from injectors.
3. Disconnect fuel delivery lines from injectors using tool 1852138000.
4. Disconnect fuel delivery lines from injection pump to injectors.

10.



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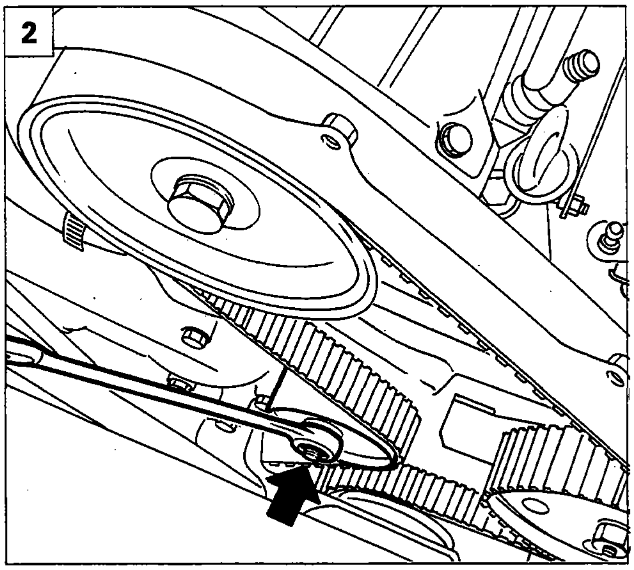

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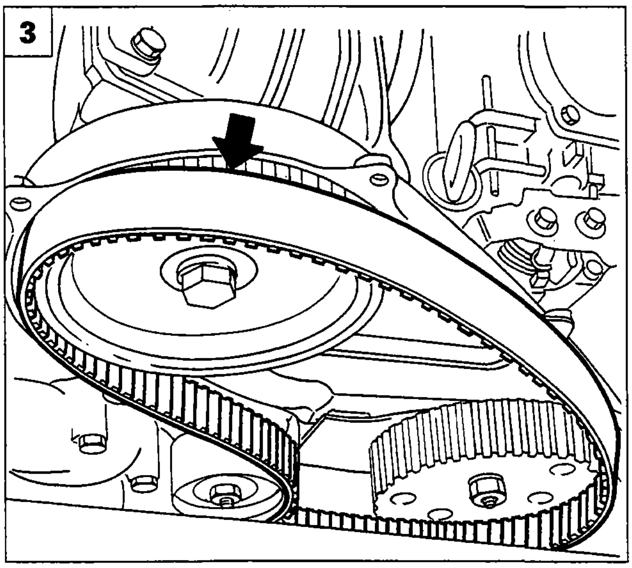
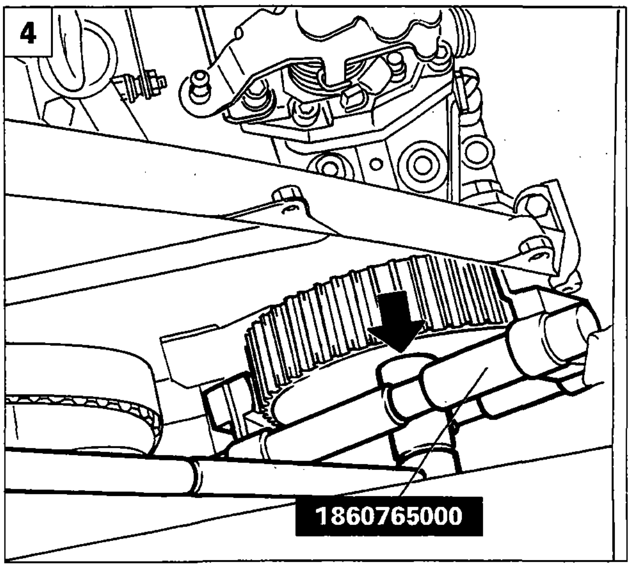


P4A02DJ05 P4A02DJ04

1. Remove timing belt by unscrewing the nuts indicated and the two retaining bolts and nuts located on the rear end.
2. Loosen the screw retaining the mobile belt tensioner.
3. Remove the timing belt.
4. Prevent injection pump pulley turning using tool 1860765000 and unscrew the pulley retaining bolt.
5. Use tool 1860886000 to remove the injection pump pulley from the tapered fitting.



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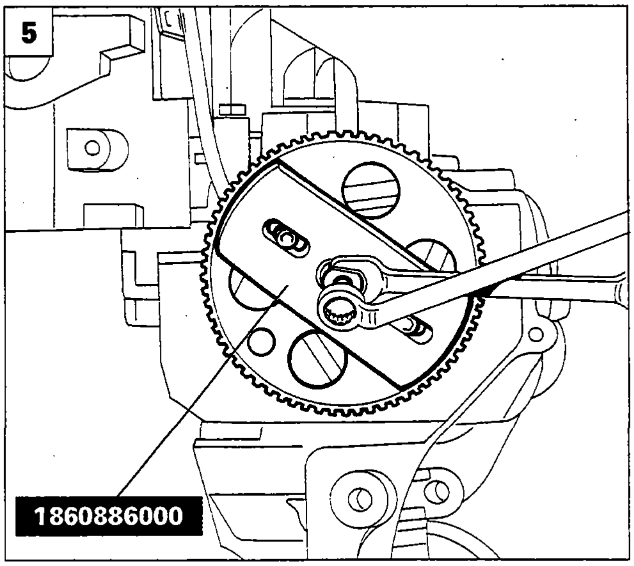

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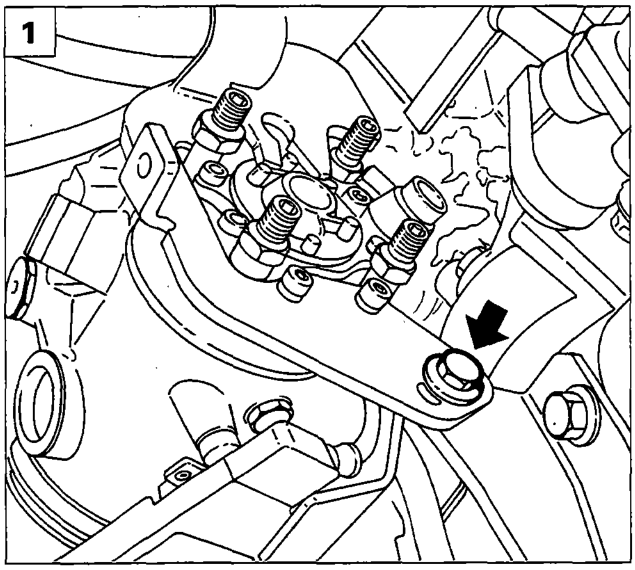

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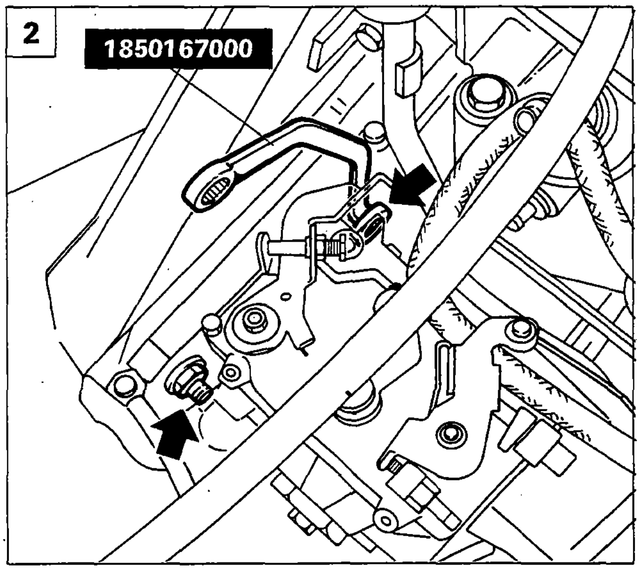

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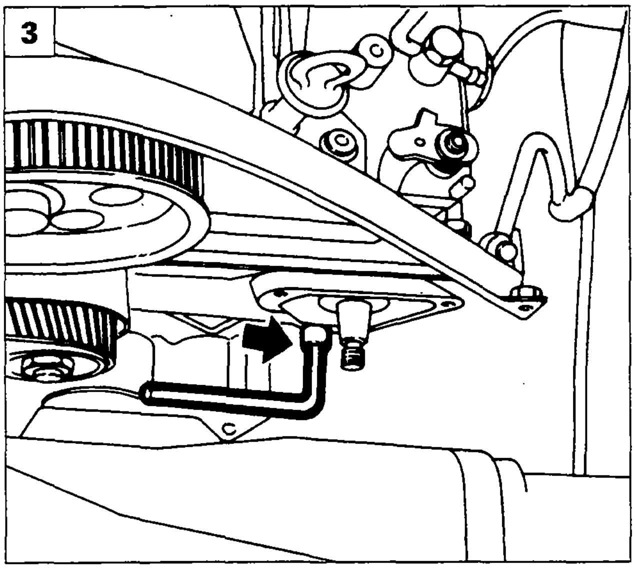

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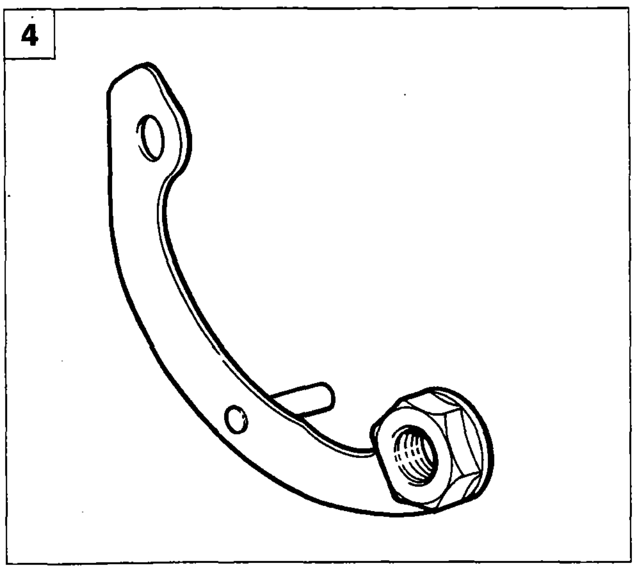


P4A03DJ04

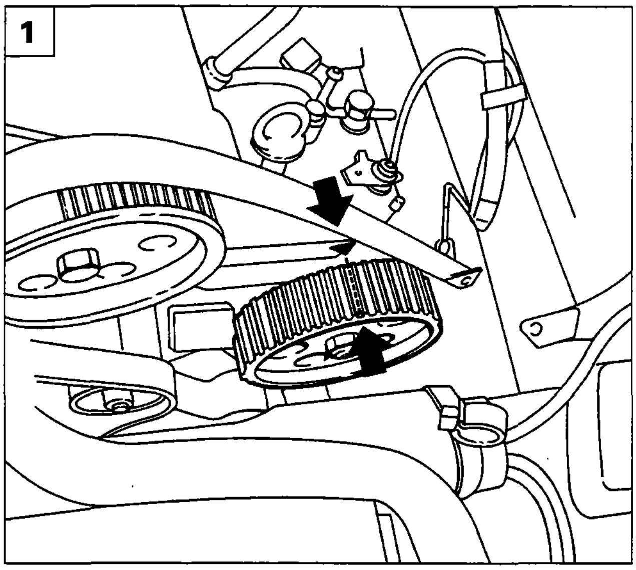
1. Unscrew the bolts indicated and disconnect the injection pump retaining bracket from the support beam fastened to the engine block

2. Use tool 1850167000 to unscrew the nuts shown.

3. Unscrew the socket screw retaining the injection pump to the mount.

4. Disconnect the rear retaining bracket and remove the pump from the engine bay.

10.



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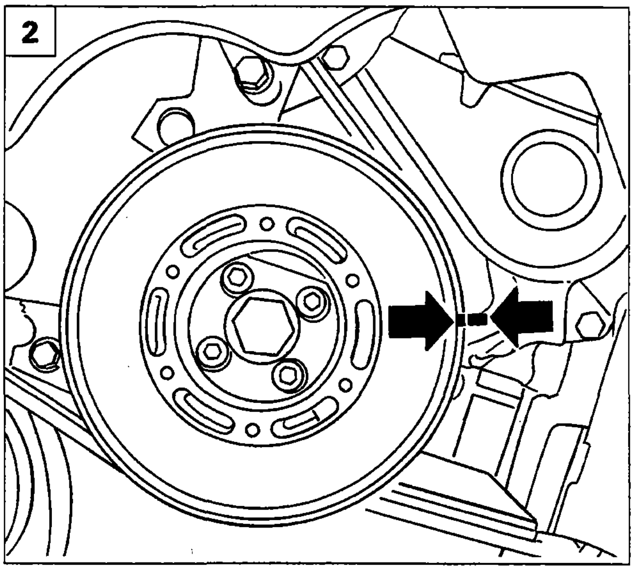

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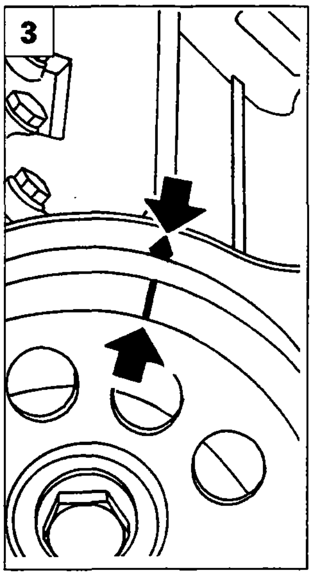

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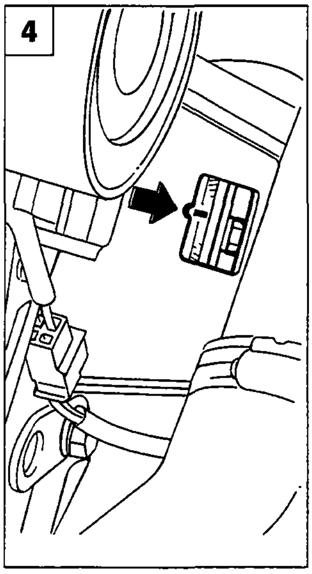

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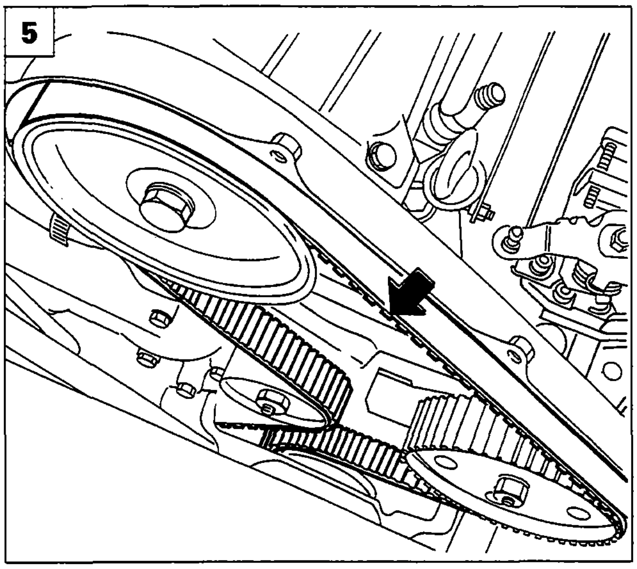


P4A04DJ07 P4A04DJ06

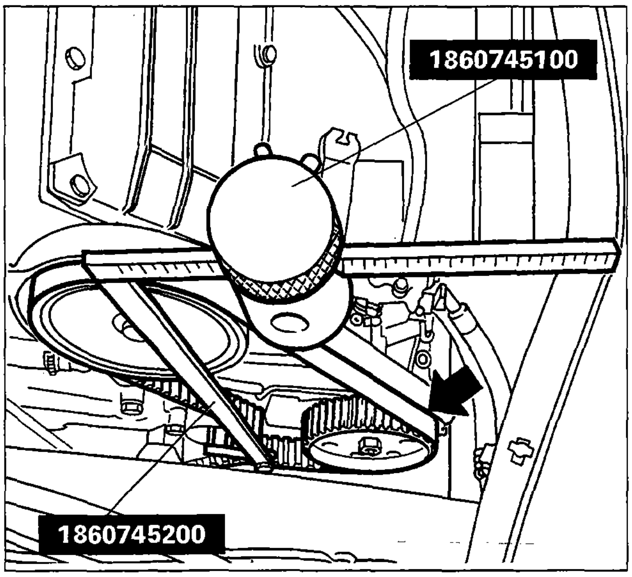
Refitting injection pump

To refit the injection pump, reverse the order of removal operations and carry out the following checks:

1. Position the injection pump drive pulley so that the reference mark on the gear is aligned with the reference mark on the rear timing belt cover.
2. Check notches on alternator pulley (damping flywheel) and coolant pump are properly aligned.
3. Chcek that the notch on the timing drive gear is aligned with the hole on the rear timing belt cover.
4. Also check that the notch on the gearbox bell housing corresponds with the notch on the flywheel.
5. Fit the timing belt.

Check belt condition every 60000 km and replace if:
- it is soaked in oil or coolant;
- it shows signs of cracks or broken teeth;
- it is frayed or tooth profiles are worn.

Replace the toothed belt every 120,000 Km or during service operations involving removal at mileages in excess of 30,000 Km.



P4A05DJ01

Adjust toothed timing belt tension as follows:

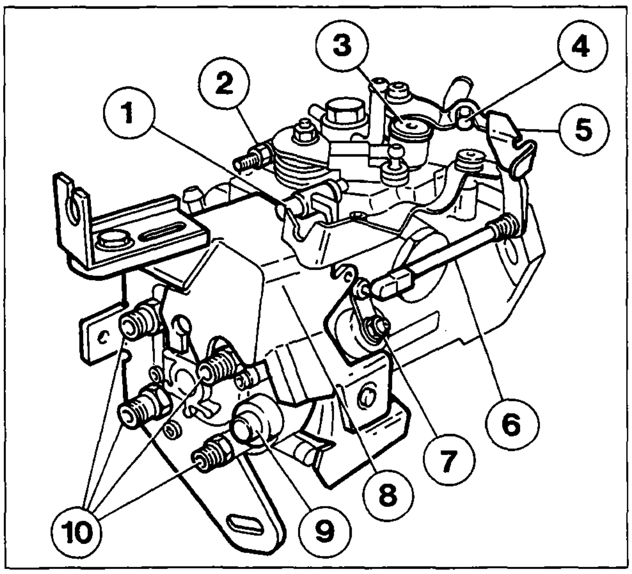
Fit part 1860745200 to tool 1860745100. Then position weight at a distance of 120 mm along the calibrated rod and secure.

Apply the resulting tool to the mobile belt tensioner as shown in figure. Adjust joint to move calibrated rod to a horizontal position. Then tighten joint retaining screw.

Settle the toothed belt by turning the crankshaft through two turns in the direction of rotation. Tighten mobile belt tensioner retaining screw.

The calibrated rod may move away from the horizontal during the final stage. In this case, adjust joint again to restore calibrated rod to its original position and repeat the operation.

Tighten mobile belt tensioner to the specified final torque.



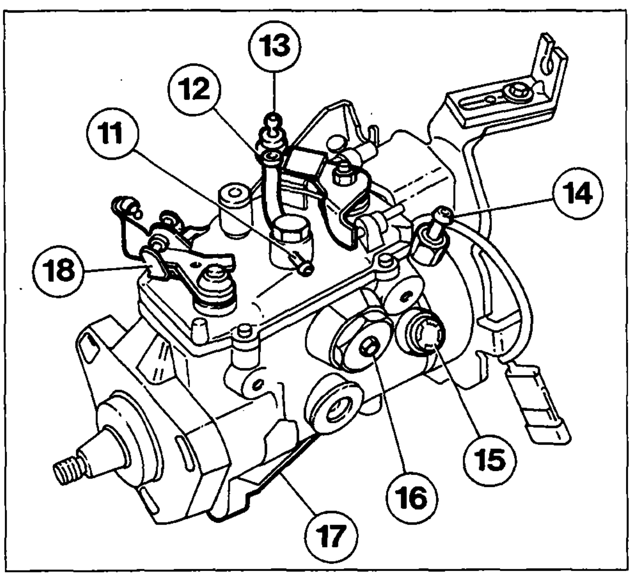
P4A05DJ02

LUCAS FT05 injection pump

1. Maximum rpm adjustment screw.
2. Anti-stall adjustment screw.
3. Fitting for adjusting pump timing on engine.
4. Fast idle adjustment screw.
5. Fast idle control lever.
6. Choke advance valve control rod.
7. Choke advance valve.
8. Engine stop solenoid protective cover.
9. Transfer pressure valve (*).
10. Fittings for diesel delivery lines to injectors.
11. Fitting for diesel return line from injectors.
12. Fitting for diesel return line to tank.
13. Accelerator control lever.
14. Fitting for diesel delivery line from filter.
15. Enrichment flow cut-out or supplement valve.
16. Automatic advance device.
17. Fiat CODE system interface ECU.

(*) This valve performs the following functions:

a. Creates transfer pressure generated by vane pump.
b. Controls transfer pressure on the basis of engine rpm
c. Allows pump to fill with diesel during start-up (priming)



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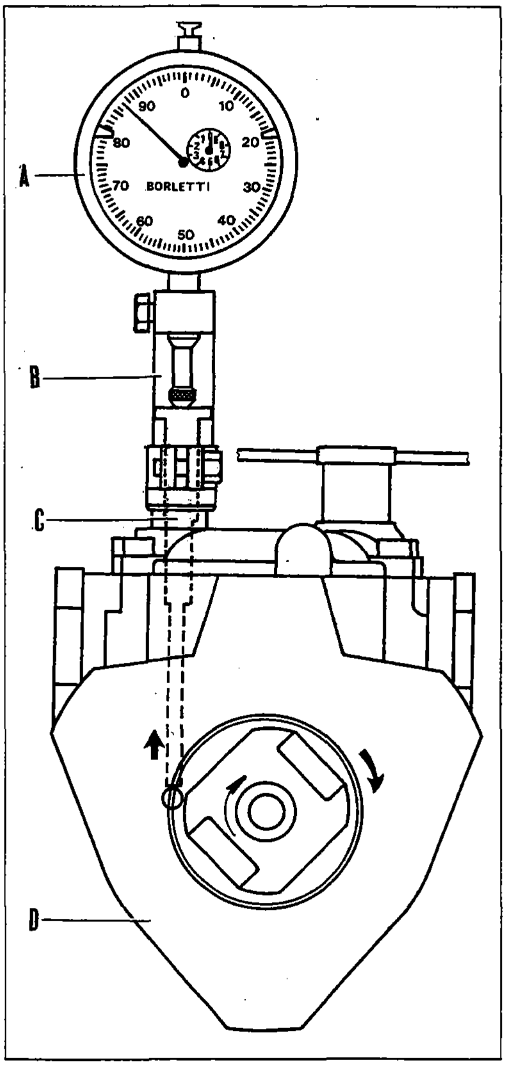


P4A06DJ01

INJECTION PUMP OPERATION ON ENGINE

Fitting pump and checking advance on engine

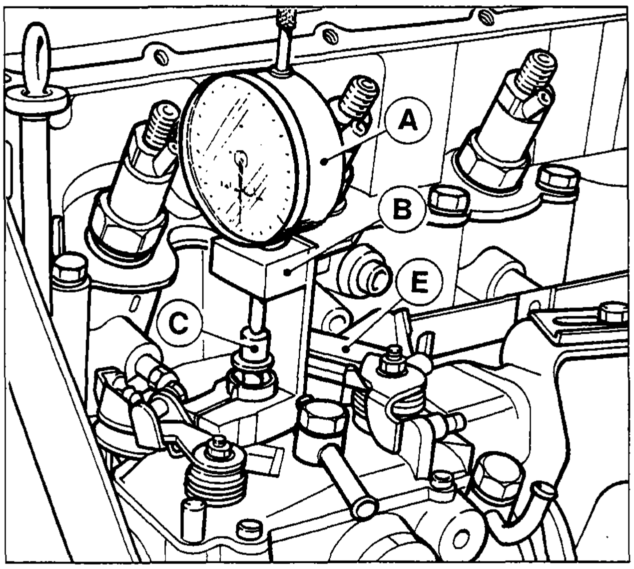
Tools required: n° 1865091000 comprising probe stylus (C), mount (B) and centesimal dial gauge (A) no. 1895885000.
Pump must also bear label (E) glued to the top. Above this is the installation gap in mm.

Fitting injection pump

First of all, check accuracy of timing as a precaution:

- Move piston of first cylinder to a position close to TDC.
- Fit injection pump (D) to its mount. Ensure ridge on pump gear is aligned with inner pump drive shaft splines but do not tighten nuts retaining pump to mount fully.
- Remove aluminium cap with fitting for socket wrench from fitting on top of pump.
- Turn crankshaft against direction of rotation through about 20°.
- Tighten tool (B) with probe (C) and dial gauge (A) into the threaded seat on top of the pump.

NOTE *In this position, probe (C) will come into contact with a seat in the pump and not against pump distributor (or rotor).*
The distance between pump seat and the position of a distributor (or rotor) drive dowel is used to achieve correct pump setting on engine: when pump is turned, probe touches drive dowel. The above fitting distance is indicated on label (E) attached to each pump.



P4A06DJ02

A. Dial gauge.
B. Tool 1865091000 for checking advance.
C. Probe plunger.
D. Injection pump.
E. Label with fitting gap.

- Secure dial gauge (A) on plunger (C). Ensure that gauge is fitted with a preload of 10 - 15 mm, then zero.

- Turn pump in its slots to move top of pump away from the cylinder assembly (maximum delay position).

- Turn the crankshaft in its direction of rotation until piston no. 1 is turned exactly to TDC.

Never turn crankshaft against its direction of rotation. Otherwise tool or pump may be damaged.

- Read distance off dial gauge. Then turn pump slowly in its slots until dial gauge shows exact fitting distance indicated on pump label (e.g. 8.52 mm).

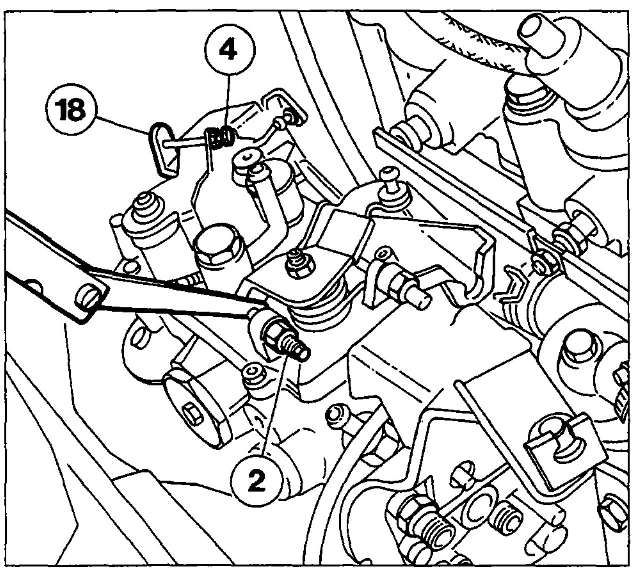
- Now tighten pump retaining screws fully.

Final check

- Turn crankshaft in its direction of rotation by a few revolutions (at least 2) until piston no. 1 is exactly at TDC. The dial gauge reading should correspond to the reading printed on the pump label. Otherwise, repeat procedure described above with greater accuracy.

POSSIBLE ADJUSTMENTS ON INJECTION PUMP FITTED TO ENGINE

Before adjusting pump, engine must be at service temperature, i.e. radiator cooling fan must have come on at least twice.



P4A07DJ01

Anti-stall speed adjustment

1. Interpose a spacer measuring exactly 2 mm between anti-stall adjustment screw (2) (see figure on previous page) and accelerator control lever.
2. Turn on engine and adjust speed to 1600 ± 100/min, using a socket wrench to turn anti-stall adjustment screw (2).
3. Remove 2 mm spacer.

4. Adjust idle speed to 780±50/min by means of idle adjustment screw (4) (see figure on page 7) after loosening locknut. After adjustment, tighten idle adjustment screw locknut.

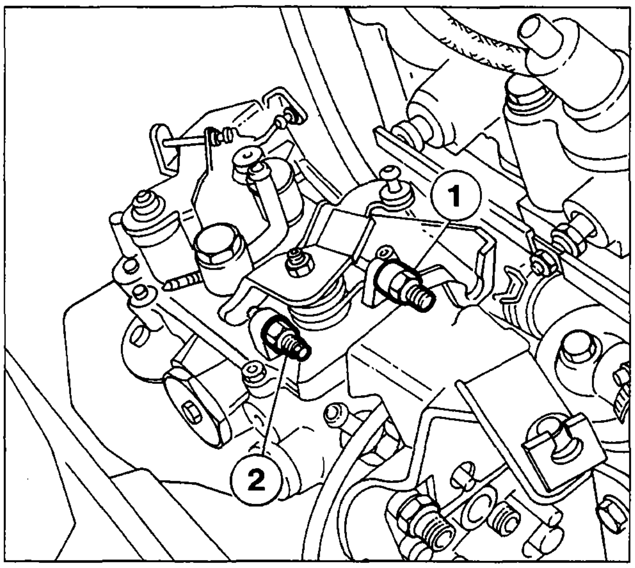
5. Move idle control and fuel cut-off lever (18) by hand (see figure on page 7) toward cut-off position by 0.5 - 1 mm. The engine should tend to stall or at least speed should drop. If this does not occur, repeat the previous adjustments described at points 1 - 2 - 3 - 4 to obtain a new engine speed that still lies between 780±50 rpm: then repeat test until a positive result is obtained.

Checking antistall screw setting

Accelerate engine to maximum speed, then release accelerator completely: speed should drop steadily to idle level without fluctuations or judder. Otherwise adjust anti-stall screw as follows:

- if deceleration is too slow, unscrew anti-stall adjustment screw (2) by 1/4 turn

- if deceleration is too fast, tighten anti-stall adjustment screw (2) by 1/4 turn.



P4A08DJ01

1. maximum rpm adjustment screw
2. anti-stall adjustment screw.

Adjusting engine top speed

Move accelerator control lever to end of its travel. If maximum speed of 5150 ± 50 rpm is exceeded, adjust maximum speed screw (1) by tightening until engine speed is as specified. Then tighten nut of screw (1) and apply a lead seal.

BLEEDING PUMP HYDRAULIC CIRCUIT

If engine stalls due to lack of fuel or if fuel low pressure lines have been disconnected or fuel filter has been changed, proceed as follows to facilitate pump self-priming:

- unscrew fittings fastening delivery lines to injectors (A);
- start engine and run until fluid emerges from open injector fittings;
- keep engine running and tighten injector fittings.

If engine will not start, check all fuel inlet pipe union points (D) and also fittings (E). Replace seal washers to eliminate the possibility of air leaks.

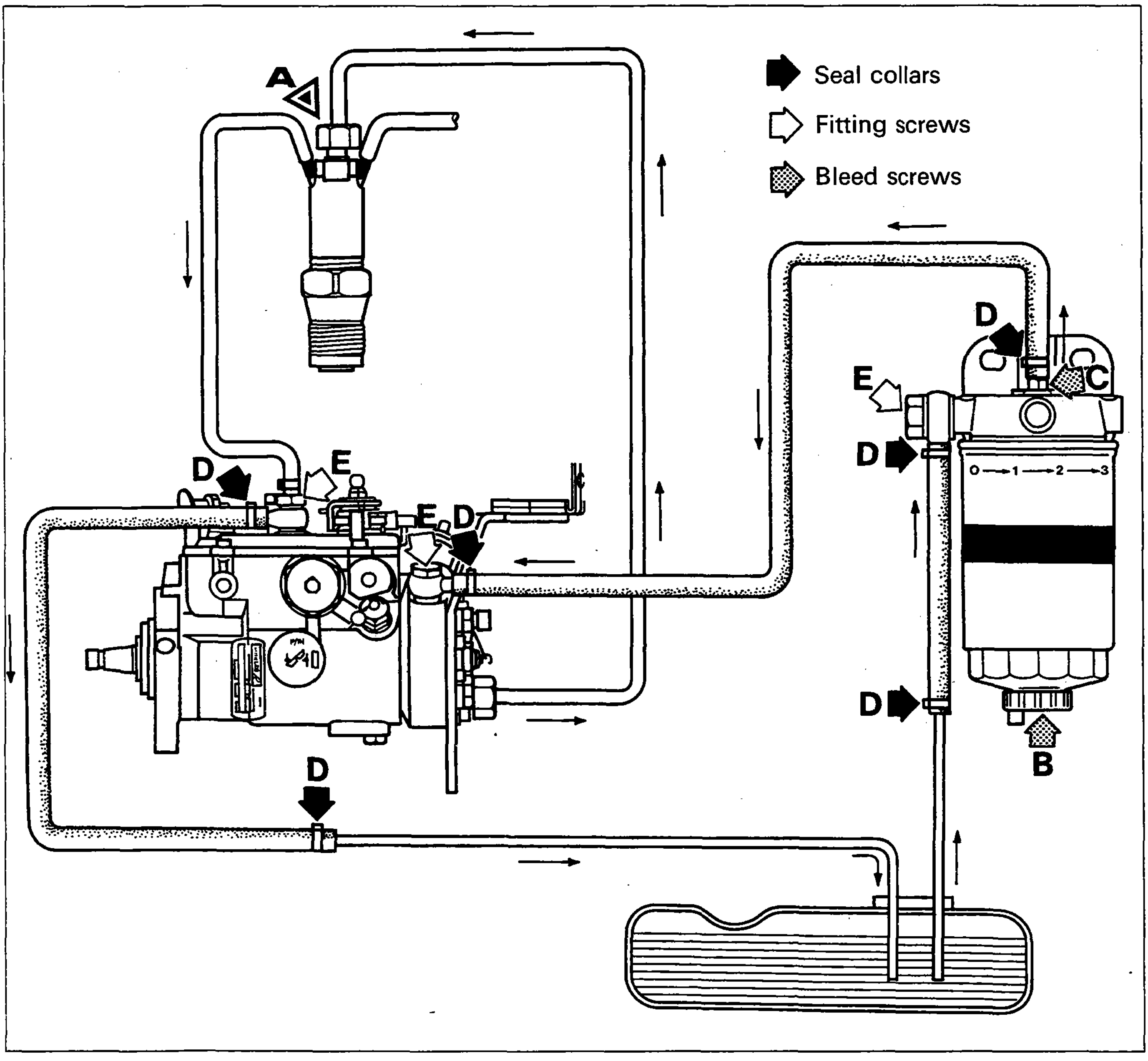


Diagram showing fuel system connections

10.

Bleeding air from diesel (See illustration on previous page)

Each time the oil is changed, bleed off the water from the fuel filter as follows:

- unscrew water bleed screw (B) under filter,
- unscrew air bleed screw (C) above the filter.

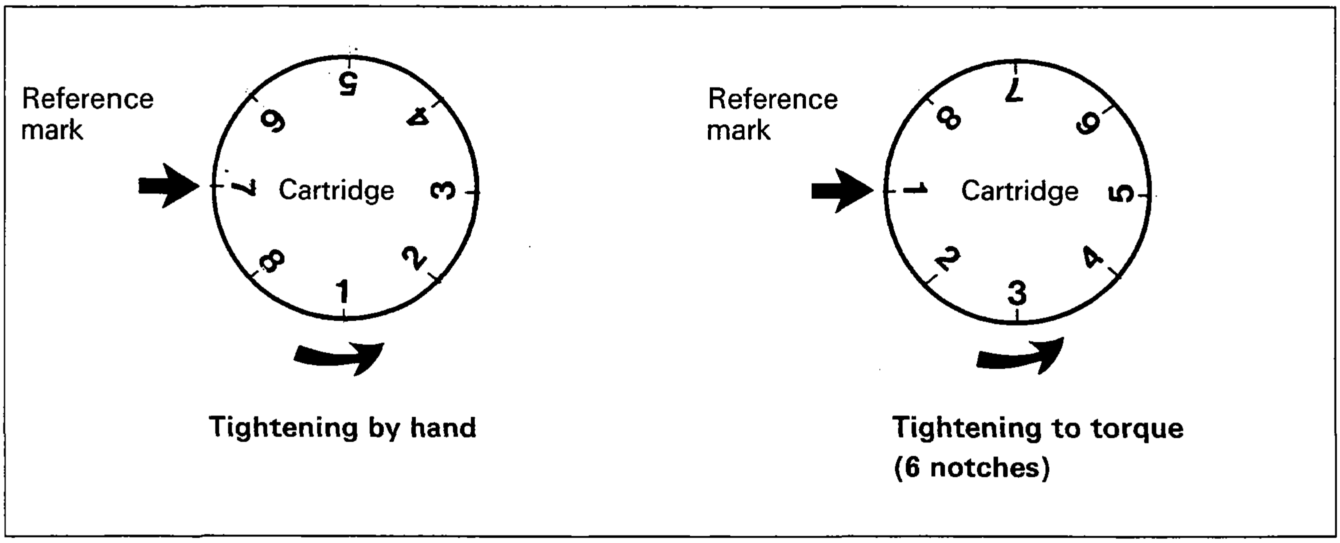
Start up engine and let water and fuel emerge until no more water is present, then tighten water bleed screw (B) beneath filter and air bleed screw (C) above filter.

Replacing cartridge fuel filter

Change diesel filter every 15,000 km. Proceed as follows to change:

- lubricate rubber cartridge seal,
- fill filter cartridge with diesel (in order to reduce self-bleeding period),
- tighten cartridge until it touches the mount,
- tighten cartridge by 6/8 turn (to obtain torque of 1.3 - 1.6 daNm).

This is achieved using numbered notches engraved on the cartridge. For example when the cartridge is moved into contact with the mount, make a mark on the mount against one of the notches engraved on the filter. Then tighten filter through 6 further notches after the reference notch.



Method for tightening cartridge fuel filter to torque

FAULT DIAGNOSIS

Introduction

The main differences experienced when working on a Diesel engine, compared to a petrol engine, are as follows:

1) The diesel fuel system is driven by an injection pump and also comprises:

- a tank and two fuel feed and return lines;
- a fuel filter (with hand pump for bleeding fuel system);
- injectors with high pressure inlet lines;
- preheating device for starting engine when cold;
- an engine arrest device.

The injection pump is the most reliable part of the fuel system due to very low component wear and low likelihood of incorrect adjustment.
Engine failure should not immediately be attributed to the injection pump but more probably to one of the other fuel system components.

2) The combustion process within a Diesel spontaneous fuel self-ignition engine produces very high temperatures. Coupled with the fact that the fuel inevitably contains traces of sulphur, this determines:
   - greater tendency than petrol engines to produce sparks and thus greater wear on moving parts, particularly those close to the combustion chamber;
   - greater tendency of piston rings to become bonded in their seats.

It is very important to change the fuel filter every 15,000 km.
Use only specified lubricant oil grade. Engine oil must be changed every 7500 km. If vehicle is used under heavy conditions (mainly town driving, continuous mountain driving, towing of trailers or caravans, routes through dusty areas) change oil more frequently, particularly when the temperature exceeds 25°C.
Make sure injectors are always efficient in order not to increase production of uncombusted products during engine operation.

3) The combustion process in spontaneous self-ignition diesel engines also gives rise to higher engine noise levels (*) with the production of combustion knock clearly discernible from outside.
   Although this phenomenon has been greatly reduced in present-day engines with prechambers, it is still present, particularly at low speed, but tends to diminish at medium-high speeds.

   NOTE *If the injection pump is advanced only slightly in relation to correct timing setting, combustion knock is considerably accentuated.*

4) An indirect injection Diesel engine needs a prechamber preheating device (rapid glow plugs and ECU) to facilitate fuel self-ignition when the engine is cold and hence engine start-up.
   A special solenoid is used to turn off the engine (which occurs when the fuel supply to the injection pump ceases). This opens up fuel flow in the injection pump when the ignition key is in MARCIA position and turns it off when the ignition key is turned to STOP.

(*) Engine running noise: this is due to an excessive fuel pressure gradient, i.e. the ratio between pressure developed by combustion and corresponding crankshaft angles of rotation.

Test tables

This fault diagnosis table is applicable only if the engine is efficient and the electrical equipment has been properly checked.

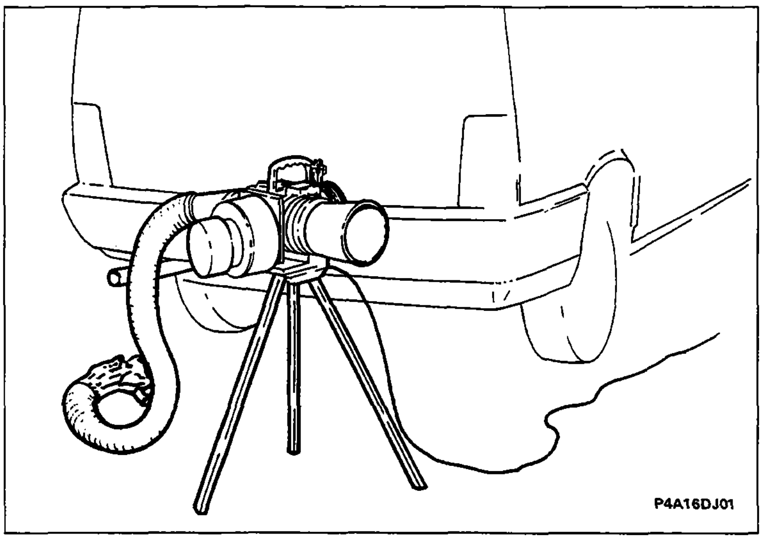
ANOMALY	CAUSE	REMEDY
When warm, the engine will not start or starts with difficulty	Tank empty, ventilate blocked tank	
	Water in fuel	Drain water from filter, clean filter and bleed air
	Air in fuel system	Bleed and eliminate air leaks into system
	Injection order does not correspond to firing order	Fit pipes from pump to injectors in correct order
	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump timing at bench
When cold, engine does not start or starts with difficulty	Tank empty, ventilate blocked tank	
	Water in fuel	Drain water from filter, clean and bleed
	Air in fuel system	Bleed air and eliminate leaks in system
	Heavy paraffin build-up in fuel filter	Replace filter and use winter-type fuel
	Injection order does not correspond to combustion order	Fit injection pipes from pump to injector in the correct order
	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Pre-heating circuit defective	Check glow plugs and ECU
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump timing at bench

ANOMALY	CAUSE	REMEDY
Engine misses when idling	Fuel outlet and inlet fittings on injection pump exchanged	Fit fittings correctly
	Incorrect injection pump setting	Check injection pump setting at test bench
Uneven idling with engine warm	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Air in fuel system	Bleed and eliminate air leaks into system
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine runs irregularly or misses	Tank ventilation defective	Check tank ventilation
	Fuel delivery and return lines on injection pump changed over	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Fuel and injection lines blocked or restricted	Check lines: repair or replace
	Water in fuel	Drain water from filter
	Incorrect injection pump timing	Restore correct injection pump timing on test bench
	Injectors defective or excessively dirty	Clean injectors, check and/or replace
	Incorrect injection pump setting	Check injection pump setting at test bench

ANOMALY	CAUSE	REMEDY
Engine not efficient (road performance unsatisfactory)	Tank ventilation defective	Check tank ventilation
	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Fuel delivery and return lines on injection pump changed over	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Fuel and injection lines blocked or restricted	Check lines, repair or replace
	Air cleaner blocked	Replace filter element
	Engine will not reach maximum rated speed	Adjust top speed by means of screw on injection pump
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Excessive fuel consumption	Injection order does not correspond to combustion order	Fit injection pump lines in correct order
	Fittings loose, leaks from pipes, pipes broken	Tighten fittings and eliminate leaks
	Idle speed too high	Adjust idle speed by means of screw on injection pump
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine will not stop	Engine arrest solenoid short-circuited	Check electrical leads and/or replace solenoid

ANOMALY	CAUSE	REMEDY
Black smoke at exhaust	Injection order does not correspond to combustion order	Fit pipes from pump to injectors in correct order
	Air cleaner blocked	Replace filter element
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
White smoke at exhaust	Tank ventilation defective	Check tank ventilation
	Fuel inlet and outlet lines changed over on injection pump	Fit fittings correctly
	Air in fuel system	Bleed and eliminate air leaks into system
	Fuel filter blocked	Replace filter
	Fuel and injection lines blocked or restricted	Check lines, repair or replace
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench
Engine will not reach maximum rated rpm	Air in fuel system	Bleed and eliminate air leaks into system
	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (delayed)	Restore correct injection pump timing and adjust advance
Excessive engine noise	Injectors defective	Check and/or replace injectors
	Incorrect injection pump timing (advance)	Restore correct injection pump timing and adjust advance
	Incorrect injection pump setting	Check injection pump setting at test bench

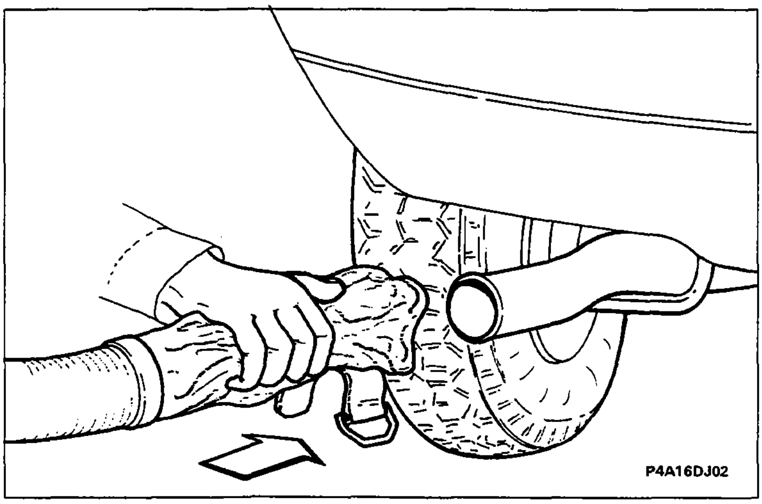
10.


P4A16DJ01

CHECKING EXHAUST SMOKE USING OPACIMETER

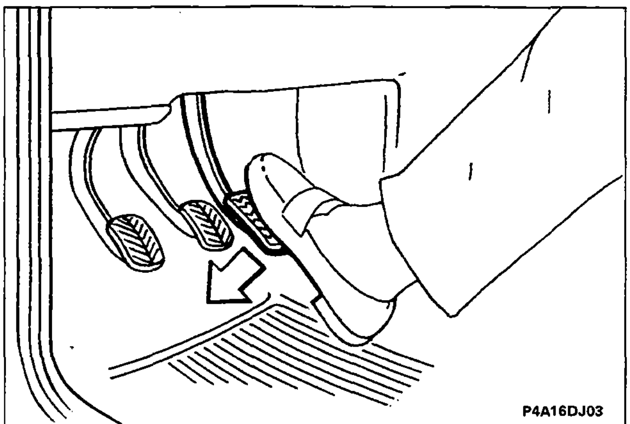
Start up vehicle engine and allow to warm up to service temperature (radiator cooling fan comes on twice).

Position opacimeter measurement unit firmly near the vehicle exhaust pipe (place opacimeter fume exhaust down wind)


P4A16DJ02

Connect hose of measurement unit to vehicle exhaust pipe.

Connect and adjust equipment as instructed by the Manufacturer.

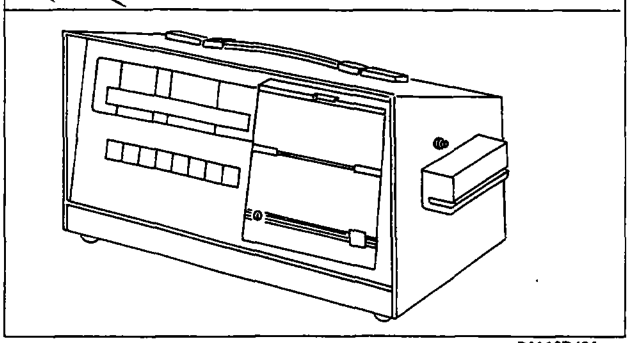

P4A16DJ03

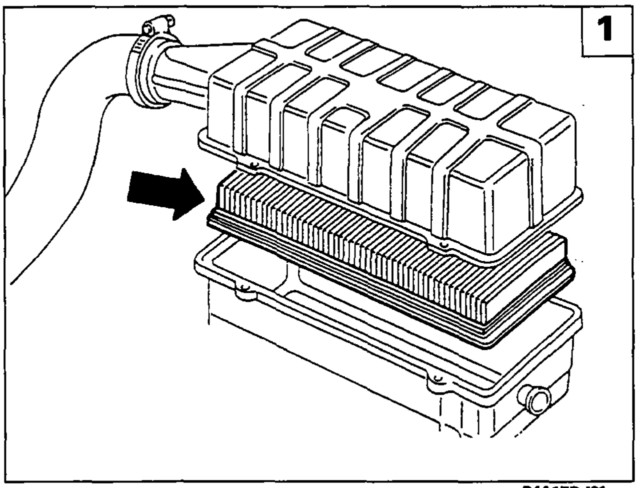
Pump accelerator pedal three times quickly to the floor until rpm limiter threshold speed is reached.

Carry out measurements over five successive full accelerator pedal pumps.
Note maximum values achieved.
Take the arithmetic mean of the three closest readings to obtain the test result.

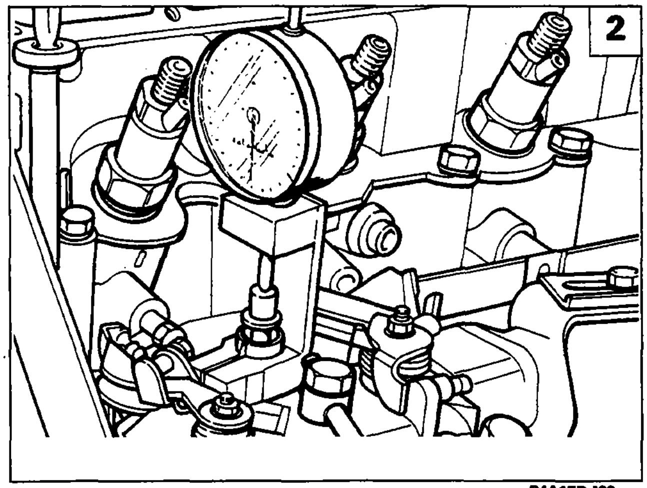
If more than one set of three readings is suitable, choose the one with the highest mean.

If exhaust smoke level exceeds 70%, carry out the tests desribed overleaf.

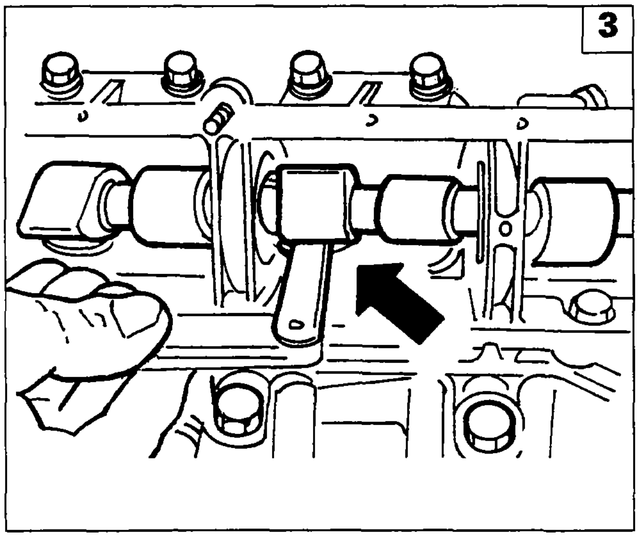

P4A16DJ04



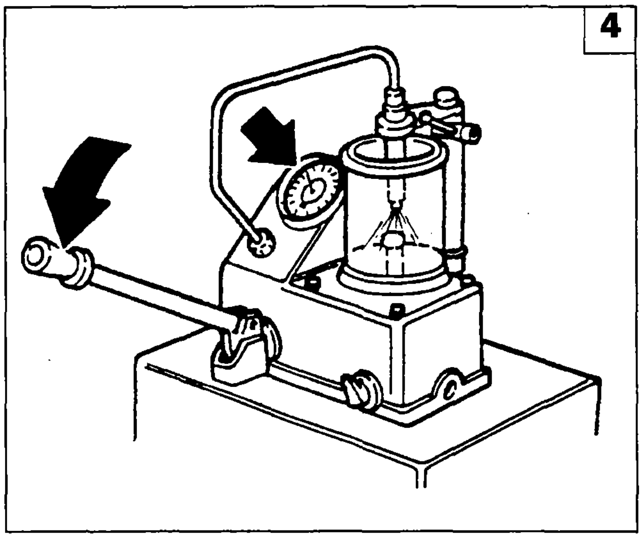
Check air cleaner condition



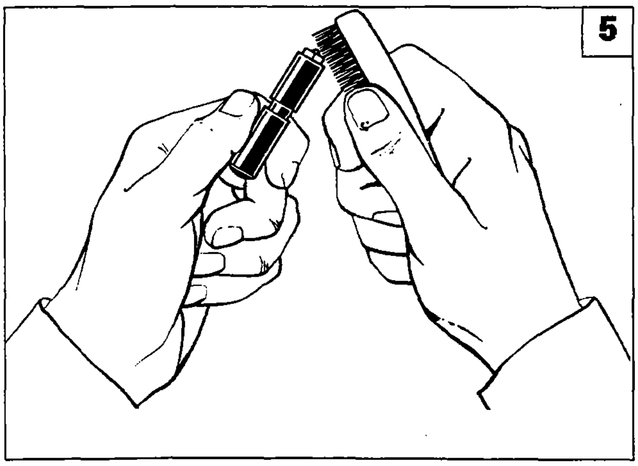
Check injection pump timing and/or output



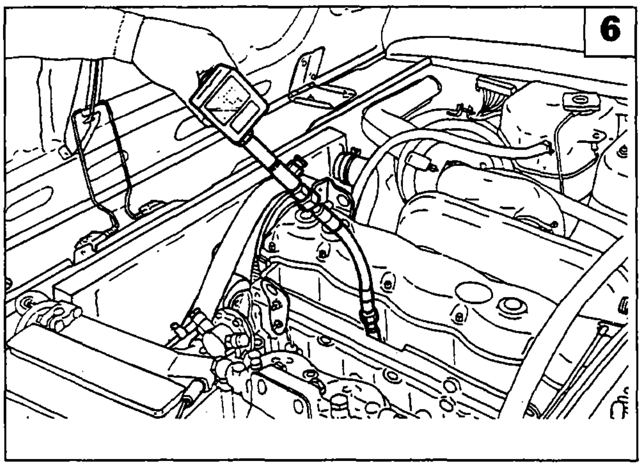
Check valve clearance and/or timing



Check injector setting



Check injectors are perfectly clean

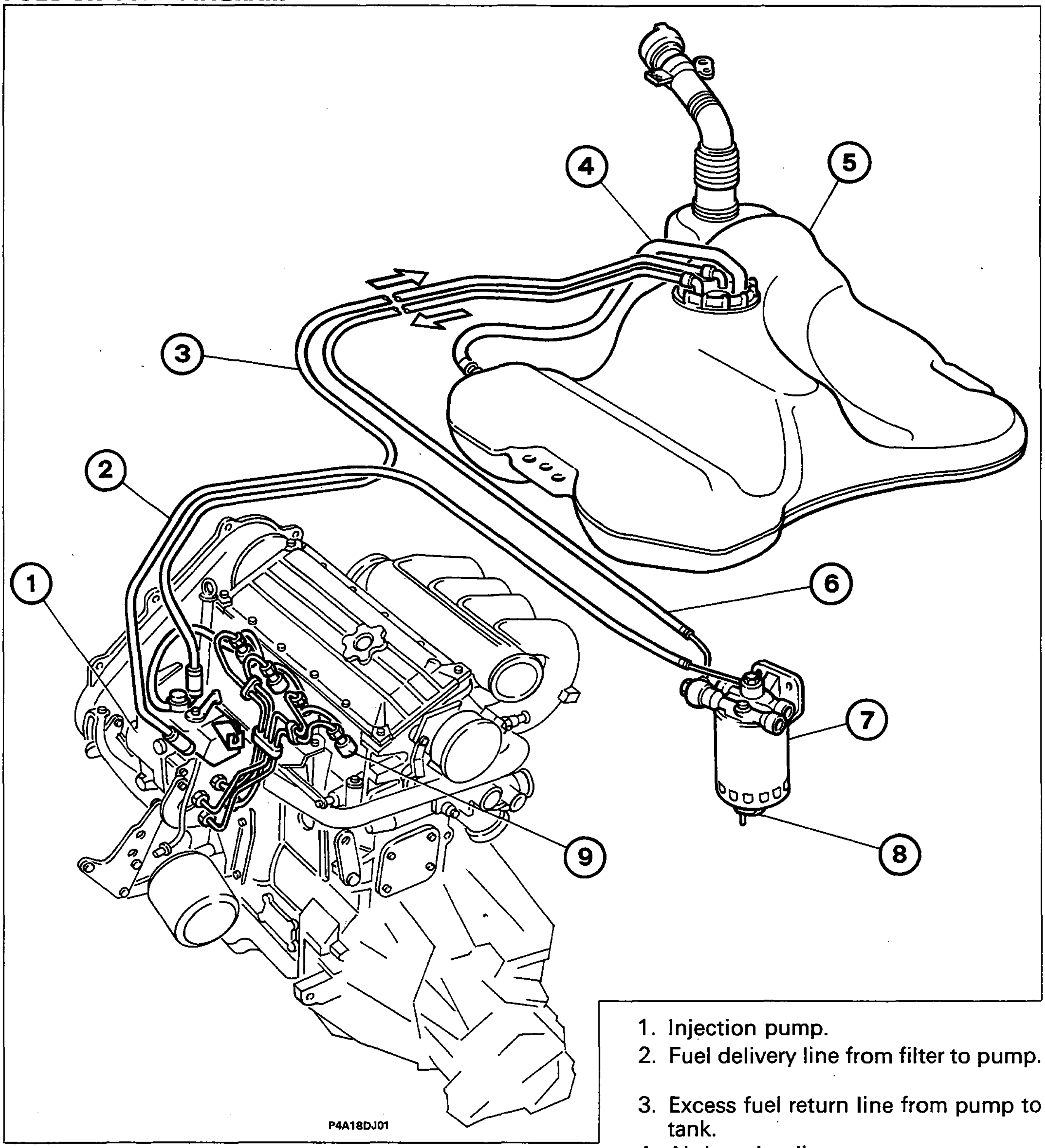


Check compression ratio

Numbers at top of illustrations indicate order of operations.

10.

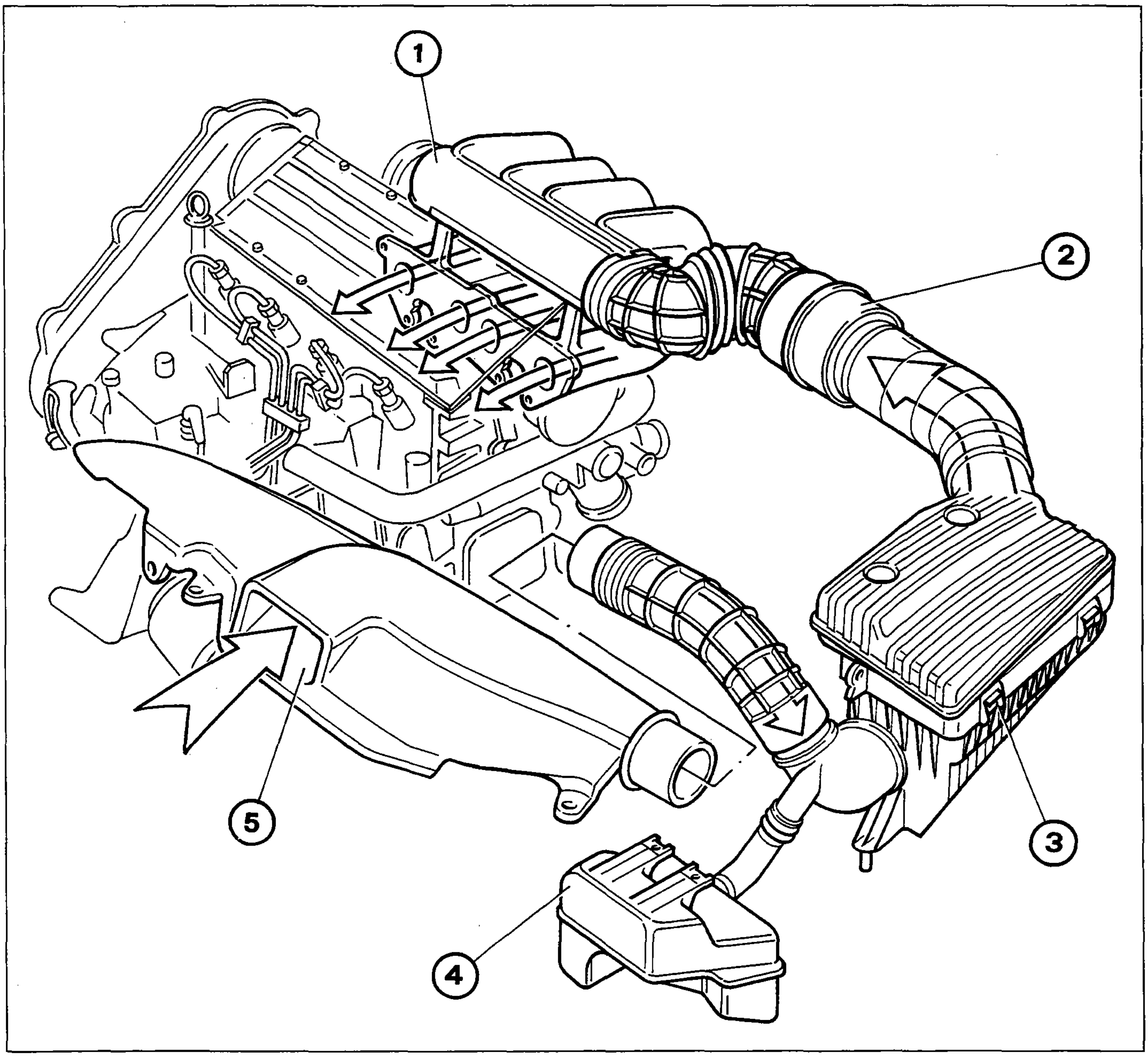
FUEL CIRCUIT DIAGRAM



1. Injection pump.
2. Fuel delivery line from filter to pump.
3. Excess fuel return line from pump to tank.
4. Air breather line.
5. Fuel tank.
6. Fuel delivery line from tank to filter.
7. Fuel filter.
8. Screw for draining water from fuel filter.
9. Injectors.

NOTE *Due to the specific shape of the tank, an air pocket will build up at the bottom fuel is added and prevent the tank being properly filled. Line (4) allows air to flow form the lower part to allow the tank to be completely filled.*

AIR INTAKE CIRCUIT DIAGRAM



P4A19DJ01

1. Inlet manifold.
2. Upper resonator.
3. Air cleaner.
4. Lower resonator.
5. Inlet fitting.

page

HYDRAULIC SYSTEM

- Diagram of hydraulic braking system (front disc brakes and rear drum brakes) and mechanical handbrake system 1
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- Vacuum unit 10

FRONT BRAKES

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REAR BRAKES

- Drum brakes 15
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- Brake discs 28
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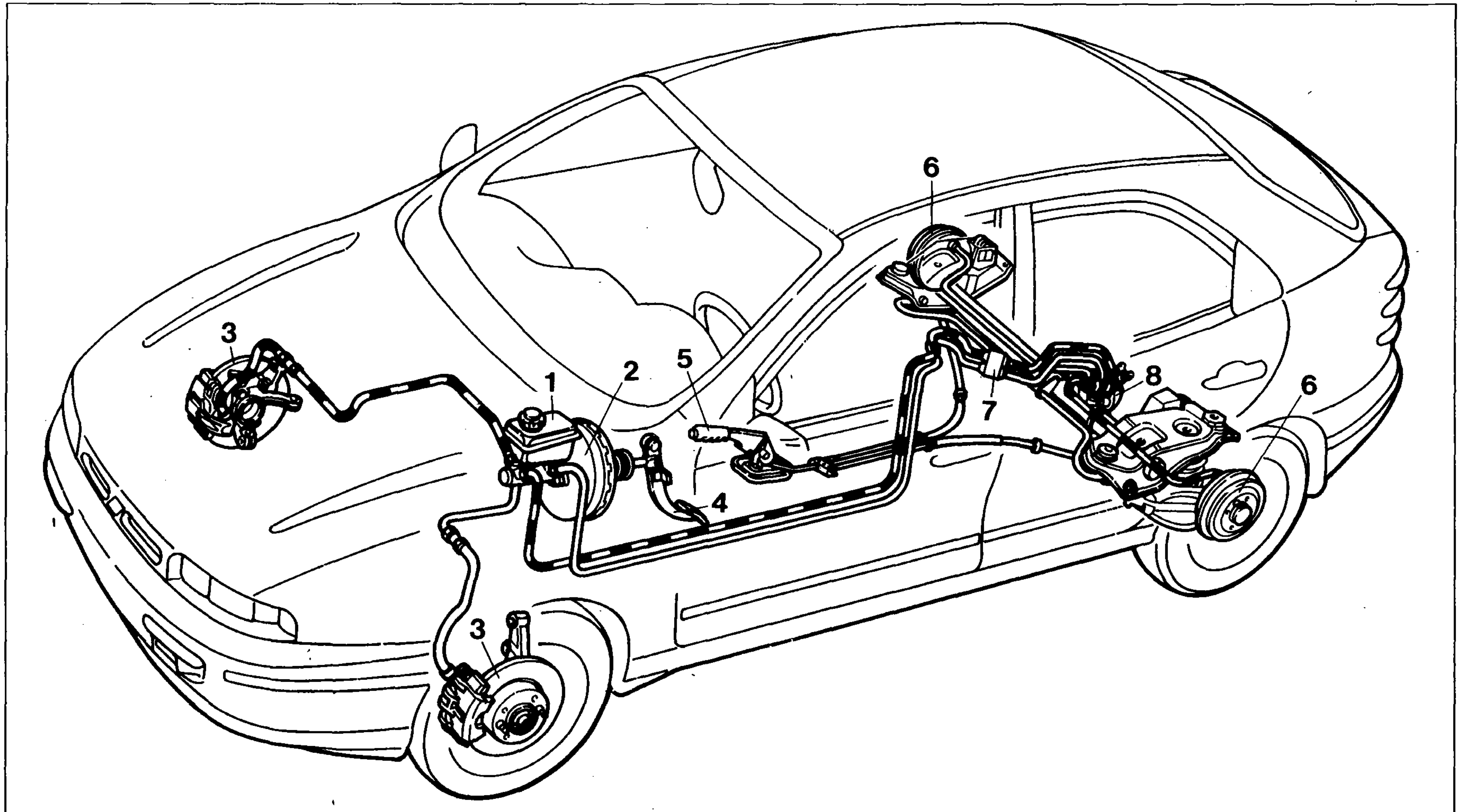
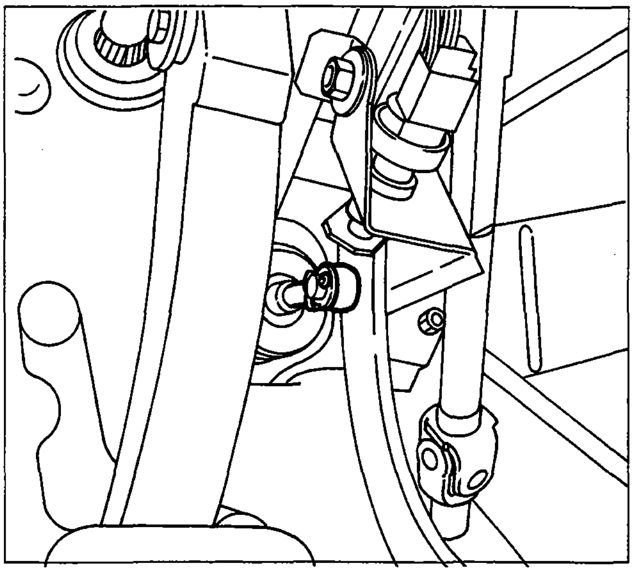
- Brake pressure proportioning valve 31
- Handbrake 32

D'AGRAM OF HYDRAULIC BRAKING SYSTEM (FRONT DISC BRAKES AND REAR DRUM BRAKES) AND MECHANICAL HANDBRAKE SYSTEM



1. Brake fluid reservoir and pump for independent brake circuits
2. Vacuum servo unit
3. Front disc brakes
4. Brake pedal
5. Handbrake lever
6. Rear drum brakes
7. Four-way distributor
8. Brake pressure proportioning valve



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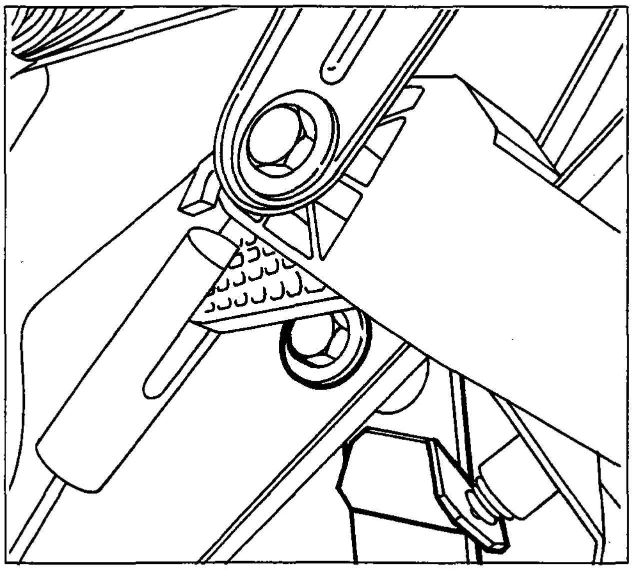
BRAKE PEDAL

Removing-refitting

To remove the brake pedal, proceed as follows:
- remove the split pin and withdraw the servo unit pushrod from the pin on the brake pedal;



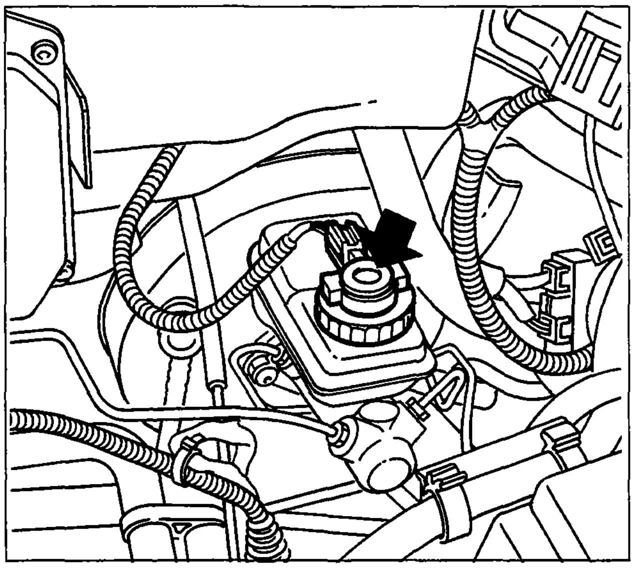
P4A002D02

- raise the clutch pedal, undo the bolt and remove the brake pedal;

P4A002D03

NOTE *To refit the brake pedal, reverse the procedure for removal.*

Lubricate the parts concerned with grease before final assembly.

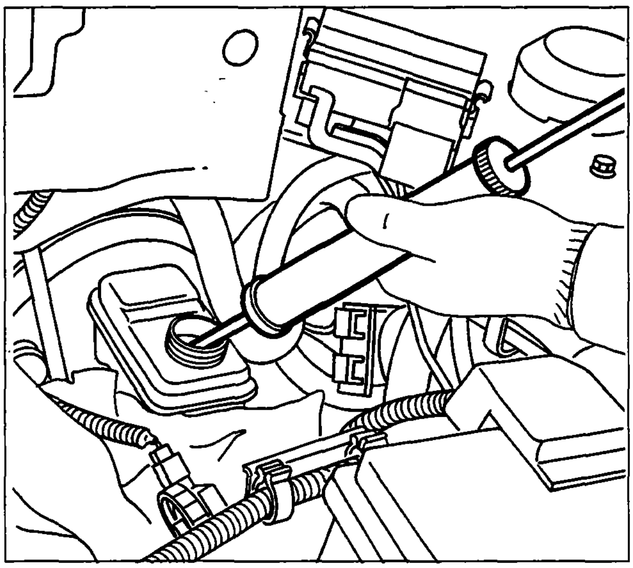


P4A003D01

BRAKE FLUID RESERVOIR

Checking low brake fluid level indicator

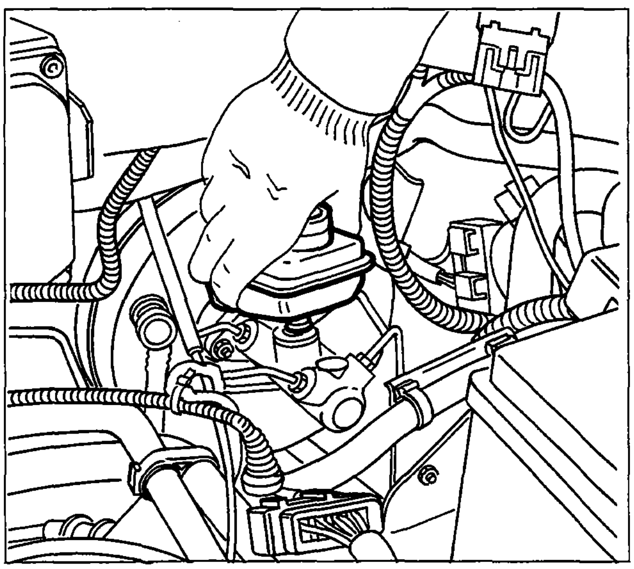
NOTE *Periodically check the operation of the indicator by pressing on the top of the reservoir cover (as shown by the arrows); with the ignition ON, the braking system fault warning light should come on.*



P4A003D02

Removing-refitting

To remove the brake fluid reservoir, proceed as follows:
- disconnect the sensor connector and undo the cap;
- remove the brake fluid from the reservoir, using the special syringe;



P4A003D03

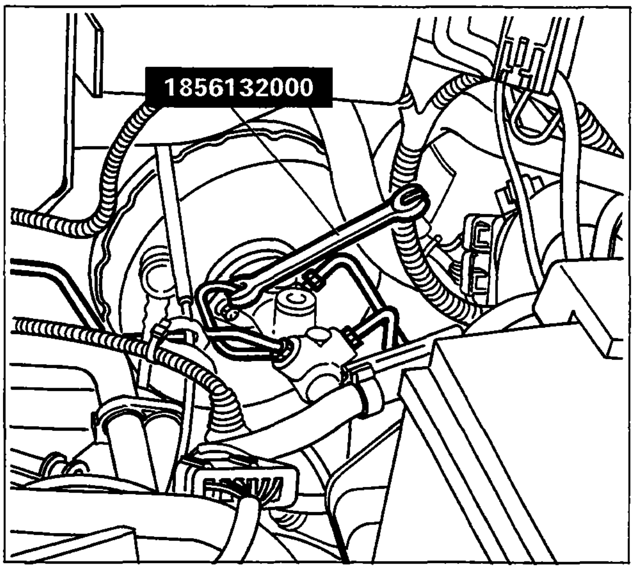
- pull the reservoir upwards to remove it.

Take care should any residual fluid emerge from the reservoir.

NOTE *To refit the brake fluid reservoir, reverse the procedure for removal.*

Before filling the reservoir, make sure that it is thoroughly clean.

Bleed the hydraulic system

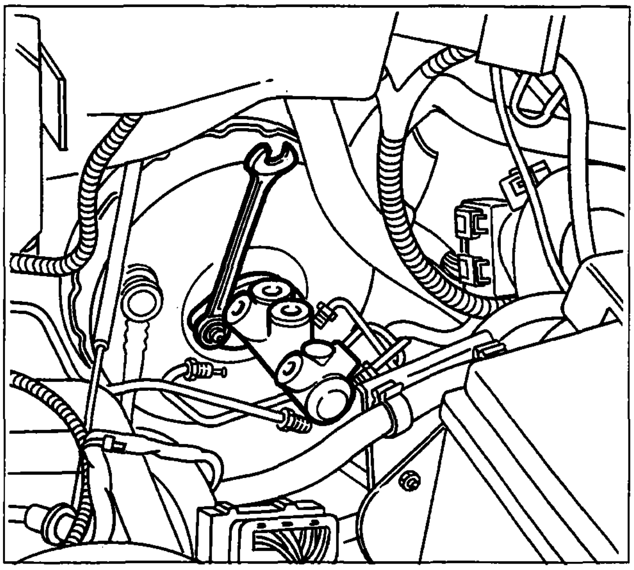


P4A004D01

BRAKE PUMP

Removing-refitting

To remove the brake pump, proceed as follows:
- undo the brake pipe connectors using tool 1856132000, so as not to damage them;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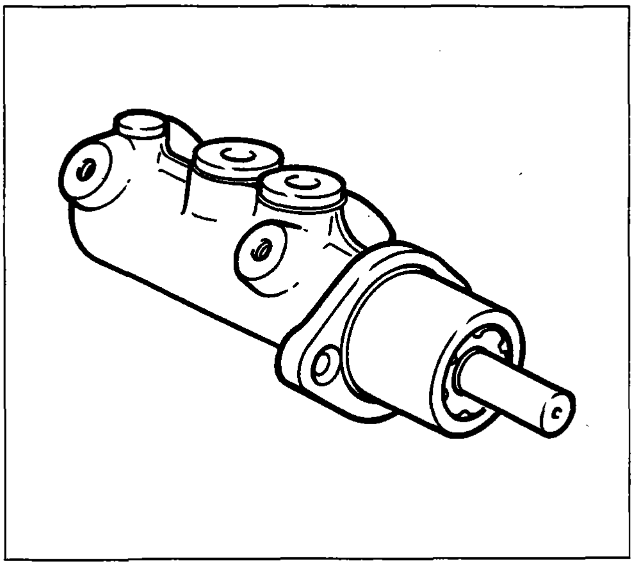
- undo the nuts and remove the brake pump.

Bleed the braking system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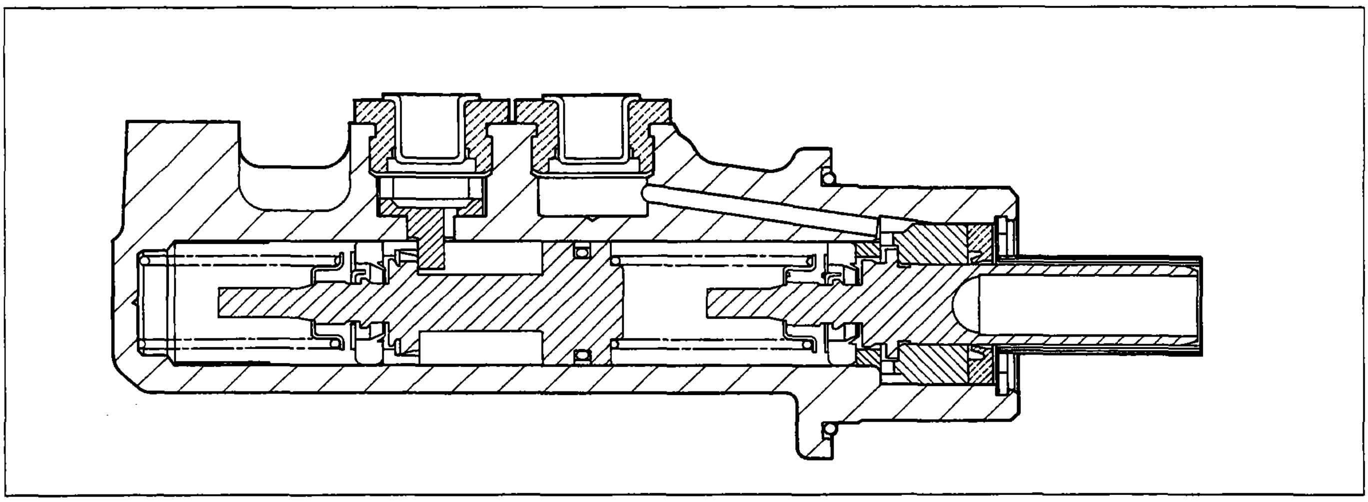
Dismantling-reassembly

When overhauling the brake pump, replace the sealing rings; if there are traces of friction or seizure on the pump casing, replace the complete brake pump.



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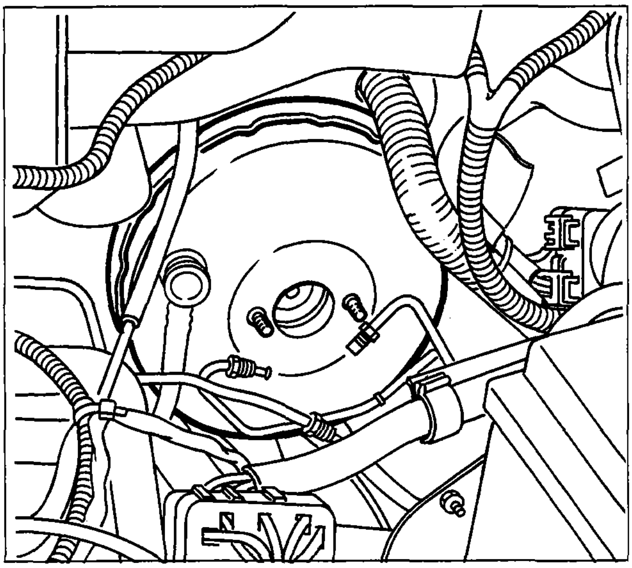
Longitudinal section of brake pump



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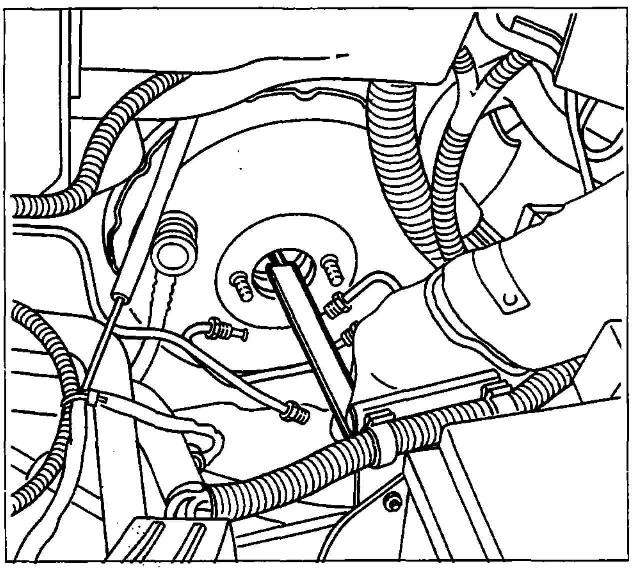
SERVO UNIT

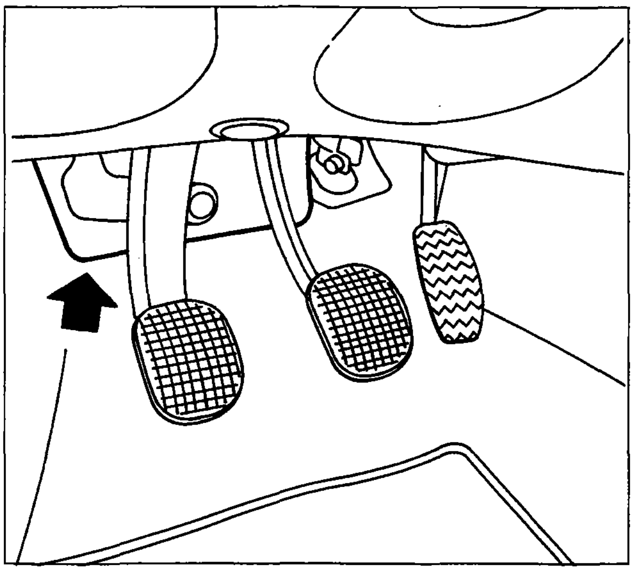
Servo unit mounted on the car



P4A005D03

Checking hydraulic pushrod recess using a depth gauge

NOTE *The servo unit is adjusted using the adjustment screw located on the end of the rod.*
At the rest position, the end of the adjustment screw should be recessed by 22.45 - 22.65 mm in relation to the plane of the front cover.



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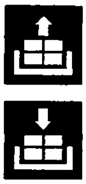
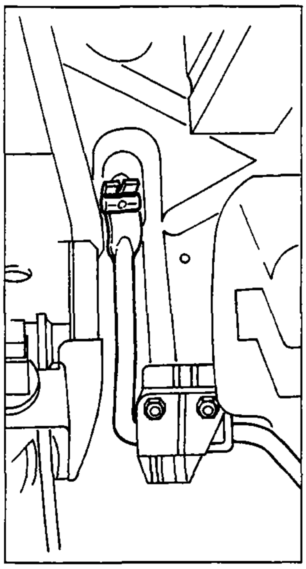


Removing-refitting

To remove the servo unit, proceed as follows:

NOTE *The arrows shows the sound-proofing panel. To facilitate dismantling, remove the accelerator pedal, whose attachment plate rests on the sound-proofing panel.*



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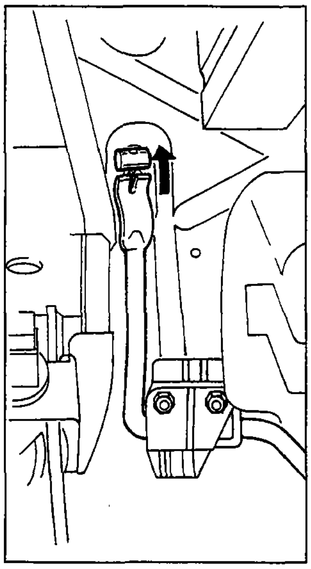

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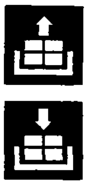
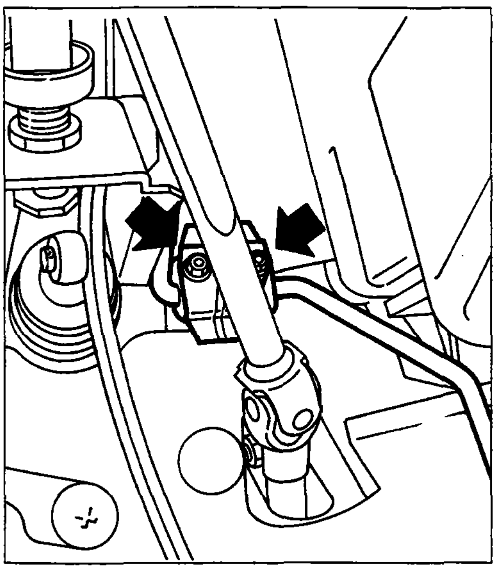


- disconnect the accelerator cable from its pedal;



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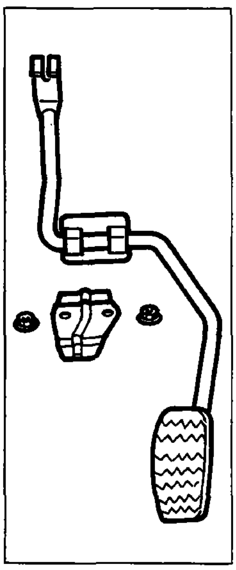

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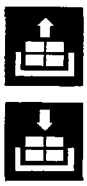
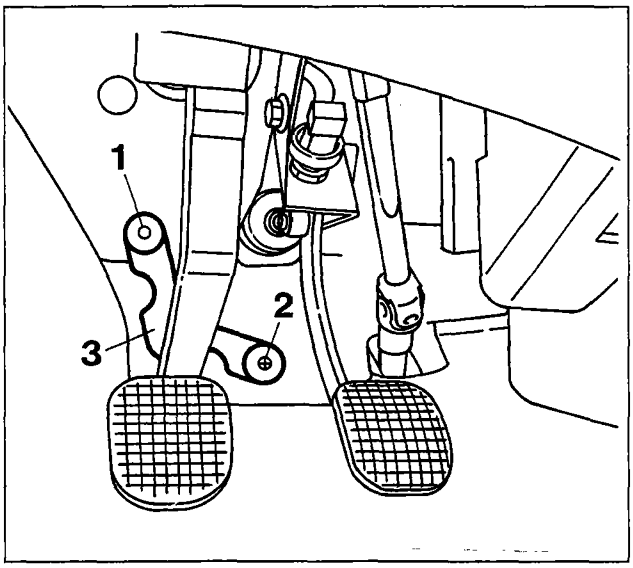


- undo the nuts and remove the attachment plate and the accelerator pedal;

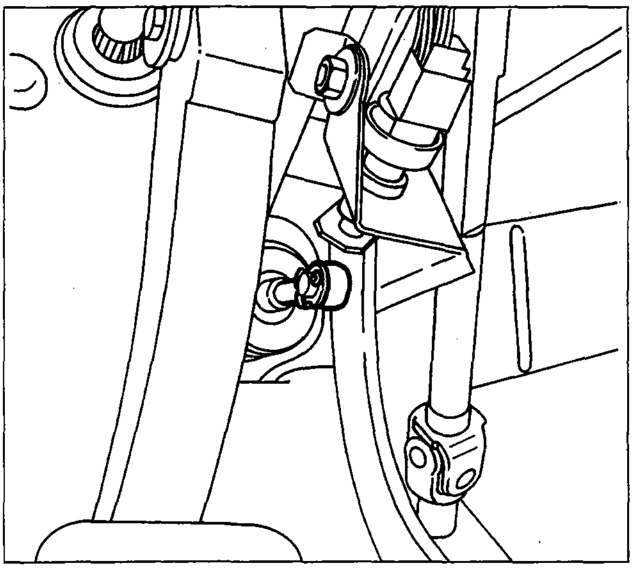


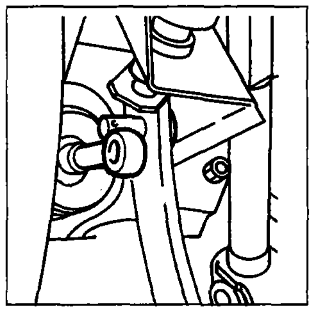
P4A007D01

- remove the attachment buttons (1) and (2) on the sound-proofing panel;

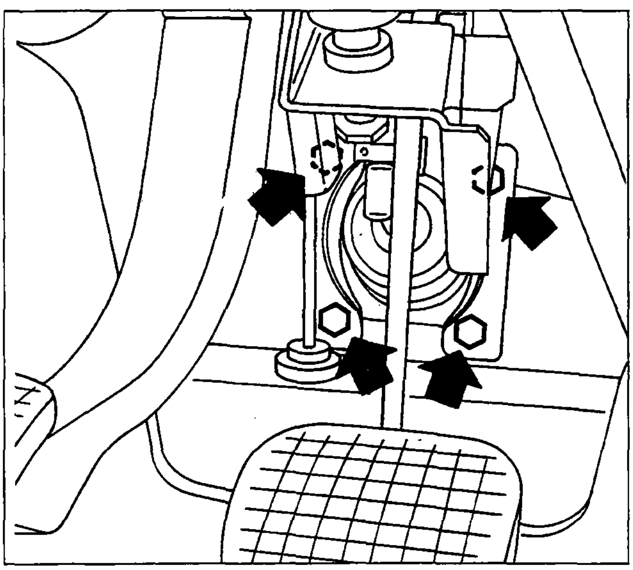
NOTE *The button (1) cannot be reused, so during assembly, after fitting the plate (3), a new button should be fitted.*

The sound-proofing panel need not be fully removed; it is sufficient to move it over to the right to permit access to the servo unit's attachment nuts.

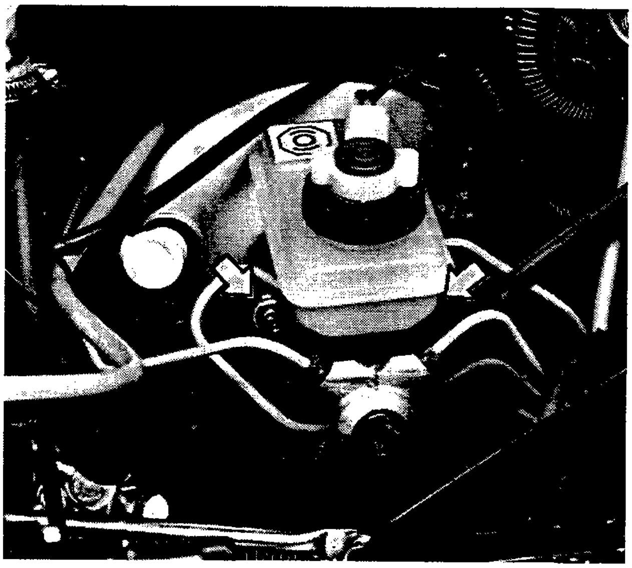

P4A007D02


P4A007D03

- withdraw the split pin to release the servo unit pushrod from the pin located on the pedal;

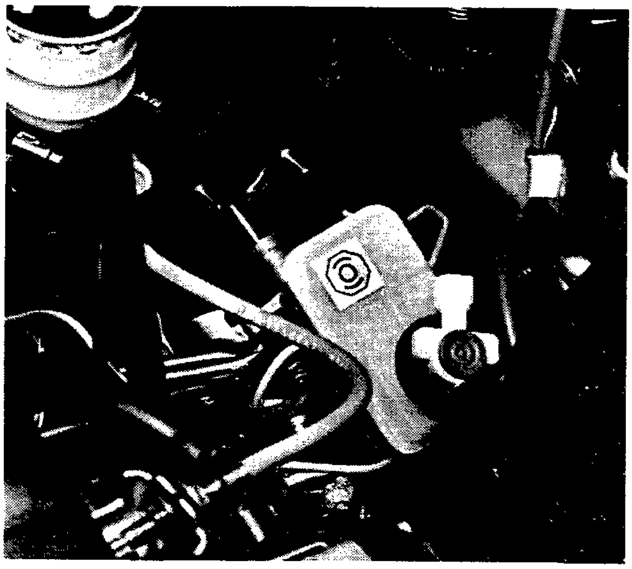

P4A007D04

- undo the servo unit nuts (arrowed) from the pedal assembly mounting;



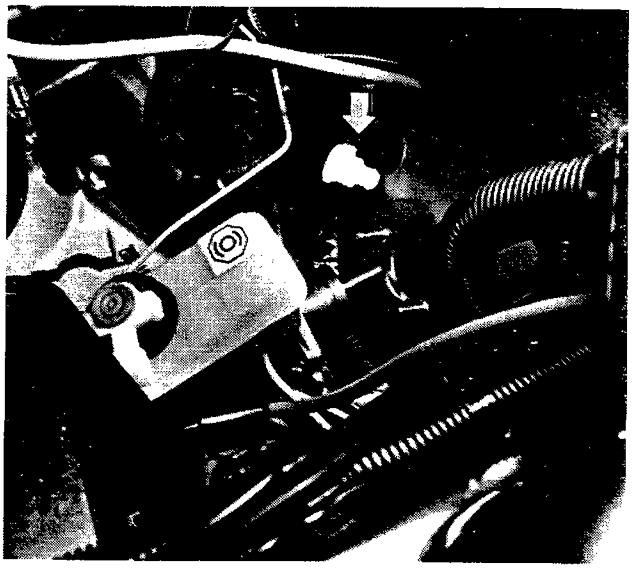
P4A008D01

- undo the nuts securing the brake pump to the servo unit;



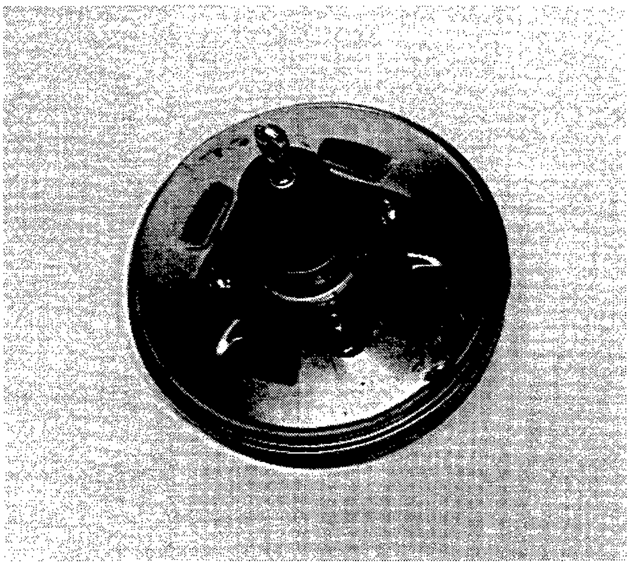
P4A008D02

- withdraw the brake pump complete with reservoir from the servo unit and rest it in the engine compartment to facilitate the removal-refitting of the servo unit;



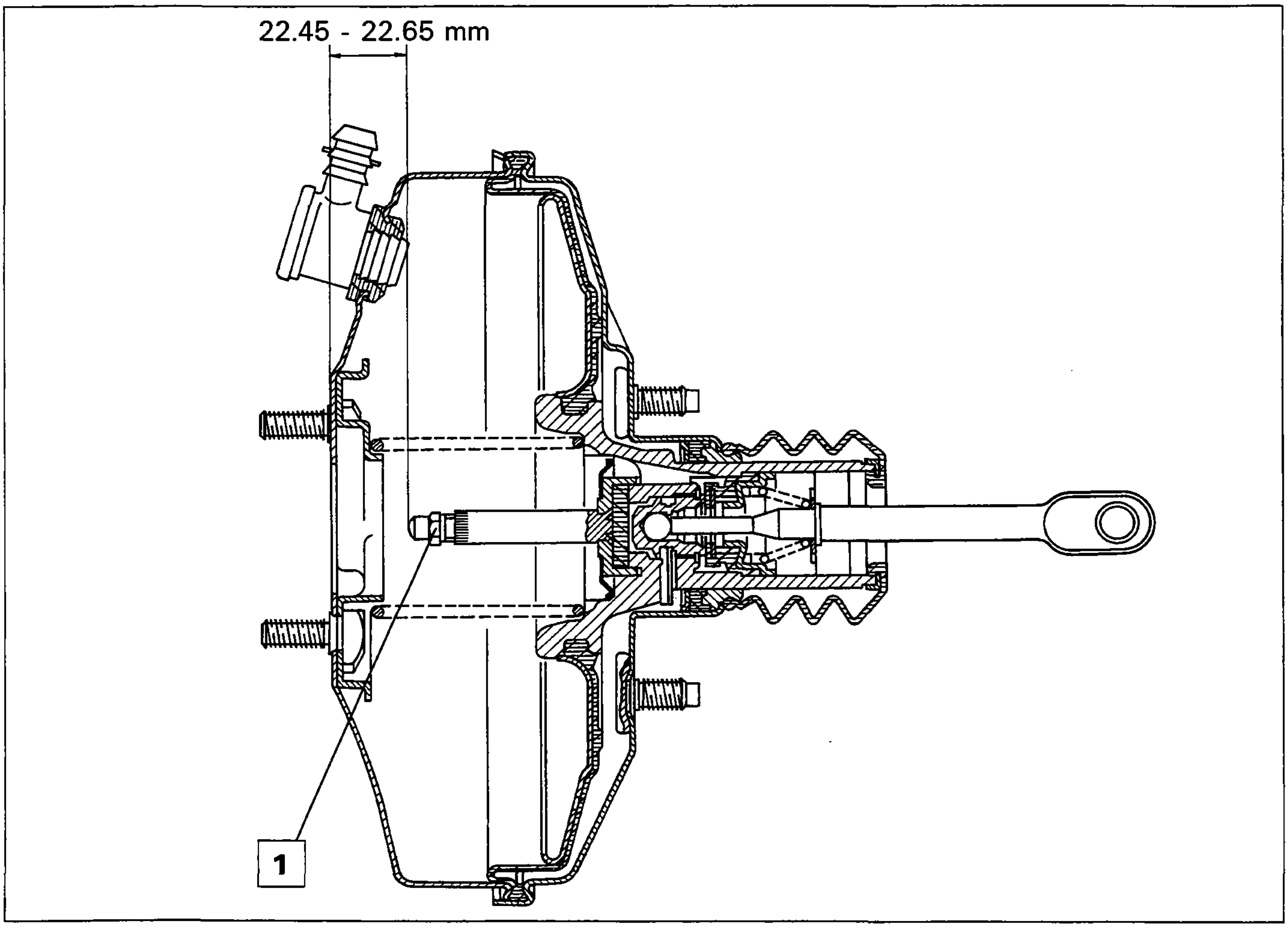
P4A008D03

- disconnect the vacuum connection pipe (arrowed) and withdraw the servo unit from inside the engine compartment.



P4A009D01

View of servo unit from attachment side to pedal assembly mounting

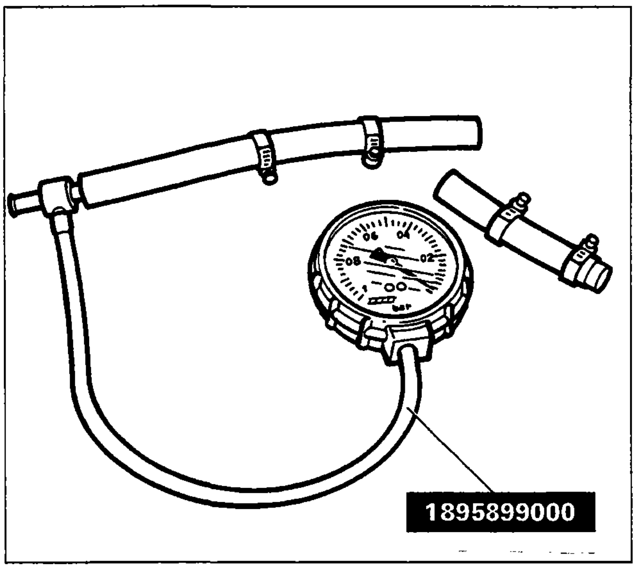


P4A009D02

Longitudinal section of Iso-Vac 8" servo unit

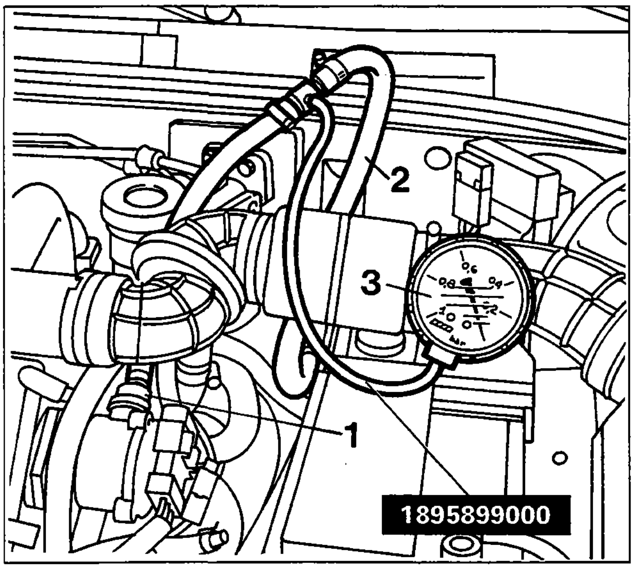
22.45 - 22.65 mm = Distance between hydraulic piston pushrod and brake pump contact plate. If necessary, adjust nut (1) to obtain correct adjustment of the servo unit.

VACUUM UNIT



P4A010D01

Vacuum gauge with connections for checking operation of vane-type vacuum unit

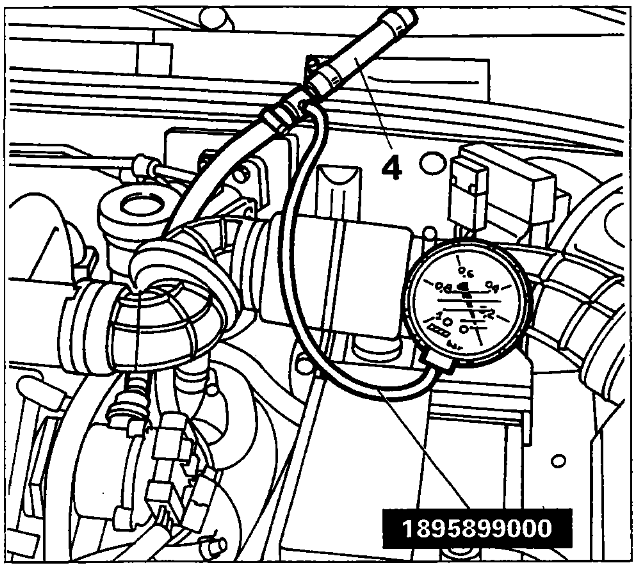


P4A010D02

Checking operating faults

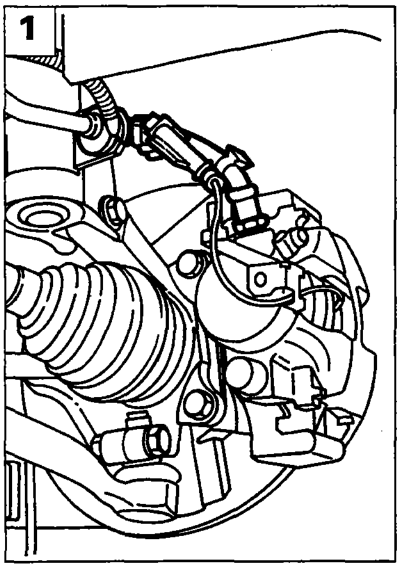
If the braking system is faulty, before replacing the vacuum unit, the vacuum circuit should be checked completely in accordance with the following procedure:

- with the engine off, empty the brake vacuum circuit fully by pressing the brake pedal to the floor several times;
- fit the vacuum gauge 1895899000 (3) between the one-way valve located on the vacuum unit (1) and the servo unit connecting pipe (2) (as shown in the drawing opposite);
- start the engine; after running the engine at idling speed for 20 seconds, the vacuum reading on the vacuum gauge (3) should be over 0.6 bar.

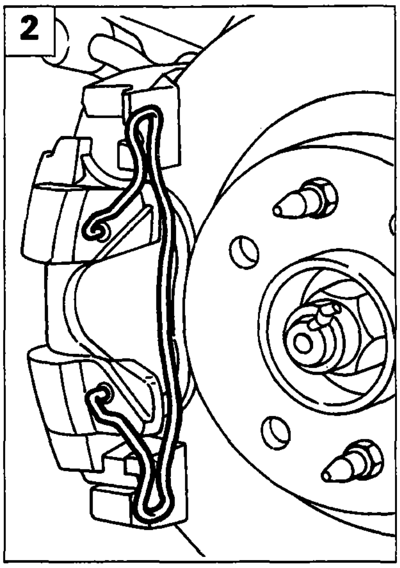


P4A010D03

If the vacuum is under 0.6 bar, the servo unit connecting pipe (2) should be disconnected and the free end should be plugged with the special plug (4).
Re-start the engine; after running the engine at idling speed for 20 seconds, the vacuum reading on the vacuum gauge should be over 0.6 bar.
If it is, the fault should be sought in the air circuit or the servo unit.
If not, the vacuum unit is faulty and should be replaced.



P4A011D01



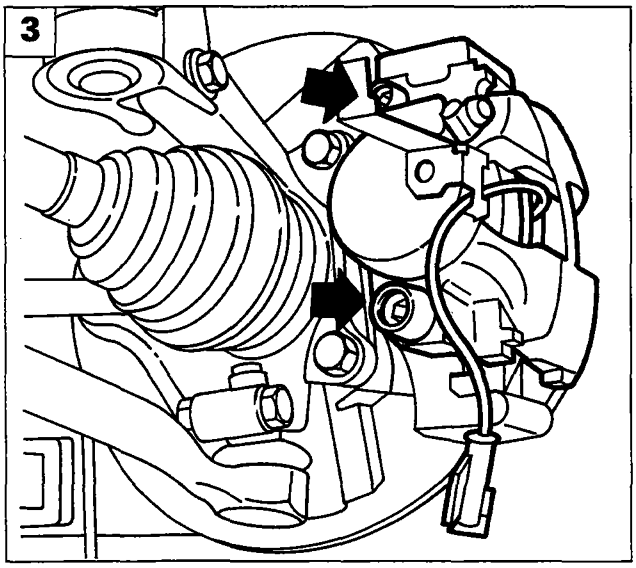
P4A011D02

REMOVING-REFITTING

Dismantle the components of the braking system as described below:
1. disconnect the brake hose using tool 1856132000 on the connectors; disconnect the brake pad wear sensor wiring connector;

NOTE *The hose must not be swollen or cracked, otherwise it must be replaced.*

Wehn refitting the brake hose, check that the mounting rubber is positioned correctly to prevent the pipe coming into contact with the wheelarch or mechanical parts of the car, whatever the travel or turning angle of the wheels.

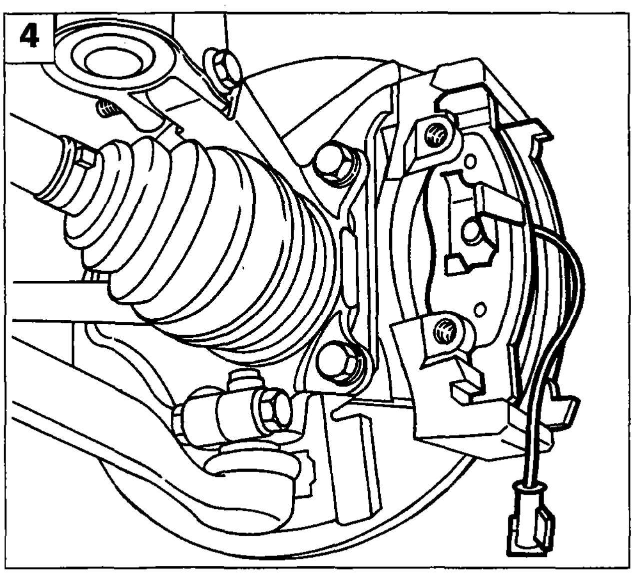


P4A011D03

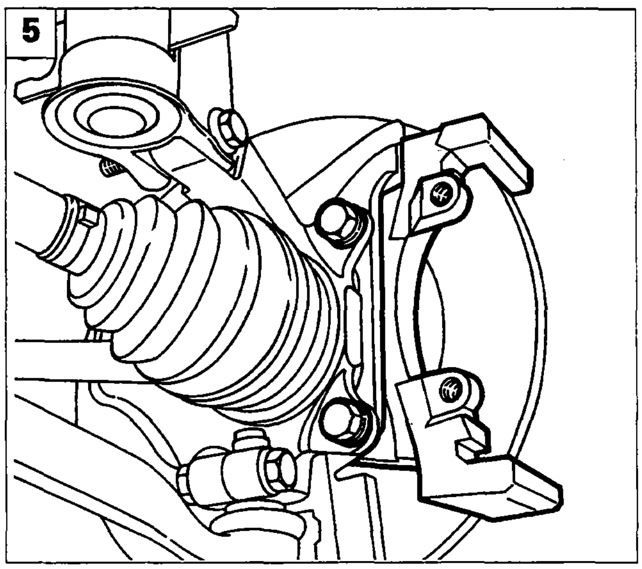
2. remove the retaining spring;
3. undo the bolts and remove the brake caliper;

The caliper case attachment bolts are self-locking and should always be renewed whenever they are slackened or unscrewed.

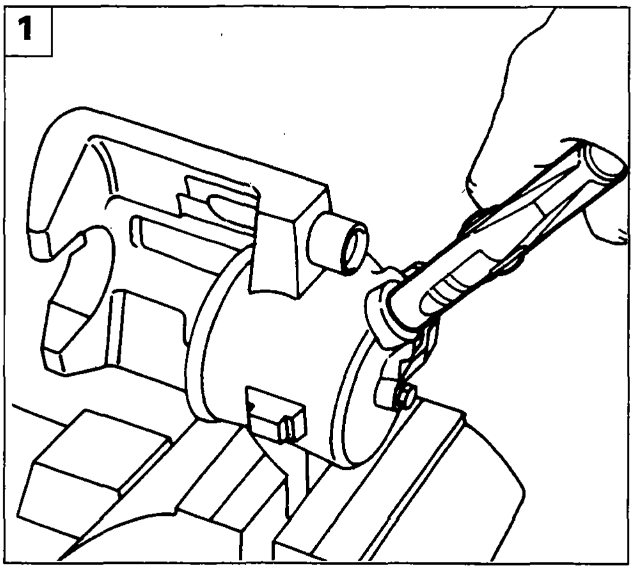
4. remove the brake pads;
5. undo the bolts securing the caliper mounting bracket and remove the latter.



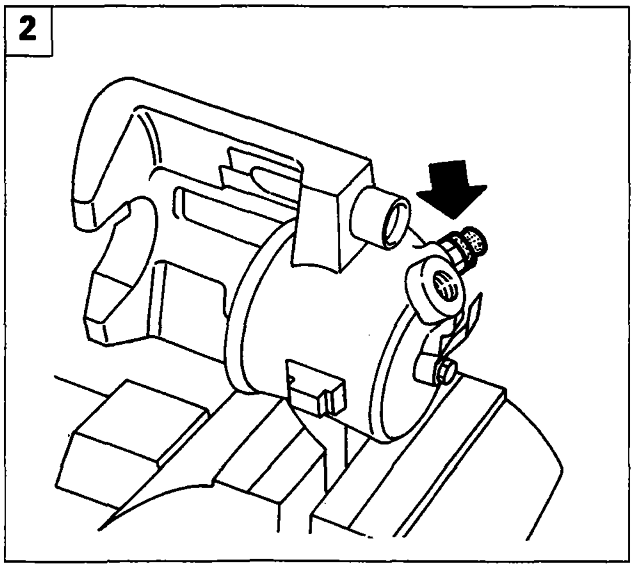
P4A011D04



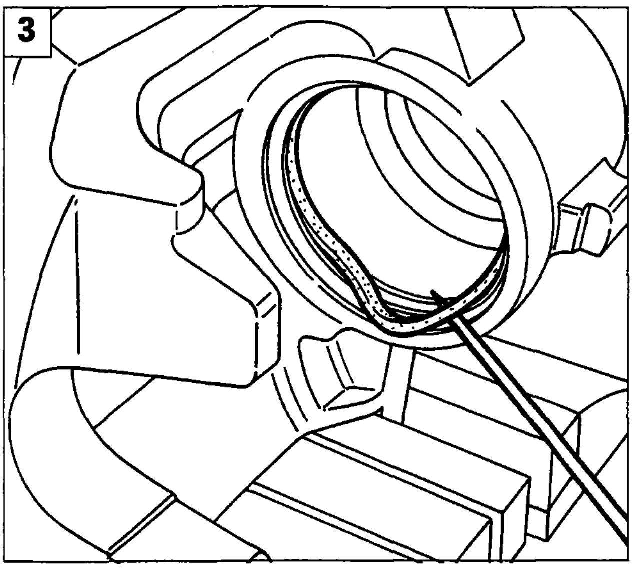
P4A011D05



P4A012D01



P4A012D02



P4A012D03

BRAKE CALIPER

Dismantling-reassembly

Place the caliper in a vice, fitting the protections, then proceed as described below:

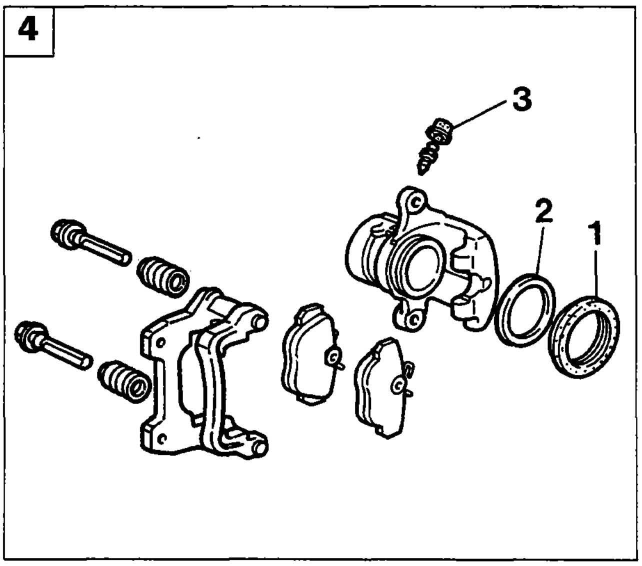
1. direct a jet of compressed air into the brake fluid inlet hold in order to dismantle the piston from the caliper case;
2. undo the air bleed screw and remove it;
3. remove the seal;
4. check the components; the piston and caliper case must not show signs of friction or seizure; if they do, the caliper complete with piston should be replaced. It is nevertheless always necessary to replace the dust excluder (1) and seal (2), and to check that the bleed screw (3) is not blocked.

Use a solution of FIAT LDC detergent in hot water to wash the metal parts.

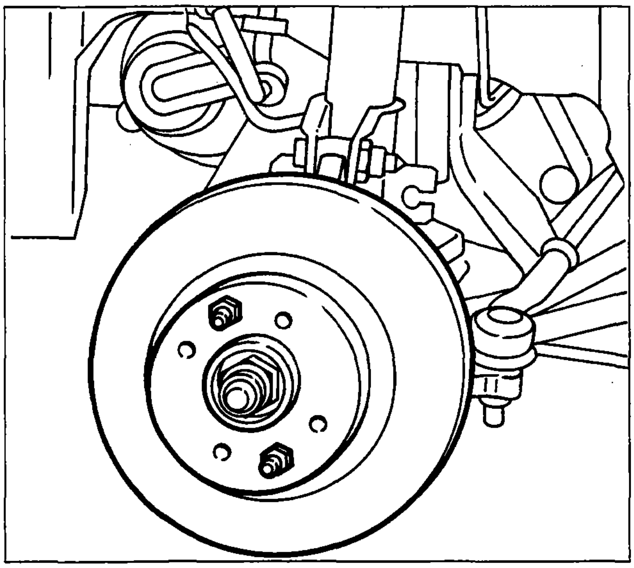
NOTE *To refit the brake caliper, reverse the procedure for removal.*

Lubricate the parts concerned with brake fluid before final assembly.

Before fitting the piston in the caliper case, fit the dust excluder on the rear end of the piston. Insert the piston gradually, taking care not to damage the dust excluder.



P4A012D04

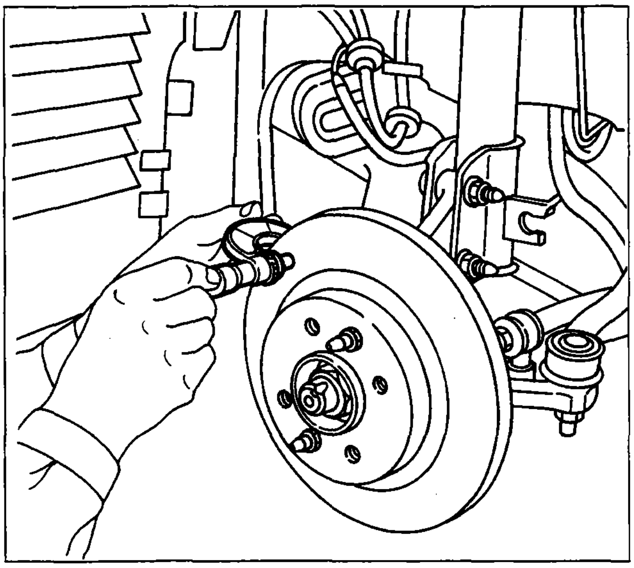


P4A013D01

BRAKE DISCS

Dismantling-reassembly

Undo the brake disc attachment bolts and remove the disc. When refitting, eliminate any traces of rust to ensure that the disc is perfectly perpendicular to the hub.



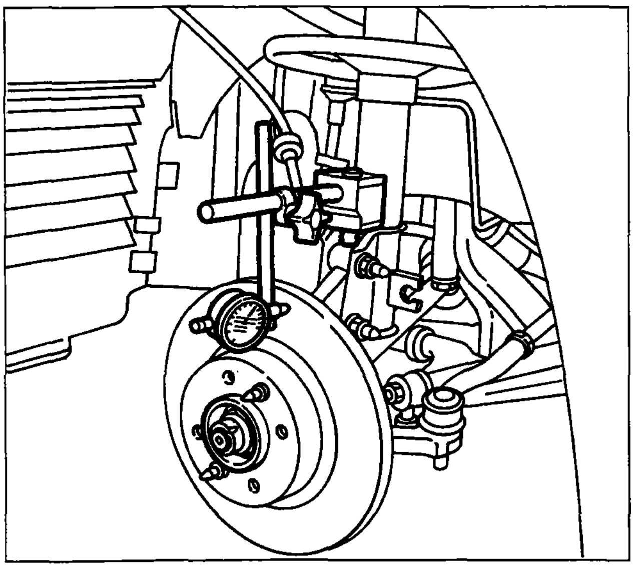
P4A013D02

Checking and measuring disc thickness

The minimum permissible brake disc thickness after wear is indicated in the table; if the measured value is less than the value in the table, the disc should be renewed.
In the case of damage or deep scoring, the brake disc surfaces can be skimmed; after skimming, the brake disc thickness must not be less than the value stated in the table;

Brake disc thickness (values in mm)

	1370 12v 1581 16v 1929 D	1747 16v 1998 20v 1910 TD
after wear	10.2	20.20
after skimming	11.1	20.55



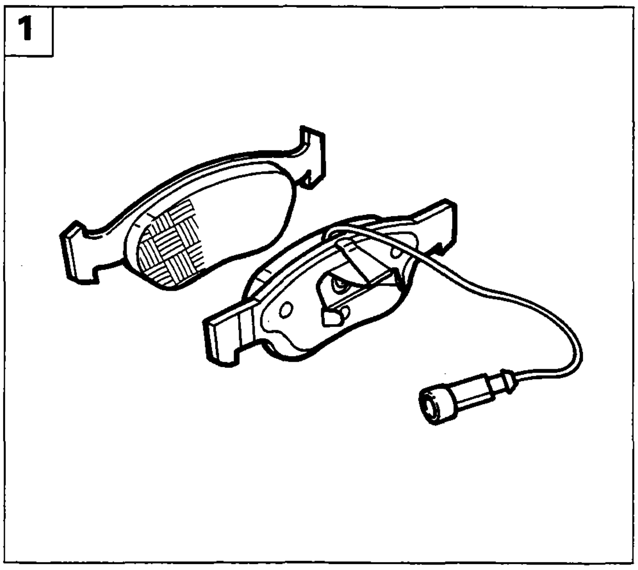
P4A013D03

Checking brake disc run-out

Also check that the run-out does not exceed 0.15 mm; this should be checked 2 mm from the disc's outer diameter.

33.

BRAKE PADS



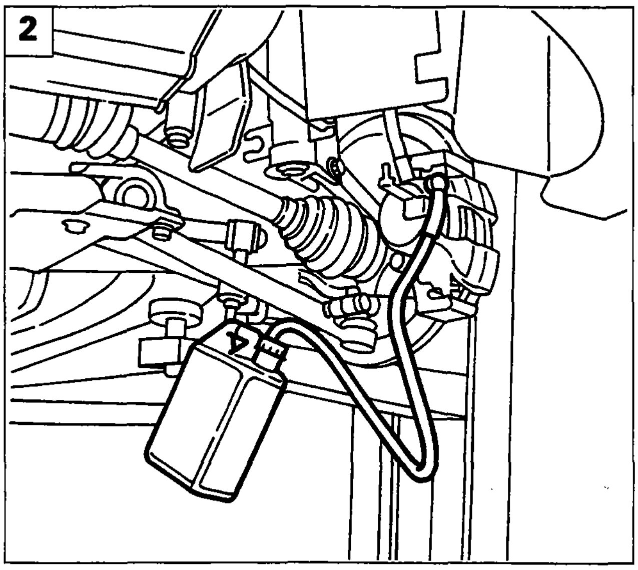
P4A014D01

Check

1. The brake pads must be renewed if the thickness of the friction material is less than 1.5 mm.

Check that brake pads of the same type are fitted to each pair of wheels.

BLEEDING



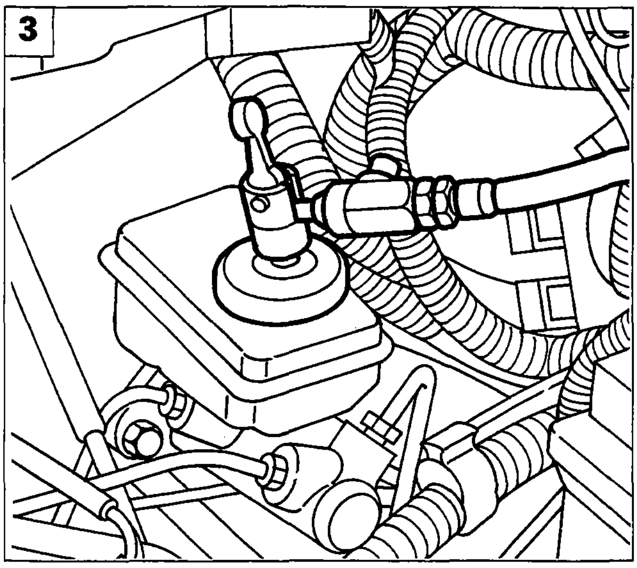
P4A014D02

2. Manual bleeding.

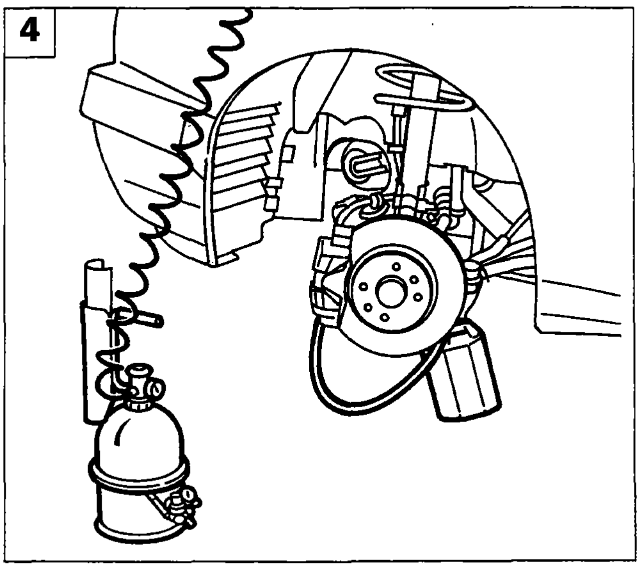
The old brake fluid should not be reused.
Top up the level with fresh brake fluid.

Bleeding with Jollyfren device

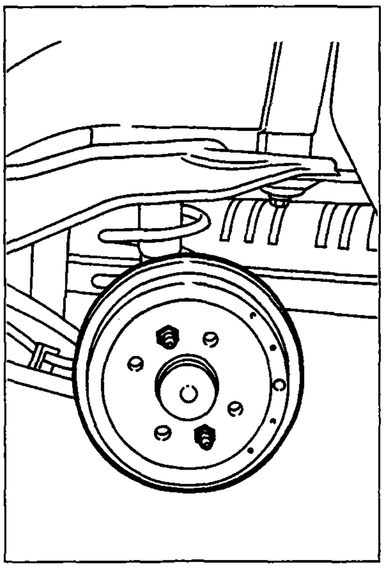
3. Connect the device's pipe to the brake fluid reservoir;
4. connect the device to the compressed air pipe and bleed the system as described in the device's instructions sheet.



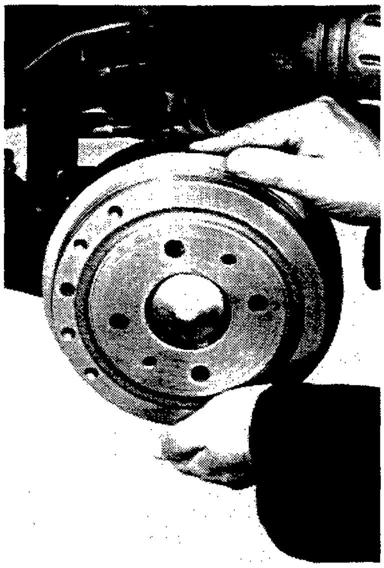
P4A014D03



P4A014D04



P4A015D01



P4A015D02

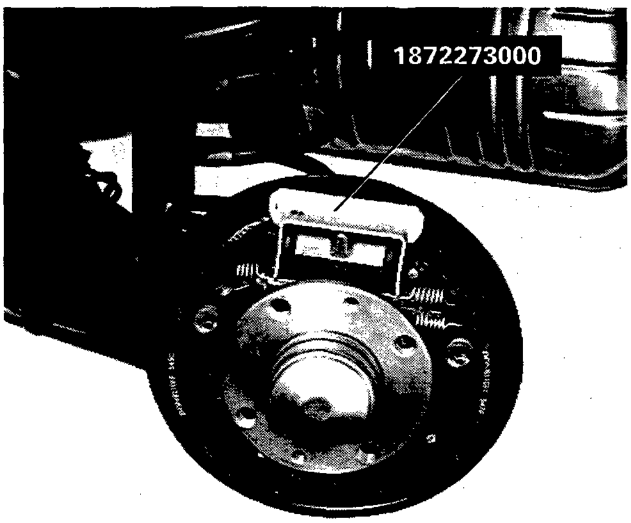
DRUM BRAKES

Removing-refitting

To dismantle the rear drum brakes, proceed as follows:

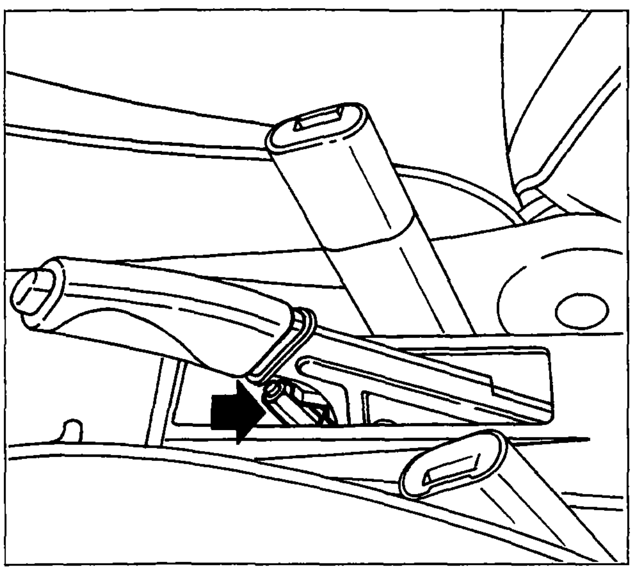
- undo the two bolts and remove the brake drum;

NOTE *Before removing the brake drum, eliminate any traces of rust on the contact surfaces.*



P4A015D03

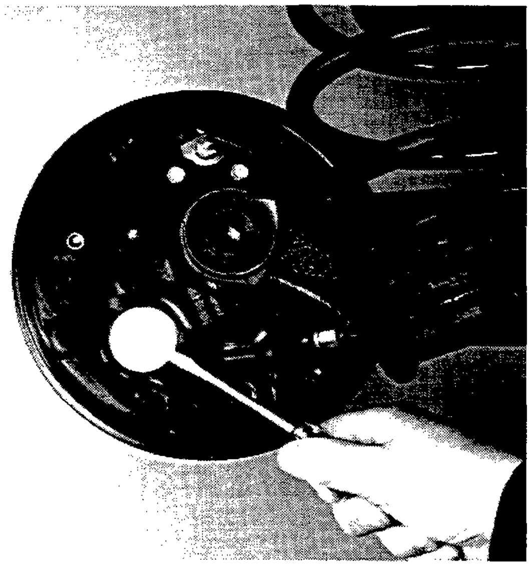
- fit tool 1872273000 to lock the wheel cylinder, to enable the brake shoes to be removed and refitted;



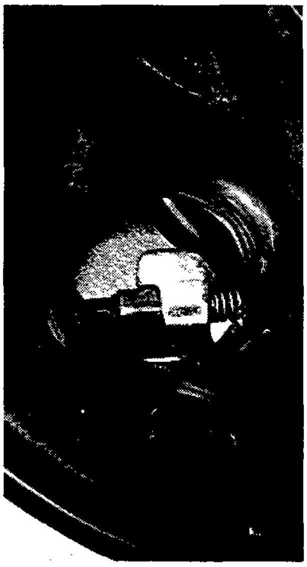
P4A015D04

- slacken the handbrake cable;

33.

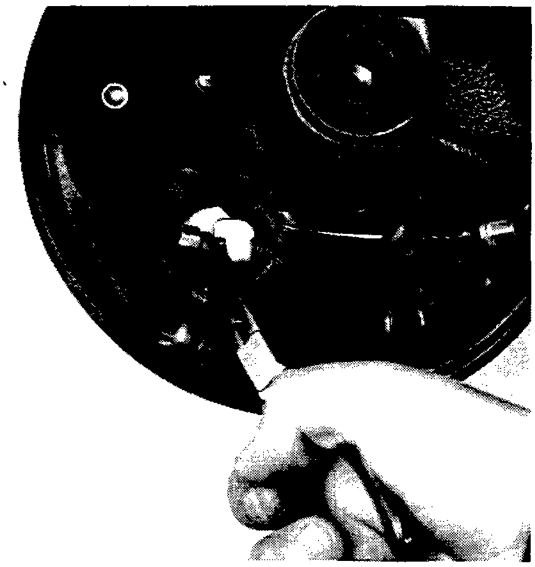


P4A016D01



P4A016D02

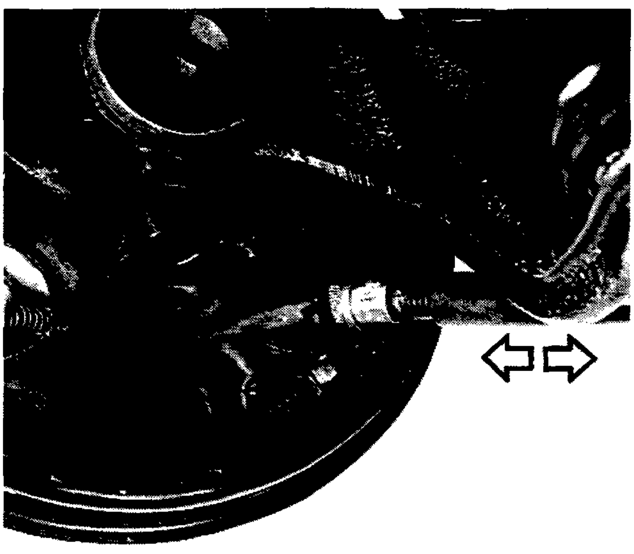
- dismantle the handbrake cable anchorage cover;



P4A016D03

P4A016D04

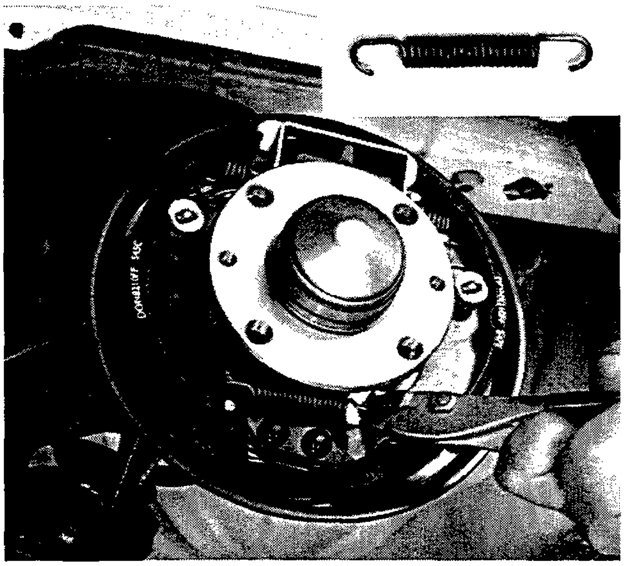
- release the handbrake cable from the anchorage on the handbrake lever;



P4A016D05

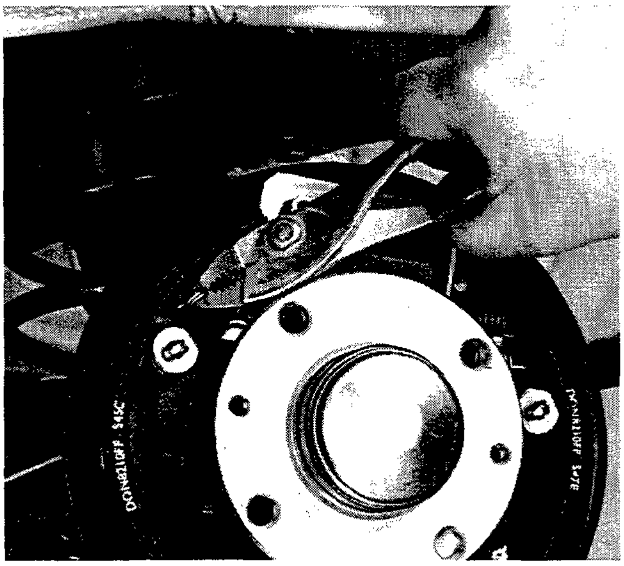
- disconnect the handbrake cable and sheath from the brake backplate;

P4A017D02



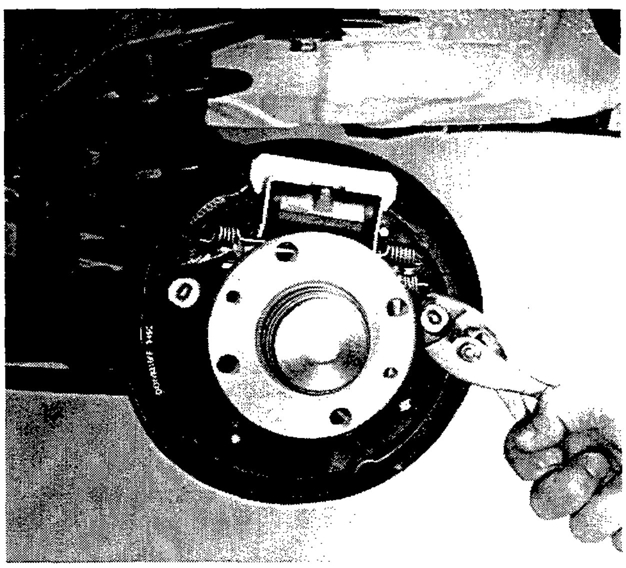
P4A017D01

- remove the lower shoe return spring;



P4A017D03

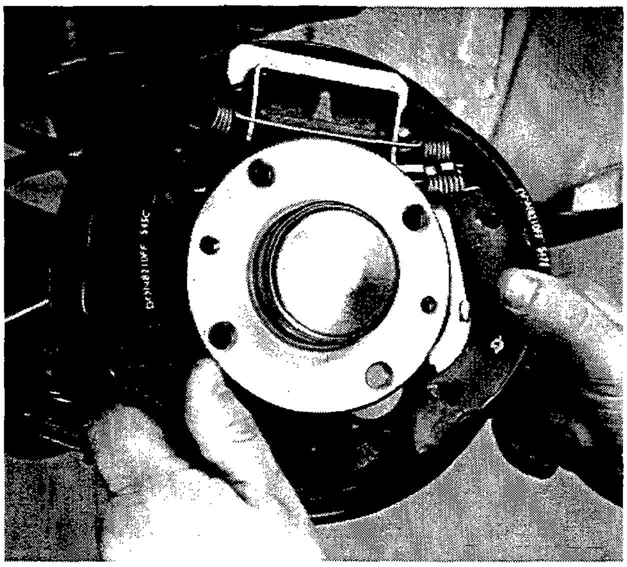
- remove the left self-adjuster spring;



P4A017D04

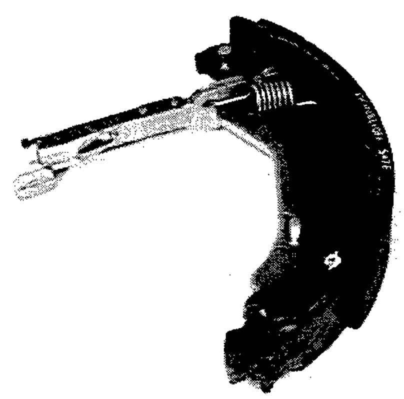
- withdraw the shoe hold-down pins;

33.



P4A018D01

- remove the shoes;

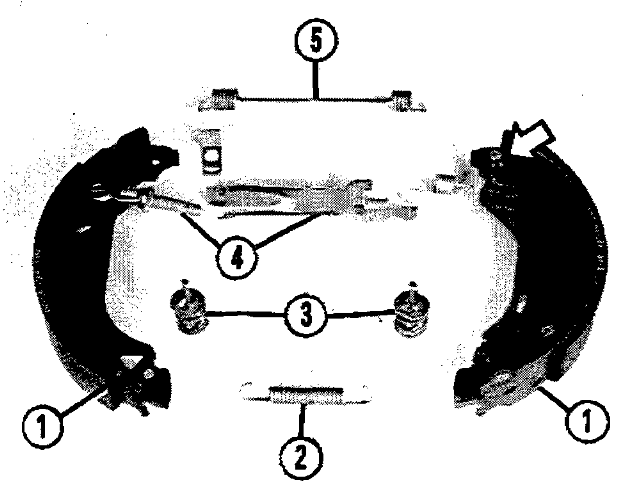


P4A018D02

P4A018D03

- dismantle the self-adjuster from the right shoe.

After refitting, adjust the handbrake by following the procedure described on page 32.



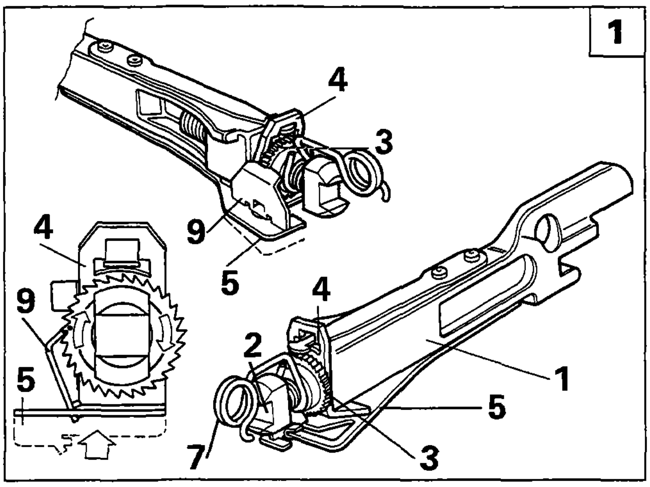
P4A018D04

Rear brake components

1. Shoes
2. Lower shoe return spring
3. Shoe hold-down pin
4. Self-adjuster
5. Upper shoe return spring

NOTE *The arrow shows the washer-clip which must be replaced whenever the shoes are replaced.*

AUTOMATIC ADJUSTER ASSEMBLY FOR RECOVERING SHOE-DRUM CLEARANCE



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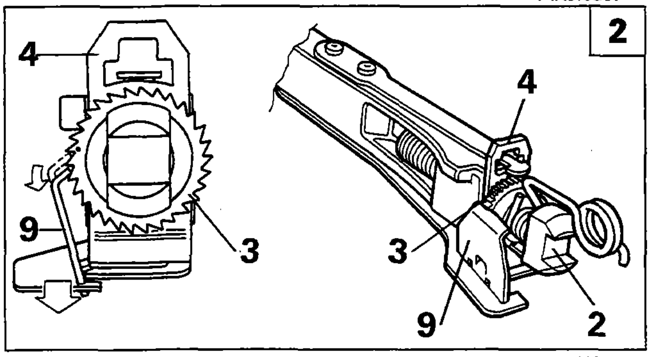
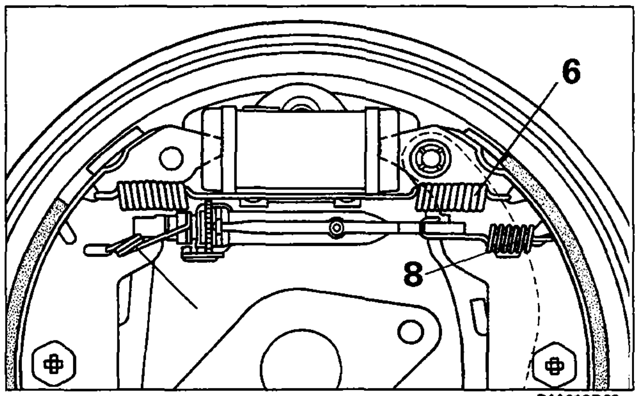


P4A019D03

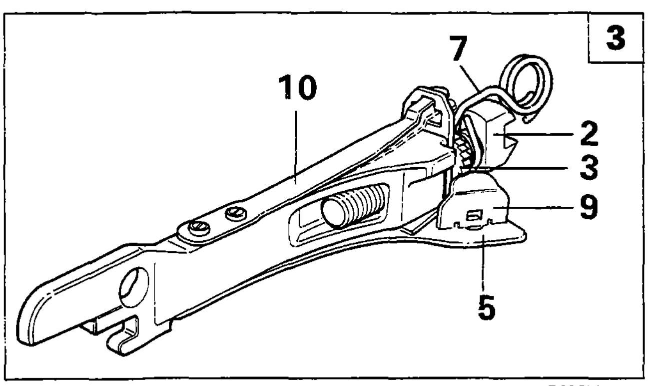


P4A019D02

The distance between the shoes and drum is adjusted automatically by the self-adjuster assembly each time the brakes are operatee, should any adjustment be necessary at that moment.
The device consists of a link rod (1) inside which an adjustment screw (2) freely slides. A ratchet wheel (3) is screwed onto this screw.
In the rest position, the front shoe return spring (6) compresses the automatic adjuster assembly, so the ratchet wheel (3) pushes the frame (4) into contact with the end of the link rod (1).

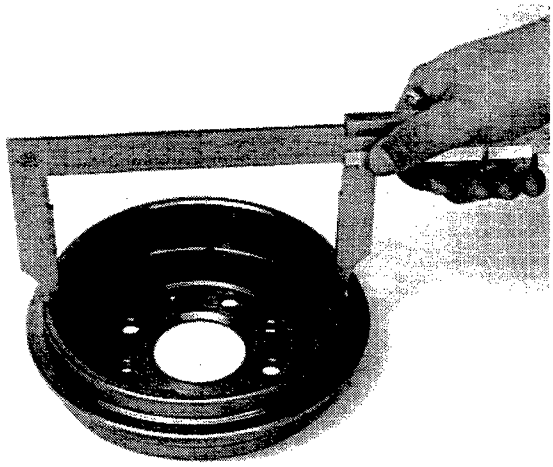
The frame (4) is also subjected to a pushing force from the flexible blade (5). During the braking action the two shoes move apart and come into contact with the drum; the two ends of the adjuster assembly are held in contact with the shoes by means of the springs (7) and (8).
The frame (4) is pushed by the flexible blade (5) against the ratchet wheel (3), and by means of the pawl (9) (permanently in contact with the ratchet wheel), causes it to rotate 1.
During brake release, the automatic adjuster assembly is again compressed by the action of the upper shoe return spring (6); the ratchet wheel (3) stops at the angle assumed during braking. This stop during rotation is caused by the friction between the frame (4) and the ratchet wheel (3). With the ratchet wheel (3) locked during rotation, if the brake linings are sufficiently worn from previous use of the brakes, the pawl (9) slips onto and engages with the next tooth 2. The maximum travel of the ratchet wheel (3) on the adjustment screw (2) is one tooth (0.020 - 0.025 mm). An exception to this is when the brakes bed in after dismantling, when the travel is two teeth (0.04 - 0.05 mm).

If after excessive braking the brakes overheat and the temperature reaches 100° - 110°C, the flexible blade (10) in the adjuster assembly comes into action by bending and locking the frame (4) in a neutral position 3.



P4A019D04

During braking the ratchet wheel (3) is no longer subjected to the pushing action of the flexible blade (5), so the pawl (9) assumes the same angle as the ratchet wheel tooth, which will be free to slide with the adjustment screw (2) on the pawl (9) without compensating for the distance created by the expansion of the drum.
During overhaul, before fitting the brake linings, the ratchet wheel (3) of the adjuster assembly must be brought into contact with the spring (7) and then unscrewed by half a turn.

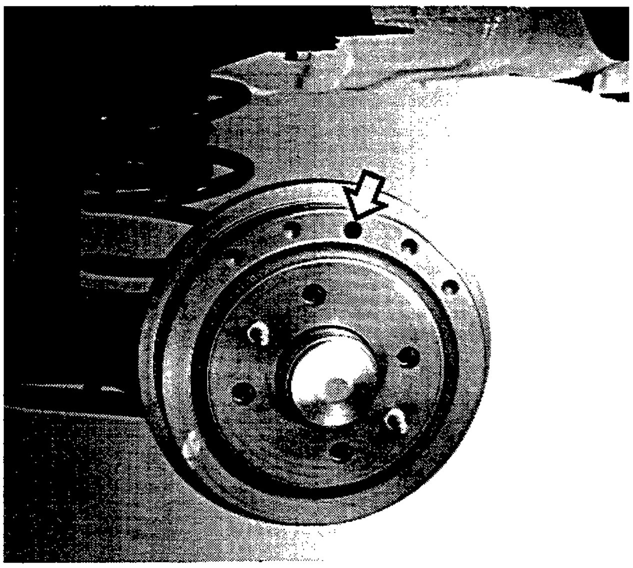


P4A020D01

BRAKE DRUMS

Checking and measuring brake drums

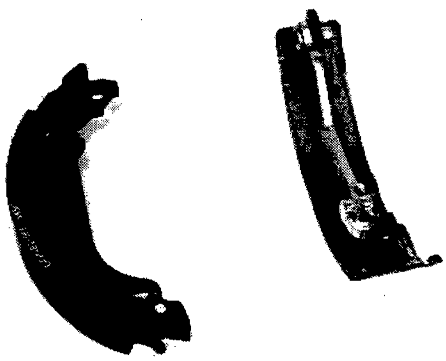
If the brake drums are deeply scored or are unevenly worn, they must be skimmed.
The maximum permitted diameter increase on the brake drums is 0.8 mm.



P4A020D02

Location on brake drum of hole for inspecting thickness of shoe friction material

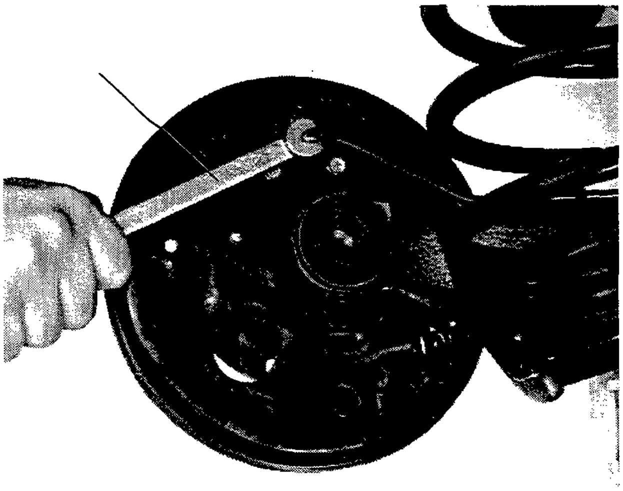
SHOES



P4A020D03

Checking shoe

The minimum permitted thickness of the brake lining is 1.5 mm.

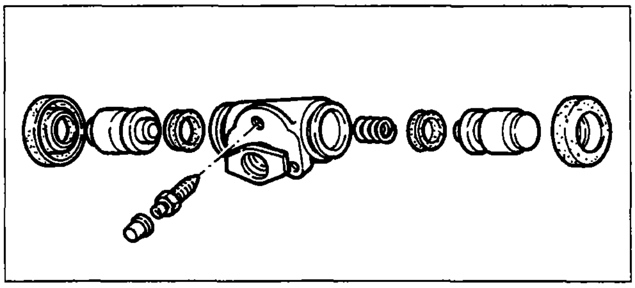


P4A021D01

WHEEL CYLINDER

Removing-refitting

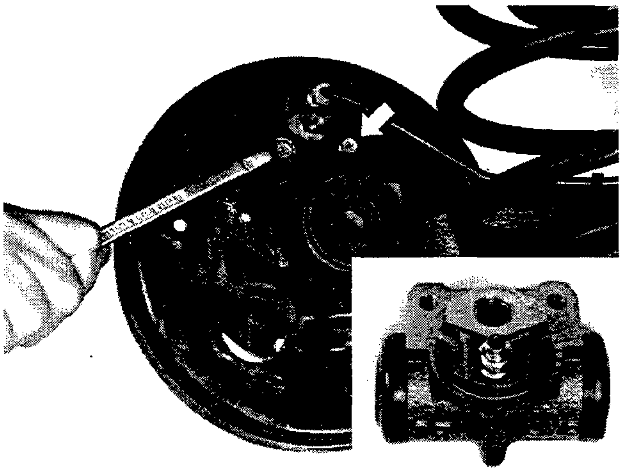
To remove the wheel cylinder, proceed as follows:
- using tool 1856132000, undo the brake pipe connection;
- undo the bolts and remove the wheel cylinder.



P4A021D04

Checking wheel cylinder components

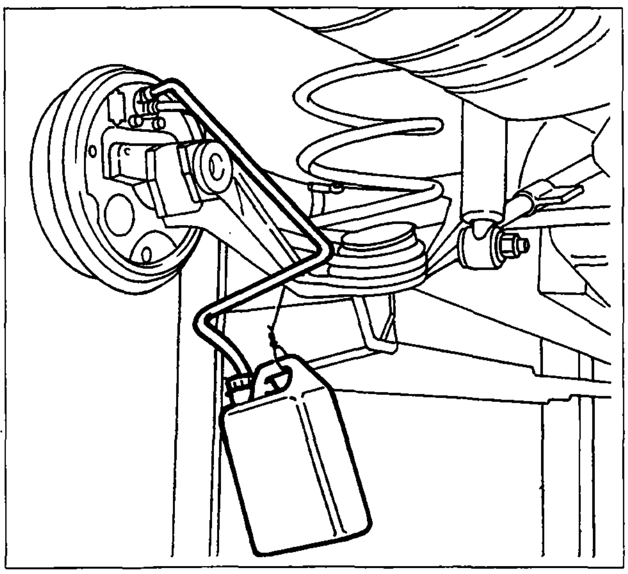
During overhaul, always replace the seals and dust excluders; if the cylinder barrel or pistons show faults, replace the assembly.
Make sure that the bleed screw is not blocked.



P4A021D02 P4A021D03

BLEEDING

Do not re-use the old fluid.
The level should be topped up with fresh brake fluid.



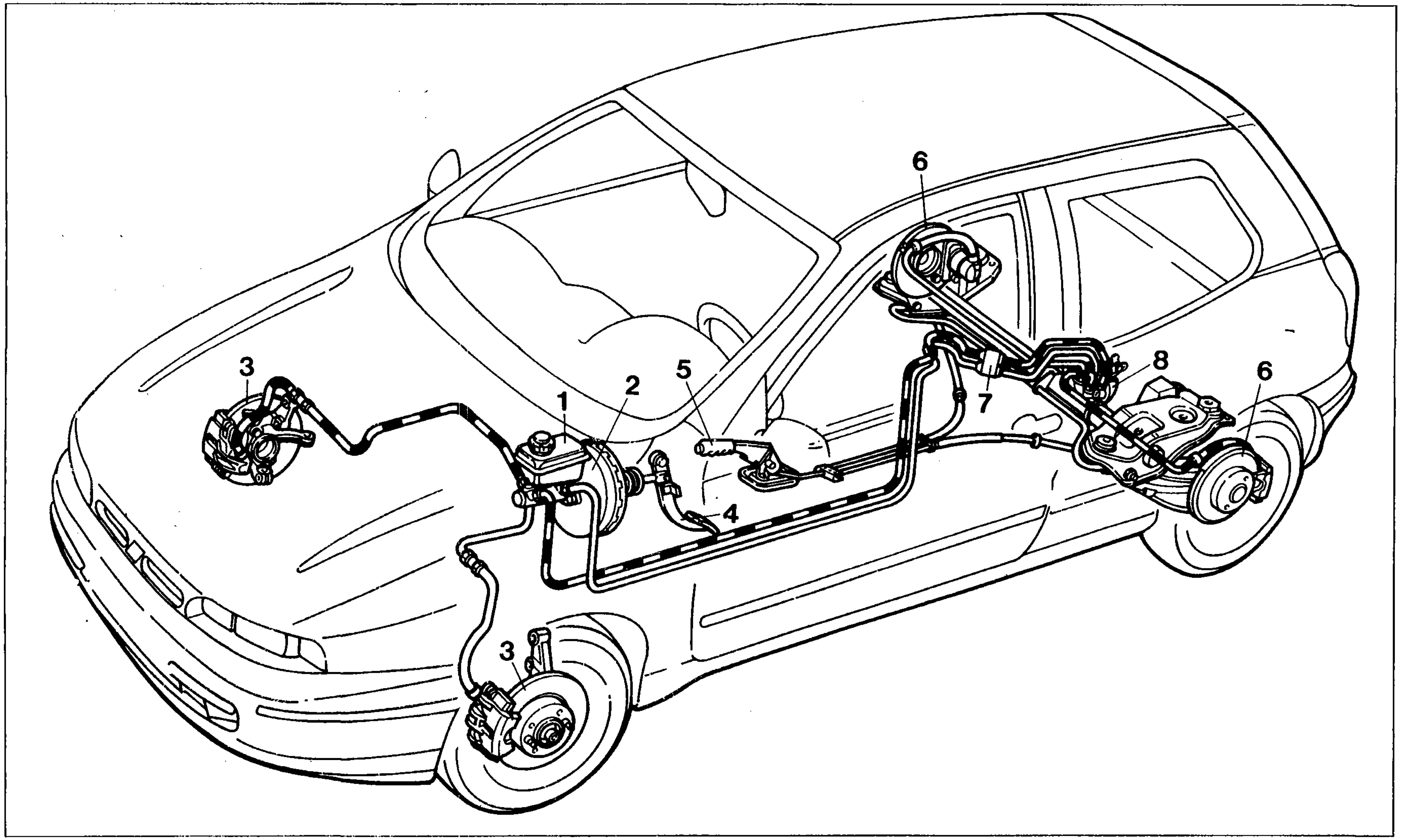
P4A021D05

The rear brakes should be bled on a platform ramp with the rear suspension resting on the ground, so that the brake pressure proportioning valve enters into operation.

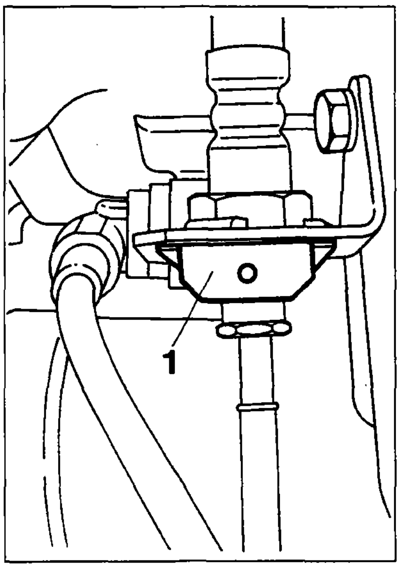
NOTE *The brakes can also be bled using the Jollyfren device, using the procedure described for the front brakes.*

Adjust the handbrake as described on page 32.

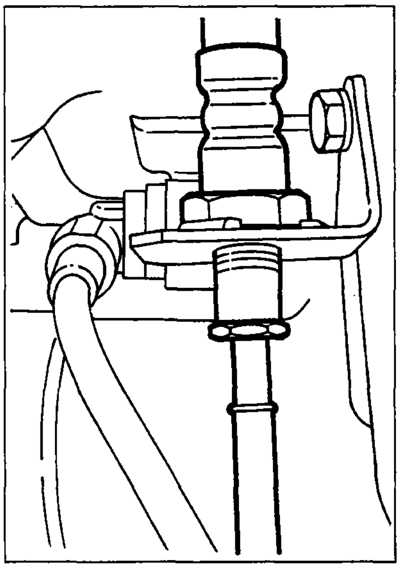
DIAGRAM OF HYDRAULIC BRAKING SYSTEM (FRONT AND REAR DISC BRAKES) AND MECHANICAL HANDBRAKE



1. Brake fluid reservoir and pump for independent brake circuits
2. Vacuum servo unit
3. Self-ventilating front disc brakes
4. Brake pedal
5. Hand brake lever
6. Rear disc brakes
7. 4-way distributor
8. Brake pressure proportioning valve



P4A023D01

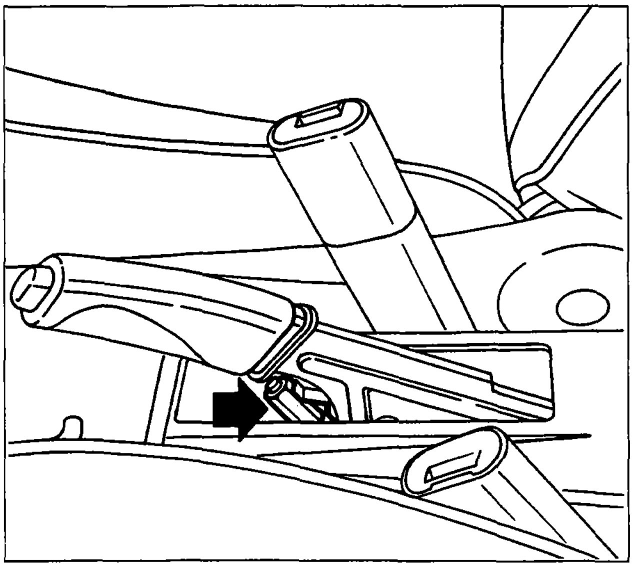

P4A023D02

DISC BRAKES

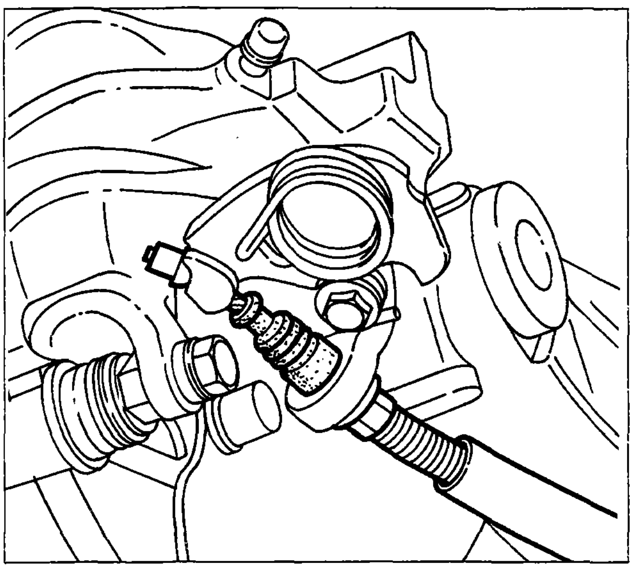
Removing-refitting

To dismantle the rear disc brakes, proceed as follows:

- withdraw the retaining clip (1);
- undo the hose connector using tool 1856132000;

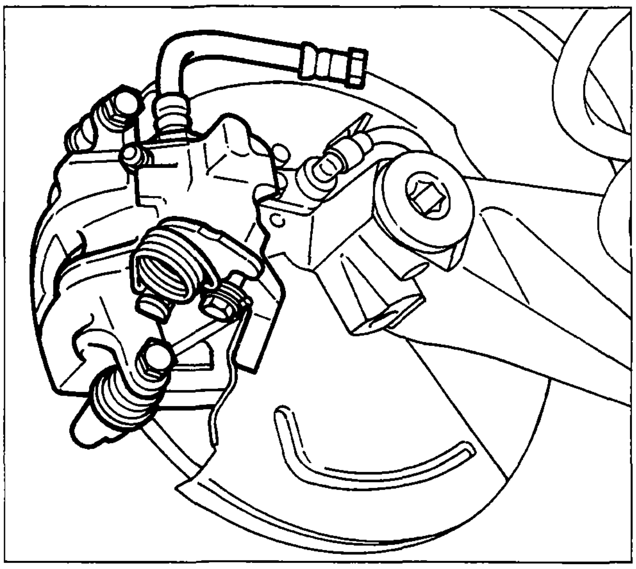

P4A015D04

- undo the screw (arrowed) to slacken the tension on the handbrake cable, in order to facilitate its disengagement;


P4A023D03

- release the handbrake cable;

33.

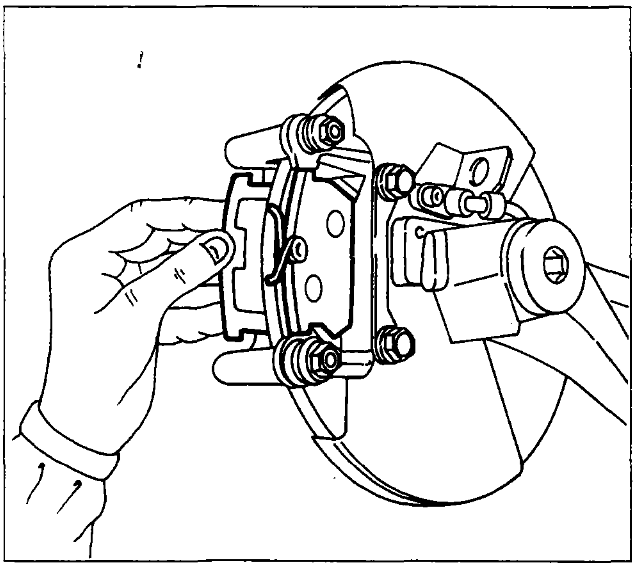


P4A024D01

- undo the attachment bolts and remove the brake caliper;

The caliper case attachment bolts are self-locking and should be renewed whenever they are slackened or unscrewed.

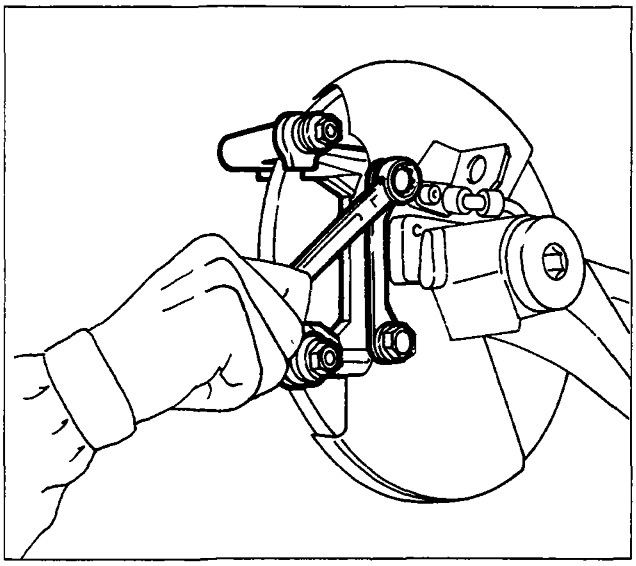
NOTE *After replacing the brake calipers, adjust the handbrake.*



P4A024D02

- remove the brake pads;

NOTE *Before fitting the new brake pads, make the caliper piston go in fully by turning it clockwise using tool 1856133000.*
Also adjust the handbrake.

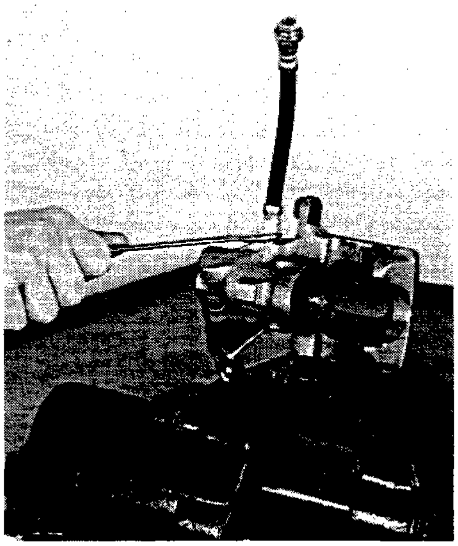


P4A024D03

- undo the caliper support bracket bolts and remove the bracket.

Before refitting the caliper support bracket, check that the rubber gaiters are in good condition; if not, they should be replaced.

When refitting, remember to fit the shim between the bolts and support bracket.



P4A025D01

P4A025D02

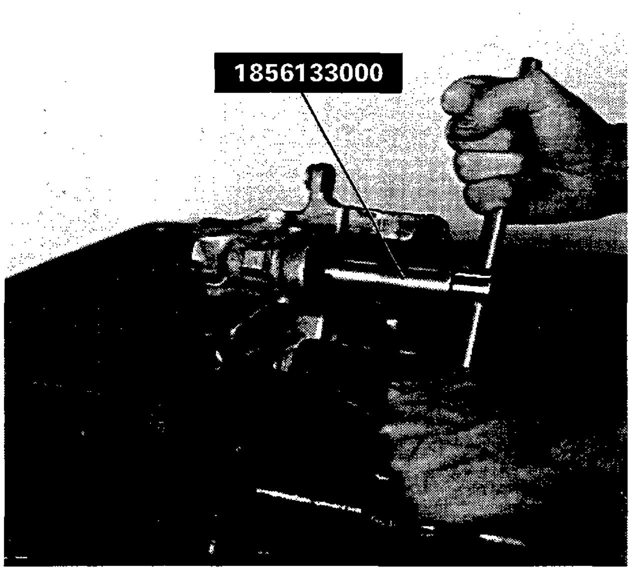
BRAKE CALIPER

Dismantling

Place the caliper in a vice, fitting the protections, then proceed as described below:

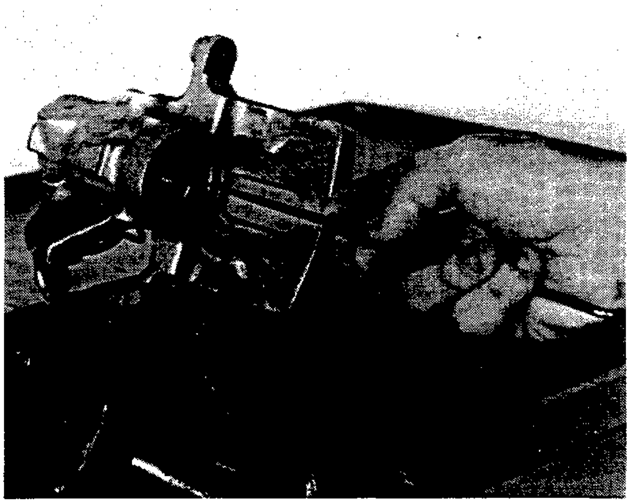
- undo the connector and remove the brake hose;
- undo the bleed screw and remove it;

NOTE *The hose must not be swollen or cracked, otherwise it must be replaced. It is advisable to replace both hoses.*



P4A025D03

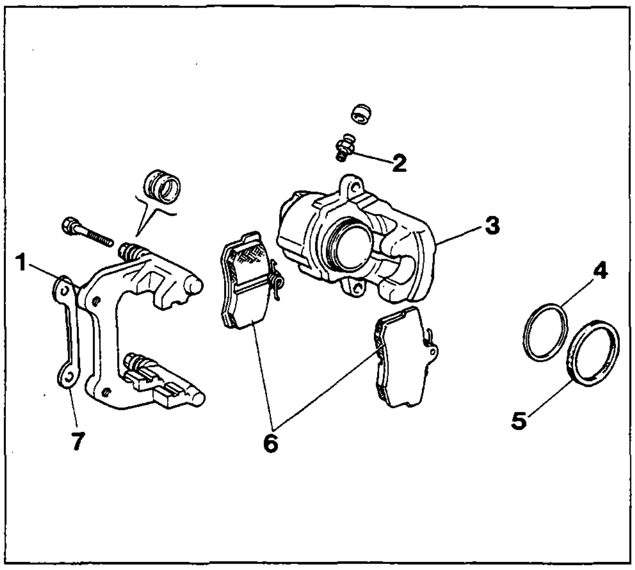
- remove the piston and dust excluder using tool 1856133000;



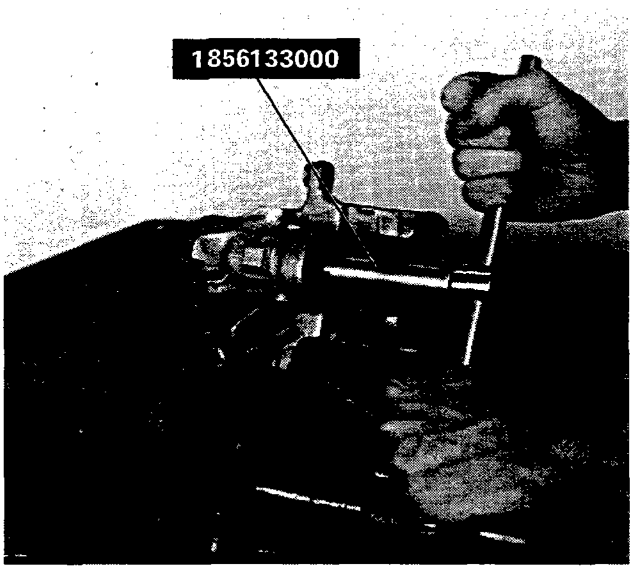
P4A025D04

- remove the seal.

33.



P4A026D01



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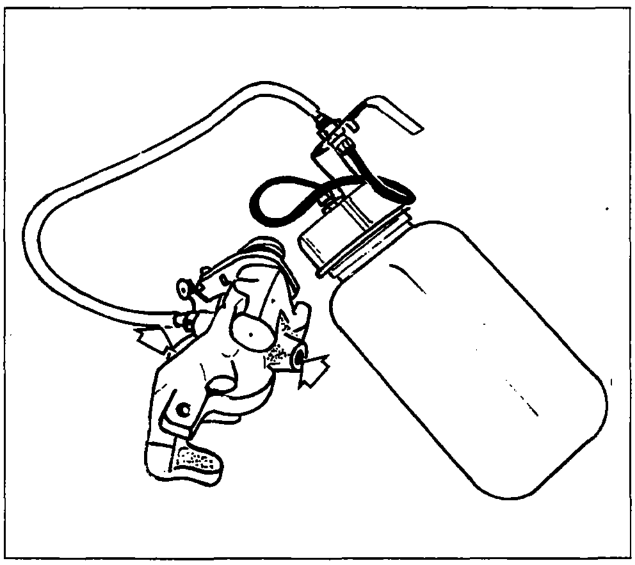


P4A026D02

Checking caliper assembly components

The piston and caliper case must not show signs of friction or seizure, otherwise the caliper complete with piston will need to be replaced.
The dust excluder and seal should always be replaced; also make sure that the bleed screw is not blocked.

Use a solution of FIAT LDC detergent with hot water to wash the metal parts.

1. Caliper mounting bracket
2. Bleed screw
3. Caliper case
4. Seal
5. Dust excluder
6. Brake pads
7. Shim

Refitting

Fit the piston in the caliper case using tool 1856133000.

Before fitting the piston in the caliper case, fit the dust excluder on the rear end of the piston.

Lubricate the parts concerned with brake fluid before final assembly.

Filling brake caliper

After overhauling the brake caliper and before fitting it to the car, it should be filled in accordance with the following procedure:
- undo the bleed screw;
- insert the end of a transparent tube in the bleed screw hole;
- using a normal container with brake fluid, fill the caliper with fluid until air bubbles emerge from the threaded hole where the brake hose pipe is connected;
- lock the bleed screw.

AUTOMATIC ADJUSTER ASSEMBLY FOR RECOVERING CLEARANCE BETWEEN REAR BRAKE PADS AND DISCS AND HANDBRAKE SLACK

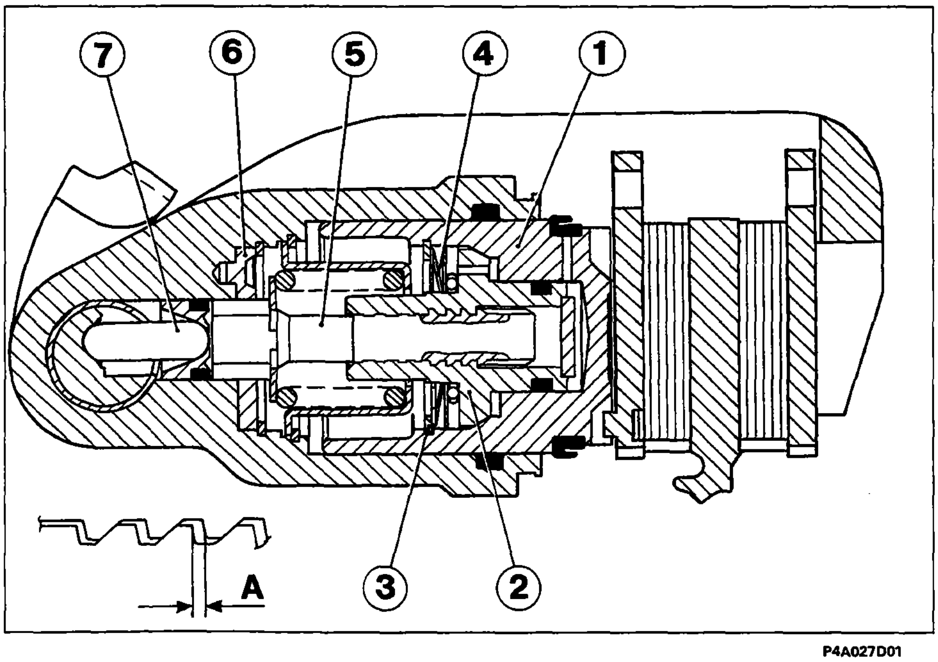
The rear brake caliper piston contains a device for automatically adjusting the distance between the disc and friction pads. This device consists of a nutscrew (2), which rotates on the shaft (5) only in the direction of advance because of the action of the Belleville washer (4) and a shaft (5), on which the nutscrew (2) is screwed. This shaft cannot rotate as it is secured to the caliper case by the retainer (6). The shaft and nutscrew are connected by a four-start threaded connection with a clearance (A) of a pre-established value.

During braking, the piston (1), pushed by hydraulic pressure, moves towards the brake pad with the nutscrew (2), the latter being secured to the piston by the retaining ring (3) and Belleville washer (4).

If the brake pads are excessively worn, the endfloat (A), even if recovered, is not sufficient to absorb by itself the entire travel of the piston (1). The nutscrew (2) then momentarily moves away from its point of contact with the piston (1), but the intervention of the Belleville washer (4) makes the nutscrew (2) rotate on the shaft (5) until it returns in contact with the piston (1).

When the handbrake is operated, the mechanical effort is transmitted from the lever to the link (7) and then, through the shaft-nutscrew connection, it reaches the piston (1) and from the latter to the brake pads.

The nutscrew (2), and thus the piston (1) joined to the latter, can rotate, since during the braking action the piston is engaged on the brake pad plate.

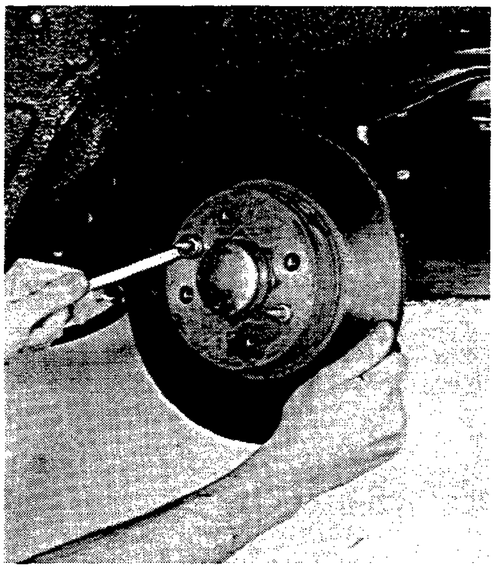


Cross section of rear brake caliper cylinder

1. Piston
2. Nutscrew
3. Retaining ring
4. Belleville washer
5. Shaft
6. Retainer
7. Link

A. Clearance between nutscrew and shaft

33.


P4A028D01


P4A028D02

BRAKE DISCS

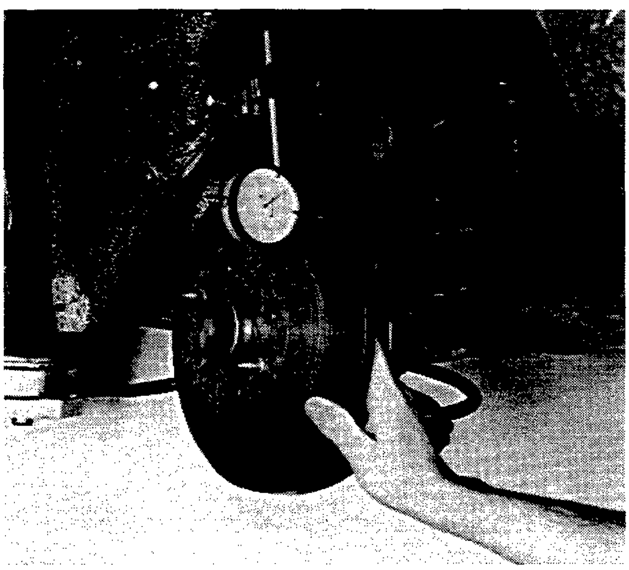
Dismantling-reassembly

Undo the the bolts securing the brake disc and remove it; when refitting, eliminate any traces of rust to ensure that the disc is perfectly perpendicular to the hub.


P4A028D03

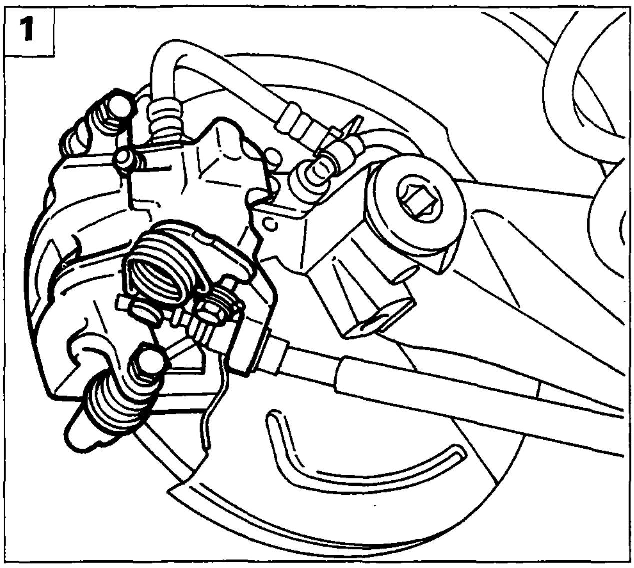
Checking and measuring disc thickness

The minimum permissible brake disc thickness after wear is 9.20 mm; if the value is lower, the disc should be replaced.
In the case of damage or deep scoring the brake disc surfaces can be skimmed; after skimming, the brake disc thickness must not be less than 10.10 mm.


P4A028D04

Checking brake disc run-out

Also check that the disc run-out does not exceed 0.15 mm. This value should be measured 2 mm from the disc's outer diameter.



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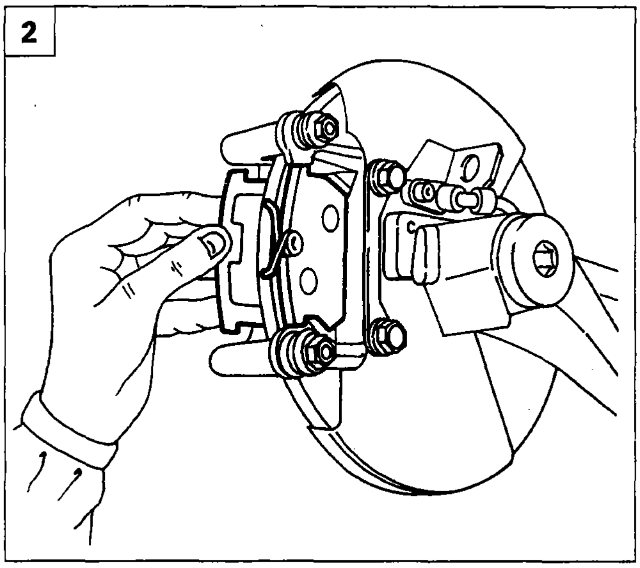
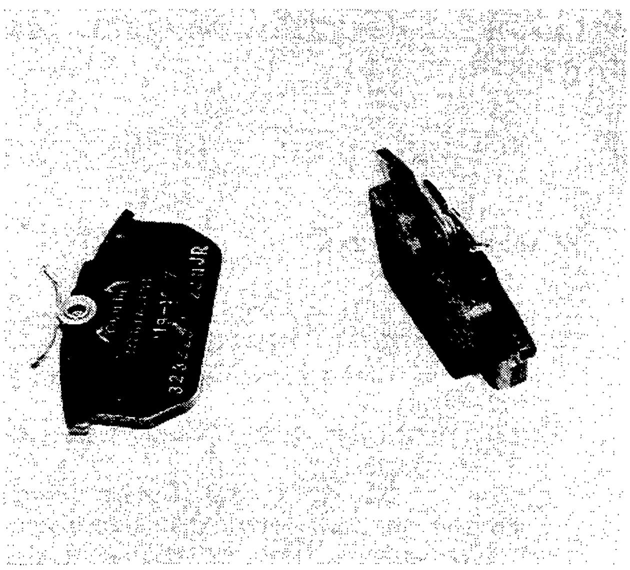


P4A024D02



P4A029D02

BRAKE PADS

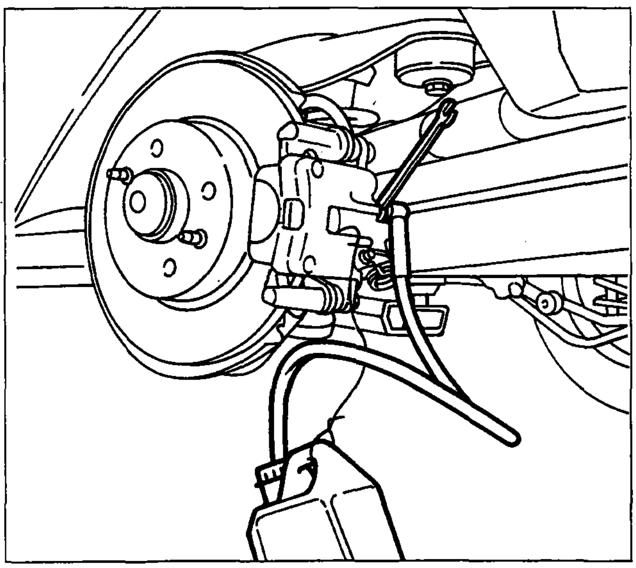
Dismantling-reassembly

To replace the brake pads, proceed as follows:

1. undo the bolts securing the brake caliper to the mounting bracket and secure the brake caliper in an appropriate manner;
2. remove the brake pads.

The caliper case attachment bolts are self-locking and should be renewed whenever they are slackened or unscrewed.

NOTE *When refitting, make the caliper piston go back in before fitting the brake caliper.*



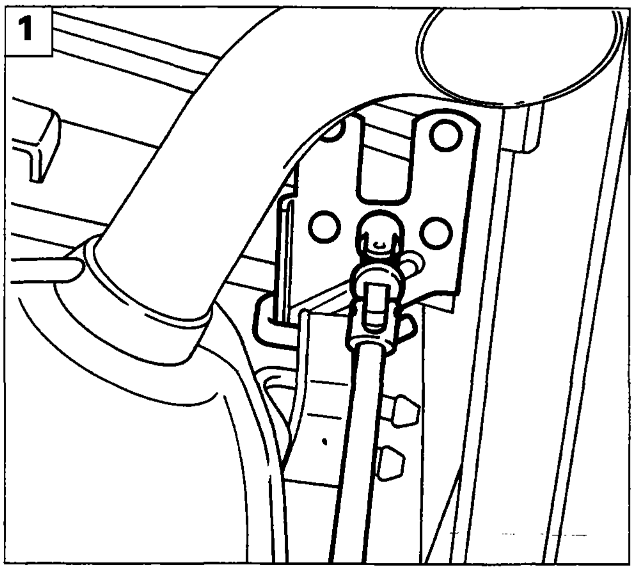
P4A029D03

Checking brake pads

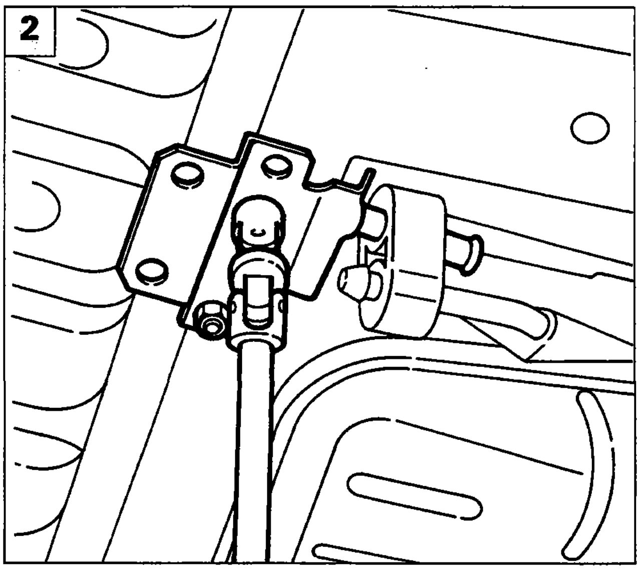
The brake pads must be renewed when the thickness of the friction material is less than 1.5 mm.
Check that brake pads of the same type are fitted on each pair of wheels.

Bleeding

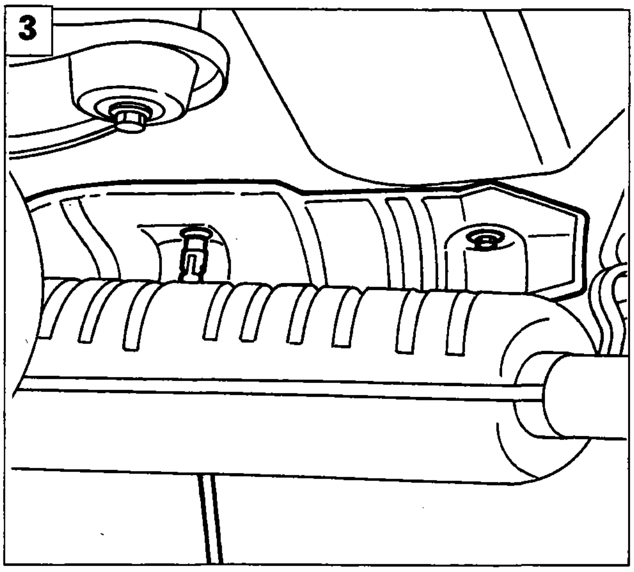
The old fluid should not be reused. Top up the level with new brake fluid.
The brakes can also be bled using the Jolyfren device, following the procedure described for the front brakes.



P4A030D01



P4A030D02

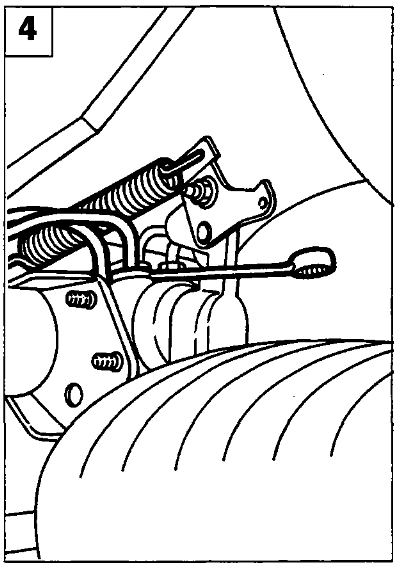


P4A030D03

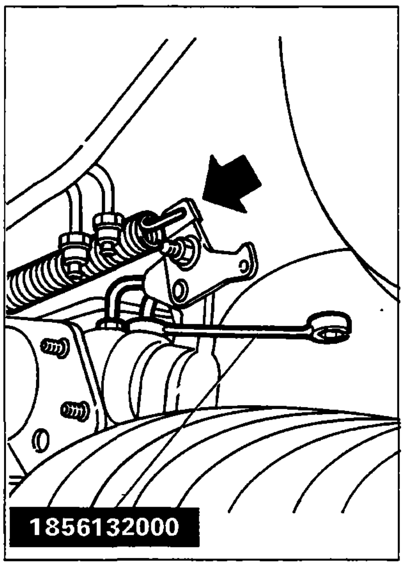
BRAKE PRESSURE PROPORTIONING VALVE

Removing-refitting

To remove the brake pressure proportioning valve, proceed as follows:
1. disconnect the exhaust pipe end section mounting;
2. disconnect the exhaust pipe intermediate section mounting;
3. undo the bolts and remove the heat shield from the exhaust pipe to facilitate access to the brake pressure proportioning valve;



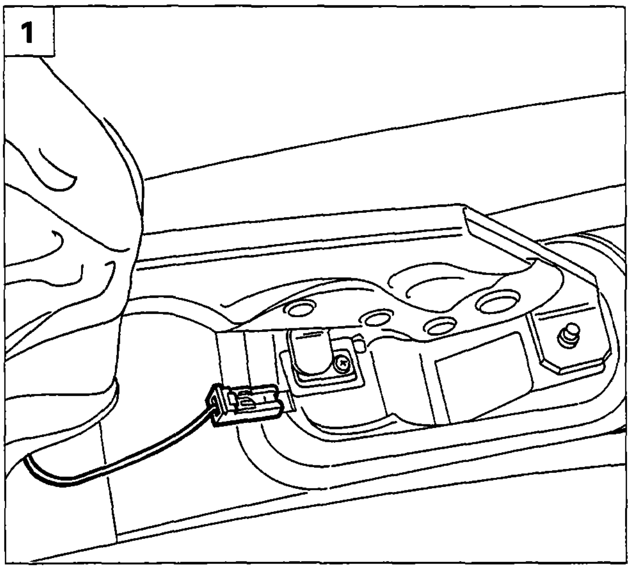
P4A030D04



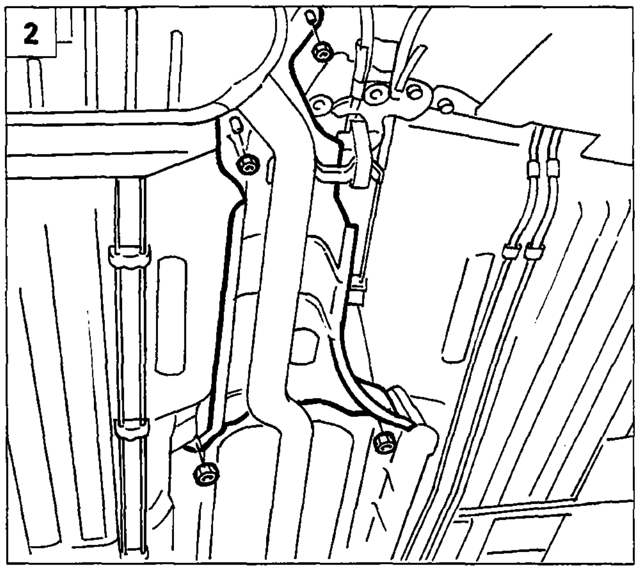
P4A030D05

4. uncrew the brake hose connections and disconnect the spring indicated;

The connectors fitted on the brake pressure proportioning valve are 11 and 13 mm; use the spanner 1856132000 for the 11 mm ones, and for the 13 mm ones use an open spanner taking care not to damage the connectors.



P4A032D03



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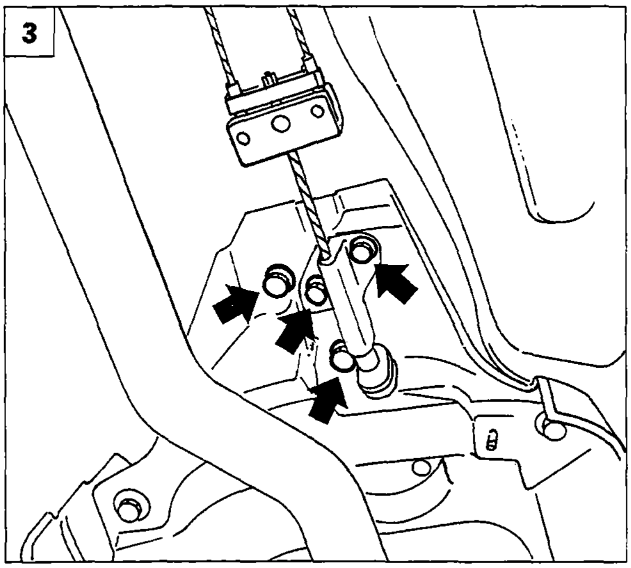

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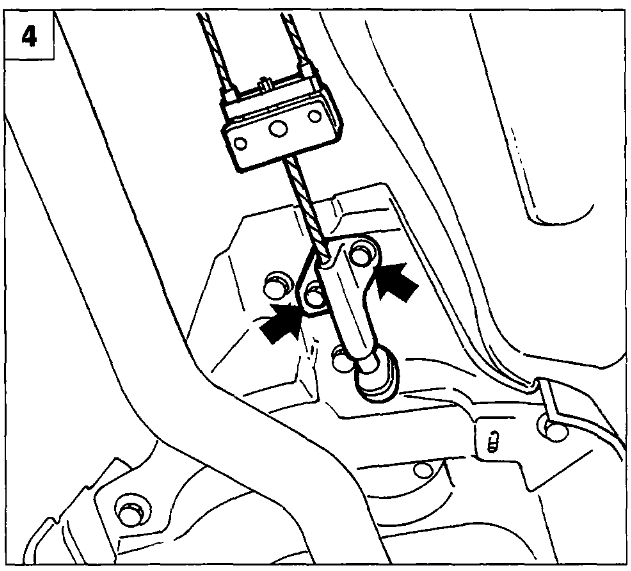


P4A032D06

Handbrake lever

Removing - refitting

1. Working as illustrated on the preceding page, remove the lever cover and undo the adjustment nut underneath, then disconnect the wiring connector for the handbrake warning light switch.

2. Raise the car on the ramps and remove the heat shield illustrated.

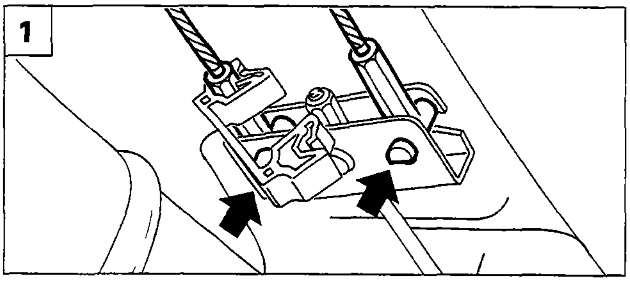
3. Undo the bolts (arrowed), lower the car and remove the lever from its seating.

Refit the dismantled parts in reverse order to removal, and then adjust the handbrake.

Handbrake cables

Removing - refitting

4. Working as described above, remove the lever cover, undo the adjustment nut, raise the ramps and remove the heat shield, then undo the bolts securing the handbrake cable to the bodyshell.



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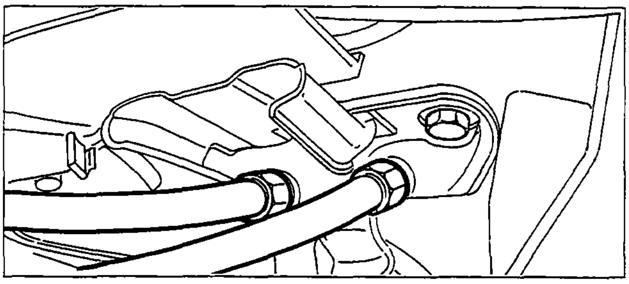
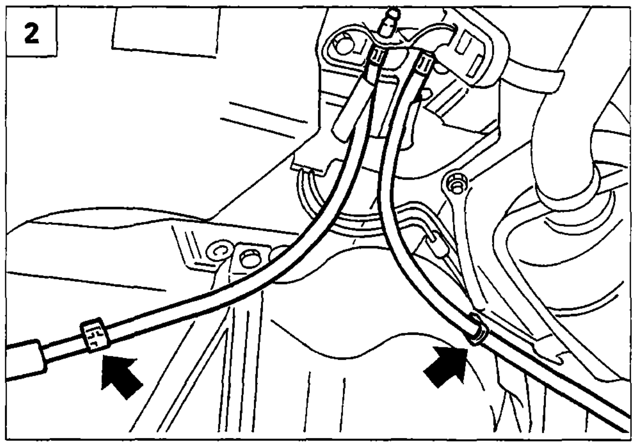
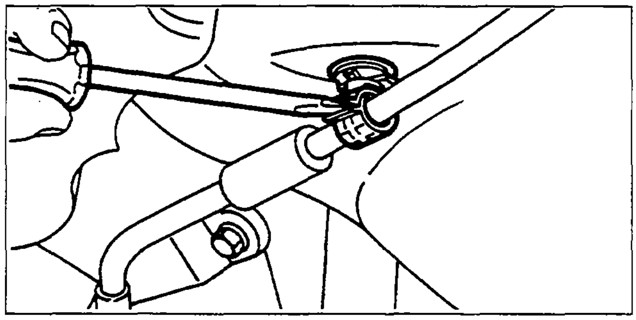


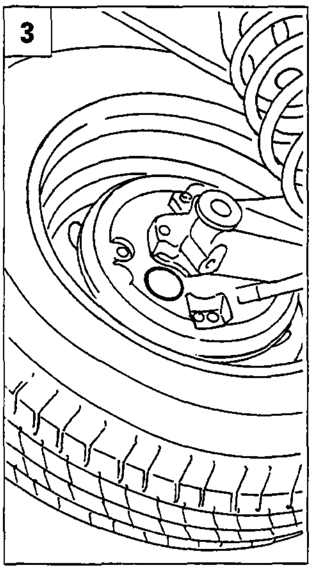
P4A033D05



P4A033D08



P4A033D09



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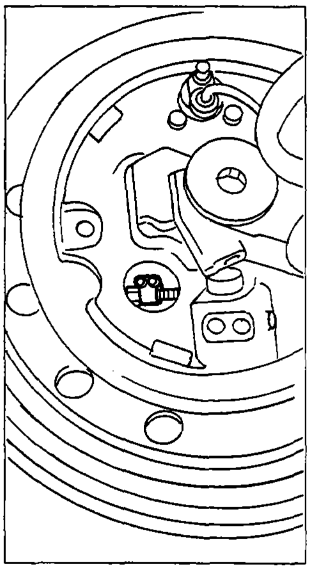


P4A033D07

1.2. Detach the cables from the handbrake control by undoing the points illustrated.

3. Remove the protective cover illustrated and release the handbrake cable from the anchor on the lever, then withdraw the sheath with the handbrake cable and remove it.

Refit the dismantled parts in reverse order to removal, and then adjust the handbrake.

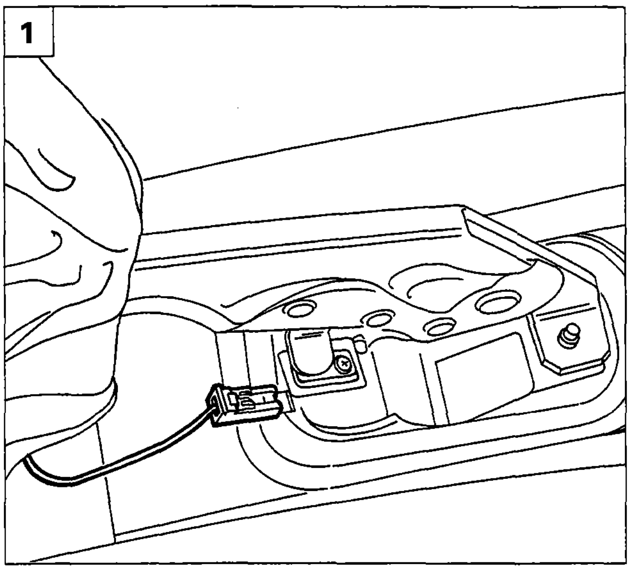
Adjusting handbrake

The handbrake cables are connected to a bracket which acts directly on the automatic adjuster. Whenever repairs are carried out on the rear brake which involve dismantling the cables, the cables must be adjusted to ensure the correct operation of the automatic adjuster.

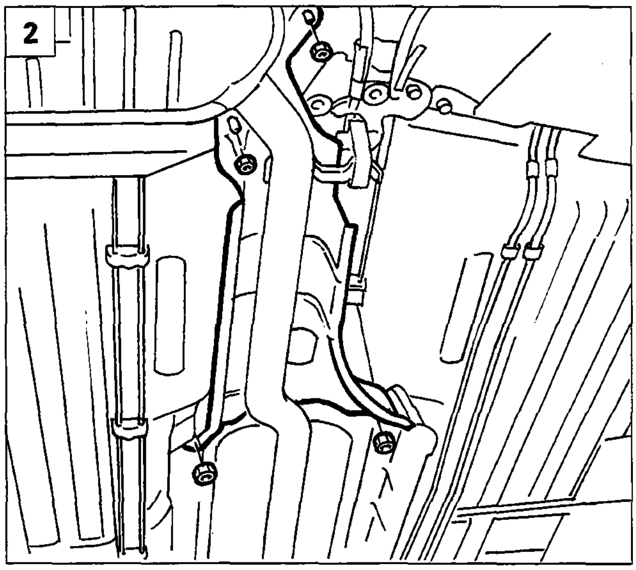
Proceed as follows:

- Undo the handbrake cable adjustment nut two or three turns, to make sure that the cable is fully slack.
- Start the car with the gear lever in neutral, and with the engine idling, depress the brake pedal fully at least 30 times.
- Retighten the cable adjustment nut previously unscrewed, making sure that the rear wheels turn freely when the handbrake lever is at rest.
- Check that the braking action starts from the first or second notch, and then at the end of adjustment the lever does not engage more than five notches on the sector gear.

4A056D



P4A032D03



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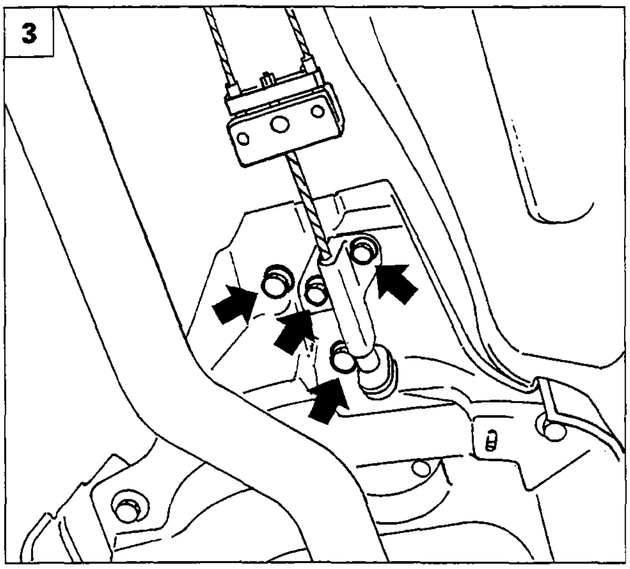

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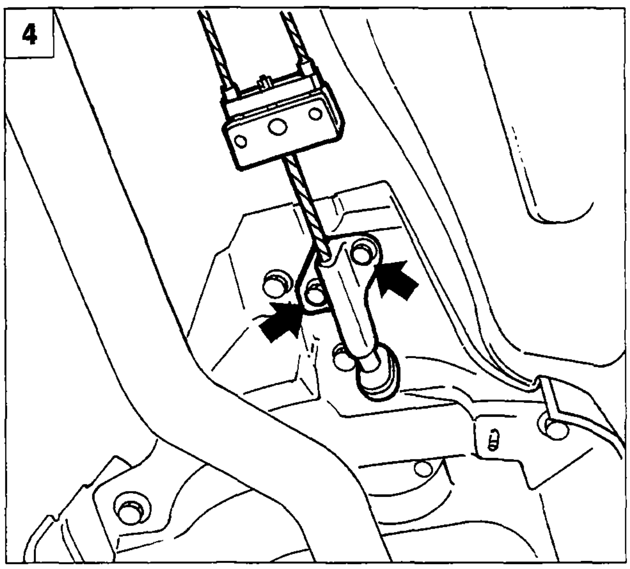


P4A032D06

Handbrake lever

Removing - refitting

1. Working as illustrated on the preceding page, remove the lever cover and undo the adjustment nut underneath, then disconnect the wiring connector for the handbrake warning light switch.

2. Raise the car on the ramps and remove the heat shield illustrated.

3. Undo the bolts (arrowed), lower the car and remove the lever from its seating.

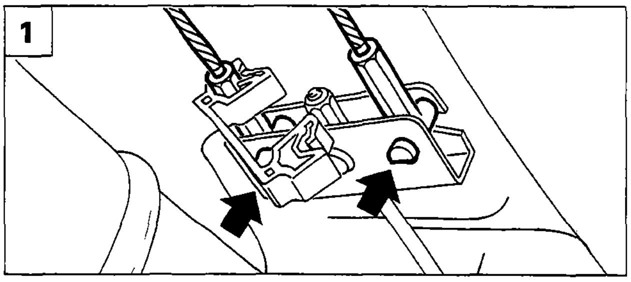
Refit the dismantled parts in reverse order to removal, and then adjust the handbrake.

Handbrake cables

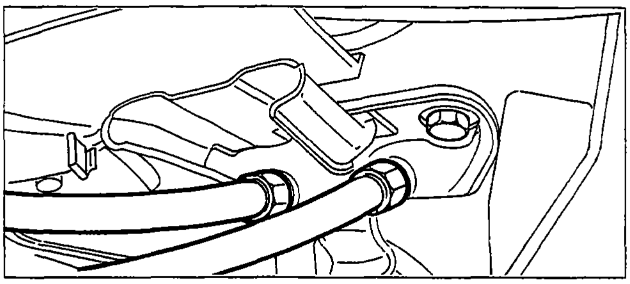
Removing - refitting

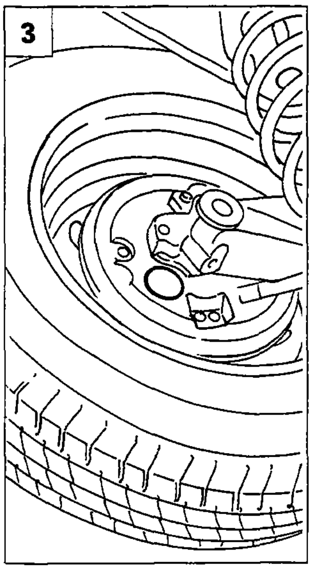
4. Working as described above, remove the lever cover, undo the adjustment nut, raise the ramps and remove the heat shield, then undo the bolts securing the handbrake cable to the bodyshell.

4A055D



P4A033D04


P4A033D05



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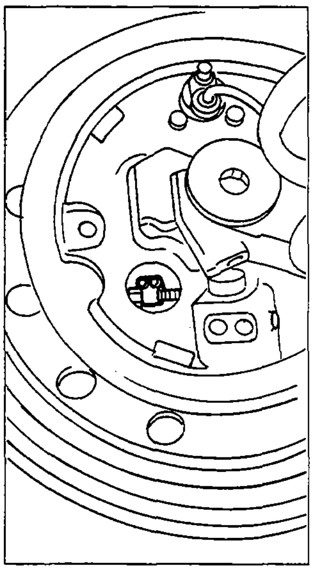
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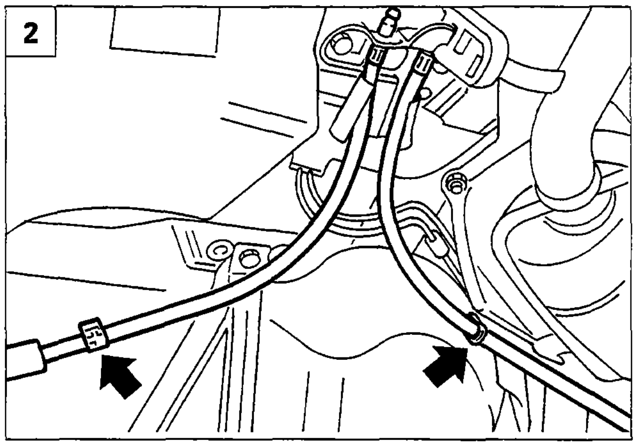
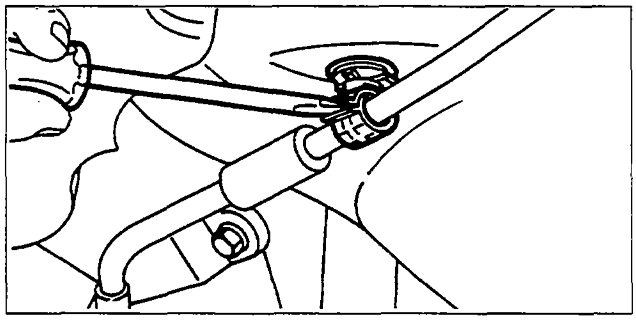


P4A033D08


P4A033D09

1.2. Detach the cables from the handbrake control by undoing the points illustrated.

3. Remove the protective cover illustrated and release the handbrake cable from the anchor on the lever, then withdraw the sheath with the handbrake cable and remove it.

Refit the dismantled parts in reverse order to removal, and then adjust the handbrake.

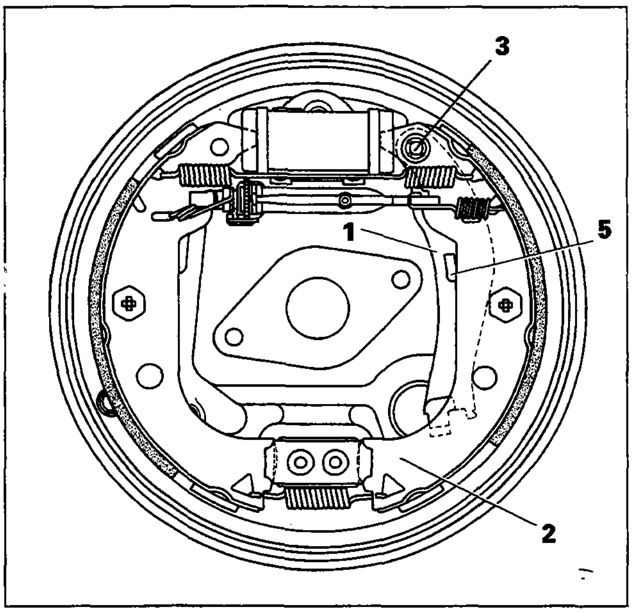
Adjusting handbrake

The handbrake cables are connected to a bracket which acts directly on the automatic adjuster. Whenever repairs are carried out on the rear brake which involve dismantling the cables, the cables must be adjusted to ensure the correct operation of the automatic adjuster.

Proceed as follows:

- Undo the handbrake cable adjustment nut two or three turns, to make sure that the cable is fully slack.
- Start the car with the gear lever in neutral, and with the engine idling, depress the brake pedal fully at least 30 times.
- Retighten the cable adjustment nut previously unscrewed, making sure that the rear wheels turn freely when the handbrake lever is at rest.
- Check that the braking action starts from the first or second notch, and then at the end of adjustment the lever does not engage more than five notches on the sector gear.

4A056D



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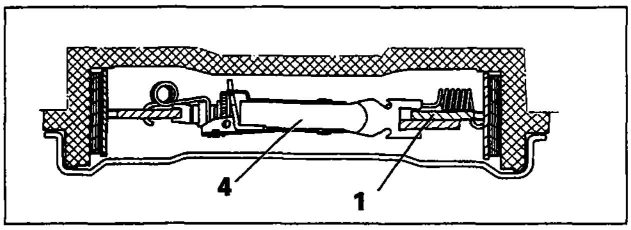

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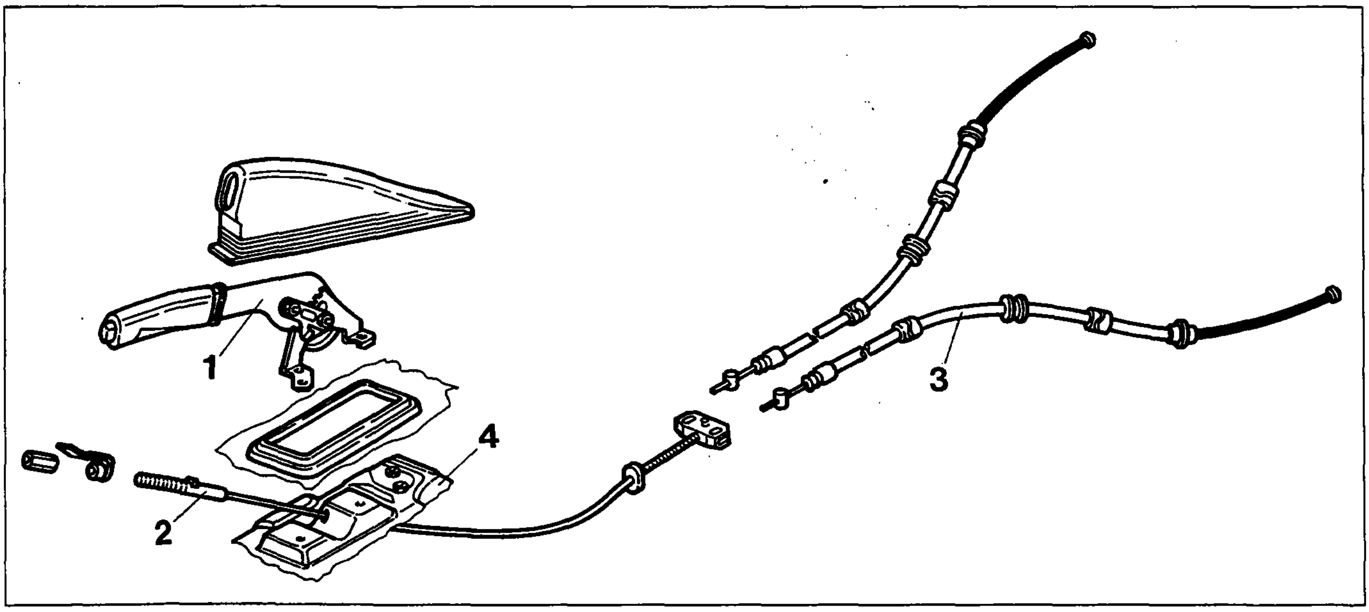
Operation

The handbrake operates by means of a cable on the rear brakes.
At the bottom, this cable is attached to the bracket (1), the top of which is hinged onto the shoe (2) by the retaining washer (3) (this should be replaced whenever the rear brakes are overhauled).
The top of the bracket (1) is also connected to the automatic adjuster assembly for recovering the clearance caused by shoe wear, so the handbrake does not require adjustment.
The bracket (1) homes on the shoe (2) via the lug (5).

Handbrake components



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1. Handbrake lever complete with sector gear
2. Handbrake cable complete with anchorage
3. Sheath with cable
4. Mounting plate

NOTE *Check the operation of each component and that the cable slides freely in its seating. If wear or tight spots are found, replace the parts concerned.*

page

ANTI-LOCK BRAKING SYSTEM

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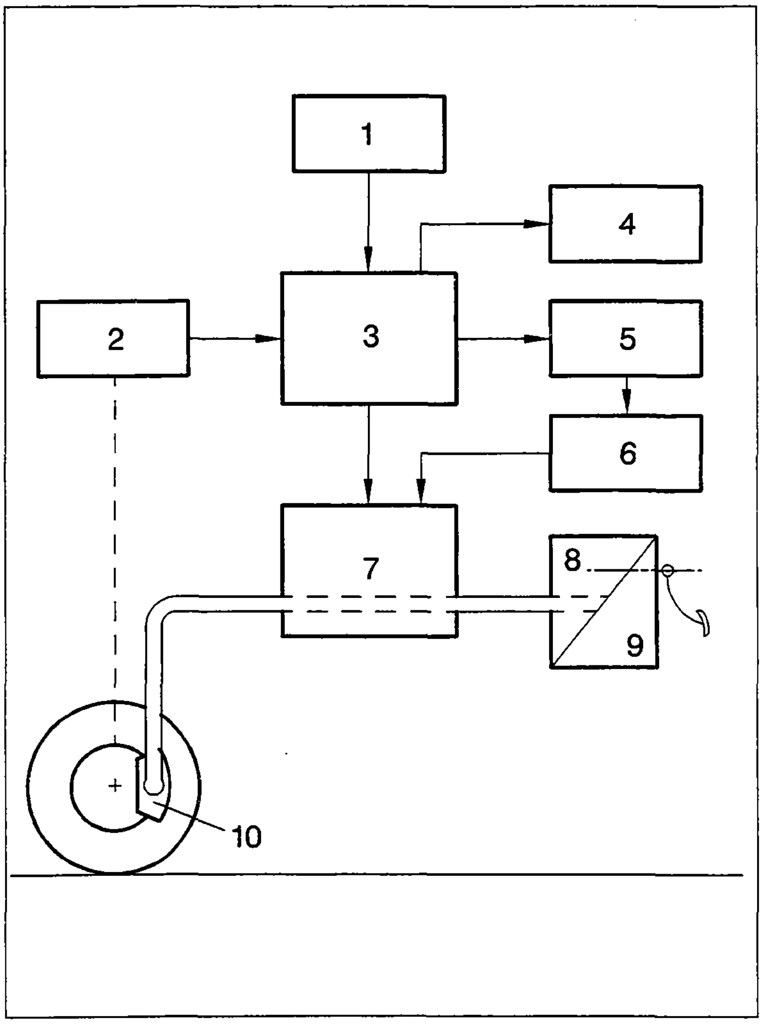
INTRODUCTION

The braking system must be rated to take account of the weight of the vehicle when fully laden and the maximum tyre/ground grip coefficient that may be achieved, in order to bring about efficient slowing down or stopping in the shortest possible distance and under any driving condition.
However, this is over-rated for the most common conditions of partial load and reduced grip.
Applying the maximum braking force under those circumstances leads to the wheels locking immediately, resulting in a reduction in the grip-friction coefficient and deterioration of braking efficiency.
In order to arrest the forward motion of a vehicle quickly and efficiently under any contingent situation, it is necessary to maintain the rolling state of the tyres, despite the fact that, because of design requirements, the braking force applied on the friction linings is often excessive in relation to the driving weight and normal grip coefficients.
It is therefore necessary to prevent the wheels locking by means of an electronically-controlled anti-lock braking system which is incorporated in the vehicle's braking system.
Since it is not possible to assess the grip conditions in advance, the braking efficiency has to be controlled only after the detection of any effects of initial skidding of the tyre caused by excessive braking force in relation to the grip coefficient present.
This detection by special sensors leads to the modulation of the braking force by the action of a set of solenoids and recycling pumps which, driven by a control unit, act on the braking circuit.



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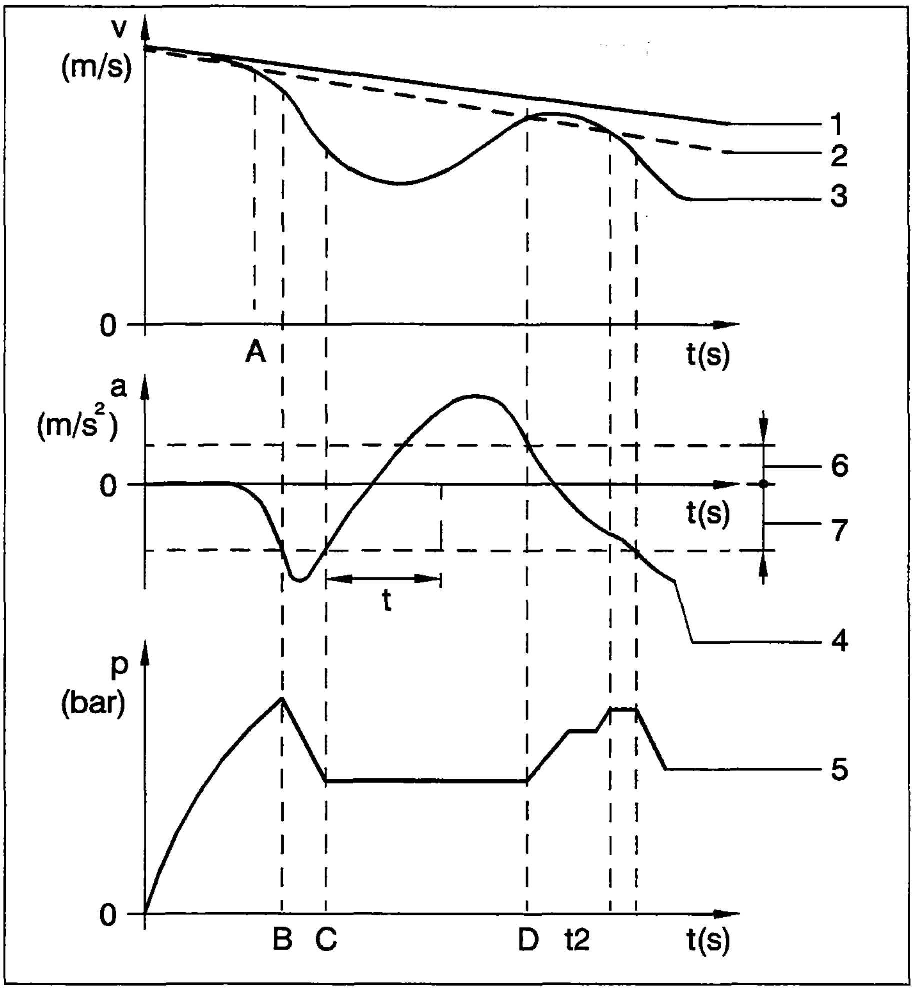
METHOD OF OPERATION OF THE TEVES MK20 ANTI-SKID SYSTEM (A.B.S.)

The TEVES MK20 anti-lock braking system is incorporated in the vehicle's ordinary braking system in order to prevent the wheels locking during braking.
Its operation is described briefly below.

Block diagram of Teves MK20 A.B.S.

1. Battery
2. Rpm sensor
3. Control unit
4. Diagnosis warning light
5. Relays
6. Recycling pump
7. Modulator
8. Brake pump
9. Servo unit
10. Brake calipers



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1. Actual vehicle speed
2. Vehicle reference speed
3. Peripheral wheel speed
4. Wheel acceleration/deceleration
5. Braking system pressure
6. Permissible acceleration band
7. Permissible deceleration band

The signals (alternating or analogue) sent by the rpm sensors to the electronic control unit are converted by the input amplifier into square-wave (or digital) signals. The frequency of these signals provides the control unit with the corresponding speed (3) and acceleration/deceleration (4) of the individual wheels. From the combination of the individual peripheral speeds of the wheels, a reference speed (2) is worked out which, constantly updated, provides an indication of the vehicle's actual speed (1).

The electronic control unit also has stored in its memory the deceleration/acceleration thresholds (6) and (7) which each individual wheel must not exceed. So by means of a systematic, continuous and very rapid comparison between the wheel's deceleration/acceleration values and those of the memorized band, the rolling of the tyres during braking is monitored.

When the driver presses the brake pedal, the wheels may decelerate to different extents.
The slowing down or total stoppage of the vehicle with deceleration within the memorized permissible band, does not lead to any intervention of the system in terms of control.
However, at the moment when excessive braking force causes the wheel speed to decrease in relation to the vehicle's reference speed, the system starts the deceleration calculation cycle (point A).

If the deceleration threshold (7) is exceeded, the system intervenes by driving the solenoids to reduce the pressure (point B). After the pressure reduction, and after the first instants in which the deceleration increases further because of the inertia of the system, the wheel which is no longer braked reverses the tendency to lock, so regaining speed.
When the deceleration returns within the threshold (7), the intervention of the control system is modified, starting the pressure maintenance phase (point C.)

If the wheel does not regain its speed within a pre-determined time (t), a new pressure reduction phase is started.

The wheel normally regains speed until it exceeds the reference speed; at this point a new braking cycle (point D) commences, characterized by the three regulation phases for reducing, maintaining or re-establishing on the brake calipers the pressure generated by the driver on the brake pedal.

The logic described is not fixed, but adapts to the dynamic behaviour of the tyres in accordance with the different grip coefficients and the relevant deceleration/acceleration thresholds at the various speeds.

The number and frequency of the correction interventions is determined by the dynamic behaviour of the chain consisting of the brake circuit and A.B.S. components, but even more so by the tyre/road surface grip coefficient.

During braking on dry tarmac, six-eight interventions per second can be reached; this frequency is considerably lower on ice or wet roads.

The electronic control unit controls the various phases, supplying pulses of different current intensity to the solenoids. It also ensures that both rear wheels are supplied with the same braking force applicable to the rear wheel which is most liable to lock, i.e. that with least grip on the ground (to ensure the best stability of the trajectory).

NOTE *During the intervention cycle, the brake pedal moves slightly depending on the increase or reduction of the controlled pressure.*

If a wheel is rolling with a flat tyre, the A.B.S. intervenes if necessary to control the braking.

The A.B.S. is also active during braking in reverse gear.

The intervention of the device usually ceases at speeds of under 2.75 km/h to permit complete locking of the wheels when the vehicle is stopped.

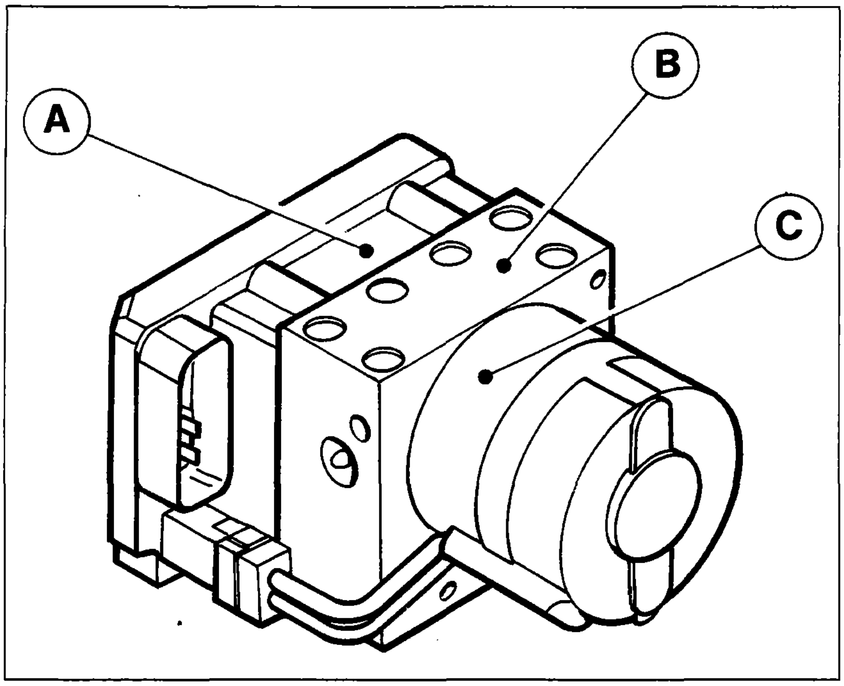
NOTE *Since the parameters monitored by the control unit (wheel speed and acceleration) are influenced by the inertia of the wheel/tyre assembly, vehicles with the anti-lock braking system* ***must only be fitted with the rims, tyres and brake linings recommended and chosen by the manufacturer.***

If snow chains are fitted, the resulting rolling condition leads to signals which, suitably filtered in the control unit, do not exclude the anti-lock braking device in the event of driving on hard and compact snow.

In *aquaplaning* conditions, the electronic control unit detects from the rpm sensor a faulty condition even during ordinary driving, with no braking, as the driving wheels tend to rotate at a higher speed than the driven wheels.

This condition would cause the electronic control unit to carry out a regulation cycle which did not meet requirements; for this reason the anti-lock braking system temporarily switches itself off (for such a short time that the warning light does not necessarily come on) and switches itself on again as soon as the *aquaplaning* ceases.

COMPONENTS OF THE TEVES MK20 A.B.S.



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The main components of the A.B.S. are:

- electrohydraulic unit (1) shown in the figure above which comprises the electronic control unit (A), the electrohydraulic control unit (B) which modulates the braking pressure to the brake calipers by means of eight solenoids (two per wheel) and a dual-circuit recycling pump (C);
- four wheel rpm sensors, one (5) for each front wheel and one (11) for each rear wheel, which measure the rotation speed of the wheels;
- a switch on the brake pedal (8) for detecting the braking condition;
- a warning light (7) located on the instrument panel indicating when the A.B.S. system is working (light goes out after a test) or not working (light stays on).

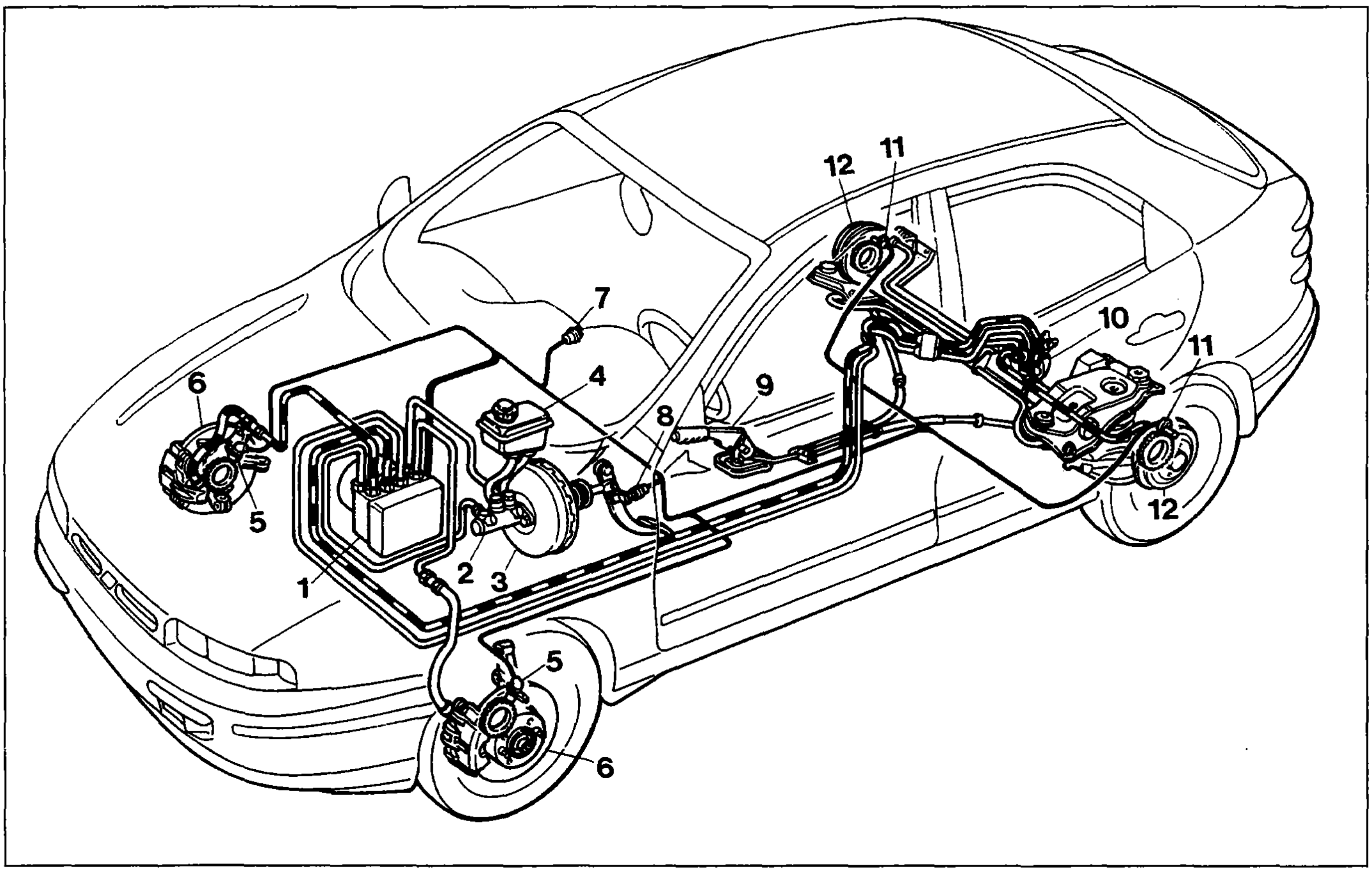
The system is completed by the hydraulic pipes, specific electrical wiring and a diagnostic socket for the F/L Tester (or Computerized Diagnostic Station).
The presence of a fault causes the A.B.S. to be deactivated immediately.
The fault information present can be read by connecting the Fiat/Lancia Tester or Computerized Diagnostic Station to the diagnostic socket.

DIAGRAM OF BRAKING SYSTEM WITH ANTI-LOCK BRAKING SYSTEM

Hydraulic circuit for front right and rear left brakes

Hydraulic circuit for front left and rear right brakes

1. Electrohydraulic control unit
2. Brake pump
3. Servo unit
4. Brake fluid reservoir
5. Front wheel rpm sensors
6. Front disc brakes
7. Fault warning light
8. Stop lights switch
9. Handbrake lever
10. Brake pressure proportioning valve
11. Rear wheel rpm sensors
12. Rear drum brakes (excluding 1998 16v)
13. Rear disc brakes (1998 16v only)



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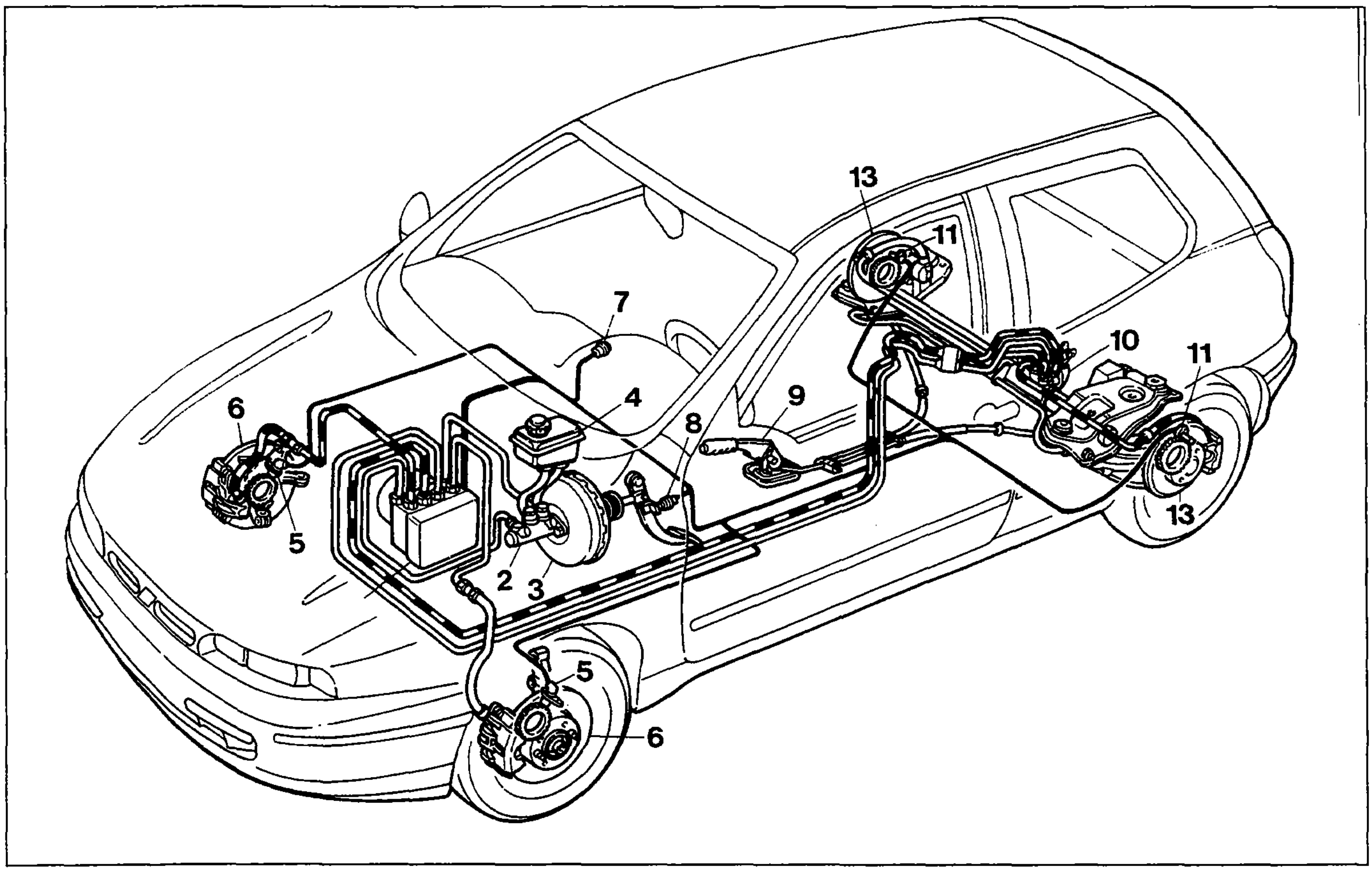

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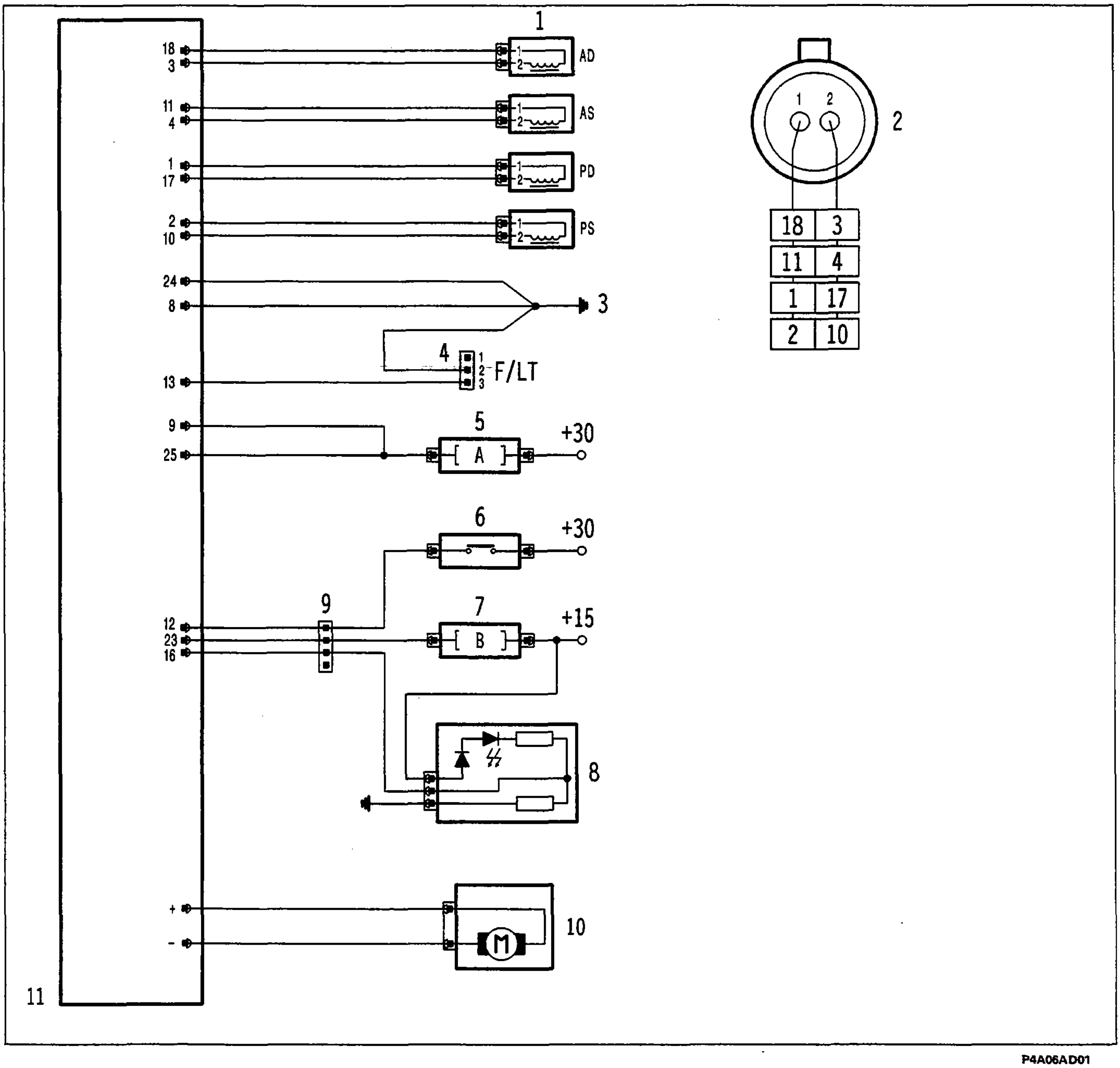
TEVES MK20 A.B.S. SYSTEM ELECTRICAL DIAGRAM



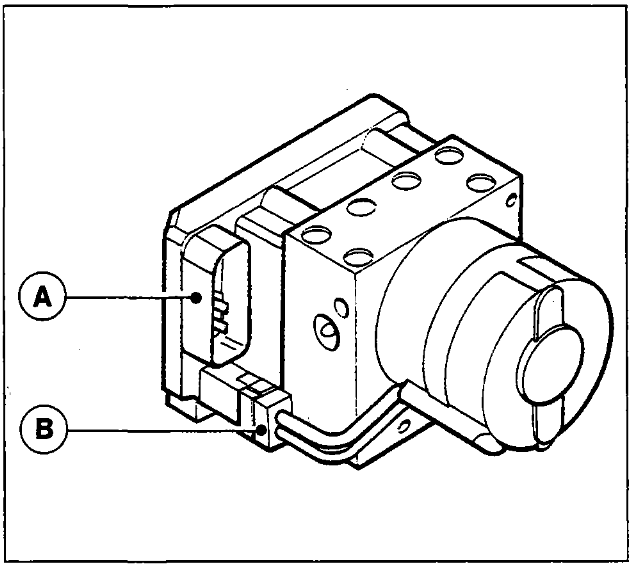
1. Wheel speed sensors
2. Wheel speed sensor connector (viewed from insertion side)
3. Control unit ground
4. F/L Tester diagnosis socket
5. Fuse A (60A)
6. Brake pedal switch
7. Fuse B (10A)
8. Instrument panel with failure warning lamp
9. Connector interconnecting ABS wiring and dashboard
10. Pump motor
11. Control unit

NOTE *The numbers printed inside boxes refer to the control unit pins.*

CONTROL UNIT

The electronic control unit (E.C.U.) consists of:

- **input circuits** for filtering, conditioning and digitizing the signals received from the system via wiring;
- **integrated logic circuits** for processing signals and managing program memories;
- **specific data memory** for the application for which it is intended;
- **output or power stages** for driving, with sufficient current intensity, the regulating solenoids, recycling pump motor and fault warning light.



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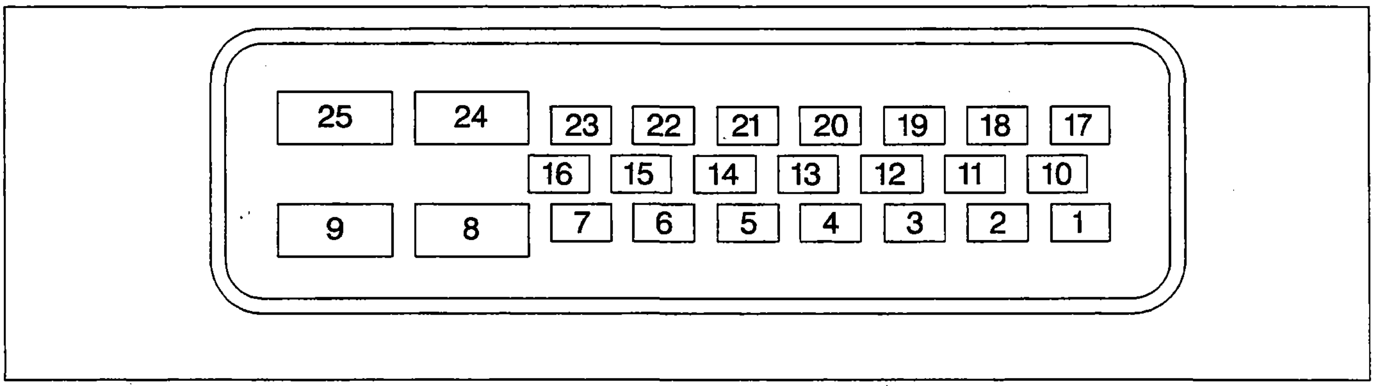
NOTE *In the event of a fault, the complete assembly is supplied as a spare part, so the connector (B) must never be disconnected.*

A. Socket for connector on cables between control unit and system

B. Connector for cables connecting recycling pump to control unit

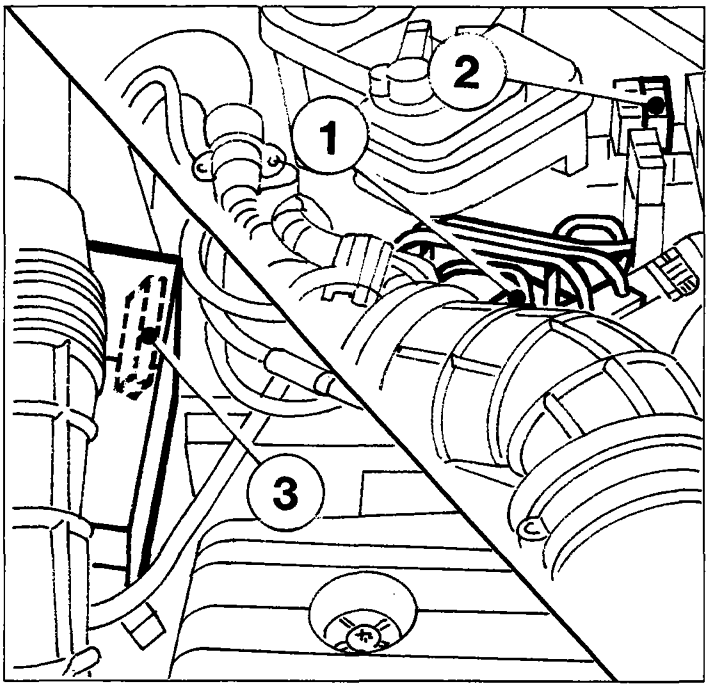
Teves MK 20 A.B.S. control unit output pins



P4A07AD02

1. Rear right sensor earth
2. Rear left sensor earth
3. Front right sensor signal
4. Front left sensor signal
5. N.C.
6. N.C.
7. N.C.
8. Power earth
9. Supply from battery (+VB)
10. Rear left sensor signal
11. Front left sensor earth
12. Brake pedal switch
13. F/L Tester connection
14. N.C.
15. N.C.
16. System fault warning light
17. Rear right sensor signal
18. Front right sensor earth
19. N.C.
20. N.C.
21. N.C.
22. N.C.
23. Ignition switch supply (+15)
24. Power earth
25. Supply from battery (+VB)

33.



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The control unit (1) is supplied:
- directly from the battery (+VB) on pins 9 and 25, through a 60A fuse (2);
- under ignition key (+15) on pin 23, through a 10A fuse (3).

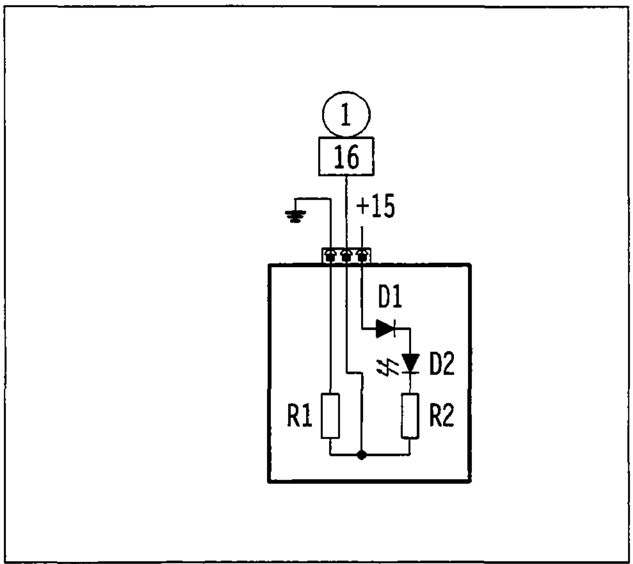
FAULT DIAGNOSIS

The system has a self-test function which checks if there are any faults on the following components:

- wheel rpm sensors (4 sensors);
- input solenoids (4 solenoids);
- output solenoids (4 solenoids).

If a malfunction is identified, the control unit's safety circuit excludes the A.B.S. system, nevertheless ensuring normal operation of the conventional braking system.
When the A.B.S. system is switched off, this is indicated to the driver by the warning light on the instrument panel coming on. For safety reasons, the electronic control unit, by means of two microprocessors, controls all the logic functions, its software and all the input signals.
If the two microprocessors receive identical input signals, they supply identical output signals.
If there is a logic discrepancy between input signals and output response over a certain period of time, the safety system detects the fault and the A.B.S. is de-activated.
The electronic control unit also has a safety circuit which monitors the efficiency of the system before every start-up and during driving.

The safety circuit carries out the following self-tests:
1. after the ignition has been switched on and for about 2 seconds, it checks the operation of the control unit, the relays which operate the solenoids and the connection of the sensors;
2. after the engine has started, as soon as the speed of 6 km/h is exceeded, it activates the solenoids and recycling pump for an operating check; it also checks that the 4 speed signals are present;
3. whenever the speed of 24 km/h is exceeded, starting from a standstill, it checks that the 4 speed signals are present;
4. during driving it continuously checks the peripheral speed of the wheels against the calculated reference speed, it checks the memory conditions and supervises the operation of the two relays;
5. during driving it constantly checks the battery voltage.



P4A09AD01

NOTE *The fault warning light is connected so that it is on if the connector is not connected to the control unit or if the wire (1) is shorting to earth. Supplied by the instrument panel, it is only off if the battery voltage reaches the wire (1) from the control unit interface.*

D1 : protective diode
D2 : LED
R1 & R2 : load resistors

1) Positive from control unit pin 16

Diagnosis of the system with the F/L Tester is only feasible if the peripheral speed of the wheels is below 4 km/h, the battery voltage is over 7 Volts and the A.B.S. system is not operating.
Full diagnosis of the system consists of the following three stages:
1. display of a set of operating parameters;
2. display of any errors that may be present and their deletion;
3. activation of the actuators (active diagnosis).

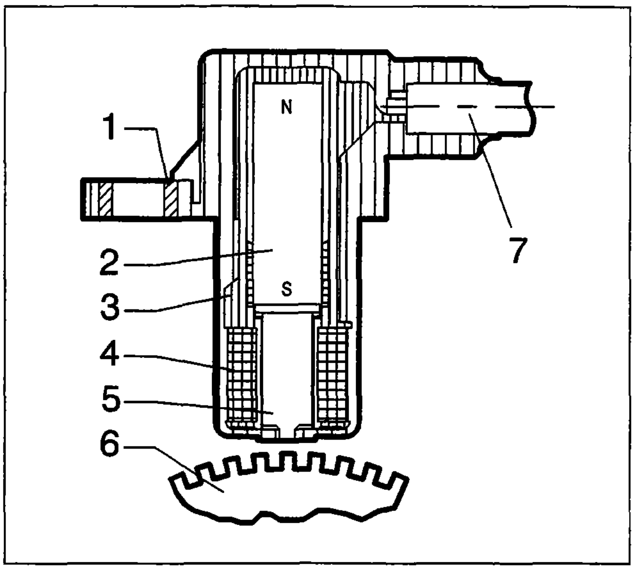
1. PARAMETERS DISPLAYED	2. PROCEDURE	3. PARTS ACTIVATED
Speed of the individual wheels State of recycling pump motor State of brake pedal switch State of fault warning light	Detection of faults Memorization of the error Deletion of the error	Input solenoids (4) Output solenoids (4) Fault warning light Recycling pump motor

Detection of faults
This is carried out during performance of basic functions and diagnostic tests relating to the sensors/actuators.

Memorization of the error and structure of the error memory.
The error type code and the error counter are memorized for each error in the order in which they arise. This parameter consists of the code of the last fault which has occurred and the relevant counter. The latter is set at 31 in the event of a fault, and subsequently decreased by 1 for every start-up and subsequent increase in speed to over 20 km/h which takes place without the fault.

Error deletion
The error is deleted as follows:
- by a command from the F/L Tester;
- when the error counter reaches zero.

NOTE *As the start-up of the procedure involves disabling the system, the fault warning light remains on throughout the duration of the procedure.*
The procedure is interrupted if the vehicle exceeds the speed of 10 km/h.

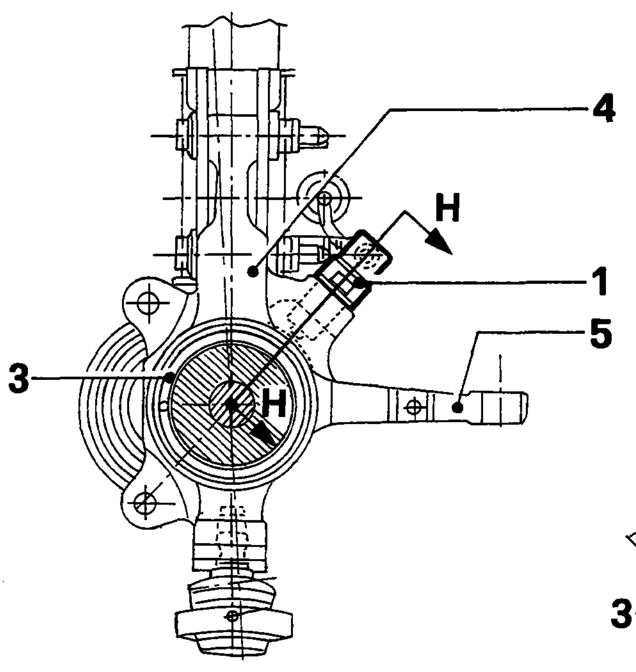


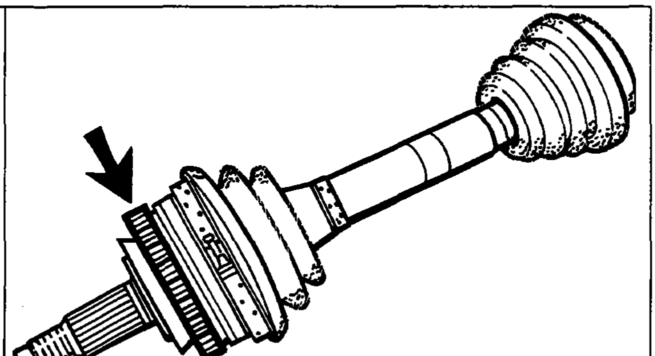
P4A10AD01

WHEEL RPM SENSOR

The vehicle speed measurement system consists of a wheel or toothed crownwheel (phonic wheel) fitted on the hub or wheel axle, and a variable reluctance sensosr.
This assembly generates an electrical signal whose frequency is proportional to the speed of rotation.

1. Brass bush
2. Permanent magnet
3. Plastic casing of the sensor
4. Winding or coil
5. Polar core
6. Toothed crownwheel or phonic wheel
7. Coaxial twin cable





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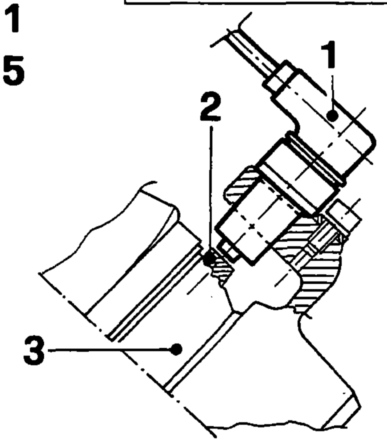
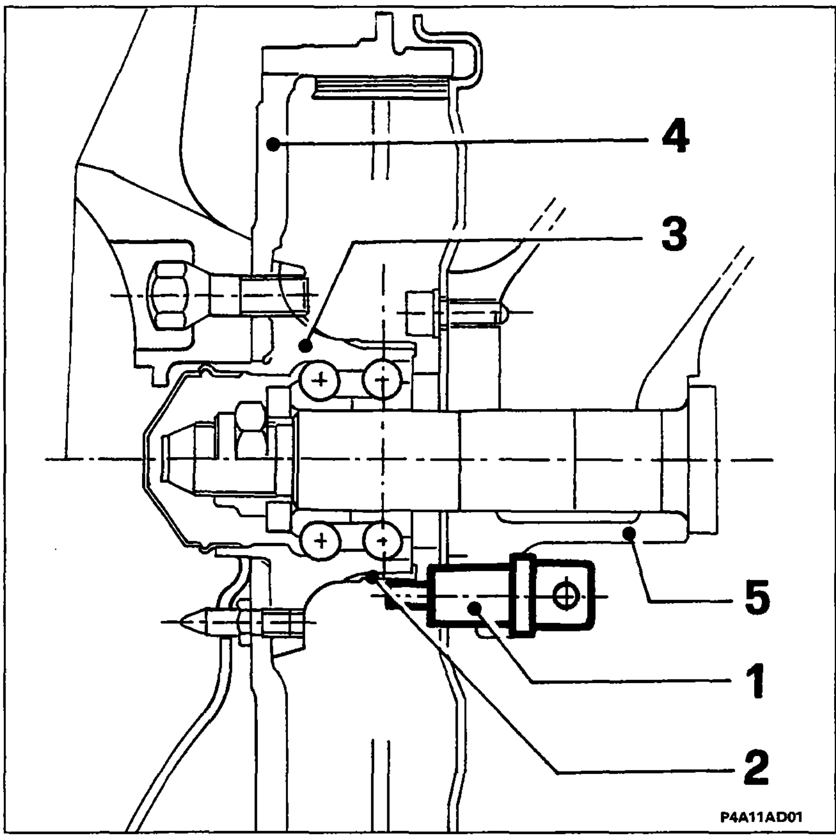


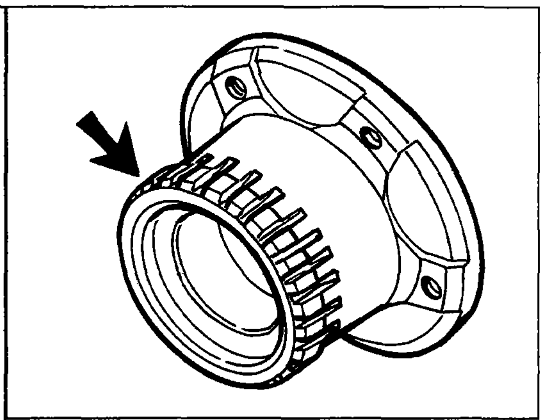
Sensor/phonic wheel on front wheel

1. Sensor
2. Phonic wheel
3. Hub
4. Vertical link
5. Steering arm

P4A10AD03

The signals are obtained from magnetic flow lines which close through the teeth of a metal toothed wheel facing the sensor, which rotates with the wheel.
The passage from full to empty, due to the presence or absence of the tooth, causes a change in the magnetic flow sufficient to generate an induced alternating voltage, derived from the count of teeth located on a ring (or phonic wheel). Measuring the period gives the speed data, while comparing successive periods gives the wheel acceleration/deceleration data.
The specified gap for obtaining correct signals, between the end of the sensor and the phonic wheel, must be 0.9 ± 0.4 mm.
This gap is not adjustable so, if the gap is outside the tolerance limits, check the condition of the sensor and the phonic wheel.





Sensor/phonic wheel on rear wheel

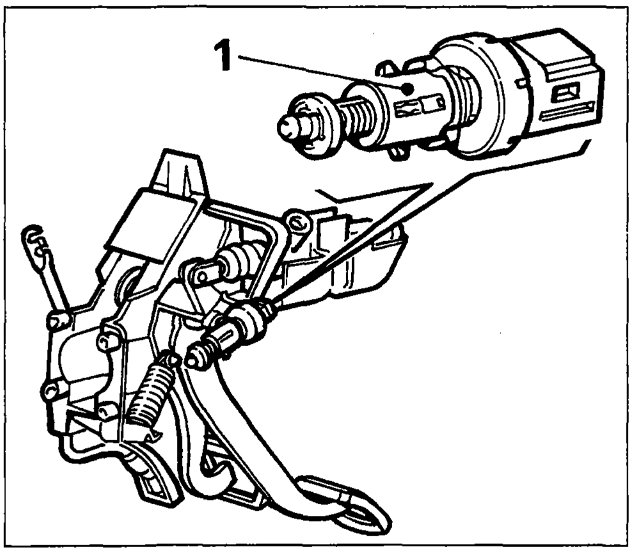
1. Sensor
2. Phonic wheel
3. Hub
4. Brake drum
5. Suspension arm

If one or more phonic wheels break or become deformed, causing a difference in speed of 25% in relation to the reference speed, the electronic control unit switches off the device and switches on the fault warning light. The time for detecting the fault is about 120 seconds with a vehicle speed of over 6 km/h.

NOTE *Whenever fitting an rpm sensor, smear it with water-repellent grease, otherwise it could be damaged during subsequent withdrawal as a result of temperature variations over a period of time.*

STOP LIGHTS SWITCH

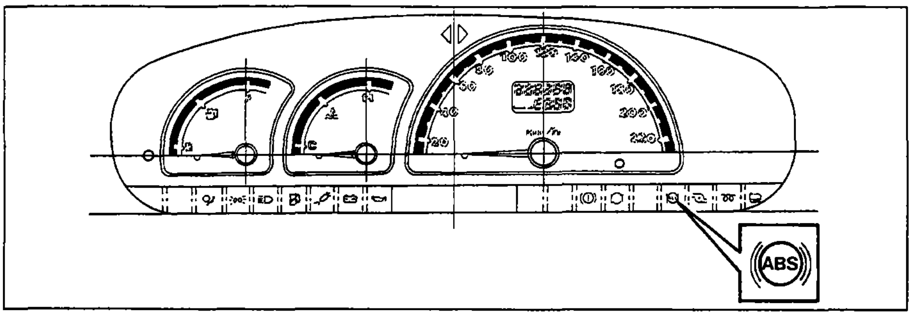
The signal that the brake pedal has been operated reaches the control unit by the connection of the switch (1) controlling the stop lights to pin 12.



P4A11AD03

This information is useful not only for controlling braking, but also under particular conditions, for example if sudden acceleration which makes the wheels skid is followed by heavy braking, or in the case of rough road surfaces (bumps etc.) which could cause variations in wheel speed for reasons not associated with the braking in progress.

Under these conditions the microprocessors work out a strategy linked to the changes in wheel speed at these moments, ensuring that braking is within correct parameters. As these are particular circumstances of braking control, the efficiency of the system is not impaired if the brake pedal switch is not connected to the control unit. For this reason it is not indicated by the warning light coming on, nor is the A.B.S. disabled.



P4A12AD01

A.B.S. FAULT WARNING LIGHT

Under normal operating conditions, the red warning light (arrowed) is off.

During starting, when the ignition is switched on, the control unit carries out a static self-last lasting about 2 seconds, during which time the warning light stays on.

If there are no faults after this time, the warning light goes out.
During driving, the control unit carries out continuous self-tests. If an error is recognized, the warning light comes on and the A.B.S. is disabled, without affecting the operation of the conventional braking system.

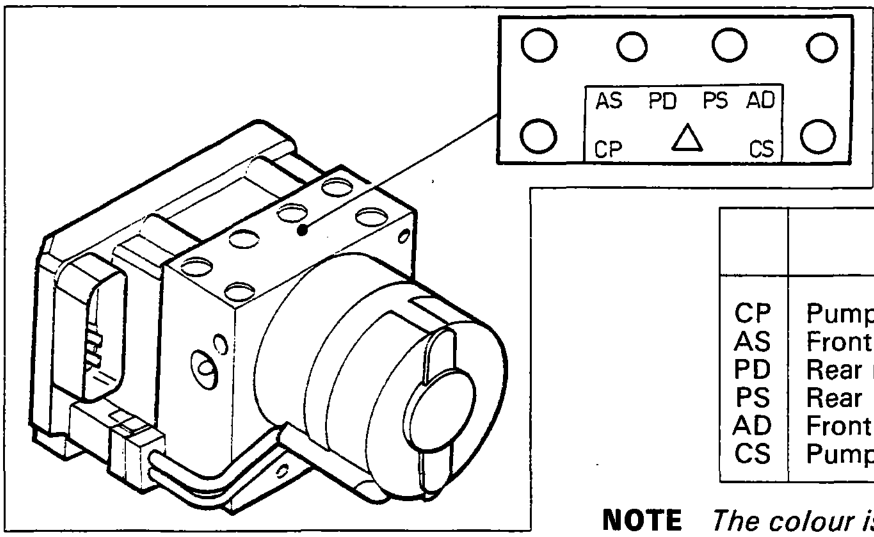
NOTE *If the battery has insufficient charge, the warning light and the A.B.S. may be excluded (for example in towns, travelling at low engine speeds, with all the electrical devices switched on).*

ELECTROHYDRAULIC CONTROL UNIT

The electrohydraulic control unit is connected to the brake pump and brake caliper cylinders by brake pipes and is incorporated in the electronic control unit.
Its purpose is to vary the pressure of the brake fluid in the brake caliper cylinders in accordance with the control signals coming from the electronic control unit.
It consists of eight two-way solenoids (two for each hydraulic circuit) and a dual-circuit recycling pump all driven by the electronic control unit.
In particular, the pump enables brake fluid to be recovered during the pressure reduction phase, making it available again upstream of the solenoids for the subsequent pressure increase phase.

The accumulators allow brake fluid to be absorbed during the pressure reduction phase.

NOTE *The electrohydraulic control unit cannot be overhauled. If found to be faulty, it must be fully replaced. The spare part is supplied filled with brake fluid (DOT 4). The braking system is bled in the same way as a conventional system.*

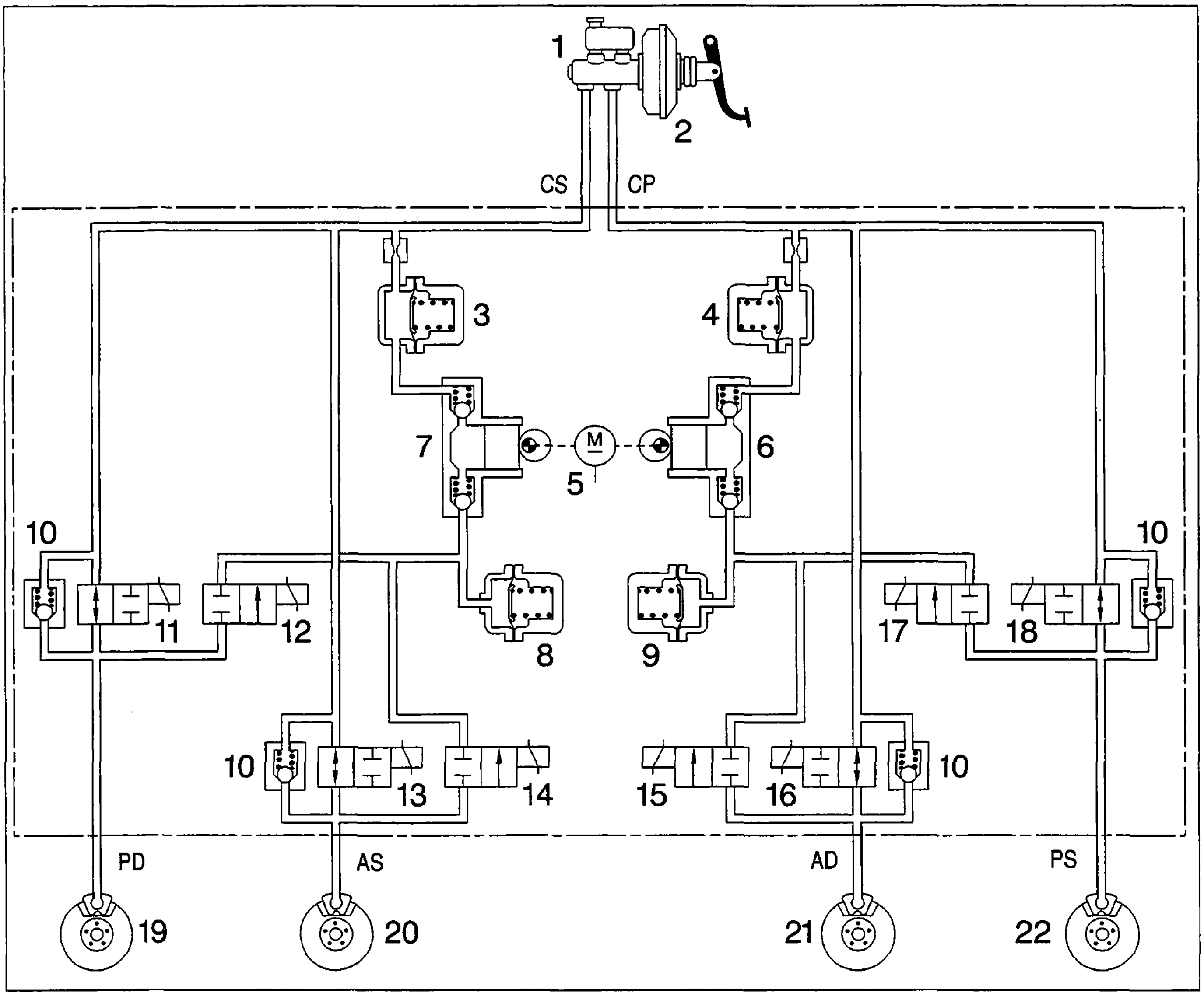


P4A12AD02

	Name	Colour	Connector
CP	Pump primary	-	M12x1
AS	Front left	YELLOW	M12x1
PD	Rear right	BLUE	M10x1
PS	Rear left	RED	M12x1
AD	Front right	GREEN	M10x1
CS	Pump secondary	-	M12x1

NOTE *The colour is also shown on the relevant pipe.*

HYDRAULIC DIAGRAM OF TEVES MK20 A.B.S.



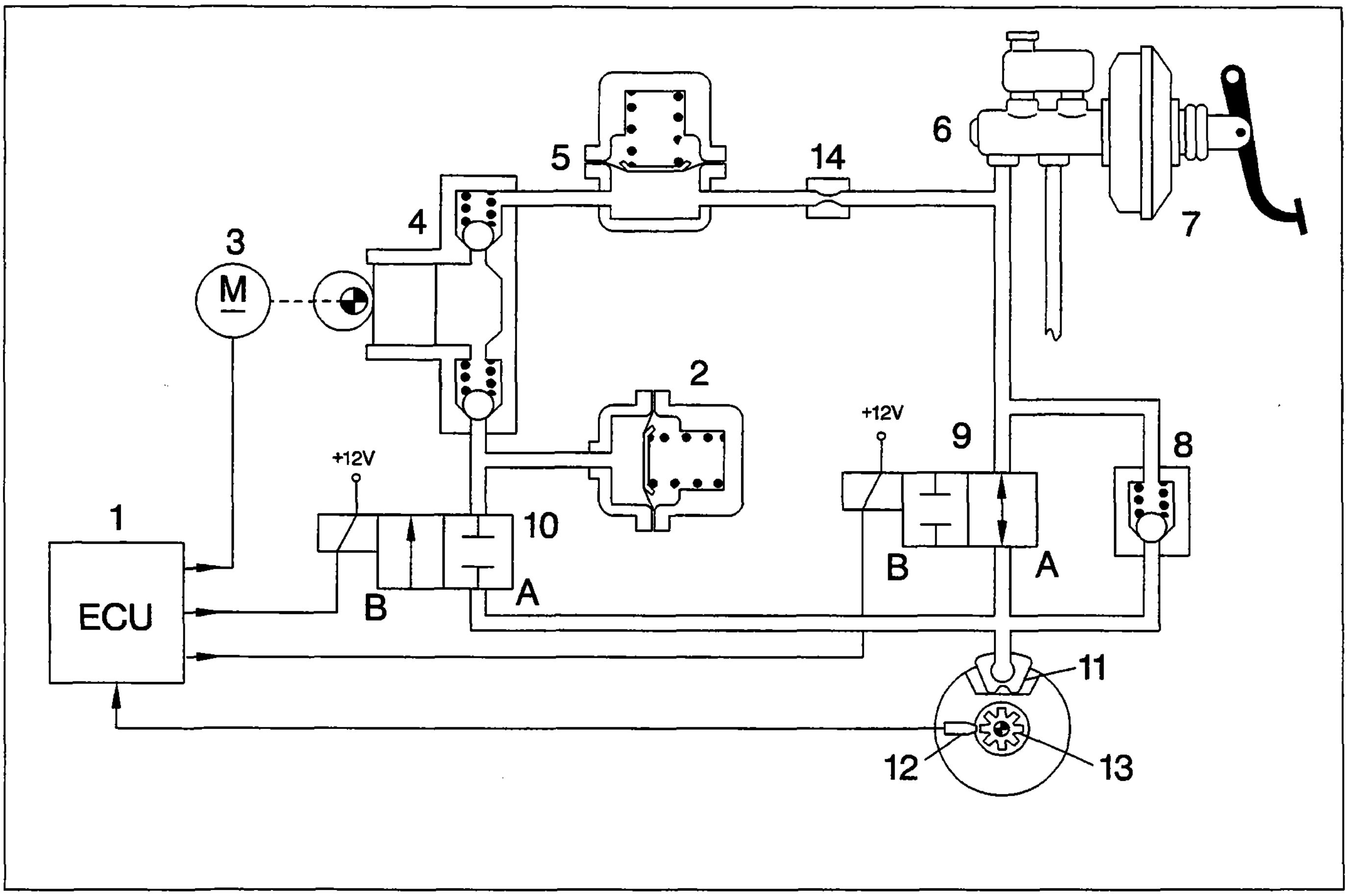
P4A13AD01

1. Brake pump
2. Servo unit
3. High-pressure accumulator (damping chamber)
4. High-pressure accumulator (damping chamber)
5. Recycling pump motor
6. Recycling pump
7. Recycling pump
8. Low-pressure accumulator (reservoir)
9. Low-pressure accumulator (reservoir)
10. Rapid pressure reducing valve
11. Rear right inlet solenoid
12. Rear right outlet solenoid
13. Front left inlet solenoid
14. Front left outlet solenoid
15. Front right inlet solenoid
16. Front right outlet solenoid
17. Rear left inlet solenoid
18. Rear left outlet solenoid
19. Rear right brake caliper
20. Front left brake caliper
21. Front right brake caliper
22. Rear left brake caliper

C.P. Primary supply connector
C.S. Secondary supply connector
P.D. Delivery connector to rear right caliper
A.S. Delivery connector to rear left caliper
A.D. Delivery connector to front right caliper
P.S. Delivery connector to rear left caliper

DESCRIPTION OF HYDRAULIC OPERATION OF TEVES MK20 A.B.S.

Rest position

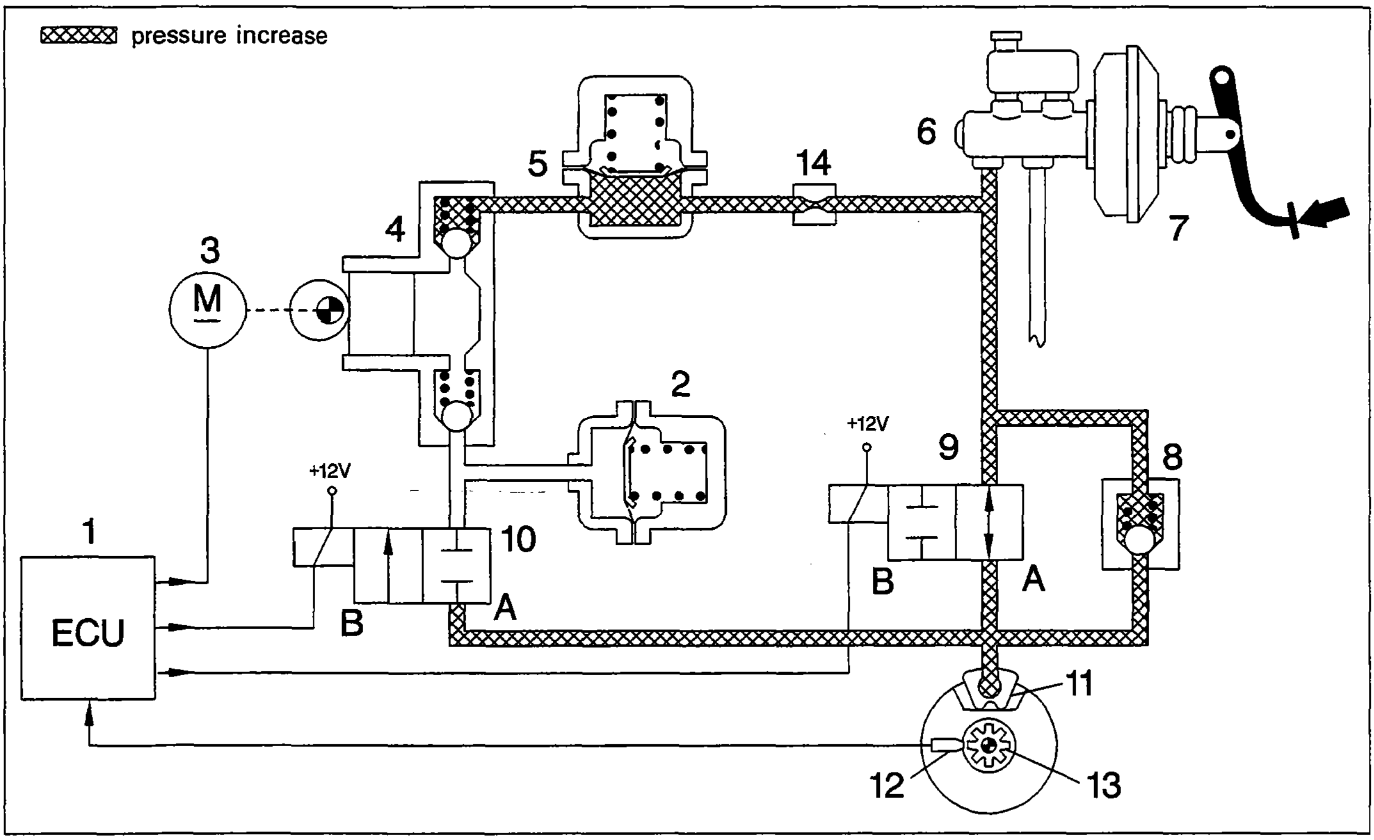


P4A14AD01

1. Electronic control unit
2. Low-pressure accumulator (reservoir)
3. Recycling pump motor
4. Recycling pump
5. High-pressure accumulator (damping chamber)
6. Brake pump
7. Servo unit
8. Rapid pressure reducing valve
9. Inlet solenoid (A) open (B) closed
10. Outlet solenoid (A) closed (B) open
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Constriction

The Teves MK20 A.B.S. has two two-way solenoids for each hydraulic circuit.
When de-activated (not earthed by the control unit), the inlet solenoid (9) is in the open position, thus allowing fluid to pass to the brake caliper. The pressure is maintained by closing this valve, i.e. supplying it electrically.
When de-activated (not earthed by the control unit), the outlet solenoid (10) is in the closed position and does not allow fluid to discharge to the low-pressure accumulator (2).
The accumulators (2) and (5) temporarily store the brake fluid which becomes available during the pressure reduction phase. The recycling pump (4) sends the brake fluid, which flows from the brake calipers during the pressure reduction phase, to the brake pump through the relevant accumulator. On the basis of the signals received from the rpm sensors located on the front and rear wheels, the electronic control unit drives the electrohydraulic control unit which in turn varies the pressure of the brake fluid sent to the caliper in accordance with three phases: increase, maintenance or reduction of pressure.

Presssure increase phase



P4A15AD01

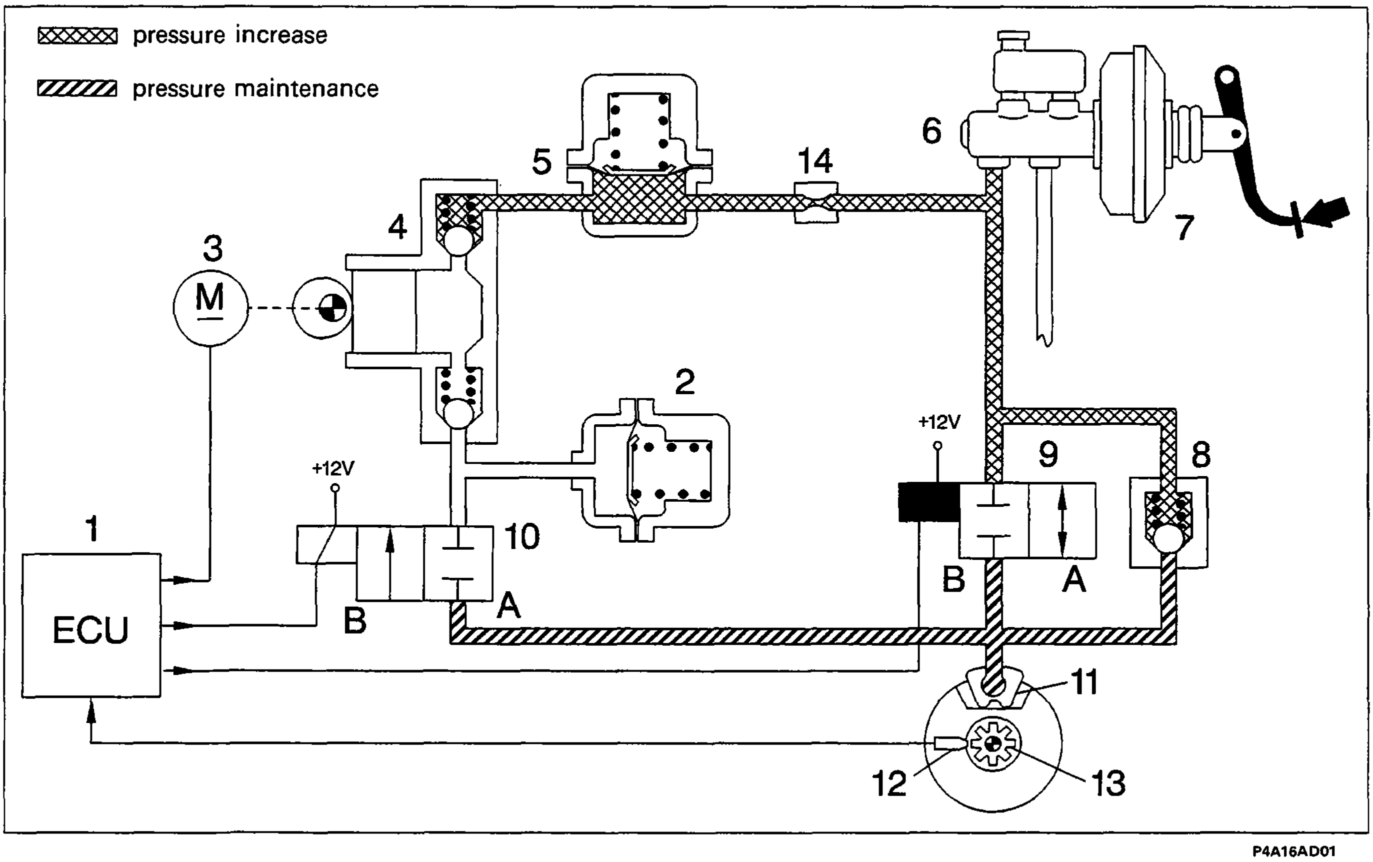
1. Electronic control unit
2. Low-pressure accumulator (reservoir)
3. Recycling pump motor
4. Recycling pump
5. High-pressure accumulator (damping chamber)
6. Brake pump
7. Servo unit
8. Rapid pressure reducing valve
9. Inlet solenoid (A) open (B) closed
10. Outlet solenoid (A) closed (B) open
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Constriction

When the driver presses the brake pedal, the pressure generated by the brake pump (6) reaches the brake calipers without undergoing variations, as the solenoids (9) and (10) of the hydraulic unit are not earthed by the electronic control unit.

When the braking force increases, the wheel deceleration consequently increases: this causes faster deceleration of the car (i.e. the wheel slip increases).
The slip value must not exceed a particular value beyond which the wheel loses grip with the ground and begins to skid, resulting in loss of direction control and increase in braking distances.

The wheel speed sensor (12) indicates when deceleration values which could impair the wheel's grip on the ground are reached; at this point the electronic control unit (1) drives the solenoids on the electro-hydraulic control unit, reducing the braking force and allowing the wheel to increase its speed and so recover grip.

Pressure maintenance phase



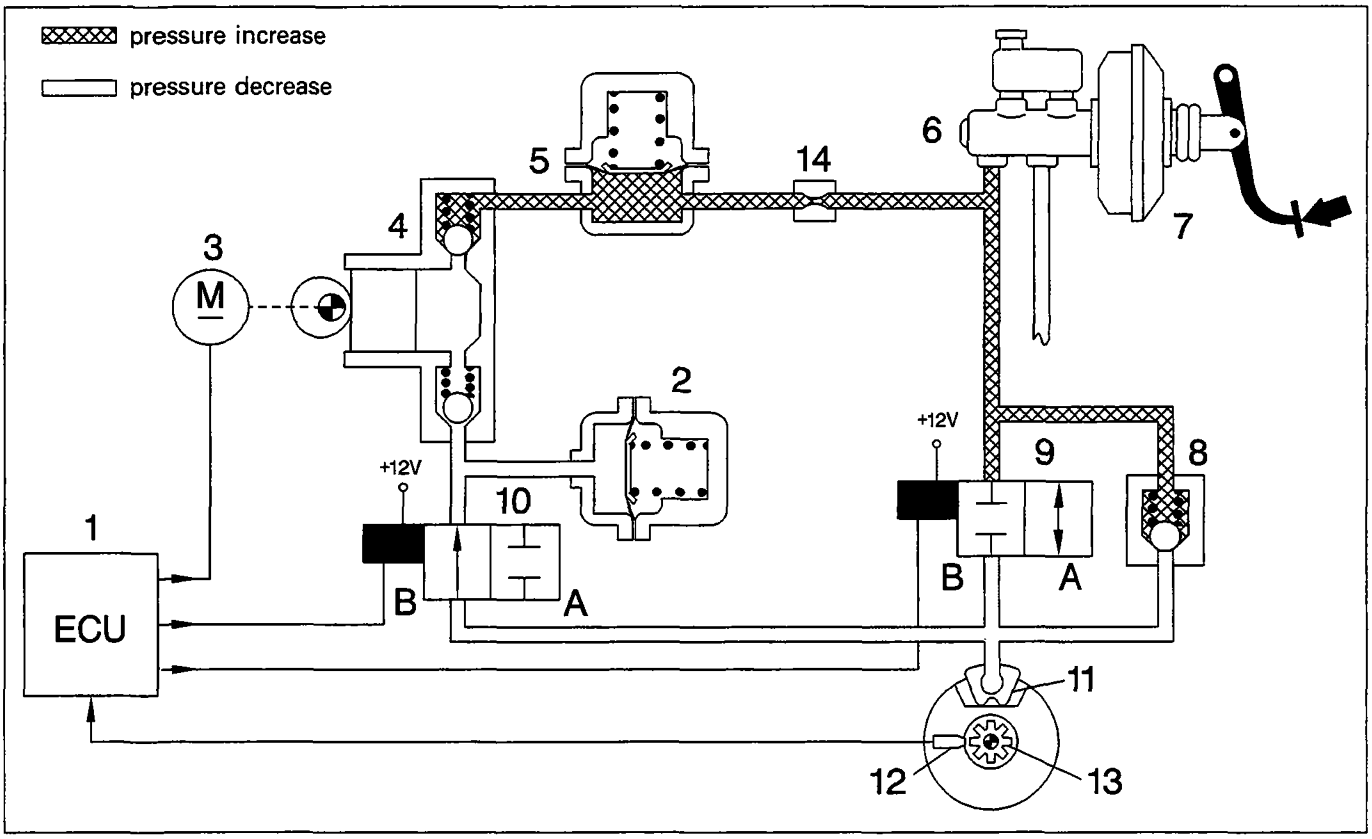
1. Electronic control unit
2. Low-pressure accumulator (reservoir)
3. Recycling pump motor
4. Recycling pump
5. High-pressure accumulator (damping chamber)
6. Brake pump
7. Servo unit
8. Rapid pressure reducing valve
9. Inlet solenoid (A) open (B) closed
10. Outlet solenoid (A) closed (B) open
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Constriction

In this phase the electronic control unit (1) earths the inlet solenoid (9) which closes, while the outlet solenoid (10), not being connected to earth, is already closed.

The hydraulic connection between the brake pump (6) and brake caliper (11) is interrupted (waiting position).
The pressure in the brake caliper (11) is kept constant at the value reached previously, whatever the pressure on the brake pedal.

Even though the braking force maintains a continuous slowing down action, the wheel varies its speed in accordance with the grip on the ground, until the rpm sensor (12) measures a value which is comparable to the reference speed calculated by the electronic control unit (1).
At this point, the control unit passes from the maintenance phase to the pressure increase phase (if the wheel accelerates) or reduction phase (if the wheel is tending to lock).

Pressure reduction phase



P4A17AD01

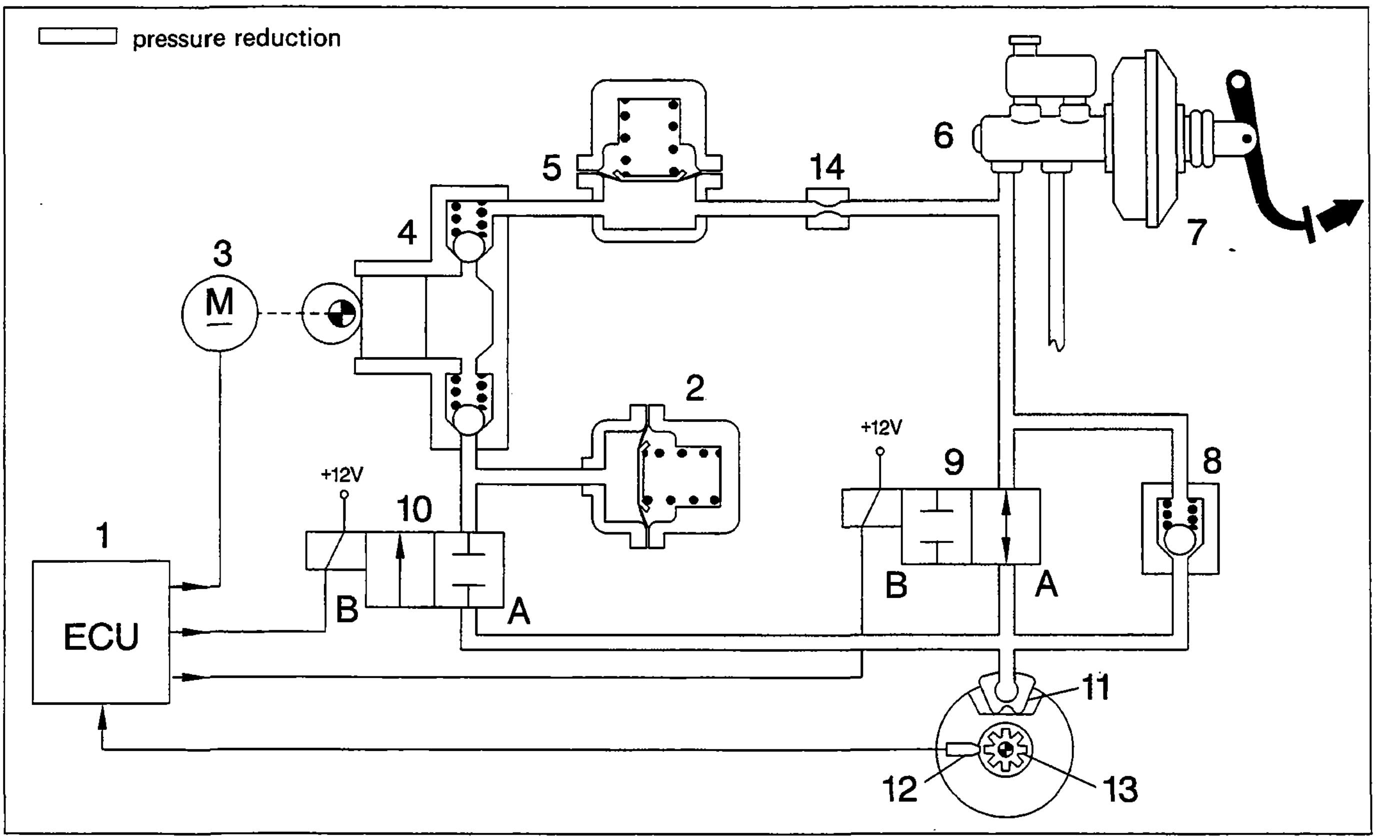
1. Electronic control unit
2. Low-pressure accumulator (reservoir)
3. Recycling pump motor
4. Recycling pump
5. High-pressure accumulator (damping chamber)
6. Brake pump
7. Servo unit
8. Rapid pressure reducing valve
9. Inlet solenoid (A) open (B) closed
10. Outlet solenoid (A) closed (B) open
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Constriction

The electronic control unit (1) detects the wheel's tendency to lock and activates the electrohydraulic unit to limit the wheel deceleration to within the permitted threshold values.
The electronic control unit (1) earths the inlet solenoid (9) and outlet solenoid (10).
The inlet solenoid (9) remains closed, maintaining the break in connection between brake pump (6) and brake caliper (11); the outlet solenoid (10) opens thus hydraulically connecting the brake caliper (11) to the low-pressure accumulator (2) and recycling pump (4), in order to remove some of the fluid from the brake caliper (11) and reduce the pressure on that caliper.
At the same time the electronic control unit (1) supplies the motor (3) for driving the recycling pump (4) which returns fluid removed from the brake caliper (11) into the main circuit. The accumulator (2) or low pressure reservoir present in the circuit stores some of the brake fluid removed from the calipers. Through the circuit of the recycling pump (4), the brake fluid is drawn in and sent, through the damping chamber (5) and constriction (14), into the main circuit of the brake pump (6). During this phase, a series of pressure waves (or hydraulic thrusts) is generated, and these are attenuated by the presence of the damping chamber (5) and constriction (14). During this phase, because of the reduction in the braking force, the wheel tends to assume the reference speed calculated by the electronic control unit (1).

The braking is therefore intermittent or in steps, and follows a succession of phases dictated by the rolling conditions of the braked wheel in accordance with a repetitive cycle in the form of jerks. This is not perceived by the driver, because of the speed and frequency with which it takes place and because it is regulated by the inertia of the wheel which, in relation to the speed of intervention of the device, prevents the wheel from reaching extreme skid coefficients.
On a car with no A.B.S., the driver is able to intervene intermittently on the brake pedal with a frequency of 2 cycles per second (2 presses and 2 releases).
With the A.B.S. system, the cycles increase to 4-10 per second (depending on the grip).
The intervention of the A.B.S. usually ceases at speeds of less than 2.75 km/h to permit complete locking of the wheels with the car stopped.

NOTE *The recycling pump is of the dual-circuit free piston type, and is driven by an electric motor which is always turning during recycling. The pistons are not coupled to the electric motor, but are only moved along their travel, by the cam, when the brake fluid arrives. The pump can therefore only accomplish one pushing travel, and cannot draw in fluid because there is no mechanical connection between motor and pump.*

Release of brake pedal



P4A18AD01

1. Electronic control unit
2. Low-pressure accumulator (reservoir)
3. Recycling pump motor
4. Recycling pump
5. High-pressure accumulator (damping chamber)
6. Brake pump
7. Servo unit
8. Rapid pressure reducing valve
9. Inlet solenoid (A) open (B) closed
10. Outlet solenoid (A) closed (B) open
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Constriction

To permit a rapid reduction in pressure on the brake caliper (11) when the brake pedal is released, the system has a non-return valve (8) located in parallel with the inlet solenoid (9).

REQUIREMENTS TO BE OBSERVED ON CARS FITTED WITH ANTI-LOCK BRAKING SYSTEM

Before carrying out welding work with electric welders, disconnect the connector from the electronic control unit.
If the battery is removed, after refitting it make sure to tighten the terminals fully.

To replace the electronic control unit, removee the entire hydraulic unit for space reasons and in order not to damage the internal connector.
Before dismantling the electrohydraulic control unit, disconnect the battery's negative lead.

The entire A.B.S. system must be checked with the Fiat/Lancia Tester whenever the electrohydraulic unit, an rpm sensor, the electronic control unit or wiring is replaced.
After every intervention on the hydraulic circuit of the A.B.S. or braking system, fill the system with DOT 4 brake fluid, bleed the air out and check that there are no leaks from the connecting points.

The electrohydraulic control unit is supplied filled with DOT 4 brake fluid and the solenoids not supplied. The system is bled and filled with brake fluid in the same way as a conventional braking system, although it takes longer.
Check that the pipes are not in contact with the bodywork at any point, in order to avoid not only the risk of damaging the pipe protection, but also the transmission of noise during operation of the A.B.S.

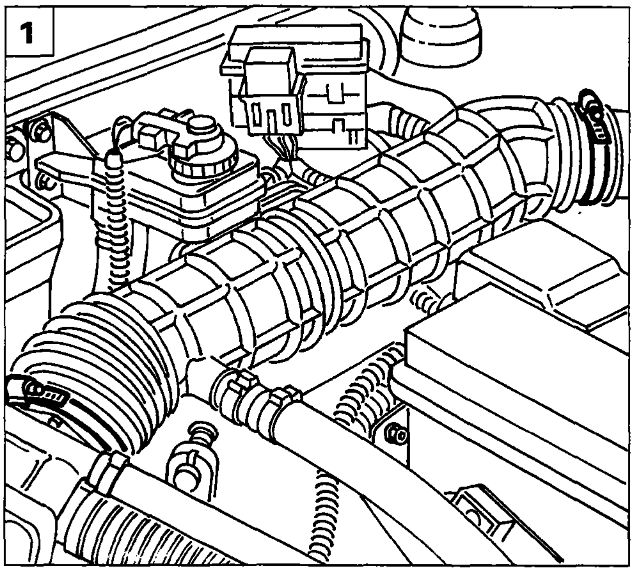
If connecting pipes have to be slackened or removed, leak tests must be conducted on the A.B.S. system.

Do not put mineral oil in the brake circuit, as this would damage all the seals.
If it is put in accidentally, the following must be replaced:
- *hydraulic unit;*
- *brake pump;*
- *calipers.*

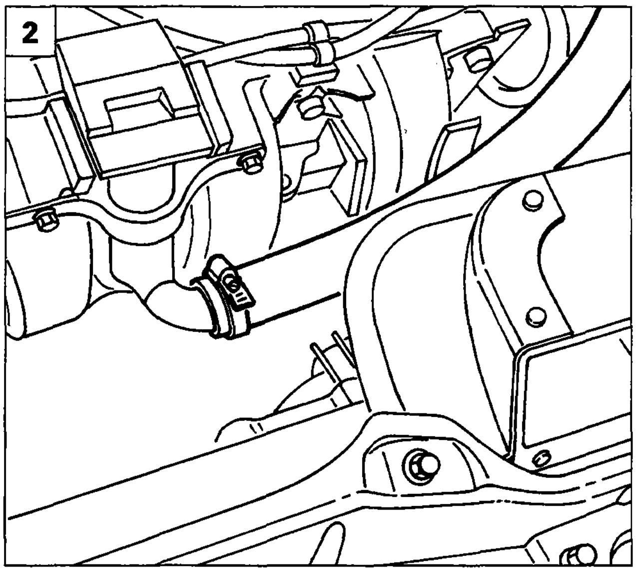
PRECAUTIONS TO BE OBSERVED DURING REPAIRS INVOLVING COMPONENTS OF THE ANTI-LOCK BRAKING SYSTEM

After any repair which has involved the electrical system of the anti-lock braking system or the rpm sensors, during either specific interventions or operations for the dismantling and replacement of mechanical parts (for example spring-damper assembly, constant velocity joints, drive shafts and wheel hubs), a very short road test should be carried out as follows:
1. increase the car speed to over 12 km/h and maintain this speed, in order to allow the electronic control unit to conduct a dynamic check on the sensors and detect any faults, insecure contacts, incorrect positions or the absence of a phonic wheel;
2. after carrying out the above operation, if the warning light does not indicate a fault, continue the test at a speed of 50-60 km/h for 10 minutes, using the brakes normally but without braking sharply. This stage of the test enables the electronic control unit to recognize the presence of an incorrect phonic wheel.

33.



P4A20AD02



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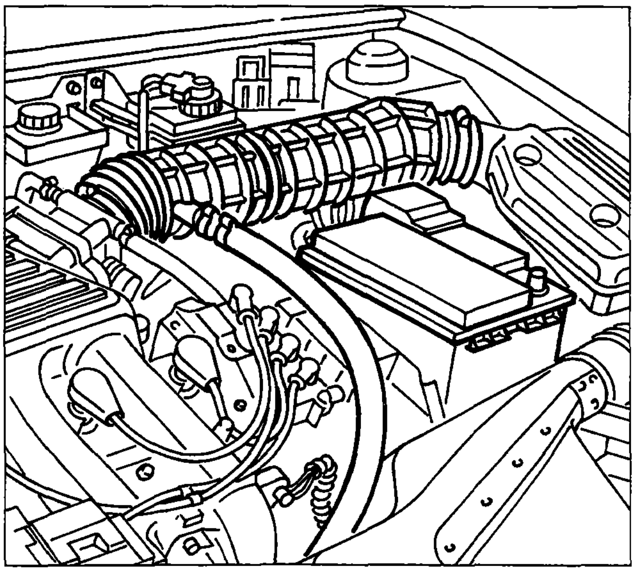


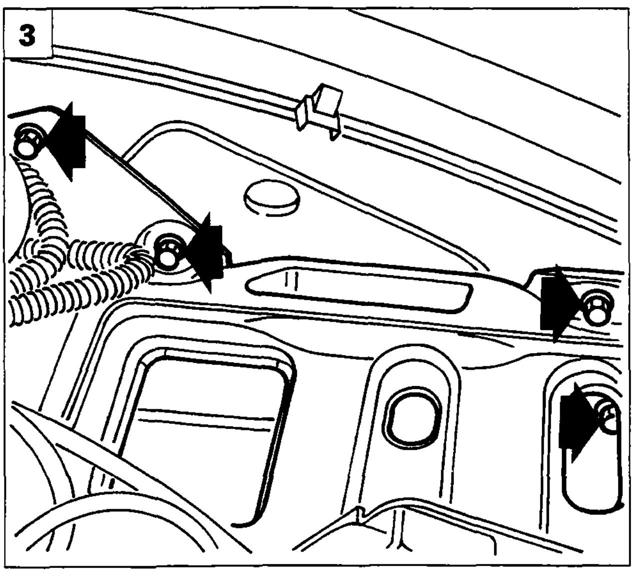
P4A20AD01

REMOVING-REFITTING COMPONENTS OF THE ANTI-LOCK BRAKING SYSTEM

Electrohydraulic control unit

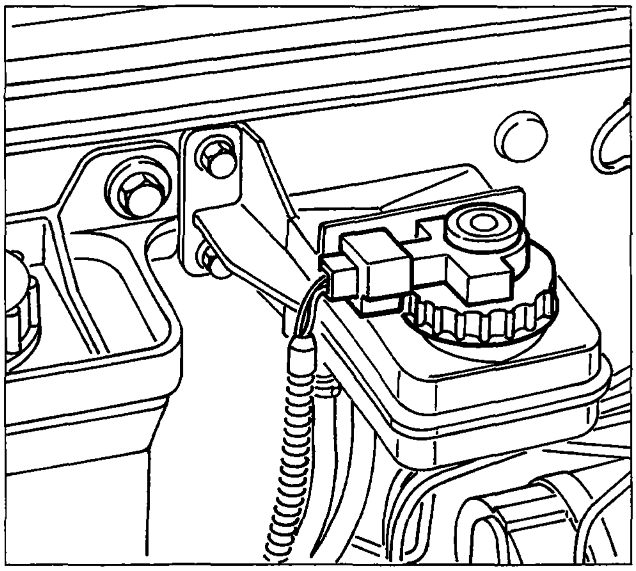
To remove the electrohydraulic unit, proceed as follows:

1. undo the clips securing the inlet pipe;
2. undo the clip securing the oil vapour recirculation pipe and remove the complete inlet pipe;



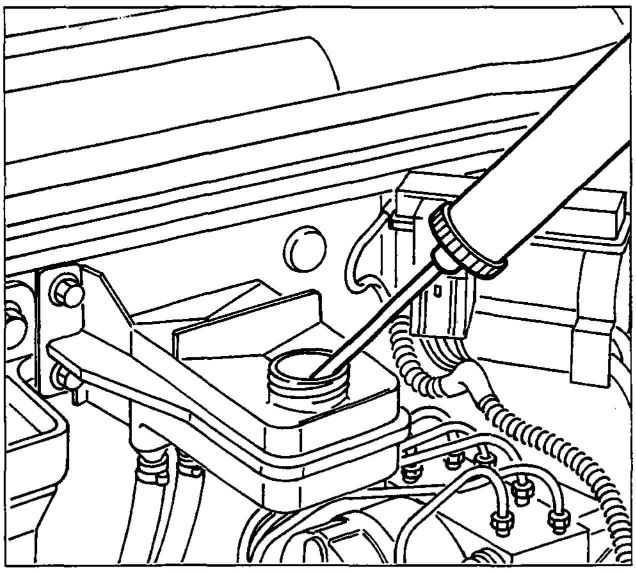
P4A20AD04

3. remove the battery then undo the bolts indicated and move aside the battery cage;



P4A21AD01

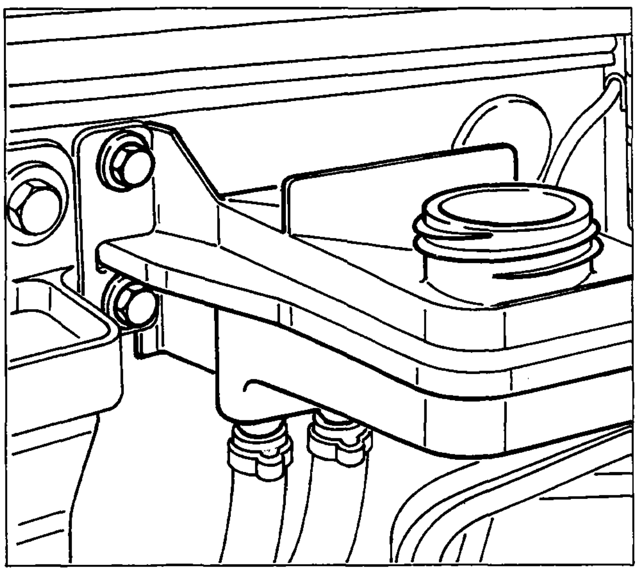
- disconnect the sensor connector on the brake fluid reservoir cap and unscrew the cap;



P4A21AD02

- remove the brake fluid from the reservoir using the special syringe;

Take care should residual fluid in the reservoir come out.



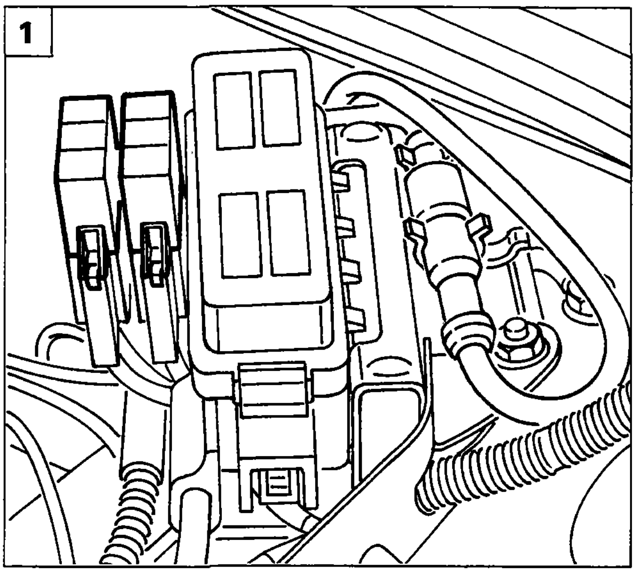
P4A21AD03

- undo the bolts and move aside the brake fluid reservoir;

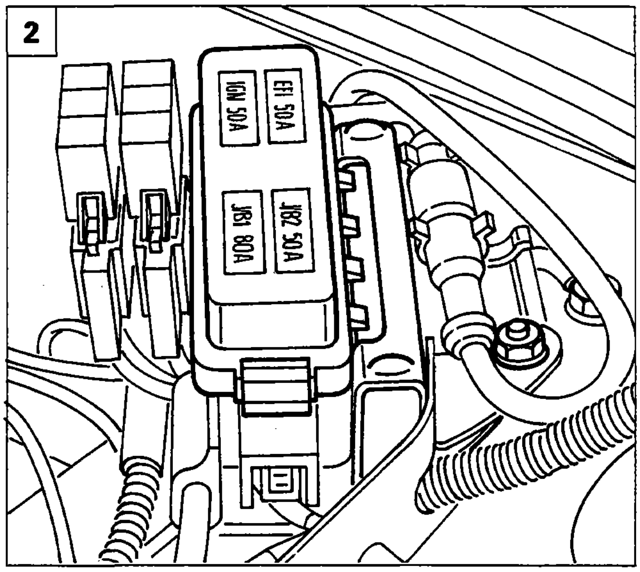
Ensure that the reservoir is absolutely clean before filling it.

Bleed the hydraulic system

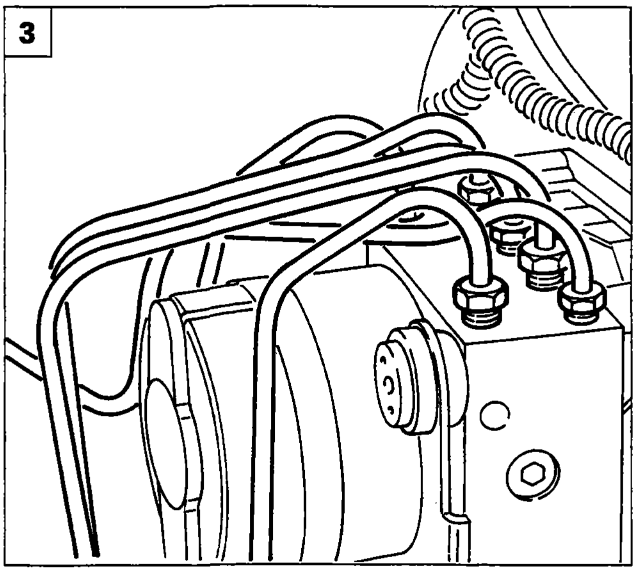
33.



P4A22AD01



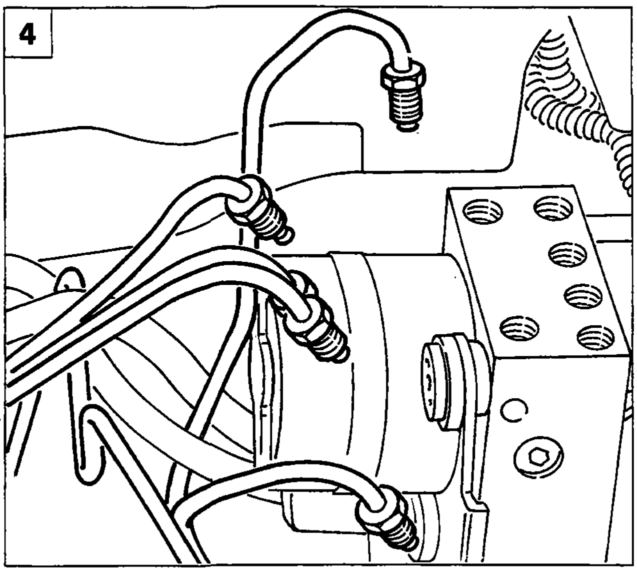
P4A22AD02



P4A22AD03

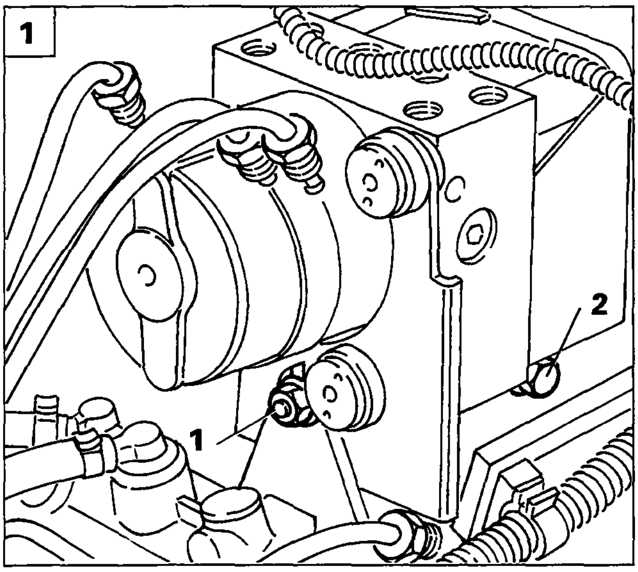
1. use a screwdriver to release the two fuses and move them aside;
2. undo the bolt securing the connector block bracket and move aside the connector block with the fuses;
3. undo the brake pipe connections using a 13 mm wrench and tool 1856132000;

Take care not to damage the pipe connections.



P4A22AD04

4. move aside the brake pipes in order to be able to withdraw the electrohydraulic unit;



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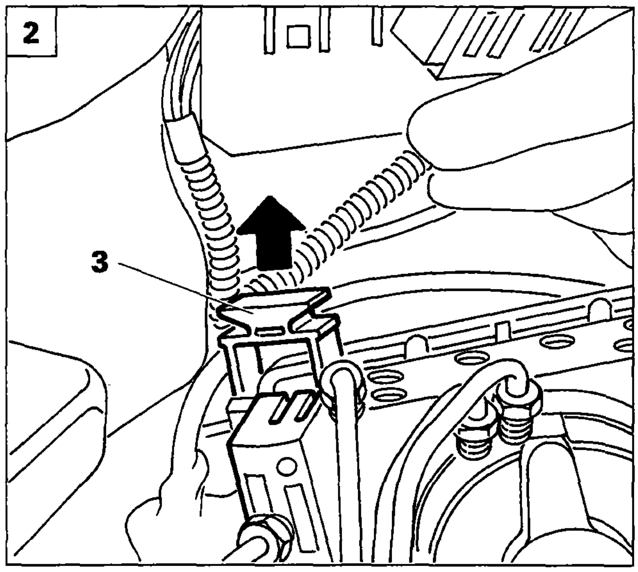

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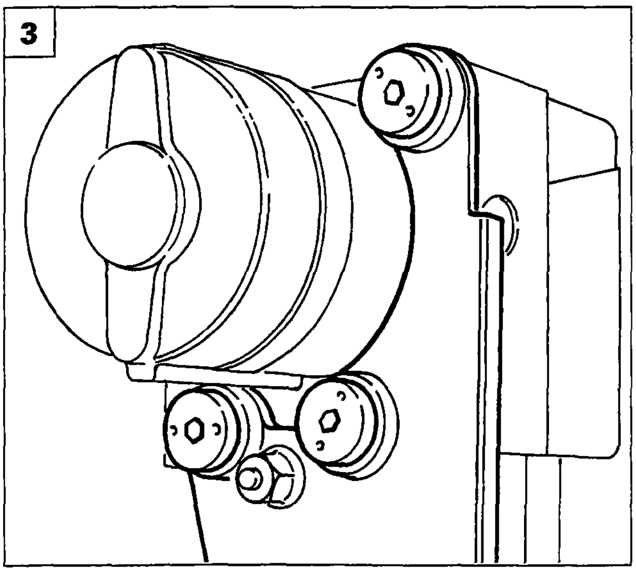
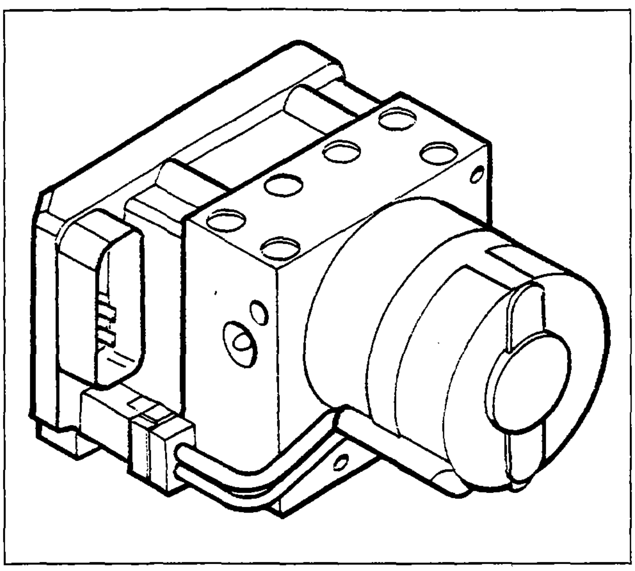


P4A23AD03

1. undo the front bolt (1) and remove the side bolt (2);
2. disconnect the connector, pulling the hooking device (3) upwards and remove the electrohydraulic unit;
3. undo the screws shown and detach the mounting bracket from the electrohydraulic unit.

NOTE *To refit, reverse the procedure for removal.*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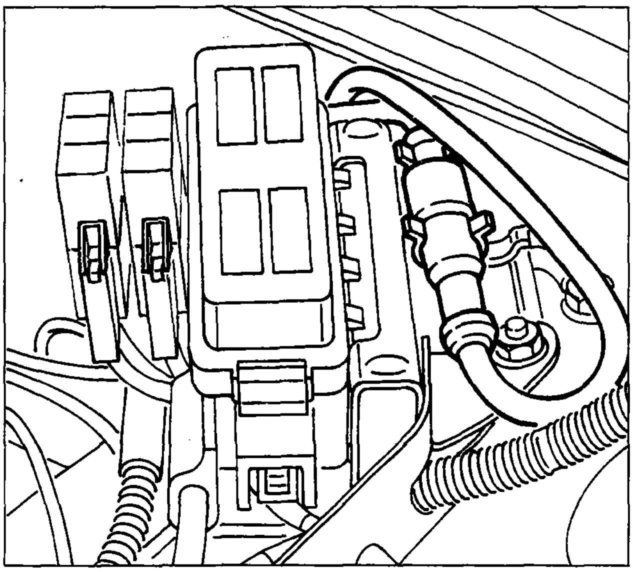
Electrohydraulic control unit

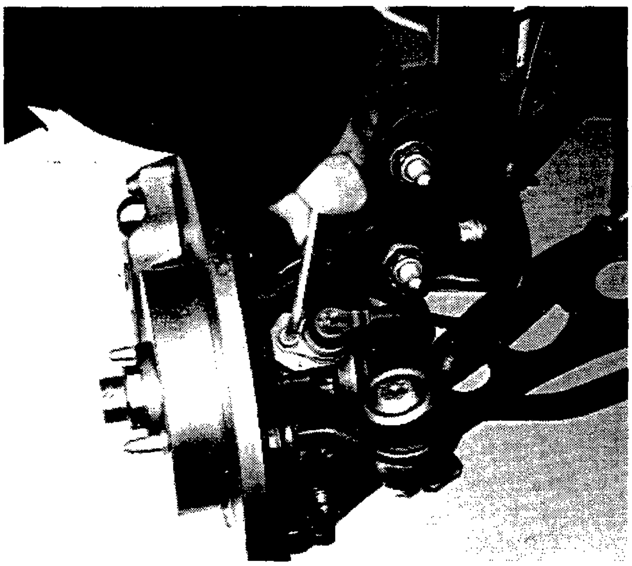


P4A24AD01

Front wheel speed sensor

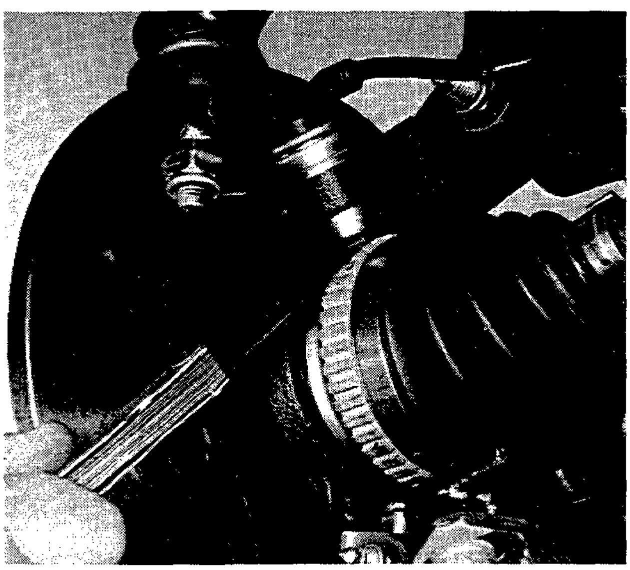
To remove the front wheel speed sensor, proceed as follows:

- disconnect the electrical connector;



P4A24AD02

- undo the bolt and remove the sensor.

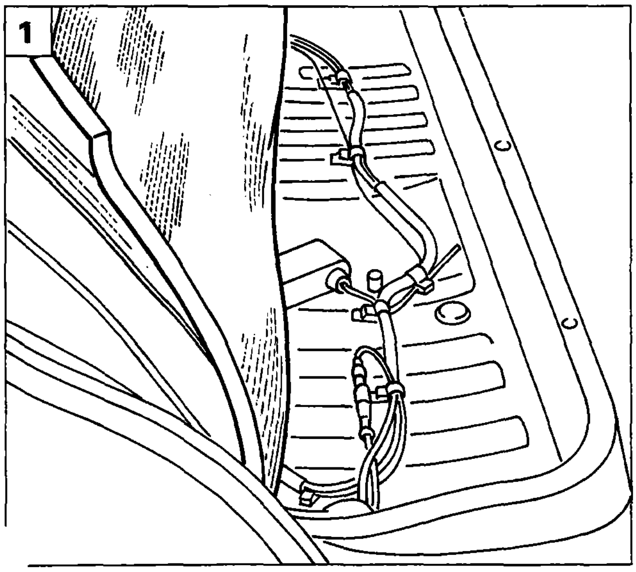


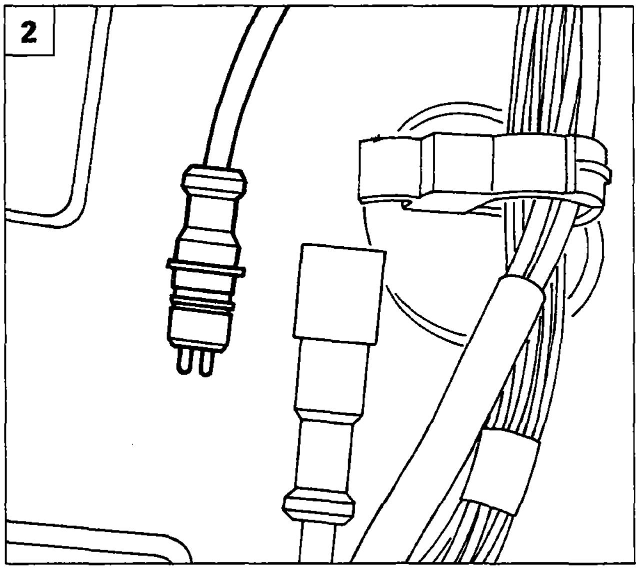
P4A24AD03

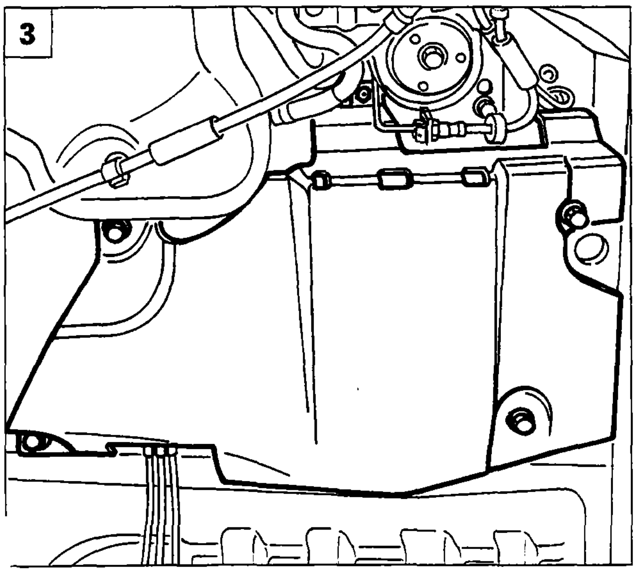
0.645 - 1.305 mm

Checking gap between wheel speed sensor and phonic wheel on front wheel constant velocity joint

The gap is not adjustable since no shims are supplied for the purpose. If the value measured is outside the specified tolerance limits, check the condition of the sensor and the teeth on the phonic wheel.





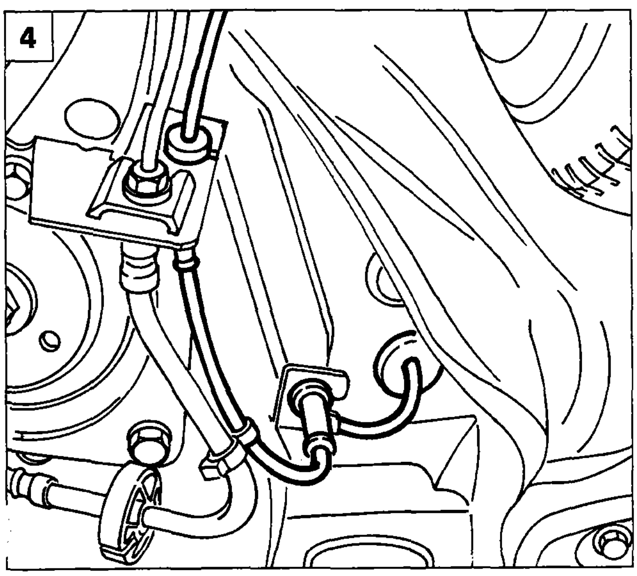


Rear wheel speed sensor

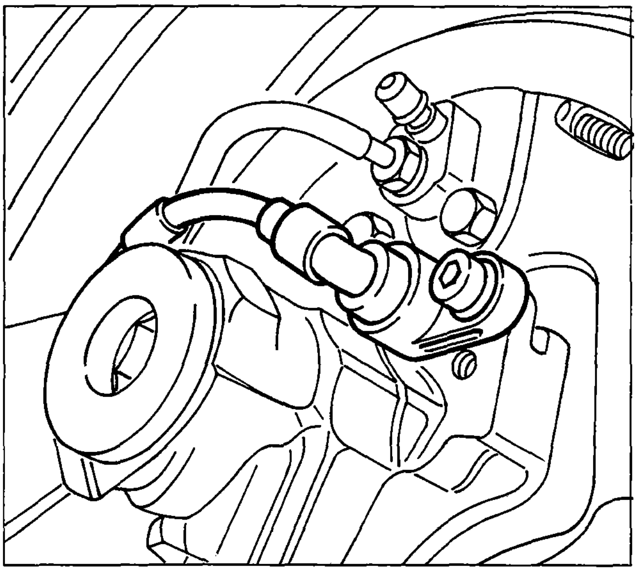
To remove the rear wheel speed sensor, proceed as follows:

1. remove the rear seat and lift the sound-proofing trim;
2. disconnect the sensor's connector.

Raise the vehicle, then:
3. undo the bolts securing the fuel filter cover;

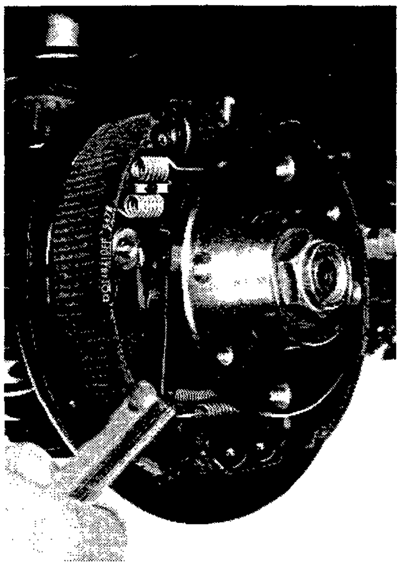


4. take out the rubber seal and withdraw the sensor cable;

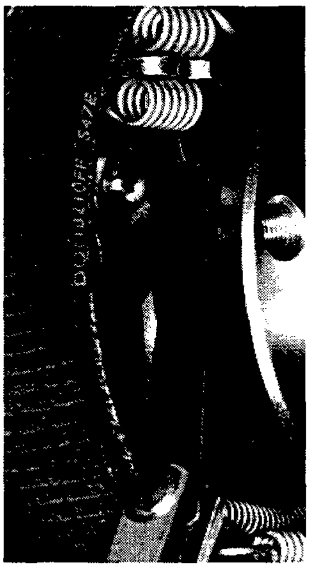


P4A26AD01

- undo the bolt and remove the sensor.



P4A26AD02



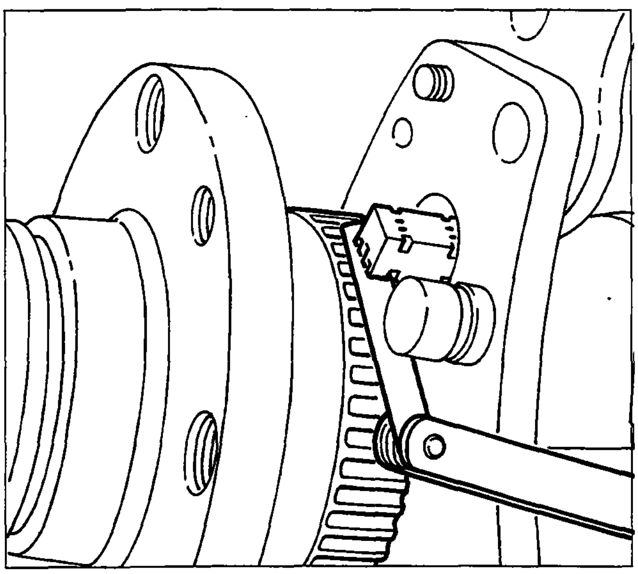
P4A26AD03

1370 12V 1581 16V 1747 16V

1929 D 1910 TD

Checking gap between wheel speed sensor and phonic wheel on rear wheel hub

1998 20V



P4A26AD04

The gap is not adjustable since no shims are supplied for the purpose. If the value measured is outside the specified tolerance limits, check the condition of the sensor and the teeth the phonic wheel.

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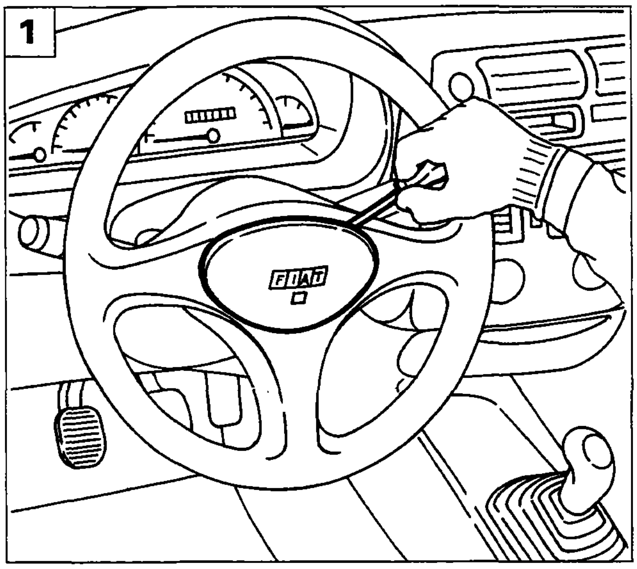

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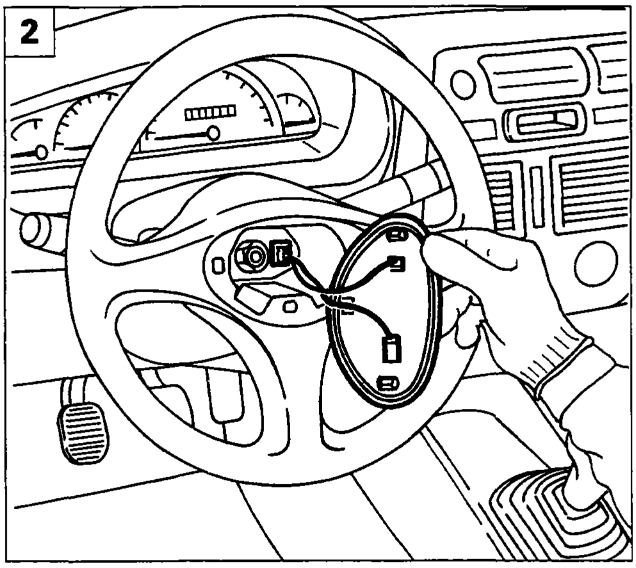

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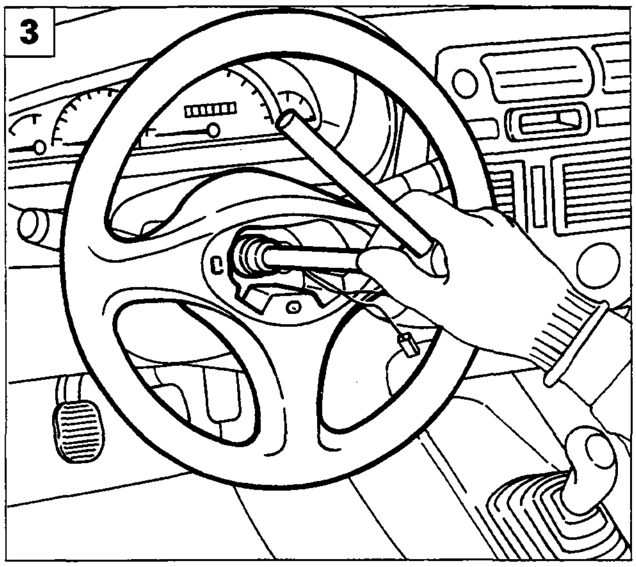


P4A001F03

STEERING WHEEL

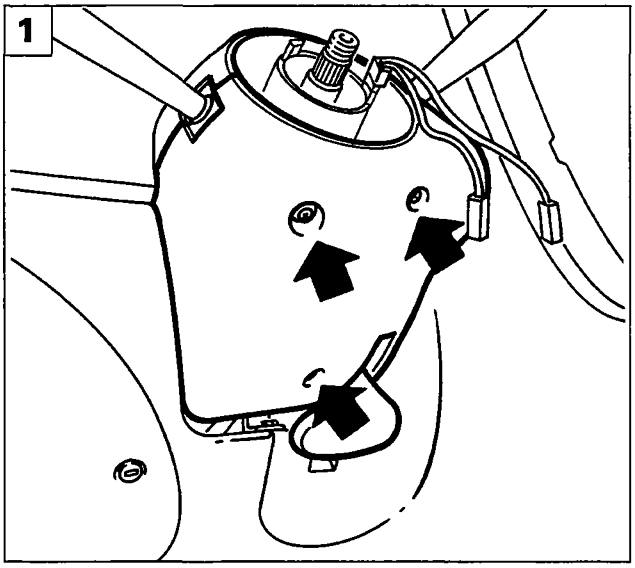
Removing-refitting

To remove the steering wheel, proceed as follows:

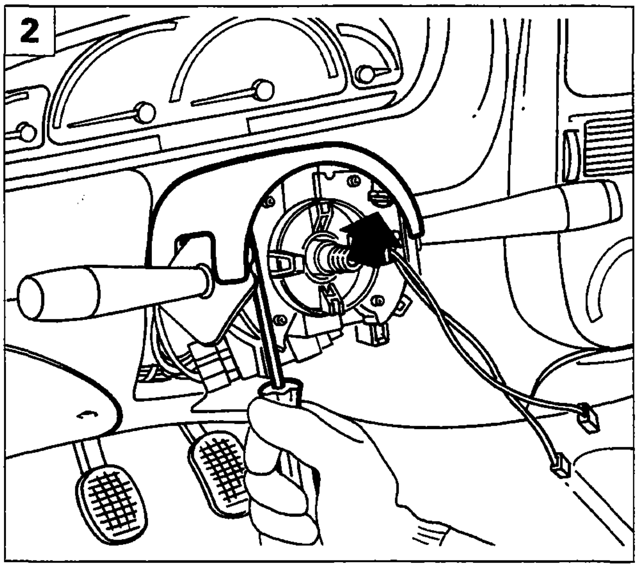
1. use a screwdriver to remove the horn cover;
2. disconnect the horn wiring connectors;
3. undo the nut securing the steering wheel to the steering column, then remove the steering wheel.

To remove the steering wheel on vehicles fitted with AIR BAG, see the procedure described in Section 55.

P4A001F04



P4A002F01



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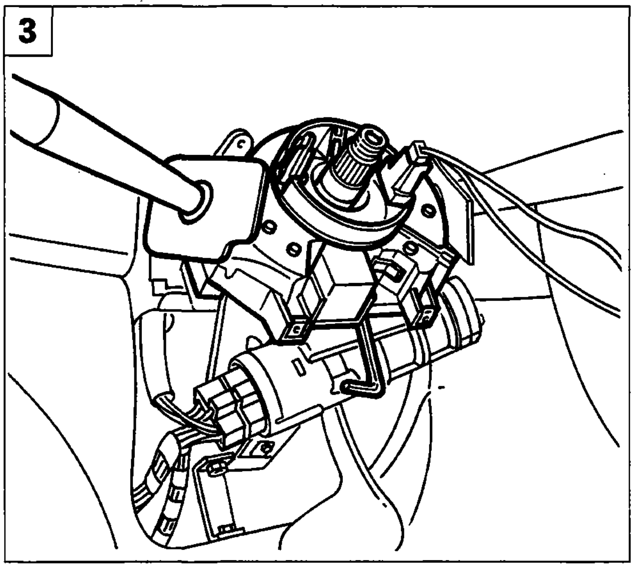


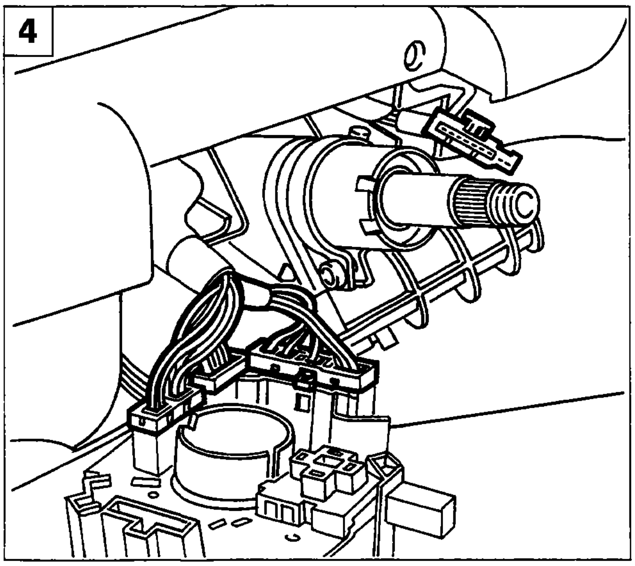
P4A002F03

STALK UNIT BASE

Removing-refitting

To remove the stalk unit base, proceed as follows:

1. undo the bolts arrowed and remove the steering column bottom shroud;
2. undo the bolts arrowed and remove the steering column top shroud;
3. using an Allen key, undo the screw on the attachment collar of the stalk unit base and withdraw the collar;
4. disconnect the wiring connectors of the stalk unit base, and remove it.



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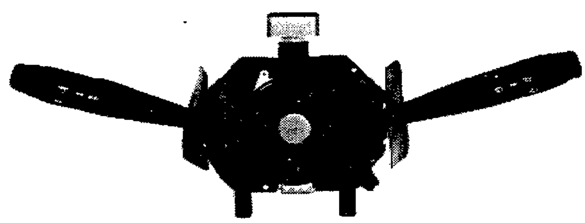
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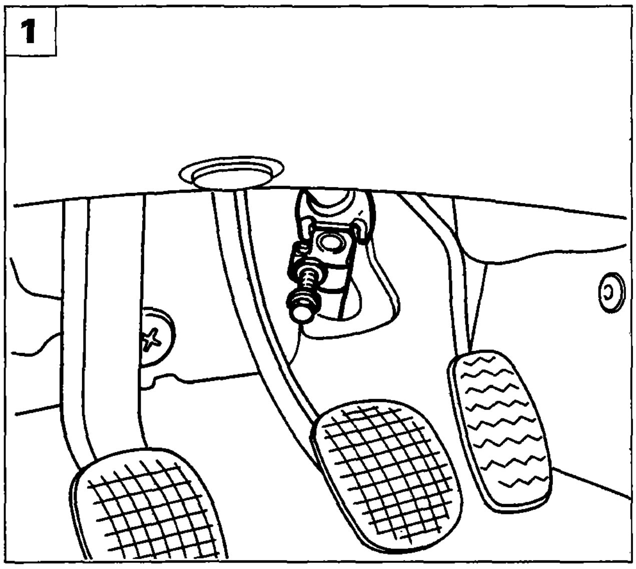
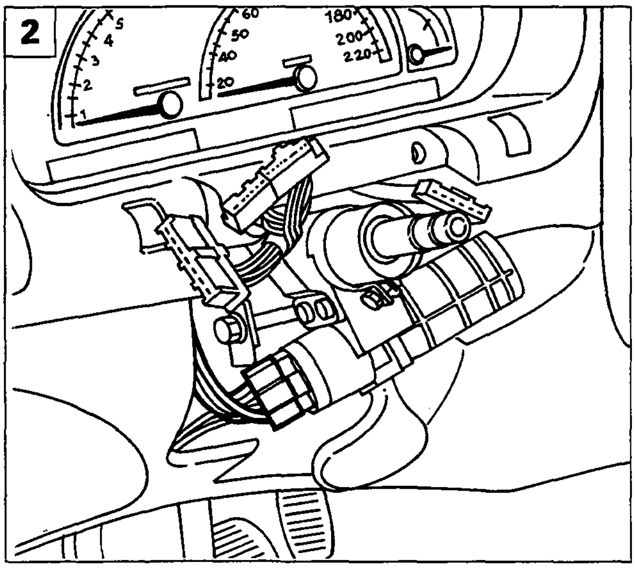
STEERING COLUMN



P4A003F01

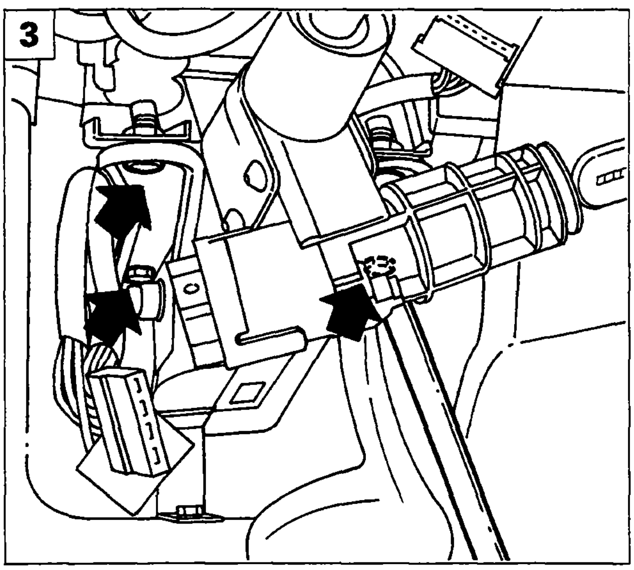
Removing-refitting

To remove the steering column, proceed as follows:
1. remove the bolt securing the lower steering column to the steering pinion;

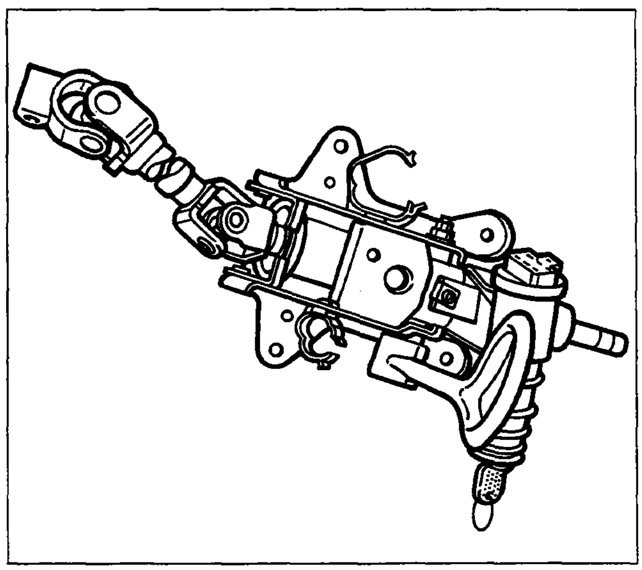


P4A003F02

2. disconnect the ignition switch wiring connector;
3. undo the bolts securing the steering column mounting to the bodywork and remove the steering column complete with lower column.



P4A003F03



P4A003F04

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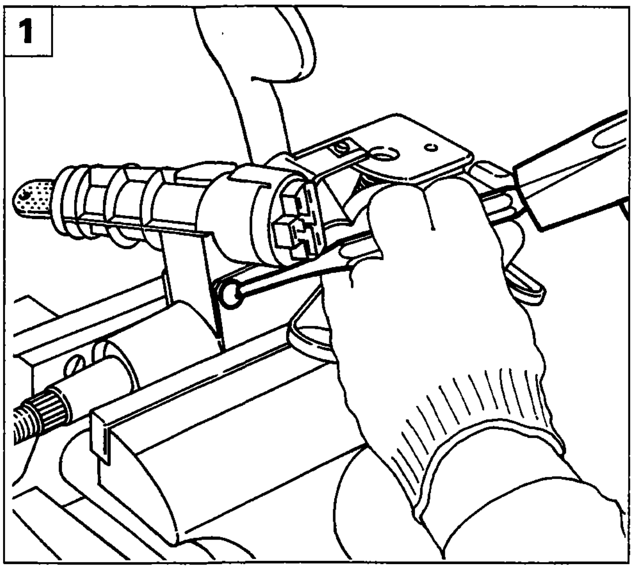


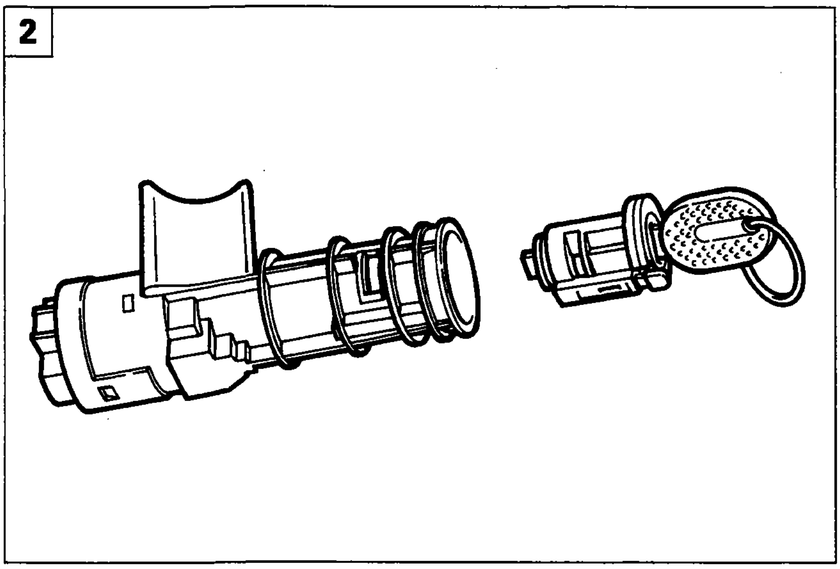
P4A004F01

IGNITION SWITCH BLOCK

Dismantling-refitting

To remove the ignition switch block, proceed as follows:

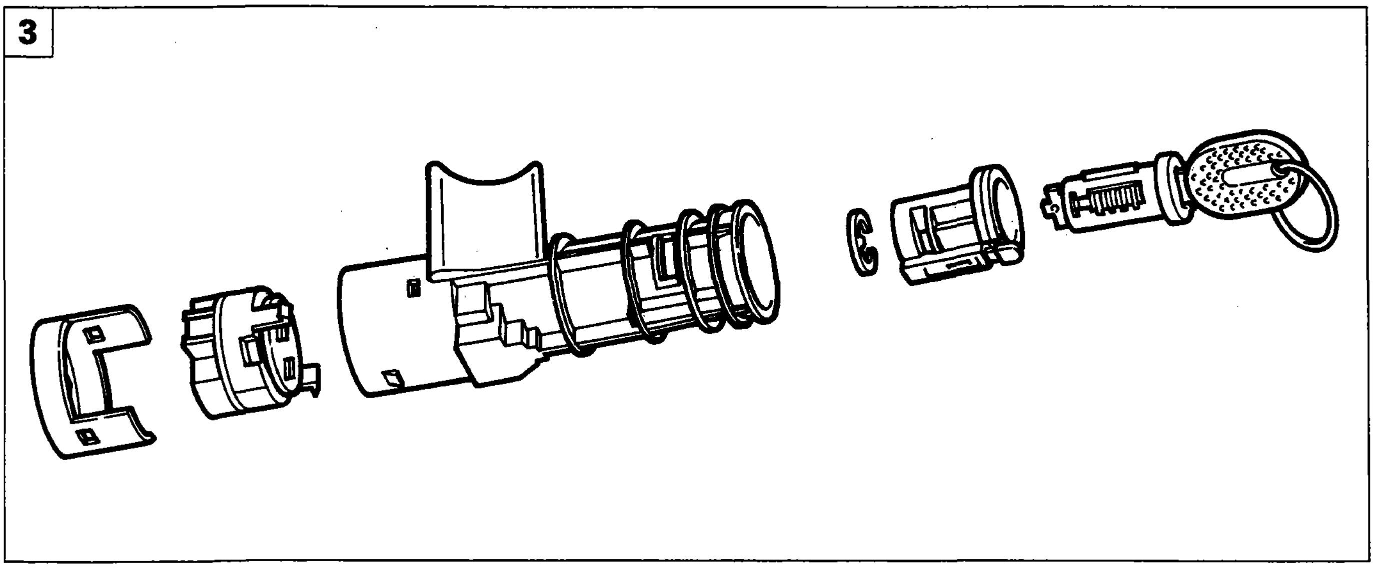
1. use a punch to undo the shear bolts locking the ignition switch block mounting;



P4A004F02

2. remove the ignition switch block;
3. dismantle the ignition switch and lock from the block.

NOTE *When refitting, use new shear bolts and tighten them until the hexagonal head shears off.*



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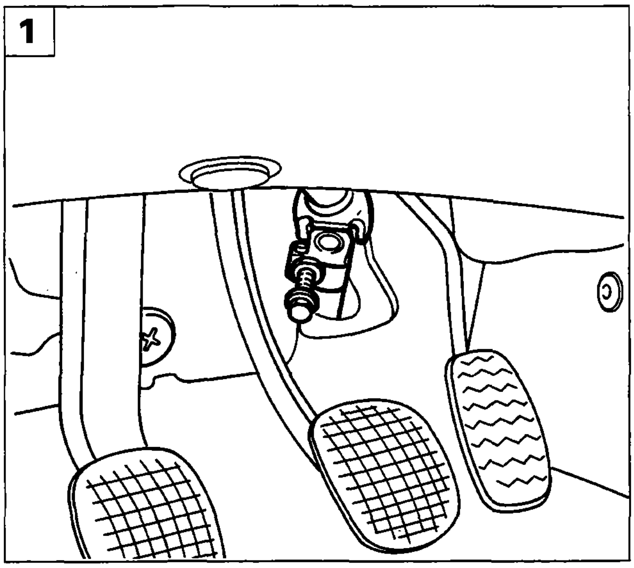
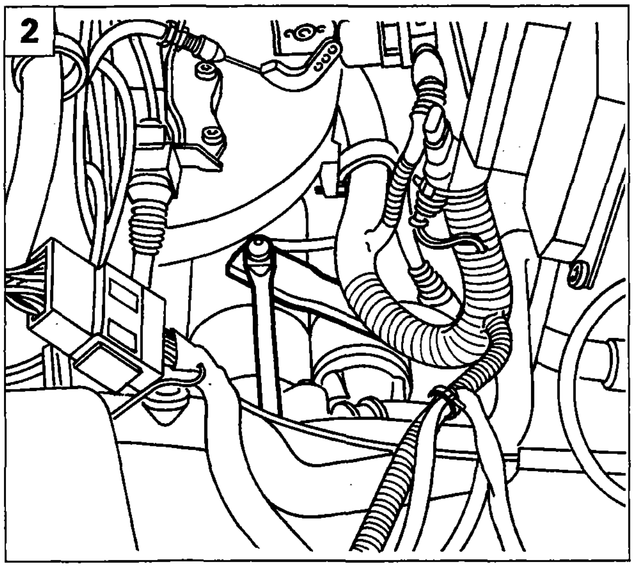


P4A003F01

VARIABLE RATIO RACK-AND-PINION STEERING GEAR

Removing-refitting

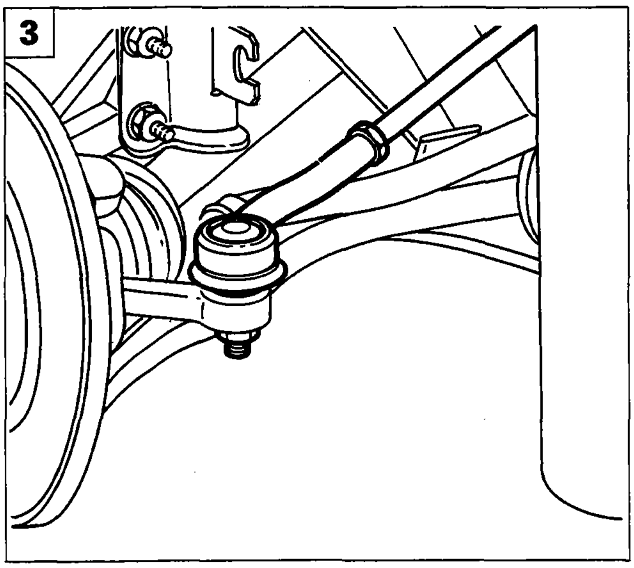
To remove the steering gear, proceed as follows:
1. remove the bolt securing the lower column to the steering gear pinion;



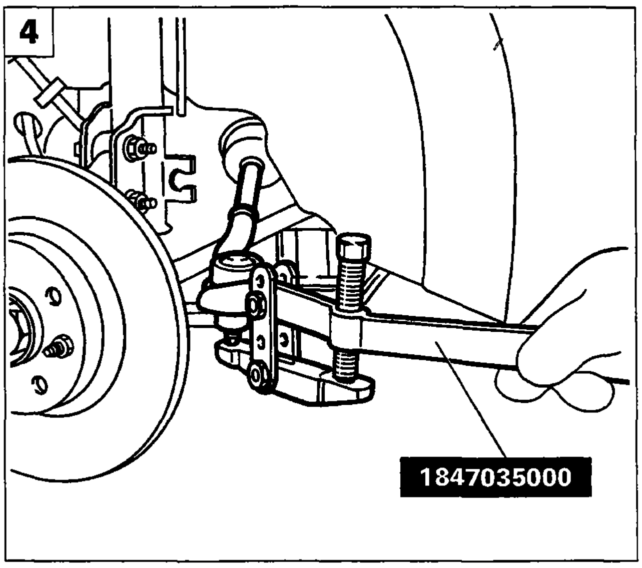
P4A005F01

2. disconnect the transfer linkage from the gearchange control linkage.

Raise the vehicle, remove the front wheels, then working from both sides:
3. undo the nuts securing the right and left tie-rods from the front vertical links;
4. use tool 1847035000 to prise off the tie-rod heads from the two vertical links;



P4A005F02



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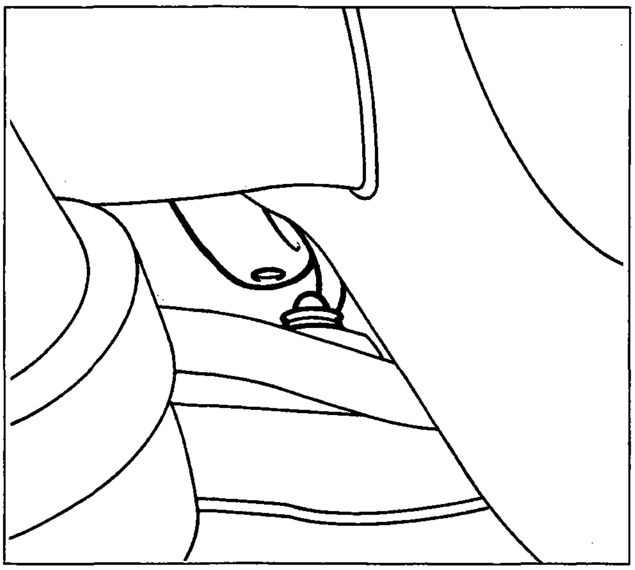
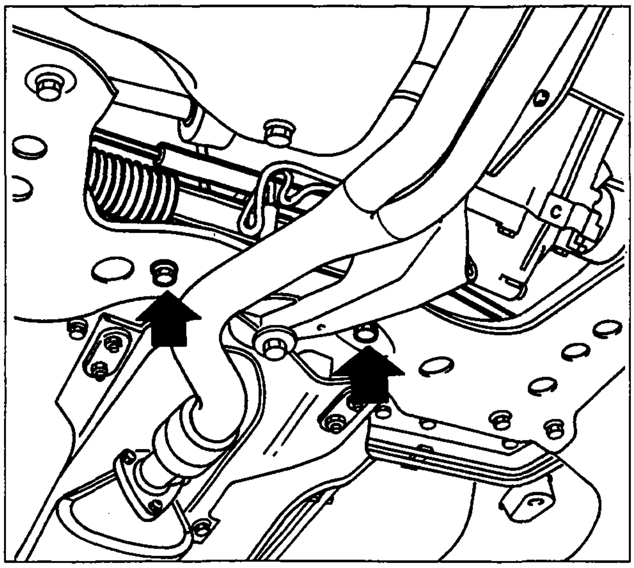


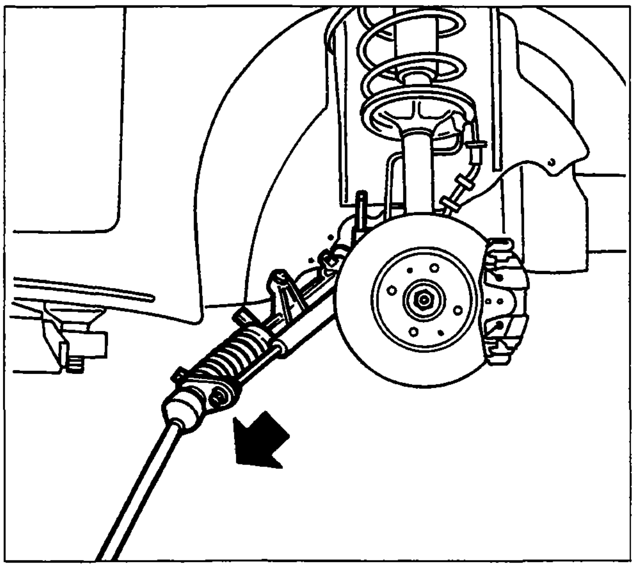
P4A006F01

- prise off the gearchange control lever from the head on the steering gear;



P4A006F02

- undo the bolts securing the steering gear to the steering subframe;

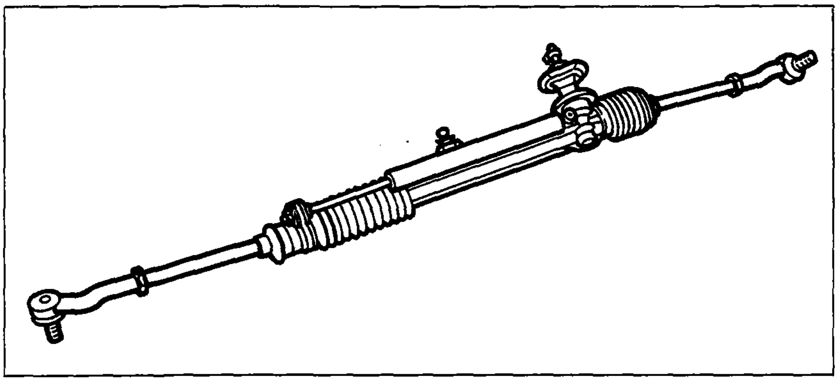


P4A006F03

- withdraw the steering gear from under the right wheelarch.

NOTE *To refit the steering gear, reverse the procedure for removal.*

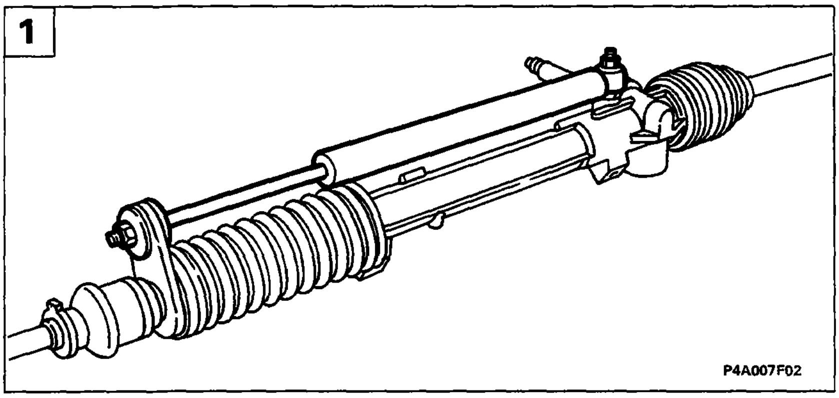
Check the front wheel toe-in whenever the steering gear is removed and refitted.



P4A007F01

Variable ratio rack-and-pinion steering gear

1

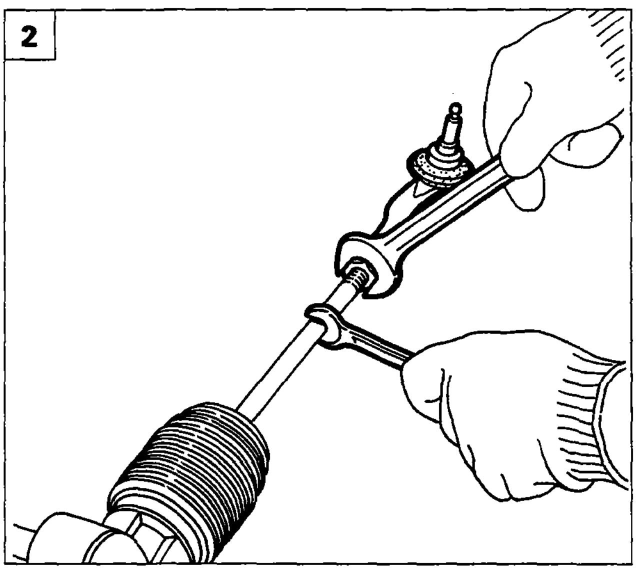


P4A007F02

Dismantling-refitting

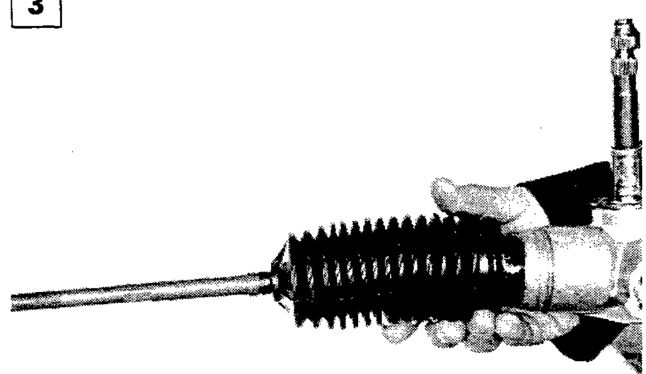
1. undo the nuts shown and remove the steering damper;

2



P4A007F03

3



P4A007F04

2. slacken the tie-rod locking nut then unscrew the tie-rod until you can remove it;

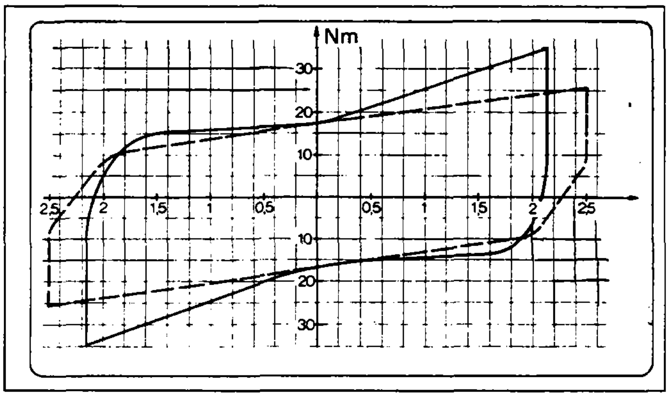
NOTE *Check that there is no stiffness or excessive play on the balljoint, otherwise it will need to be replaced.*

3. undo the clamps on the dust gaiter and lubricating seal, and remove the gaiter.

NOTE *Thoroughly check the gaiter for holes or tears, and if necessary replace it.*

Before fitting the last gaiter (pinion side), insert the specified quantity of grease.

OPERATION



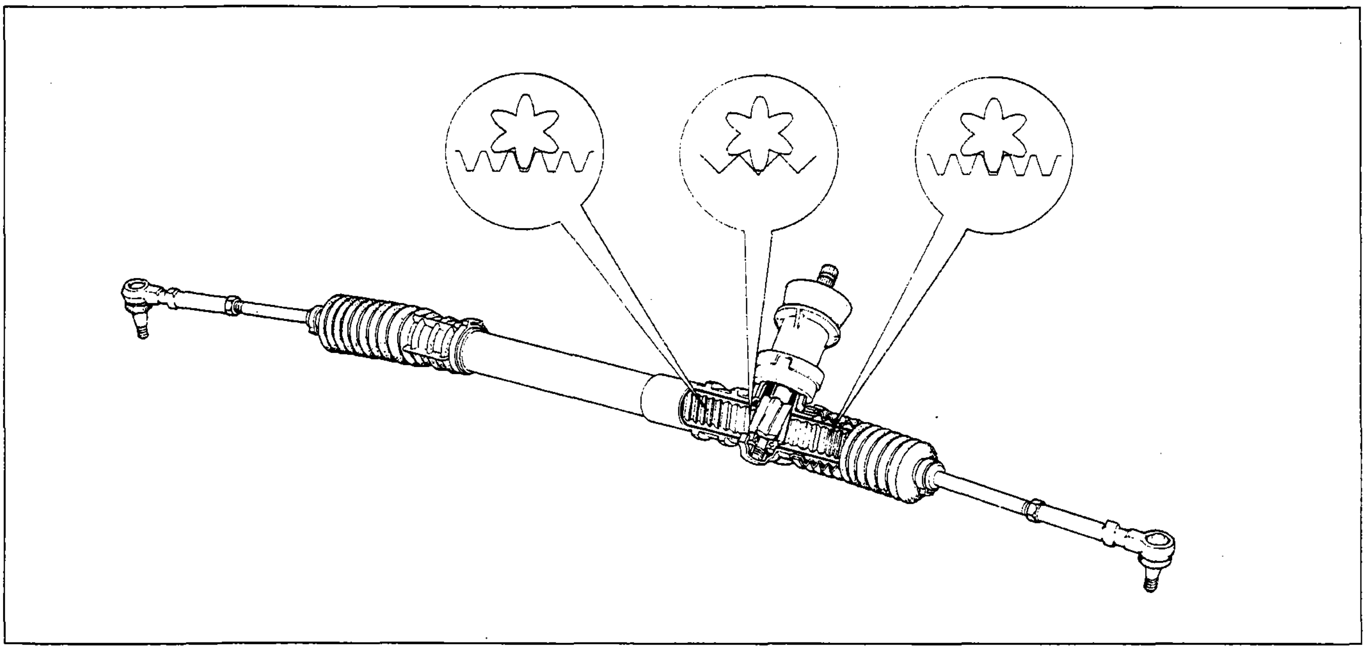
P4A008F01

Its innovative characteristic is that it can reduce the difference between the maximum force applied to the steering wheel when the car is on a bend or carrying out manoeuvres with tight steering angles, and the minimum force applied when the steering wheel is for example in the position for driving on a straight line.

Graph showing the different forces applicable on a constant ratio steering gear and a variable ratio steering gear.

------- Constant ratio steering gear
- - - - Variable ratio steering gear

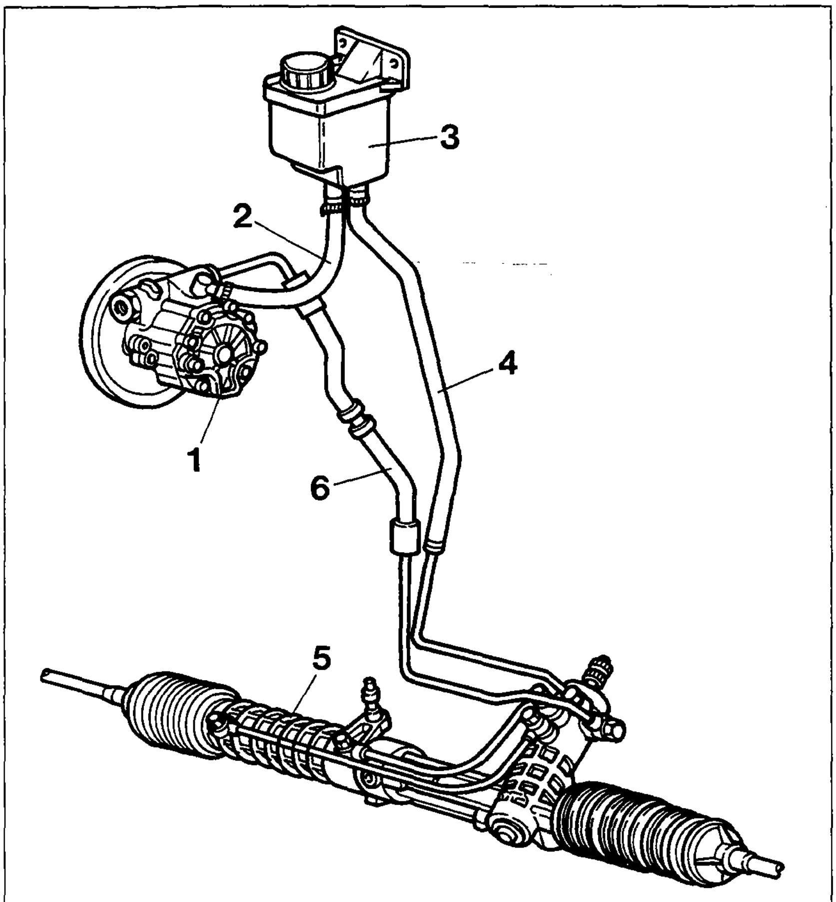
This characteristic is obtained thanks to the particular shape of the rack teeth, which can determine variable ratios between the force applied to the steering wheel and the force transmitted to the wheels, depending on the position assumed by the rack in relation to the pinion.
The rack teeth are cut with module and pressure angle varying from the centre towards the ends, so that the pinion engages with teeth of different pitch depending on the steering angle executed.
Thus a more direct ratio is obtained when the pinion works on the central part of the rack, and a more geared-down ratio is obtained as the pinion engages nearer the two ends of the rack during turning. This offers **more sensitive handling of the car on straight lines and more comfortable handling on bends and during manoeuves.**


P4A008F02

Cross-section of the variable ratio steering gear showing a schematic representation of the rack and pinion teeth.

DESCRIPTION AND OPERATION

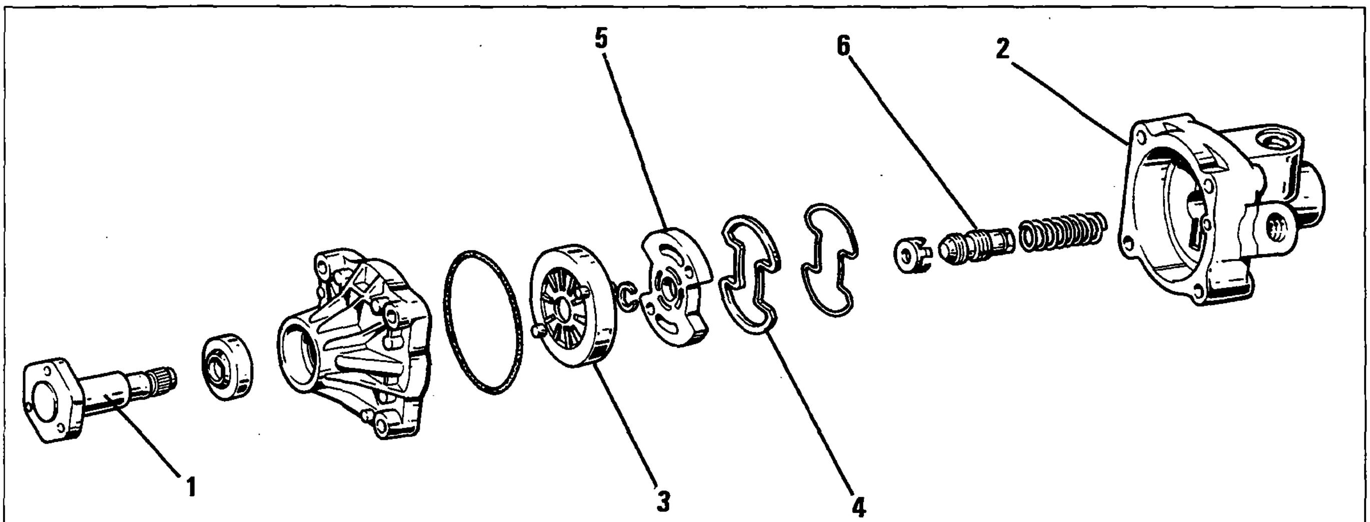
The power-assisted steering system comprises:
- a feed reservoir located in the engine compartment;
- a vane pump driven by the engine, with flow regulating and pressure relief valve;
- a set of connecting pipes between pump-distributor valve-actuating cylinder-reservoir;
- a hydraulic rack-and-pinion steering gear.



P4A010F01

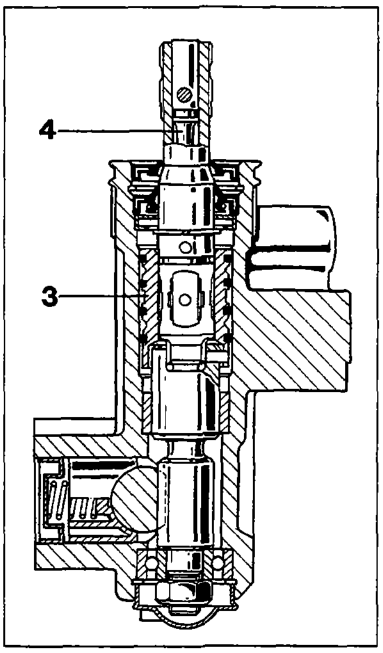
Components of the power steering system

1. Pump
2. Fluid delivery pipe to pump
3. Fluid reservoir
4. Fluid return pipe to reservoir
5. Power-assisted steering gear
6. Pressurized fluid delivery pipe



P4A010F02

1. Drive shaft
2. Pump body
3. Vane impeller
4. Seal
5. Impeller side plate
6. Regulating valve



P4A011F01

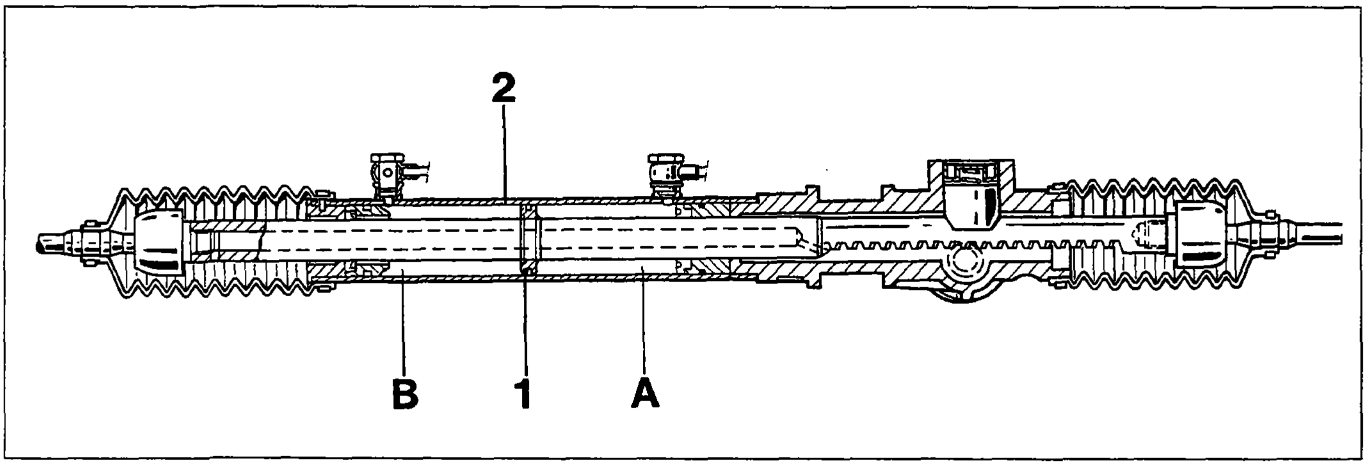
Power steering distributor valve

The power steering pump is driven by the engine by a belt, and can supply a feed pressure varying from 3.5 bar in the "neutral" position to a maximum of 85 bar in the "full lock" position.
The power-assisted steering assembly is similar to a mechanical steering gear, except for the following differences:

a. the steering gear contains an actuating cylinder (2) in which a double-effect piston (1) slides, joined to the rack;

b. in the seating of the worm screw, there is a distributor valve (3) with its pipes. It is controlled by a torsion device (4), located at the end of the worm screw.

Depending on the torsion transmitted by the steering wheel to the device, the fluid is sent from the pump to the reservoir, or to one of the two chambers A or B of the actuating cylinder.
The force generated by the fluid pressure on the lateral surface of the piston causes the piston, and hence the rack, to move.



P4A011F02

Longitudinal section of power-assisted rack and pinion steering gear

Checking operation

Check the steering wheel's rolling torque with the car stopped and the engine running. The torque should be between 0.6 daN with the engine idling and 0.75 daN with the engine at maximum rpm. If it exceeds these values, check the system pressure with the wheels at full lock. To do this, fit a pressure gauge, with a T connector, on the pressurized fluid delivery pipe to the power steering gear (from the pump) and turn the steering wheel to full lock on one side. When the steering wheel is forced to rotate further, the pressure reading on the pressure gauge should rise to about 85 bar. If this does not happen, check whether there is a fault in the power steering fluid pump or distributor valve.

The above check should be conducted with the engine running at 2000 - 4000 rpm.

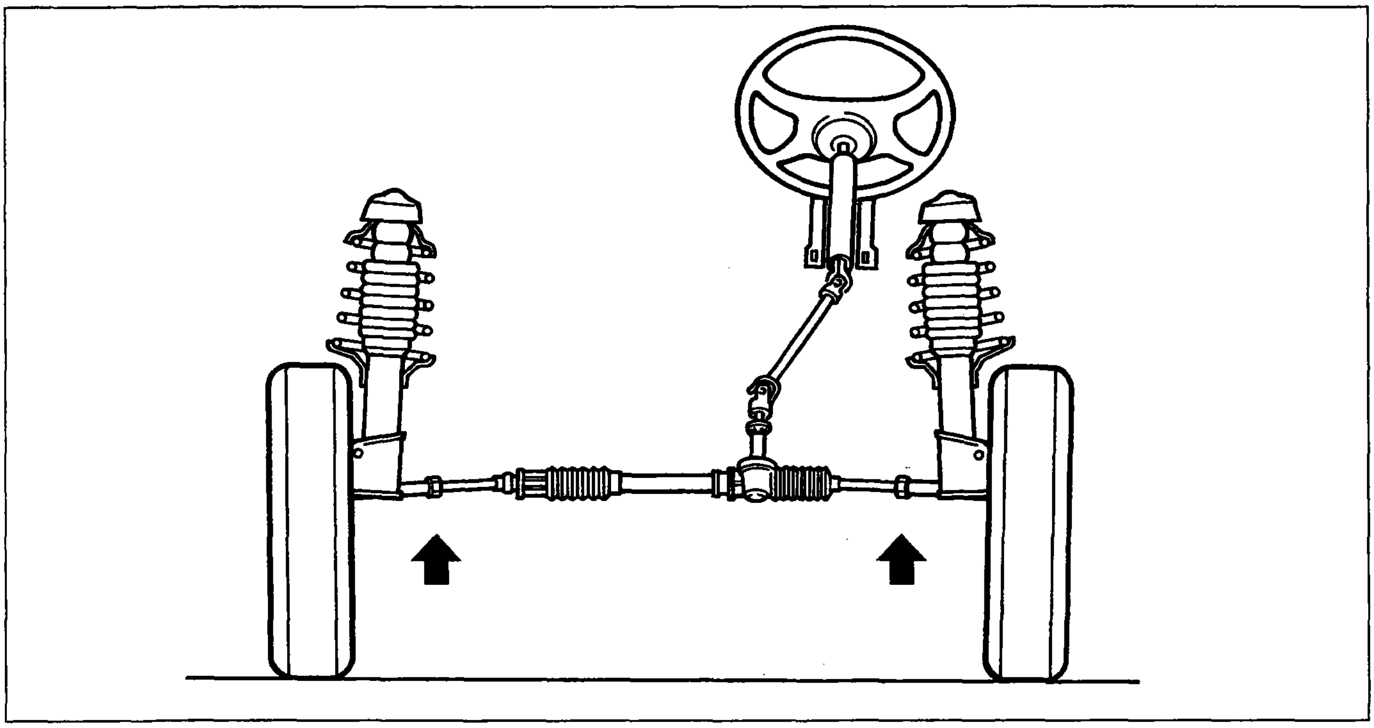
NOTE *Under no circumstances should the power steering assembly and vane pump be dismantled into their components; instead they should be returned to the manufacturer for overhaul.*

Checking fluid level: the fluid level should be checked with the engine running, and it should be topped up as necessary.

The power-assisted steering system is self-bleeding; it is bled by turning the steering wheel full lock to the right and left with the engine running and the car stopped.
This procedure should be carried out whenever the connecting pipes are removed and refitted.

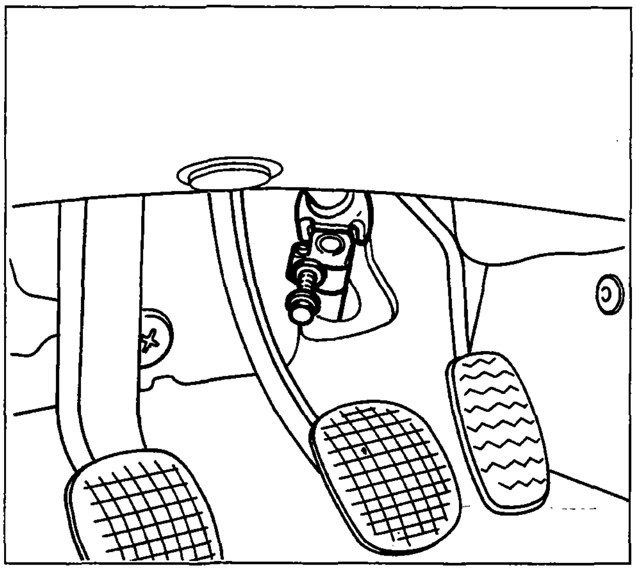
NOTE *If the steering becomes hard, this may be due to slipping of the pump pulley belt, or to a low fluid level.*
If there is a fault in the pump, actuating cylinder or distributor valve, the power steering will function as an ordinary mechanical steering gear.

FRONT WHEEL TOE-IN



F4A012F01

On both versions with mechanical steering gear and versions with power-assisted steering, the front wheel toe-in is adjusted by slackening the nut locking the tie-rod and screwing or unscrewing the tie-rod until the specified toe-in value is obtained, without changing the positions of the steering wheel spokes.



P4A003F01

RACK-AND-PINION POWER STEERING GEAR

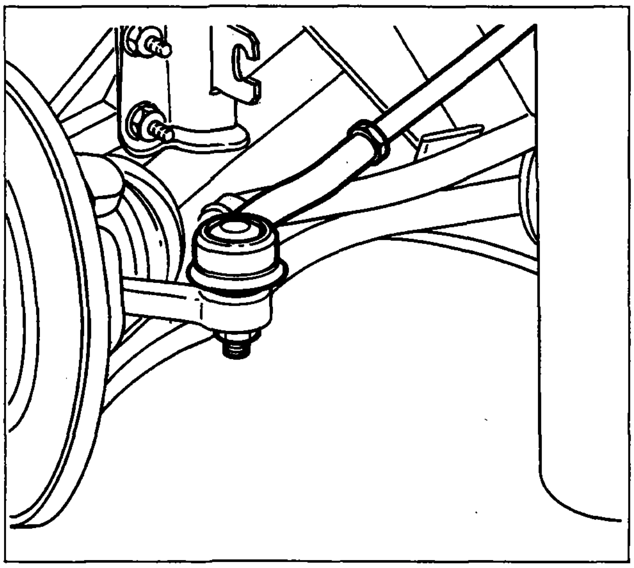
Removing-refitting

Before removing the power steering gear, drain the fluid from the reservoir.

NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*

To remove the rack-and-pinion power steering gear, proceed as follows:

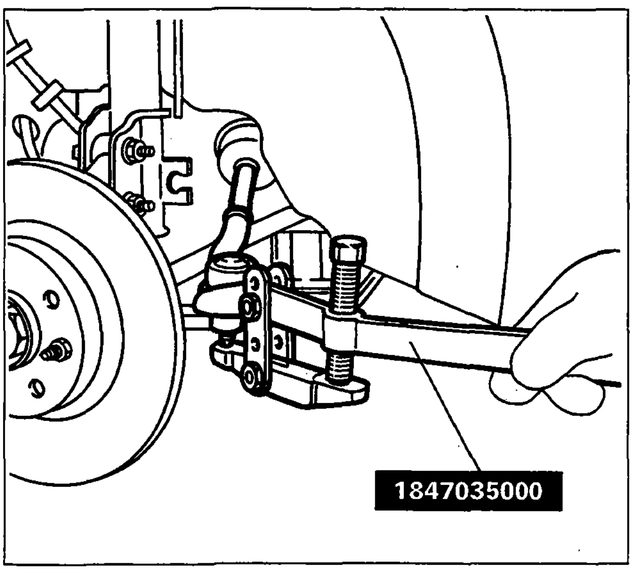
- remove the bolt securing the shaft to the power steering pinion.



P4A005F02

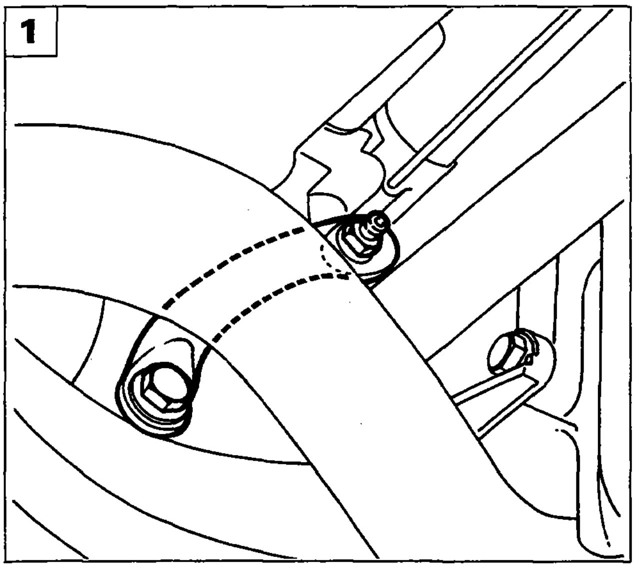
Raise the vehicle, remove the front wheels, then working on both sides:

- undo the nuts securing the right and left tie-rods to the vertical links;



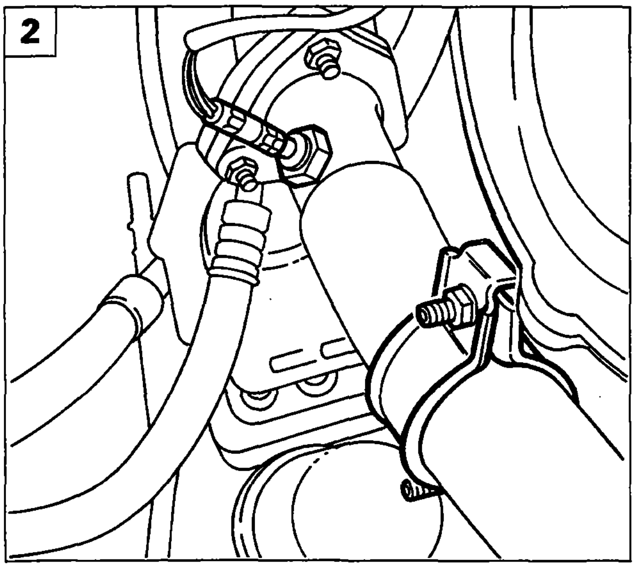
P4A005F03

- using tool 1847035000 prise off the tie-rod end heads from the two vertical links;



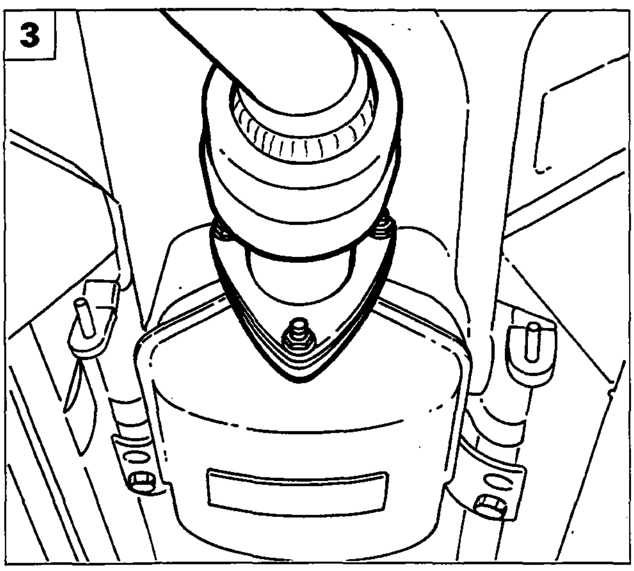
P4A014F01

1. remove the reaction link of the power unit mounting bracket, differential side;



P4A014F02

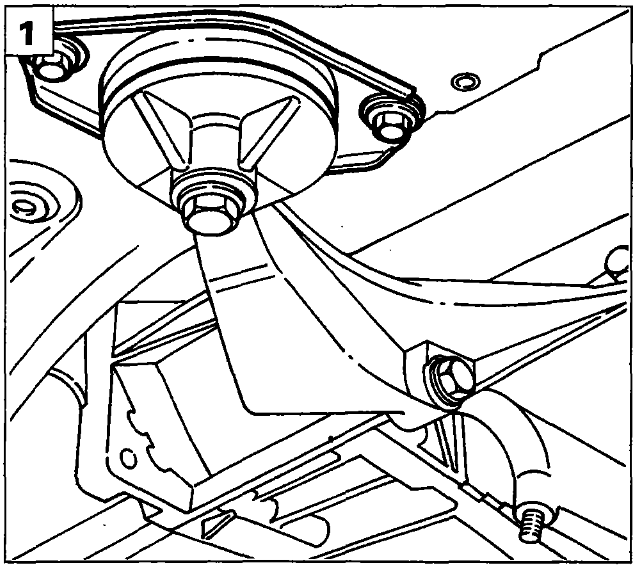
2. disconnect the Lambda probe wiring connector; also undo the two nuts on the clamp securing the front exhaust pipe;



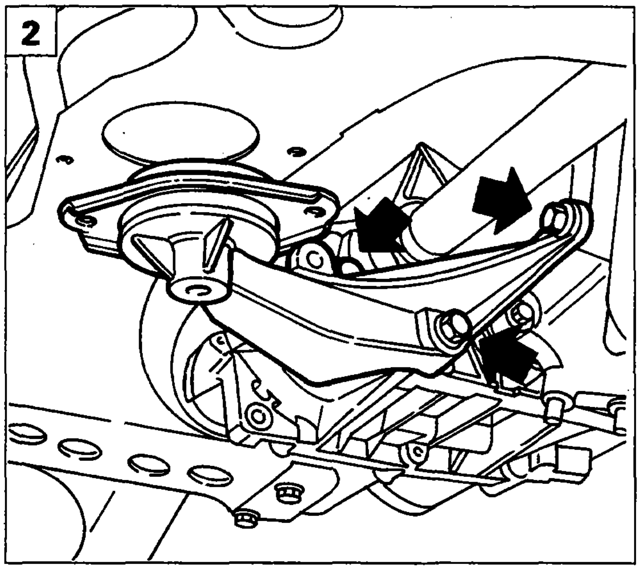
P4A014F04

3. undo the nuts securing the front exhaust pipe to the catalytic converter and remove the pipe;

41.



P4A015F01



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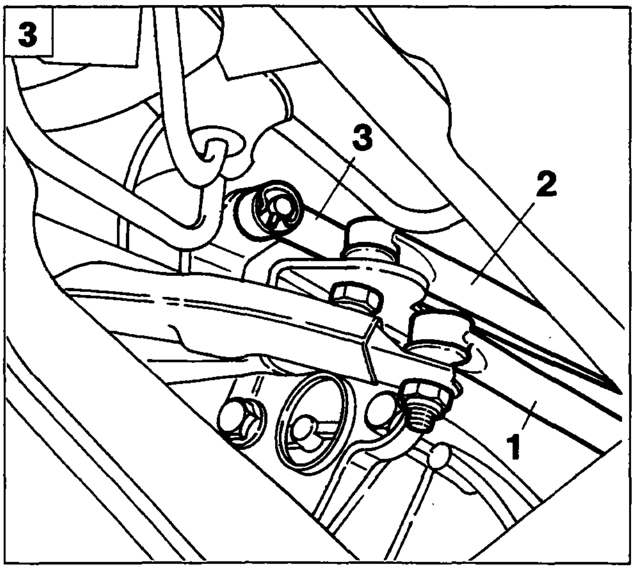
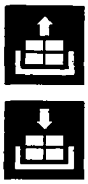
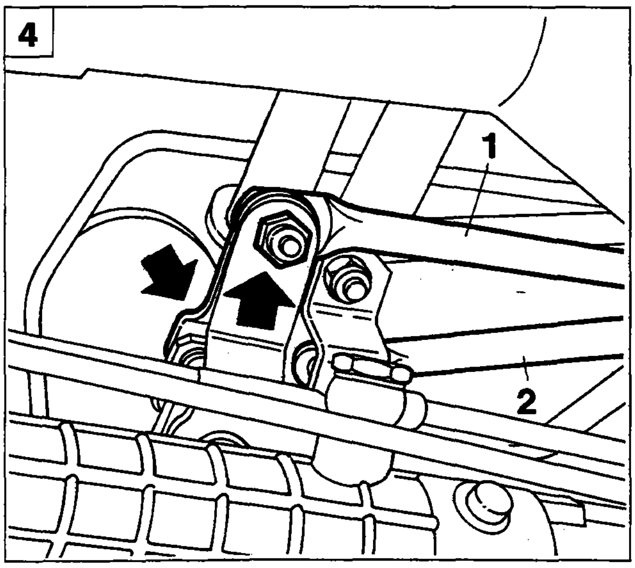


P4A015F03

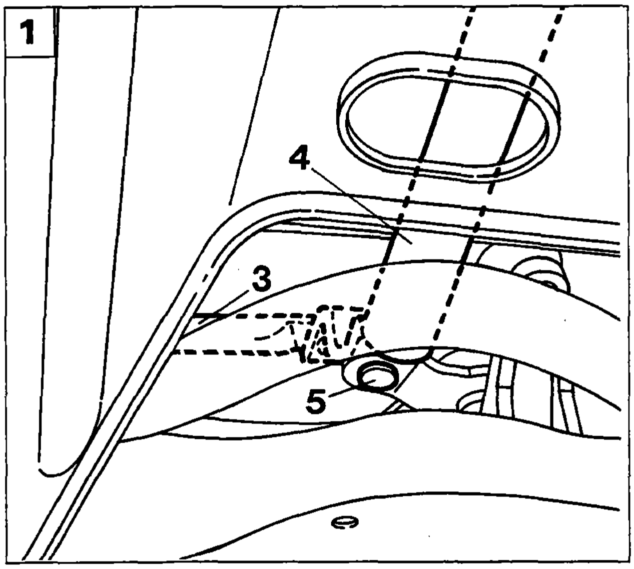


1. undo the bolts securing the power unit mounting, differential side, to the body shell;
2. undo the bolts securing the power unit mounting bracket to the gearbox;
3. undo the nuts securing the gear engagement lever rod (1) and the reaction rod (2); remove the split pin securing the gear selector lever rod (3), then release the rods from their respective seatings;



P4A015F04

4. undo the nuts (arrowed), then lift and move to the left the top of the relay mounting with the gear engagement lever rod (1) and reaction rod (2);



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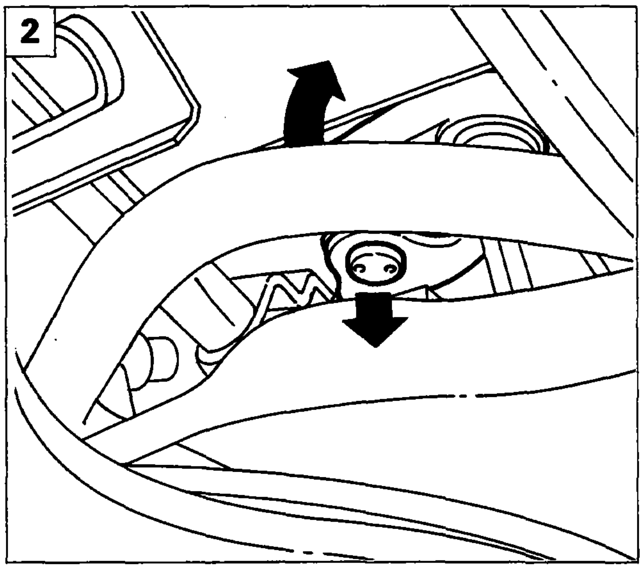
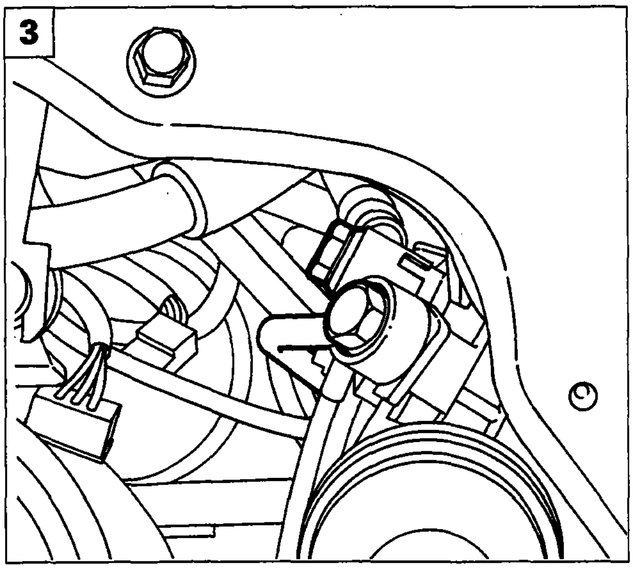


P4A016F02



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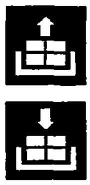
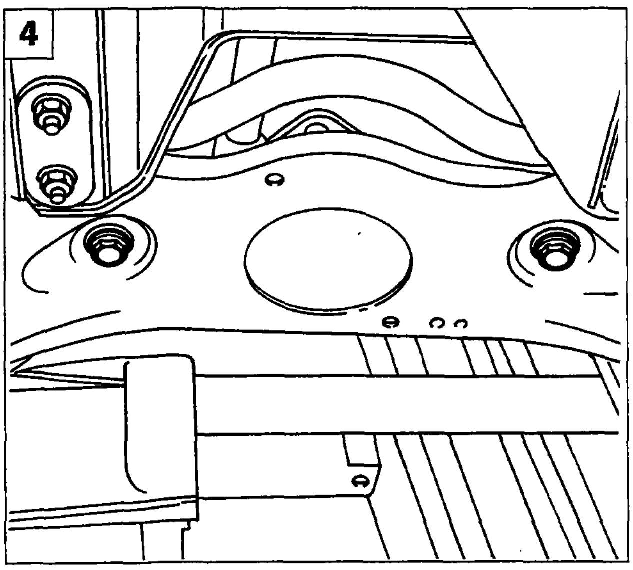
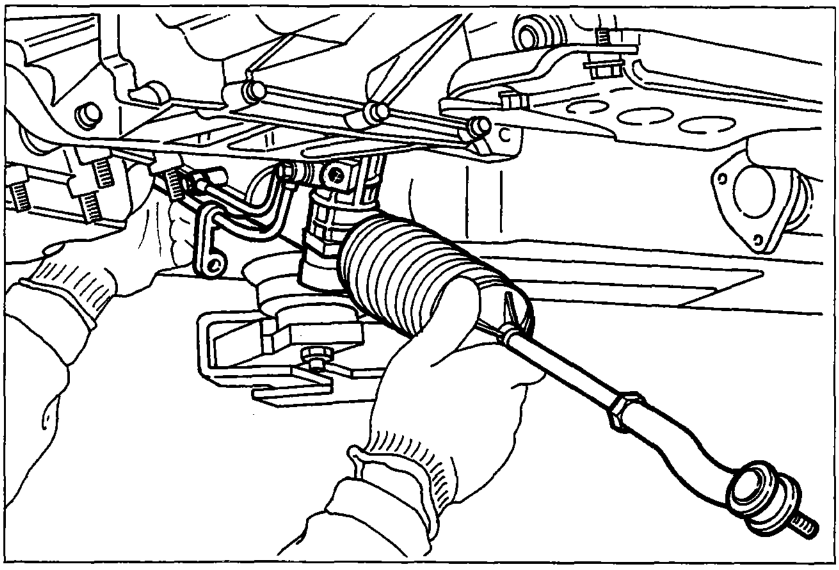


1. prise off the head (5) securing the gearchange lever (4) to the relay mounting and move to the left the gearchange lever with the gear selector lever rod (3);
2. rotate backwards the pin securing the relay mounting and withdraw the mounting downwards;
3. undo the bolts securing the fluid delivery and return pipes to the power-assisted steering gear;



P4A016F04

4. undo the bolts securing the power steering gear to the steering subframe;

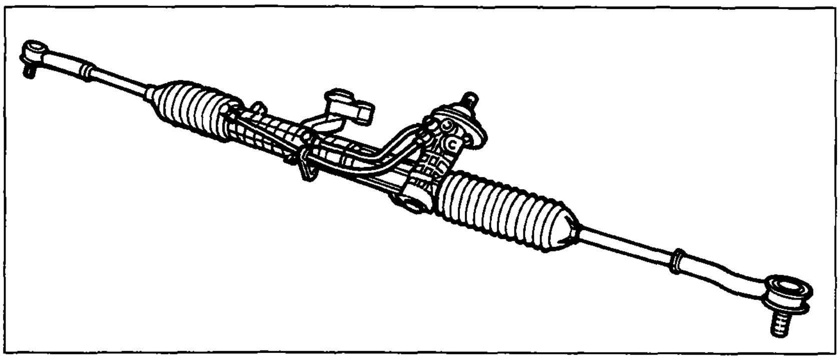


P4A017F01

- withdraw the power steering gear from underneath the vehicle.

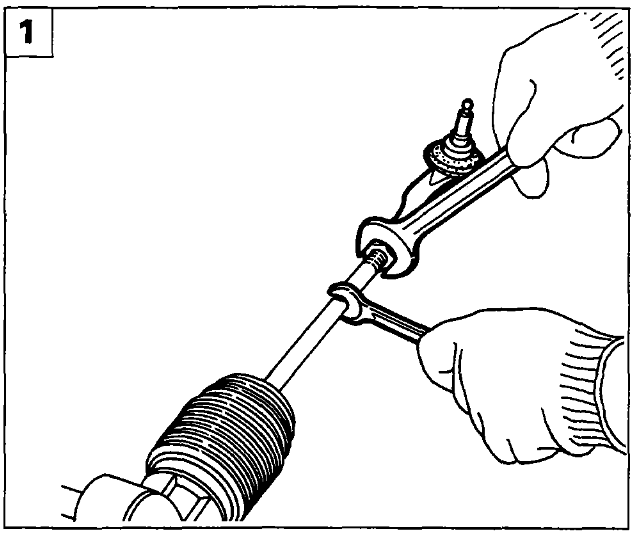
NOTE *To refit the power steering gear, reverse the procedure for removal.*

Check the front wheel toe-in whenever the steering gear is removed-refitted.



P4A017F02

Power assisted rack-and-pinion steering gear



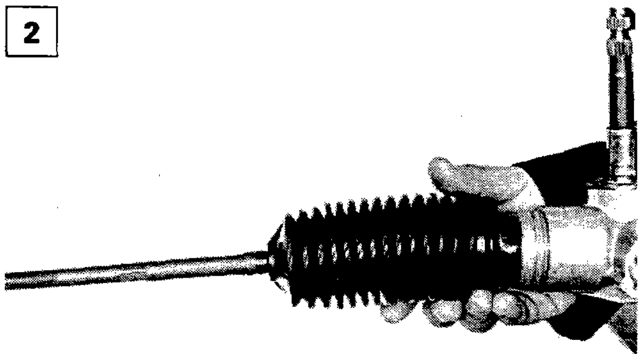
P4A007F03

Dismantling-refitting

1. slacken the nut locking the tie-rod then unscrew the tie-rod until you can remove it;

NOTE *Check that there is no stiffness or excessive play on the balljoints.*

2

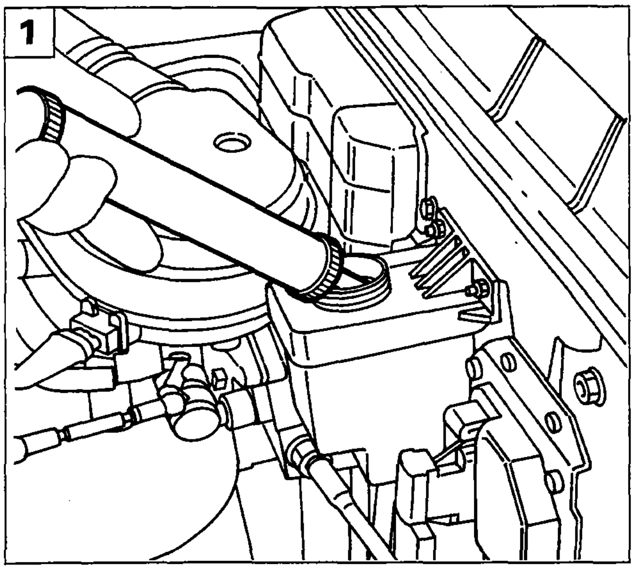


P4A007F04

2. undo the clamps on the dust gaiter and lubricating seal, and remove the gaiter.

NOTE *Thoroughly check the gaiter for holes or tears, and if necessary replace it.*

Before fitting the last gaiter (pinion side), insert the specified quantity of grease.



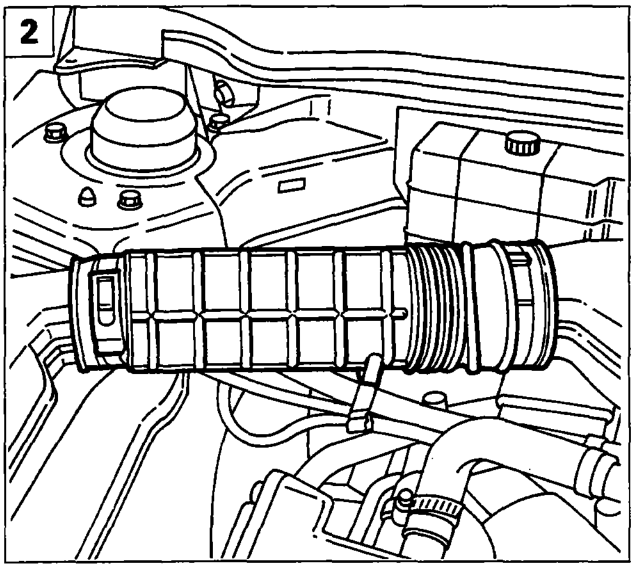
P4A018F01

Removing-refitting

To remove the power steering pump, proceed as follows:

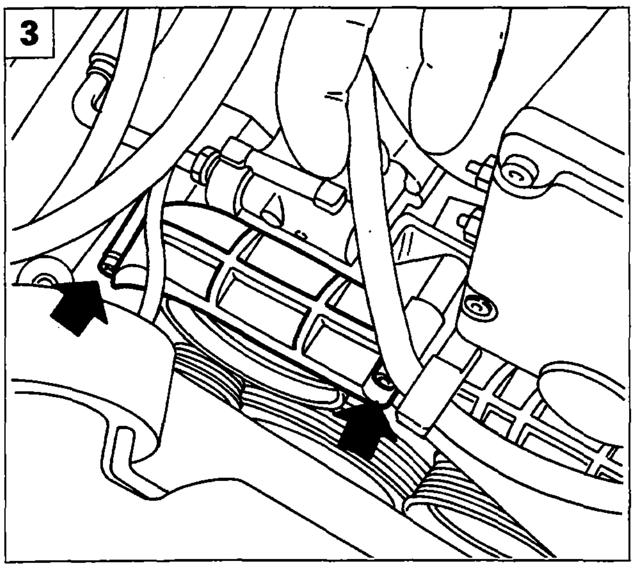
1. empty the fluid reservoir using a syringe;

NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*

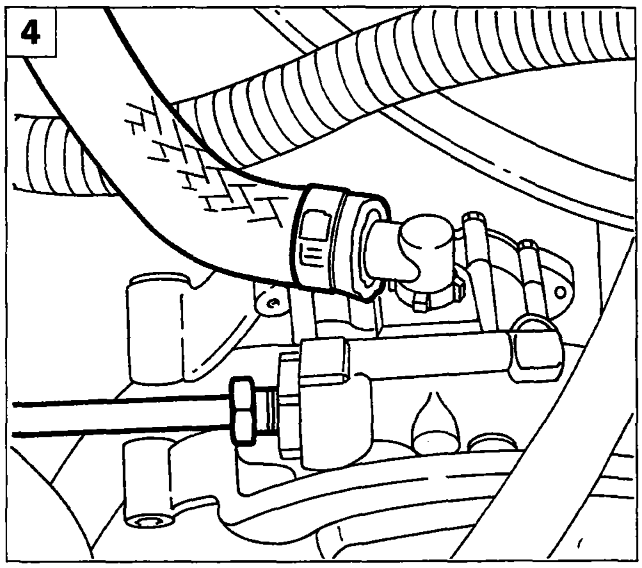


P4A018F02

2. undo the clamps and remove the air intake pipe;
3. undo the bolts indicated and remove the belt guard;
4. disconnect the fluid inlet and outlet pipes from the power steering pump.



P4A018F03



P4A018F04

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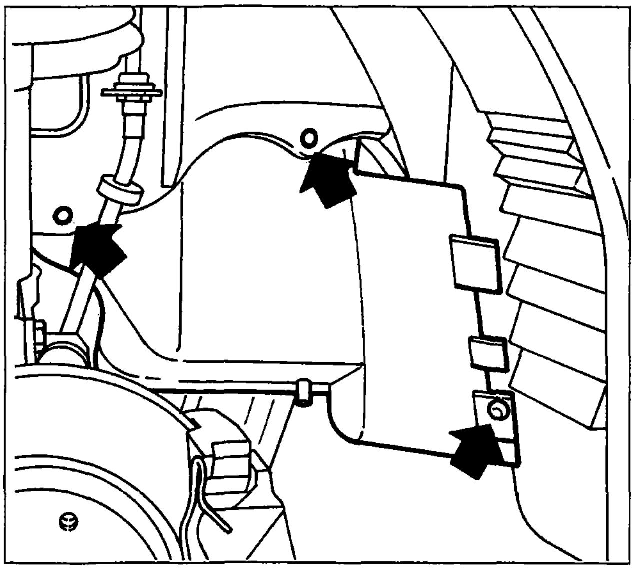
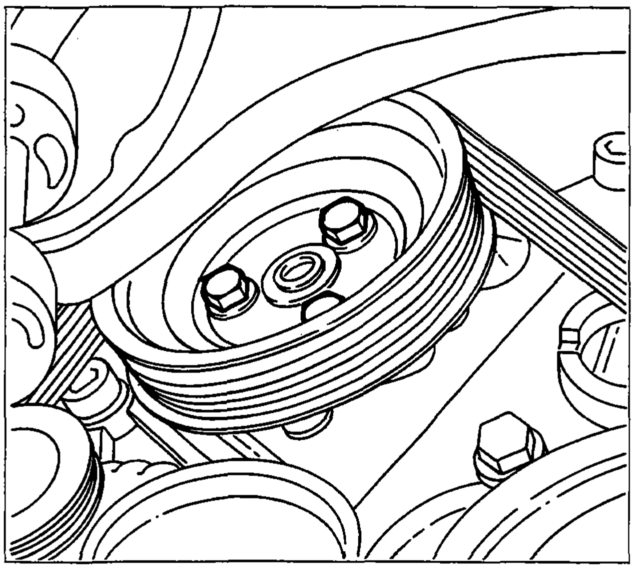


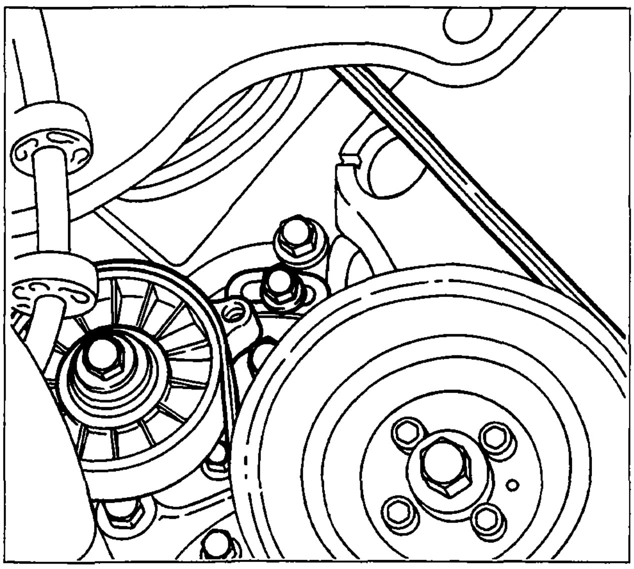
P4A019F01

Place the vehicle on ramps, remove the front wheel, then:
- undo the bolts, release the button and remove the right wheelarch cover;



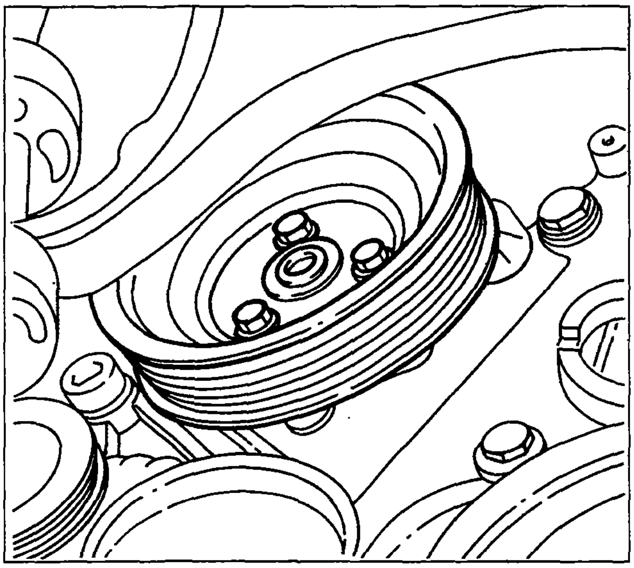
P4A019F02

- slacken the pump pulley bolts;

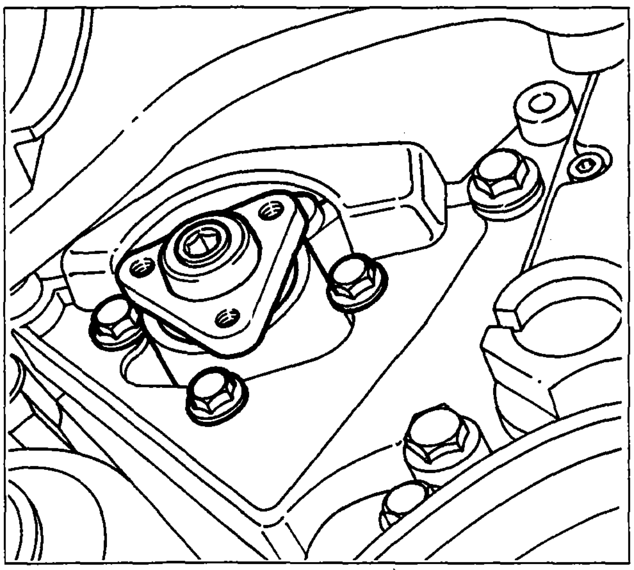


P4A019F03

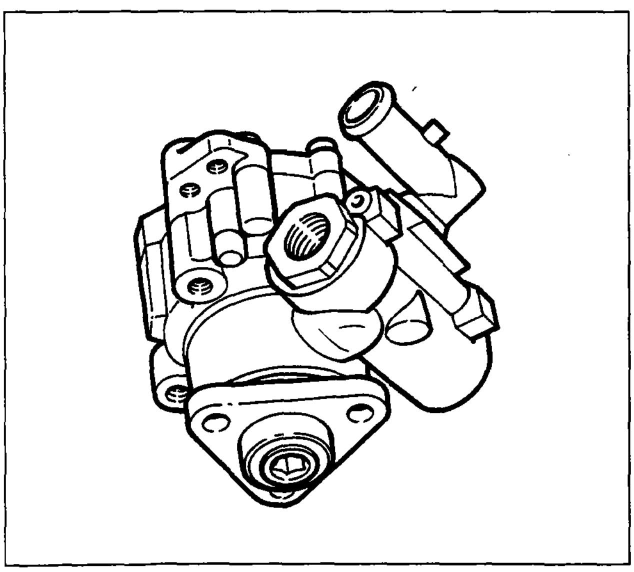
- slacken the belt tensioner and remove the belt;


P4A020F01

- undo the bolts and remove the pulley;

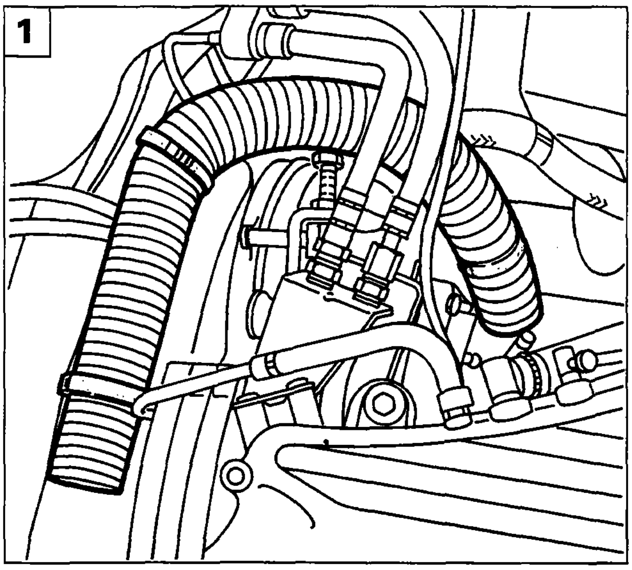

P4A020F02

- undo the bolts securing the pump to the bracket and remove the pump.


P4A020F03

NOTE *To refit the power steering pump, reverse the procedure for removal.*

41.



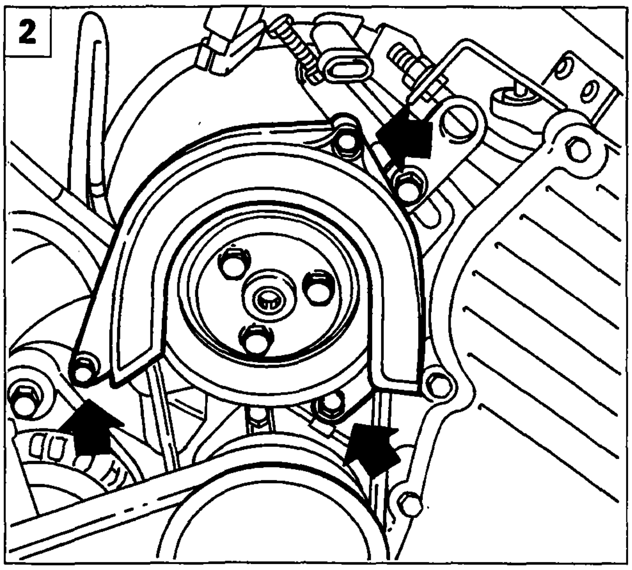
P4A021F01

Removing-refitting

Before removing the power steering pump, drain the fluid from the reservoir.

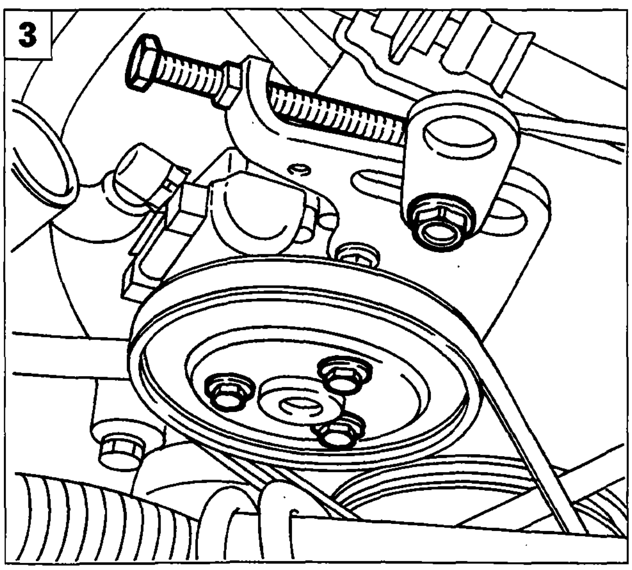
NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*

To remove the power steering pump, proceed as follows:
1. remove the alternator cooling pipe;



P4A021F02

2. undo the three bolts (arrowed) and remove the plastic guard;
3. undo the pulley bolts and belt tensioner bolts;
4. disconnect the fluid inlet and outlet pipes from the power steering pump;



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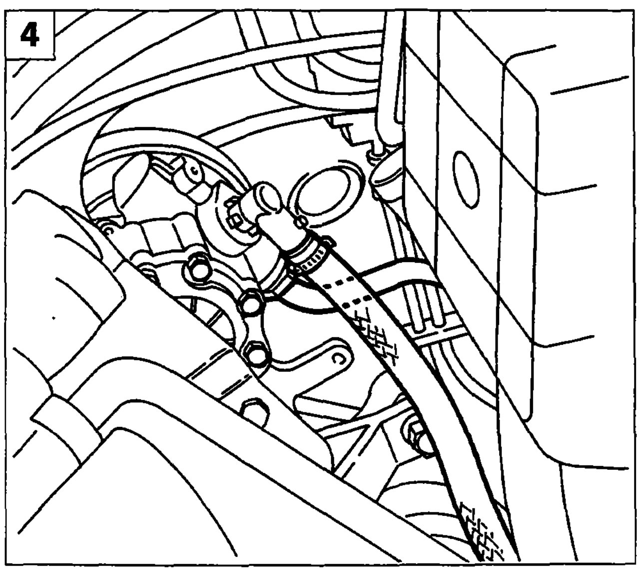

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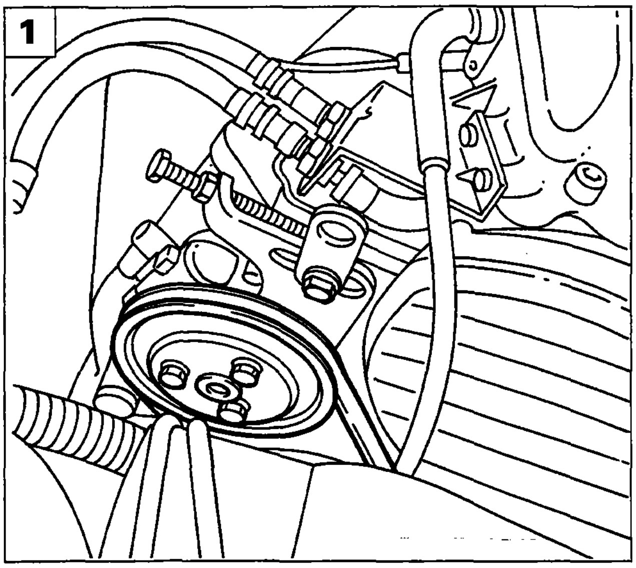

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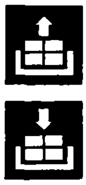
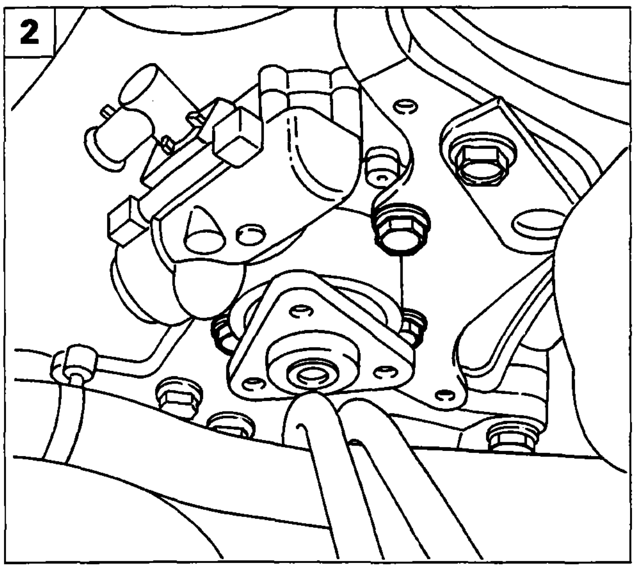


1. undo the bolts and remove the pulley and belt;



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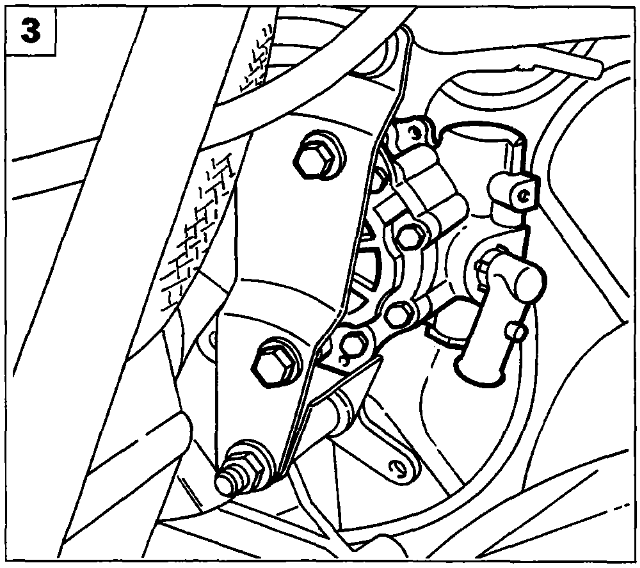

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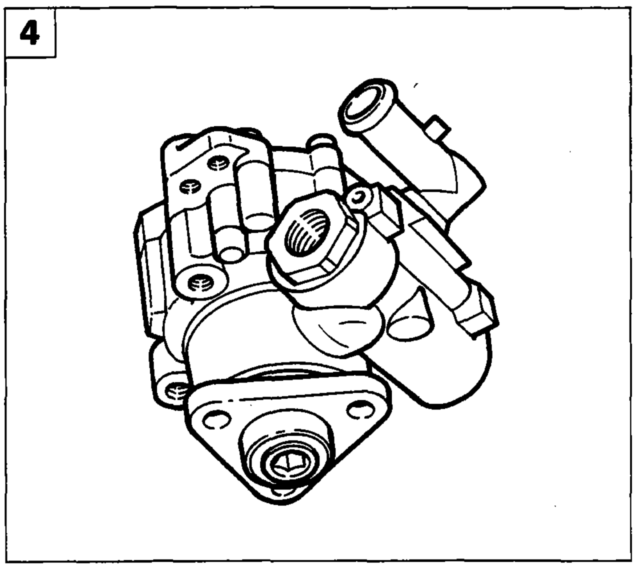
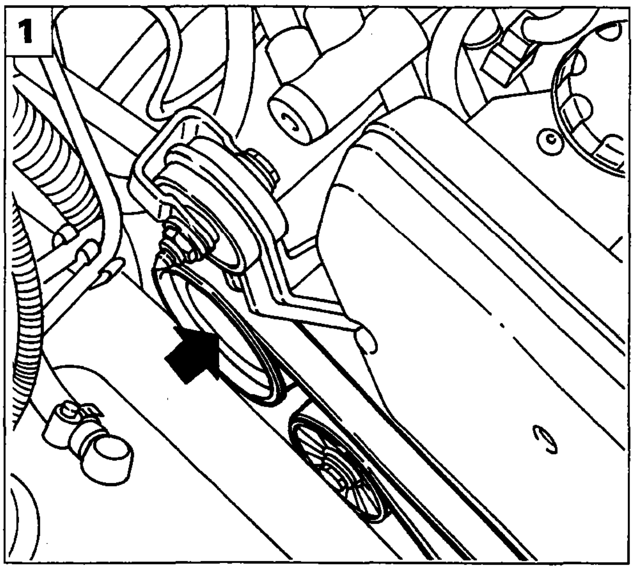


P4A020F03

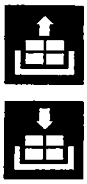
2. undo the three front bolts securing the pump to the mounting;
3. undo the two rear bolts securing the pump to the mounting;
4. remove the power steering pump.

NOTE *To refit the power steering pump, reverse the procedure for removal.*

41.



P4A023F01

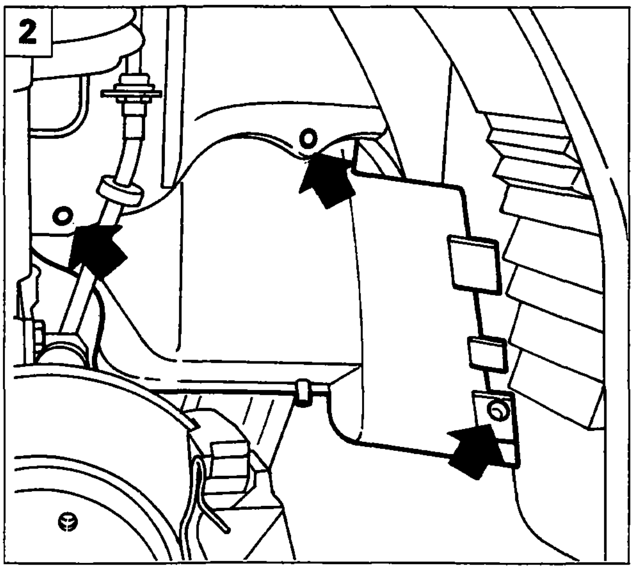


Removing-refitting

Before removing the power steering pump, drain the fluid from the reservoir.

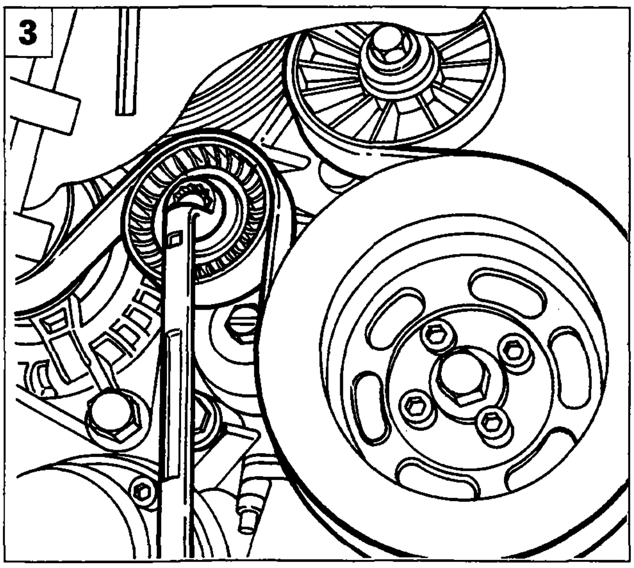
NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*

To remove the power steering pump, proceed as follows:
1. undo the pump pulley bolts;



P4A019F01

Place the vehicle on ramps, remove the front right wheel, then:
2. undo the bolts, release the button and remove the right wheelarch cover;
3. slacken the belt tensioner and remove the belt;
4. undo the bolts and remove the pulley.



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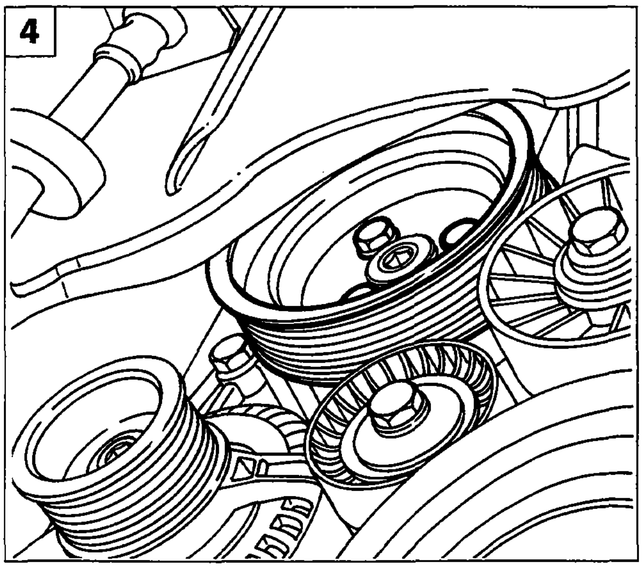

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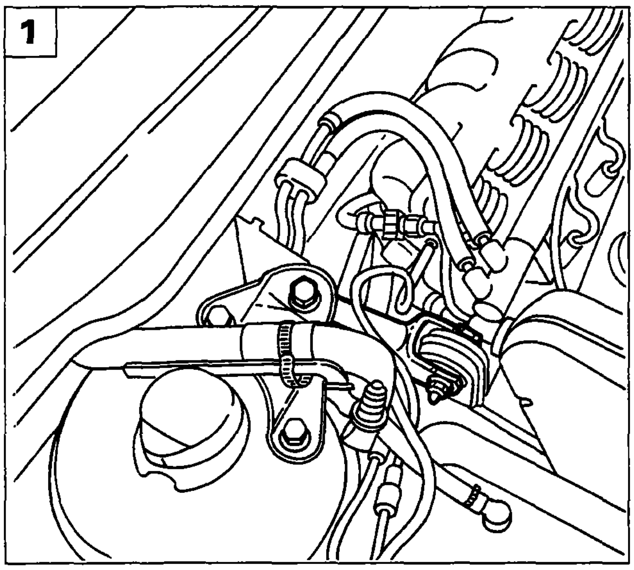
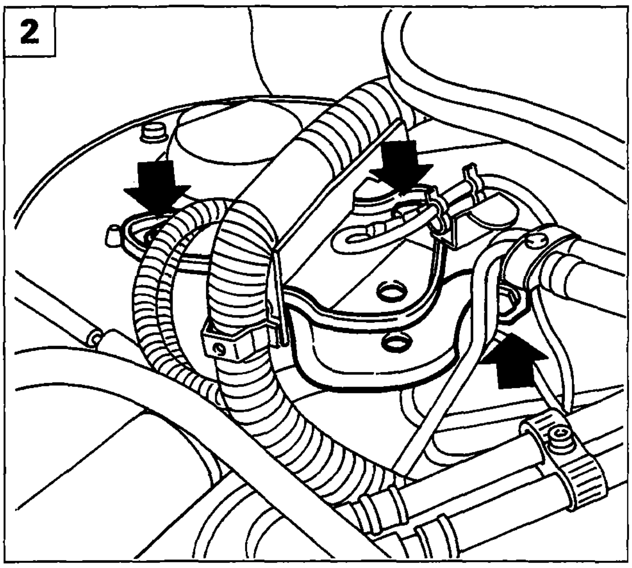


P4A024F01

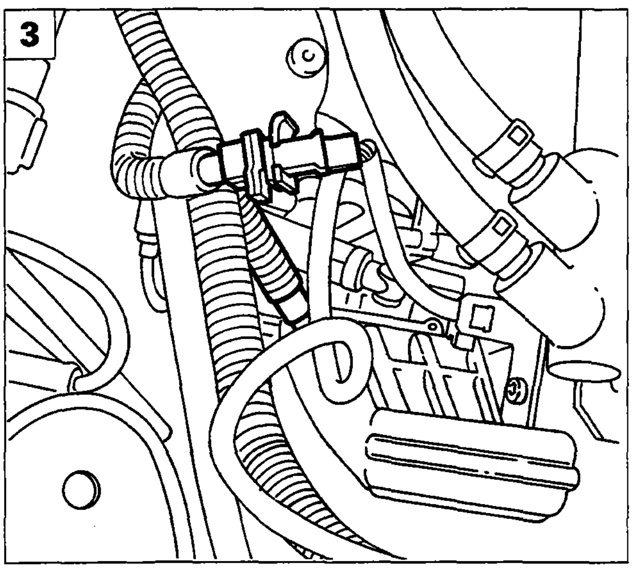
Working from the engine compartment, carry out the following operations:

1. undo the two bolts securing the link to the engine and the bracket, and remove the link;



P4A024F02

2. undo the bolts securing the bracket and link to the bodywork and remove the bracket;
3. disconnect the wiring connector and earth cable;
4. disconnect the fluid inlet and outlet pipes from the power steering pump.



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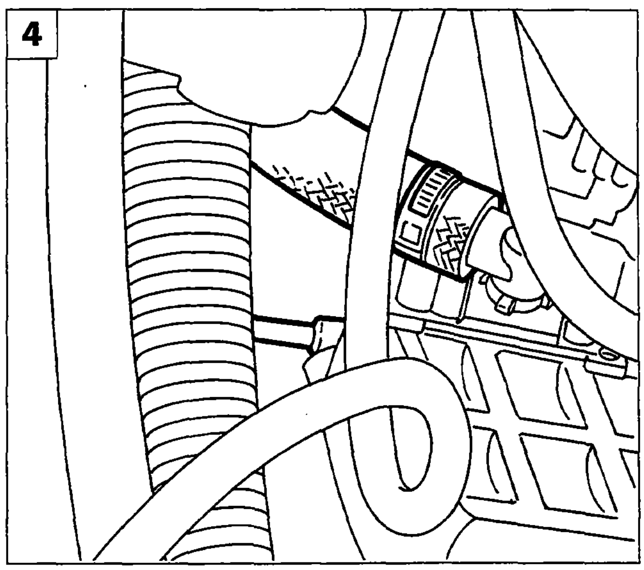

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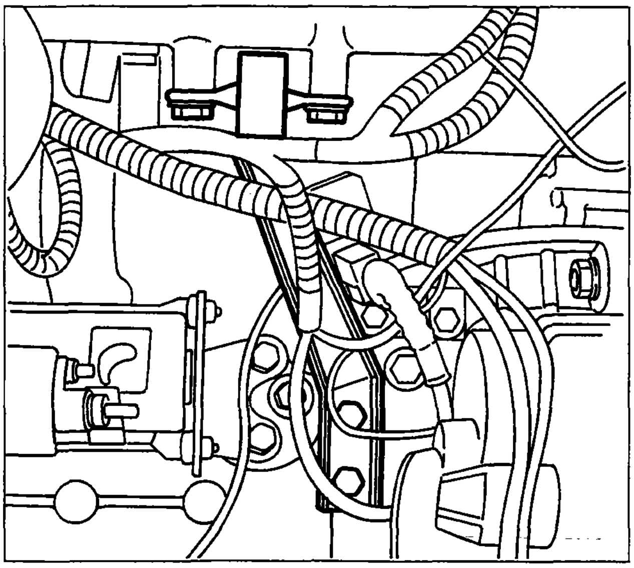
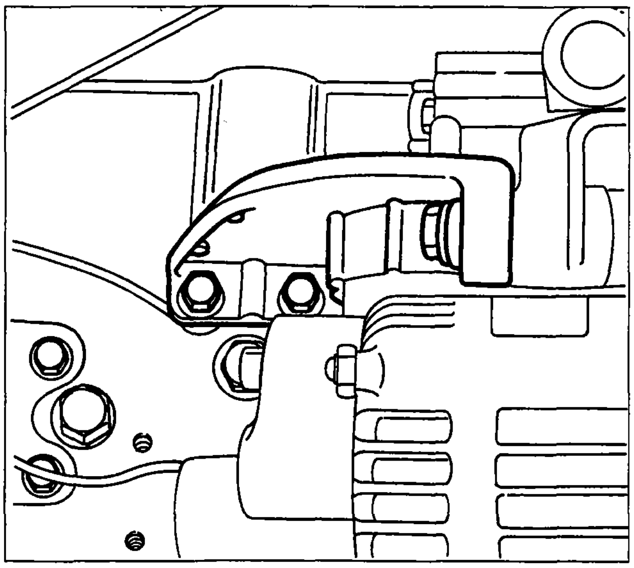


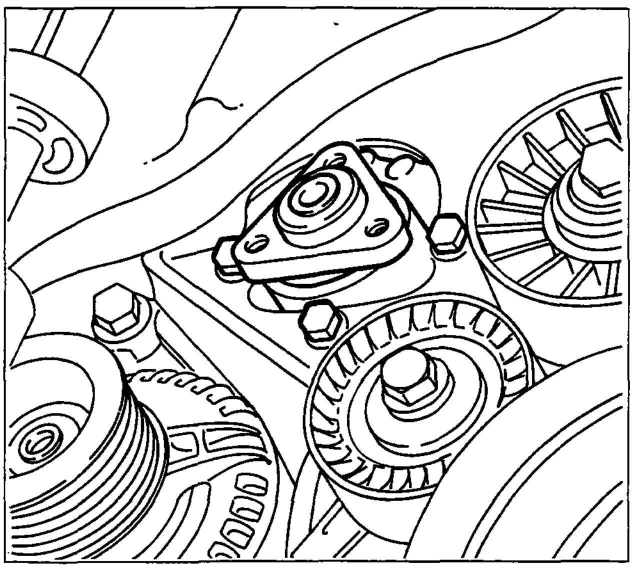
P4A025F01

Raise the vehicle, then:
- from the rear, undo the bolts securing the inlet manifold reaction bracket and remove the bracket;



P4A025F02

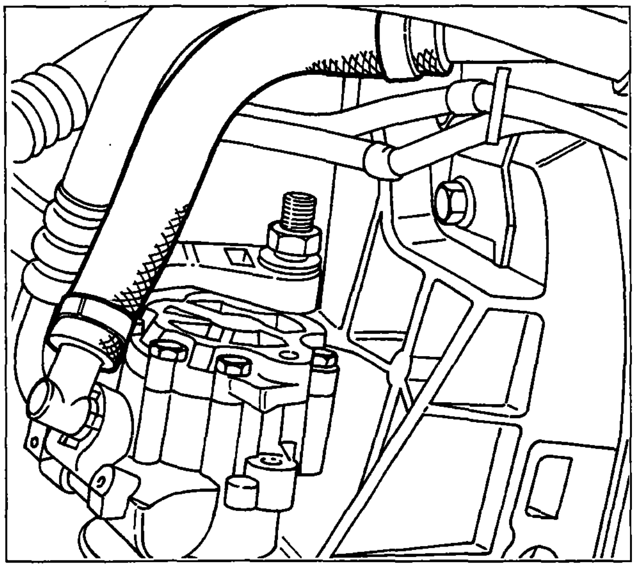
- undo the bolts securing the alternator mounting bracket and remove the bracket;



P4A025F03

- undo the bolts securing the power steering pump and remove it.

NOTE *To refit the power steering pump, reverse the procedure for removal.*

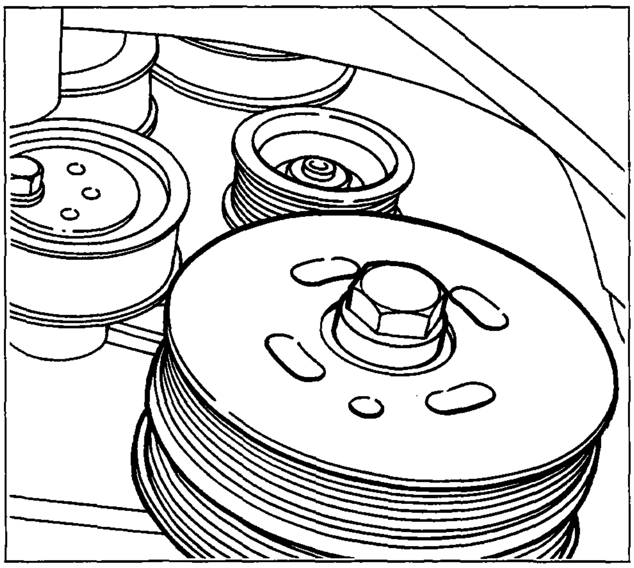

P4A026F01

Removing-refitting

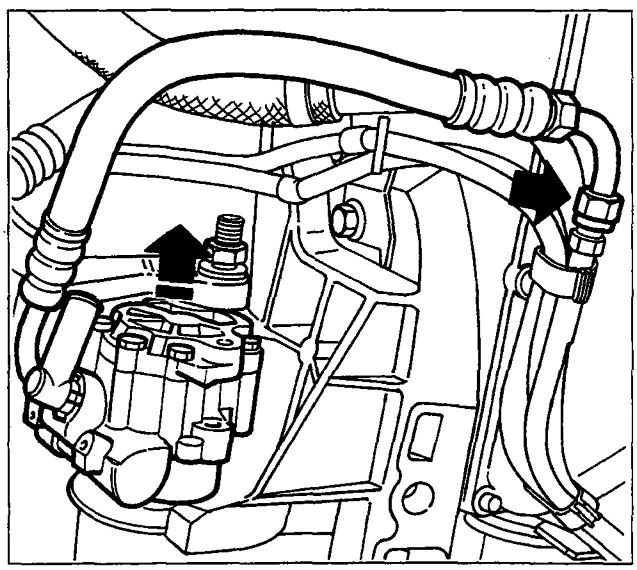
Before removing the power steering pump, drain the fluid from the reservoir.

NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*

To remove the power steering pump, proceed as follows:
- disconnect the fluid inlet pipe from the power steering pump;


P4A026F02

- after slackening and removing the belts in accordance with the procedure described in Sec. 10, undo the bolt and remove the pulley from the power steering pump;


P4A026F03

- unscrew the delivery pipe connector (arrowed), then withdraw the pump with the hose.

NOTE *To refit the power steering pump, reverse the procedure for removal, then refit and tension the belts as described in Sec. 10.*

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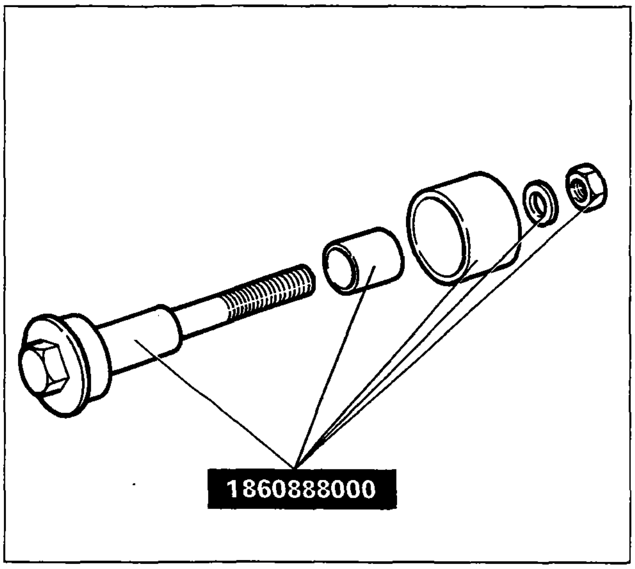

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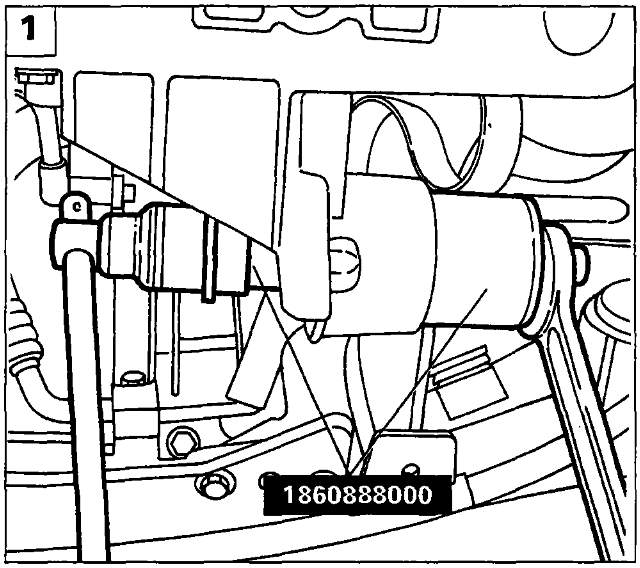

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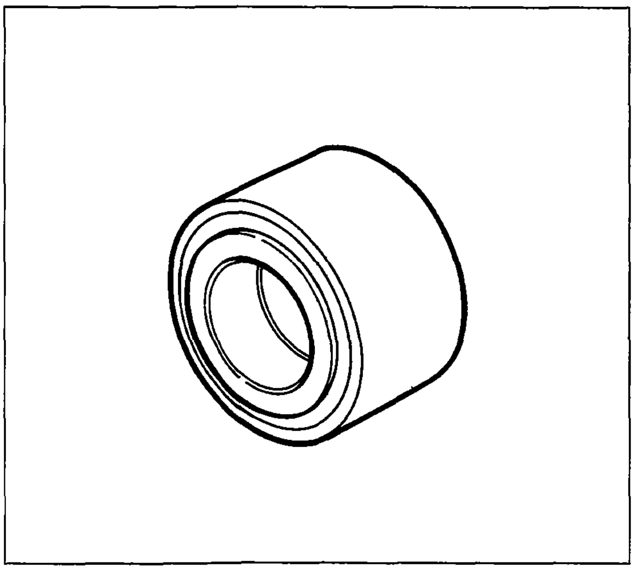
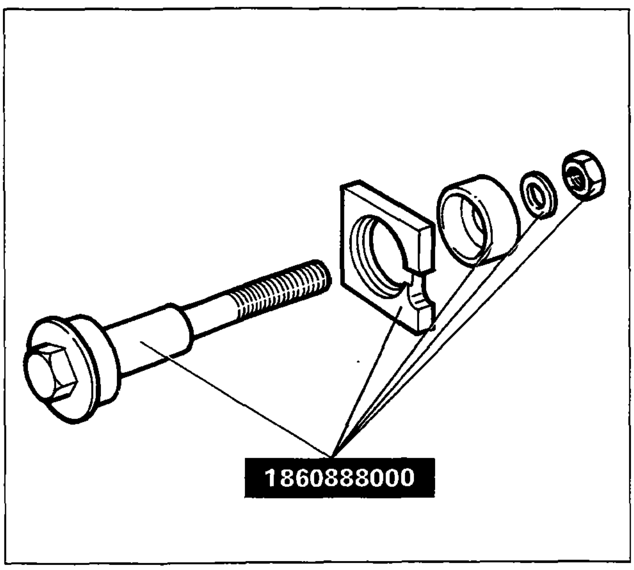


P4A027F03

Dismantling-reassembly power steering pump bearing

1. Remove the circlip and fit tool 1860888000 as shown in the figure, then tighten the nut until the bearing is fully withdrawn;
2. fit tool 1860888000 as shown in the figure, then tighten the nut until the bearing is fully inserted; refit the circlip.

Lubricate the bearing and tools before final assembly.



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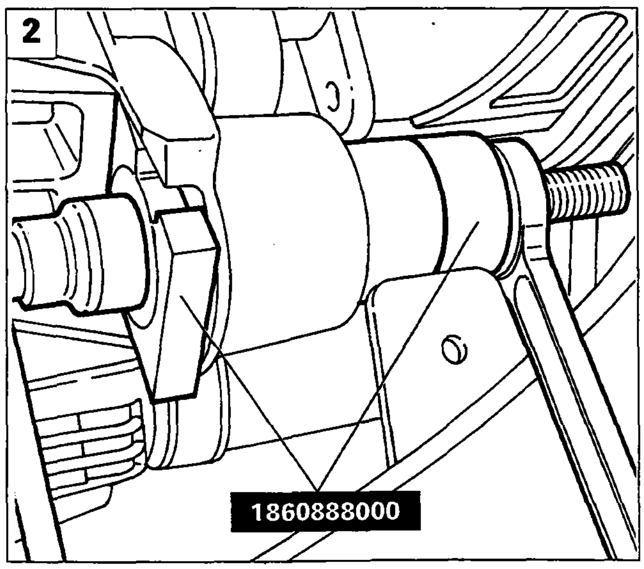

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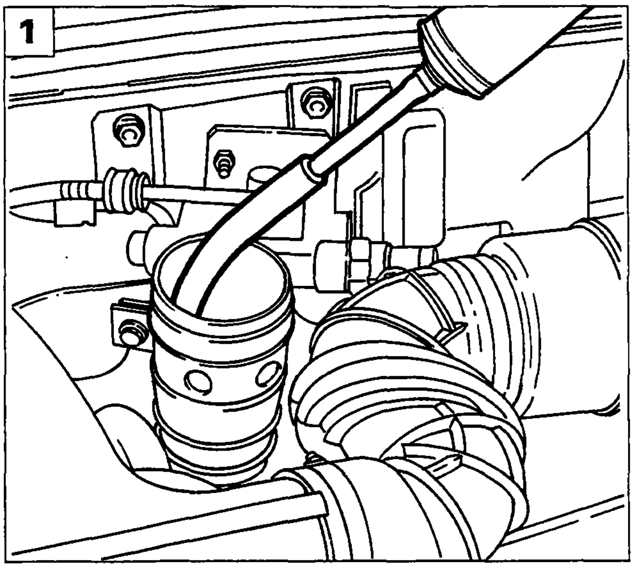
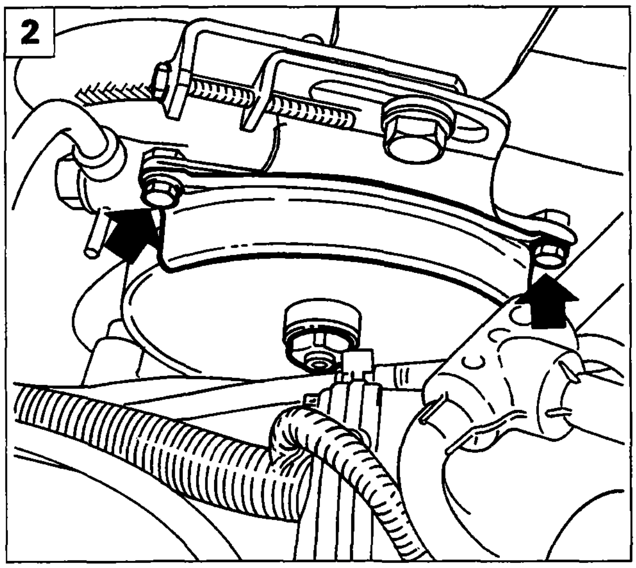


P4A028F01

Removing-refitting

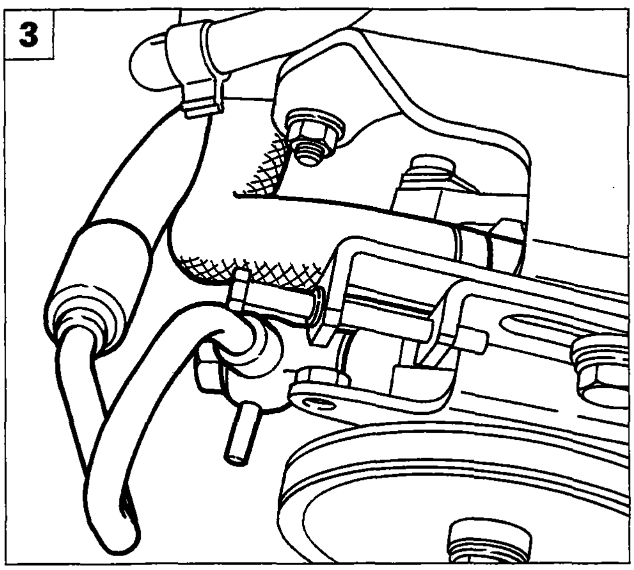
To remove the power steering pump, proceed as follows:
1. drain the fluid reservoir using a syringe;

NOTE *The old fluid should not be reused. Top up the level with fresh fluid.*



P4A028F02

2. undo the bolts (arrowed) and remove the belt guard; also undo the pulley nut;
3. disconnect the fluid inlet and outlet pipes from the power steering pump;
4. undo the bolts (1) and (2), screw up the belt tensioner (3) to reduce the belt tension, then remove the belt;



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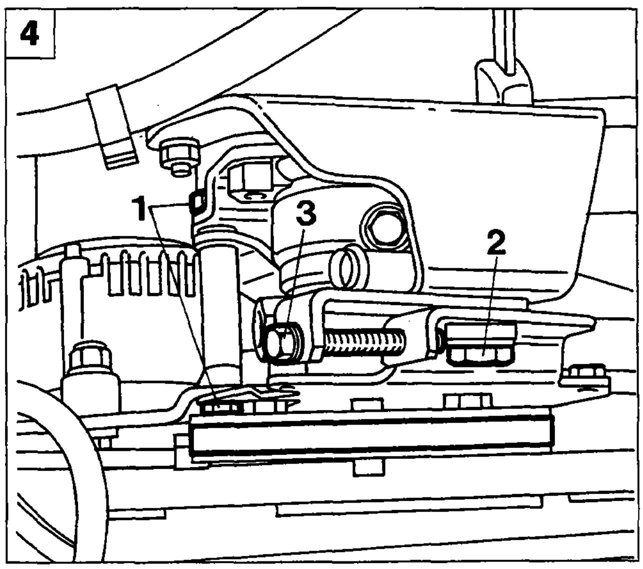
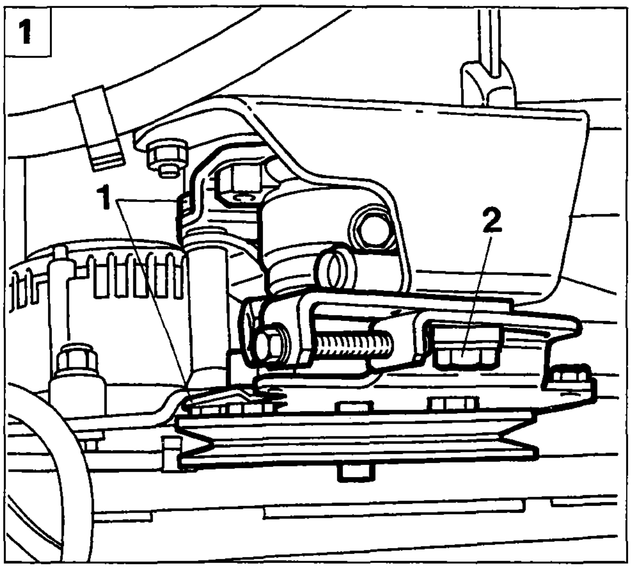


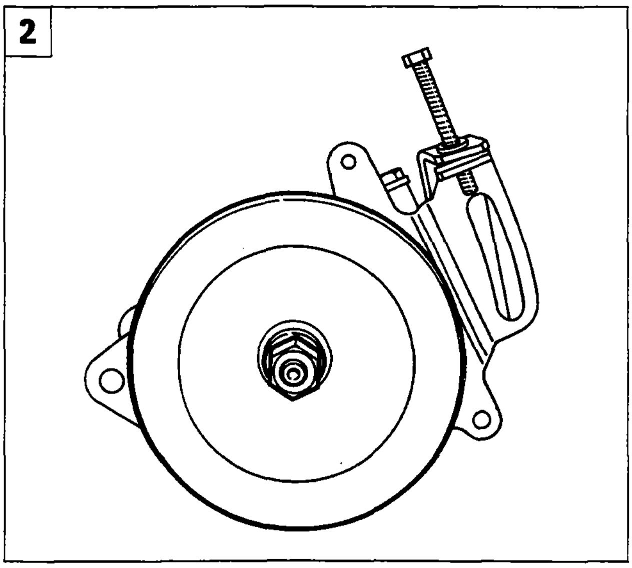
P4A028F04

41.



P4A029F01

1. remove the bolts (1) and (2), then remove the pump body complete with pulley and mounting brackets;



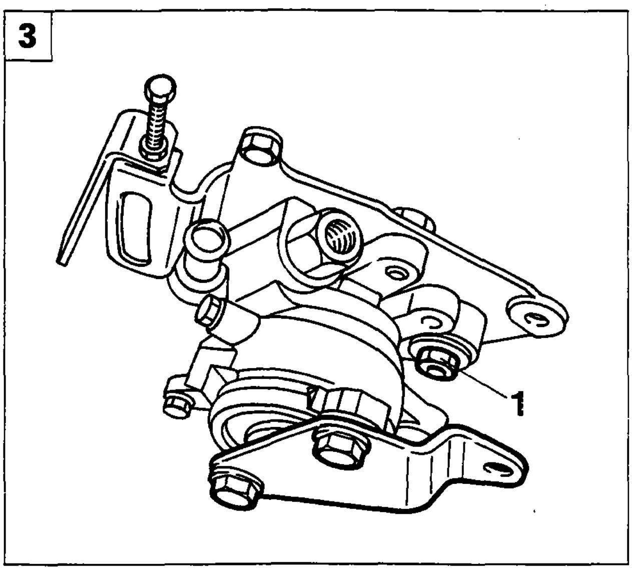
P4A029F02

2. undo the nut and remove the pulley;

Be careful with the washer during both removal and refitting of the pulley.

3. undo the bolts indicated and remove the rear bracket; also undo the nut (1) on the front bracket;
4. undo the remaining bolts and remove the front bracket.

NOTE *To refit the power steering pump, reverse the procedure for removal.*



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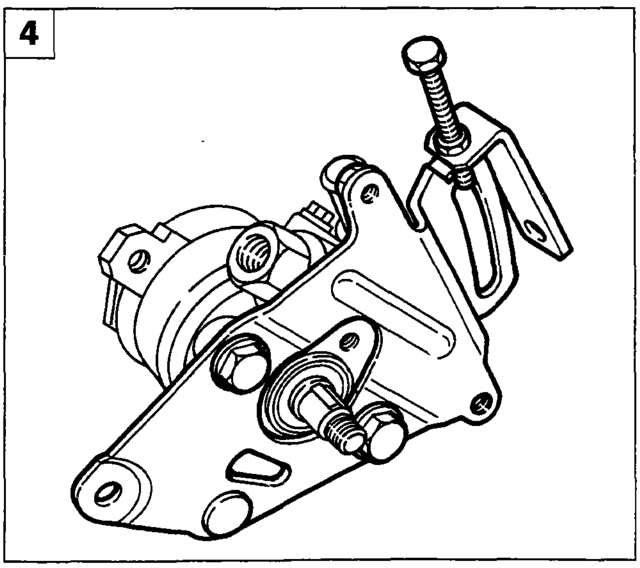

P4A029F04

The documentation relating to this engine was not yet available at the time of going to print.

The procedure for removing and refitting the power steering pump will be published in a subsequent update.

41.

1910 TD ENGINE

The documentation relating to this engine was not yet available at the time of going to print.

The procedure for removing and refitting the power steering pump will be published in a subsequent update.

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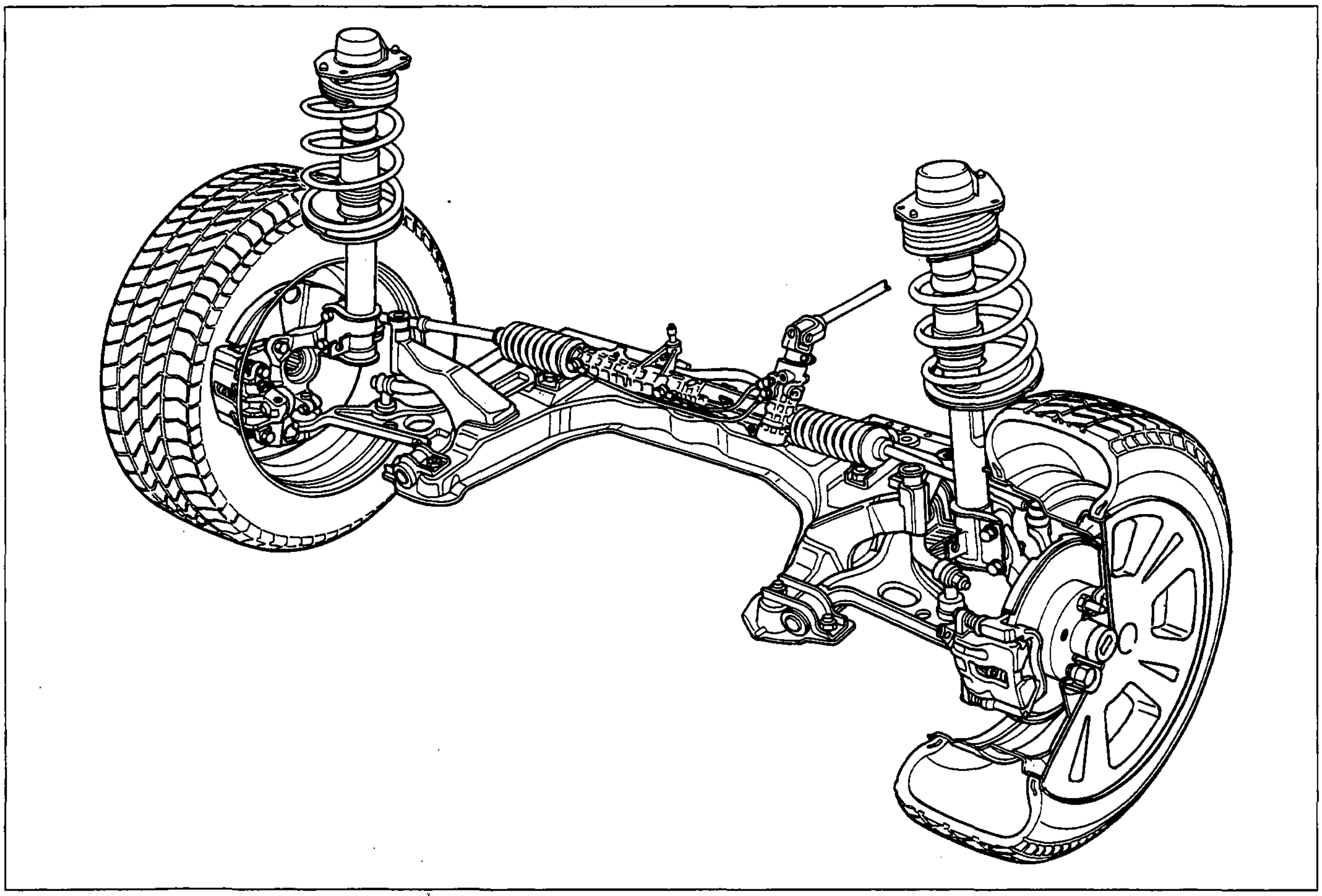
DIAGRAM OF FRONT SUSPENSION ASSEMBLY



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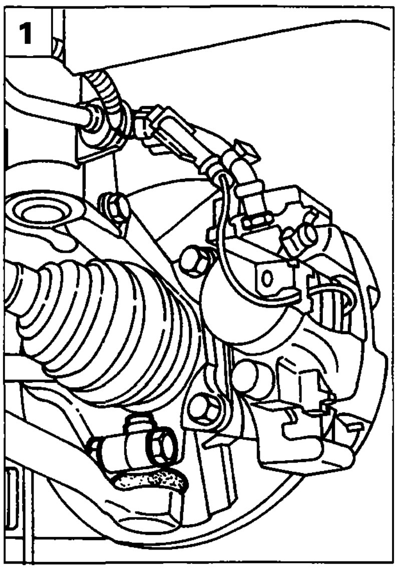

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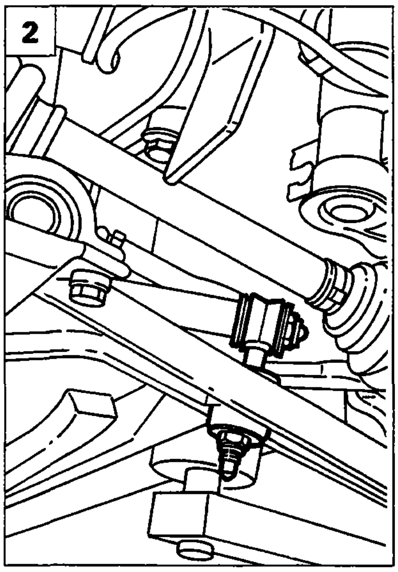

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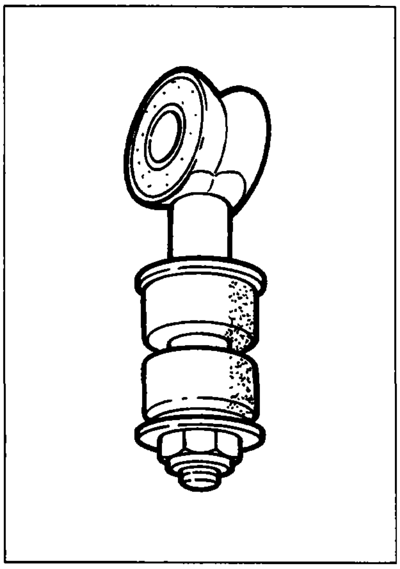

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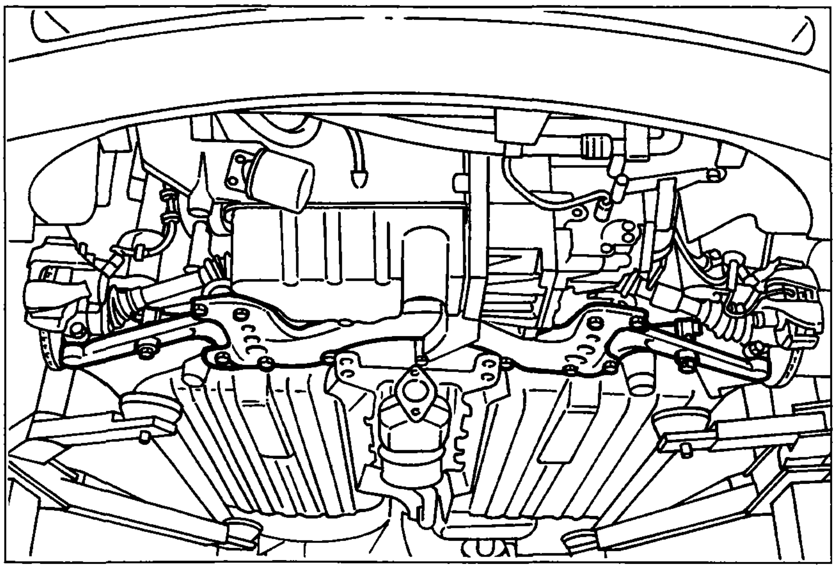


P4A002G01

WISHBONE AND STEERING SUBFRAME

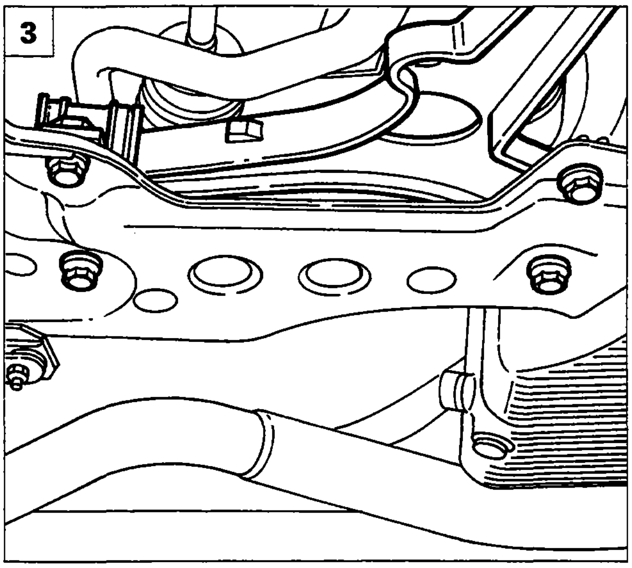
Removal

To remove the wishbone and the steering subframe, place the car on ramps, remove the front wheels and the front section of the exhaust pipe, then carry out the following operations:

1. undo the bolt securing the wishbone balljoint to the vertical link;

2. undo the two nuts securing the anti-roll bar link and remove the link;

3. undo the bolts securing the wishbone to the steering subframe and remove the wishbone;



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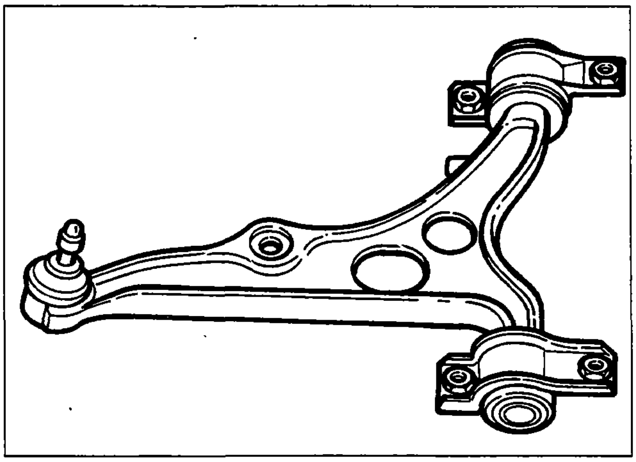

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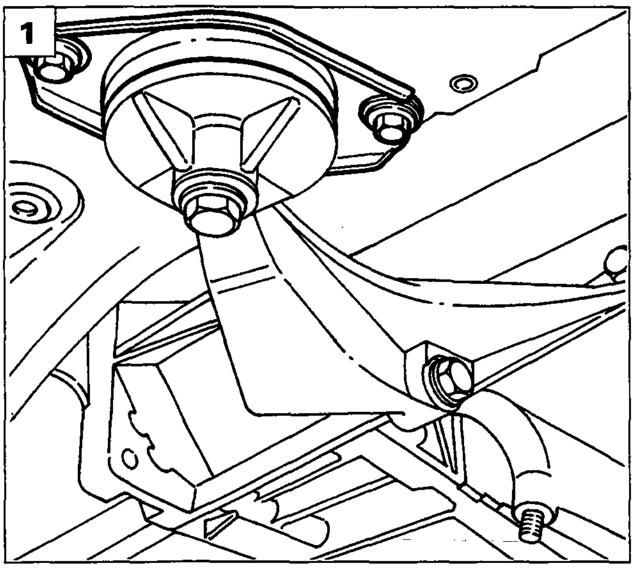
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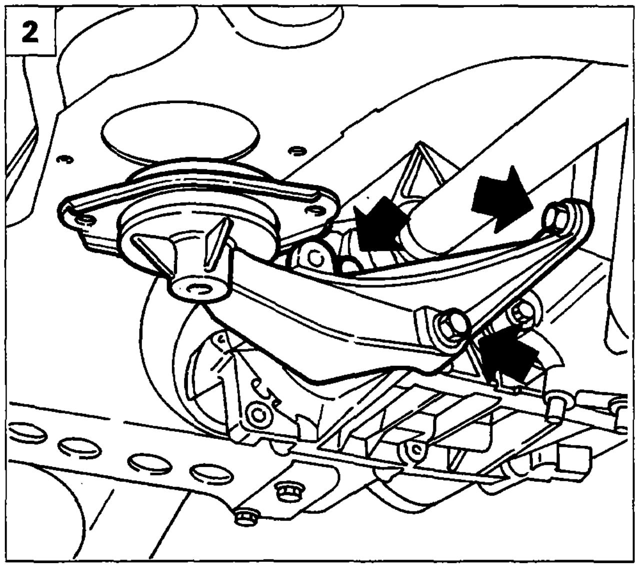
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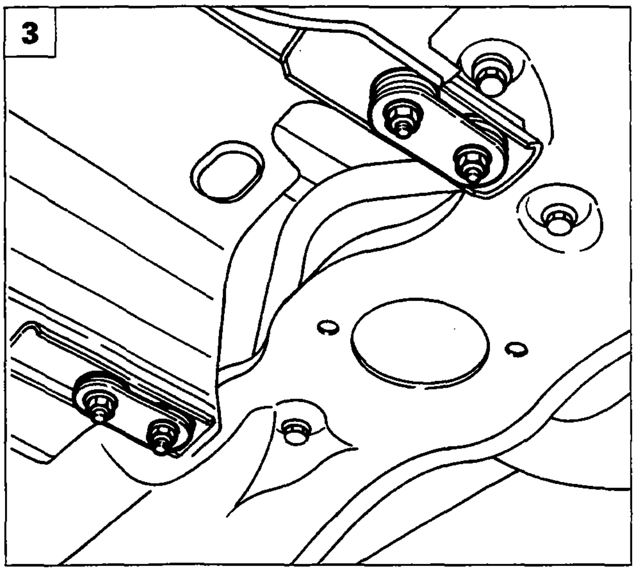
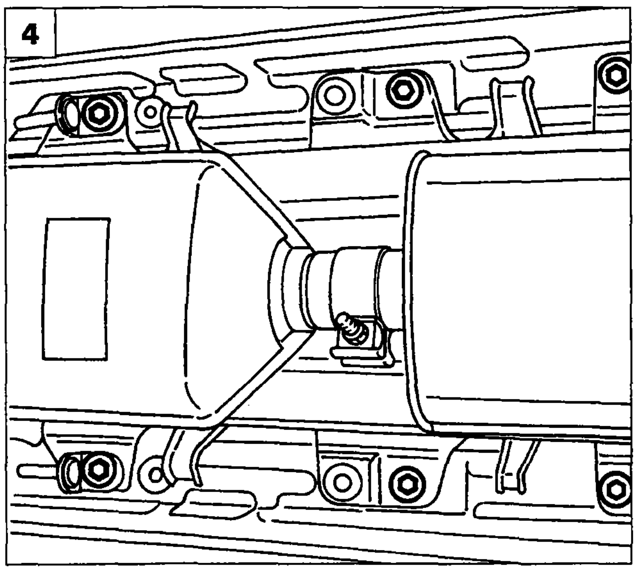

P4A003G01

1. undo the bolts securing the engine mounting, differential side, to the sub-frame;
2. undo the bolts securing the engine mounting bracket to the gearbox;
3. undo the bolts securing the heat shield;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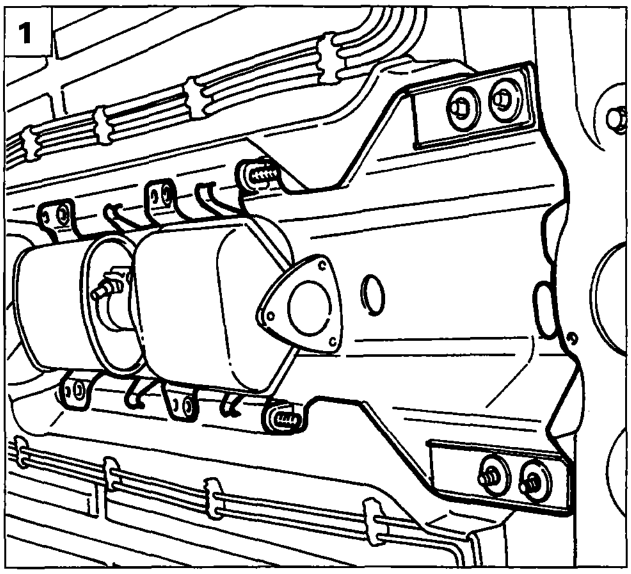
4. undo the bolts securing the heat shield;

44.



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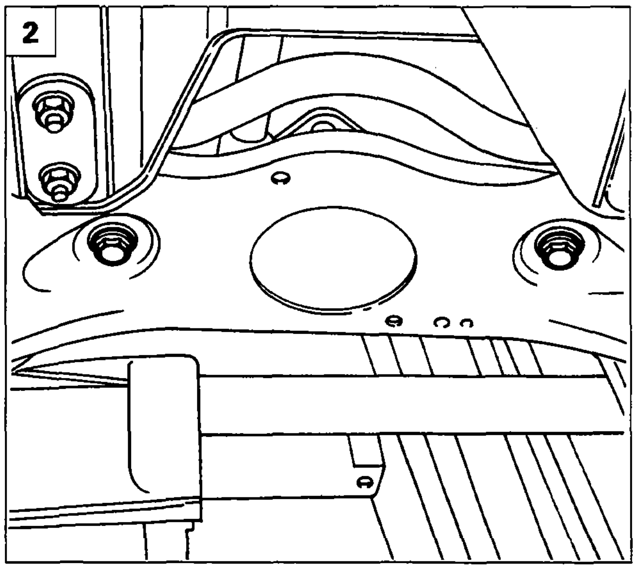

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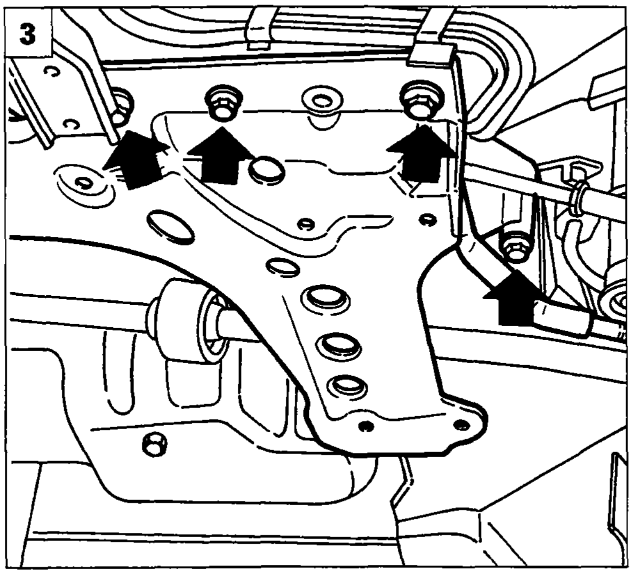


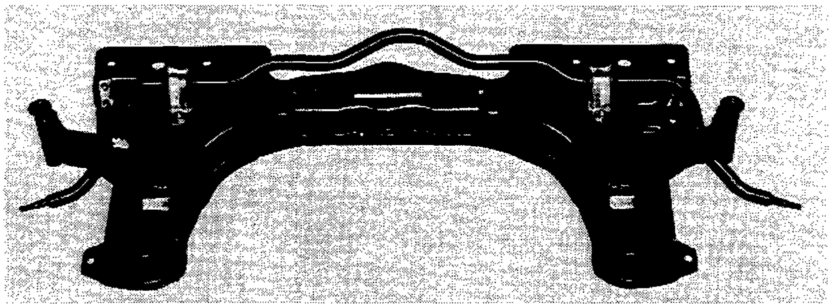
P4A004G03

1. rimuovere il riparo anticalore;
2. svitare le viti di fissaggio della scatola servosterzo alla traversa anteriore;
3. posizionare un sollevatore idraulico a colonna sotto la traversa, quindi svitare le viti di fissaggio della traversa alla scocca (frecce); abbassare lentamente il sollevatore e rimuovere la traversa anteriore.

Riattacco

NOTA *Per il riattacco della traversa anteriore e del braccio oscillante eseguire in senso inverso le operazioni previste per lo stacco.*

Effettuare la convergenza ruote anteriori ogni qualvolta si esegua lo stacco-riattacco della traversa anteriore o di un braccio oscillante.



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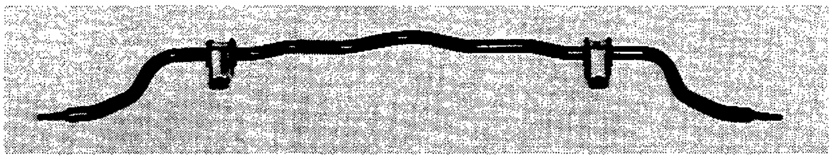


P4A005G02

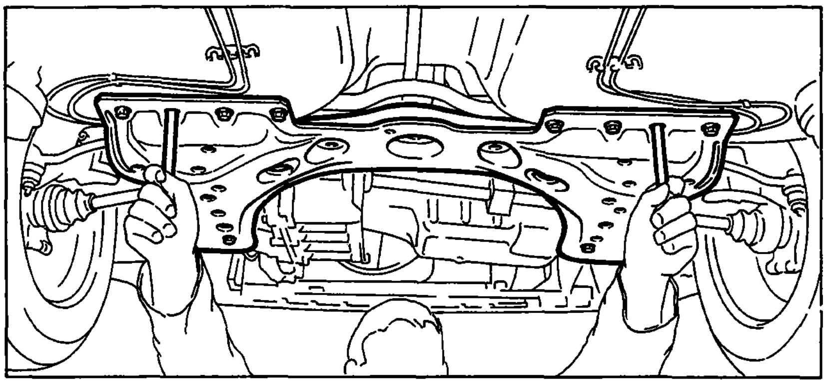
Dismantling-refitting anti-roll bar on steering subframe

Checking anti-roll bar

Neither the rubber buffers nor the bar should show signs of damage, otherwise the buffers and the bar must be replaced.

Checking steering subframe

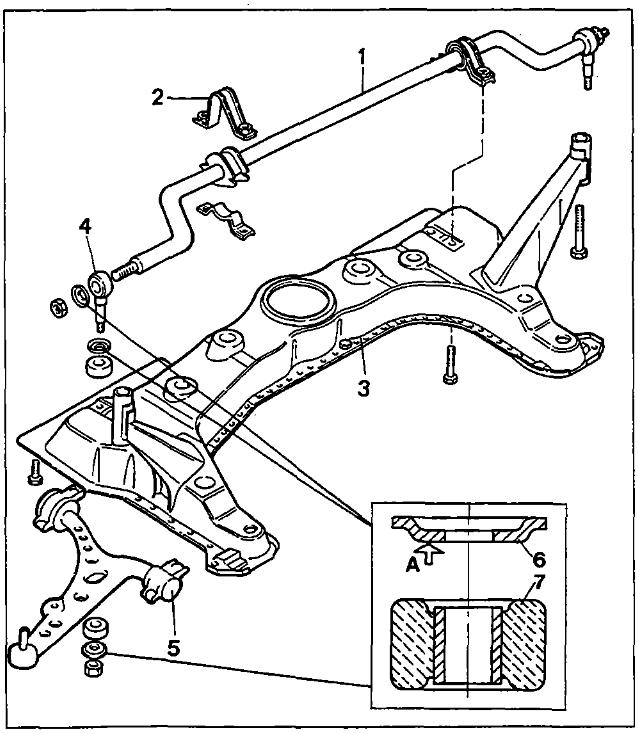
Check that the steering subframe is not cracked or deformed such that its efficiency is impaired.



P4A005G03

Refitting steering subframe to body shell

The subframe should be secured temporarily, then centred on the bodywork using two studs of a diameter of about 12 mm, then it should be secured finally.

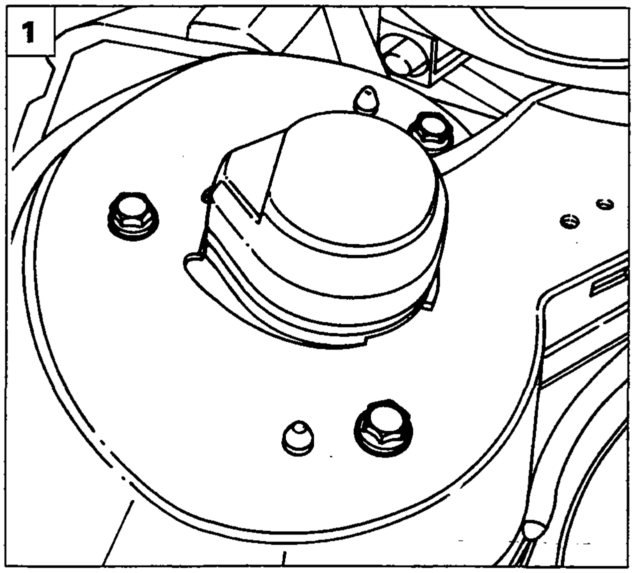


P4A005G04

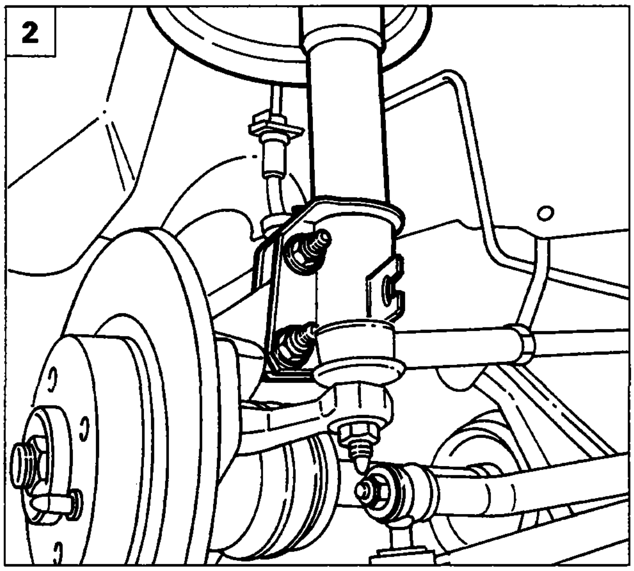
Components of the front suspension supplied as spare parts

1. Anti-roll bar
2. Bracket securing anti-roll bar to steering subframe
3. Steering subframe
4. Link connecting anti-roll bar to wishbone
5. Wishbone
6. Washer for rubber buffer
7. Rubber buffer

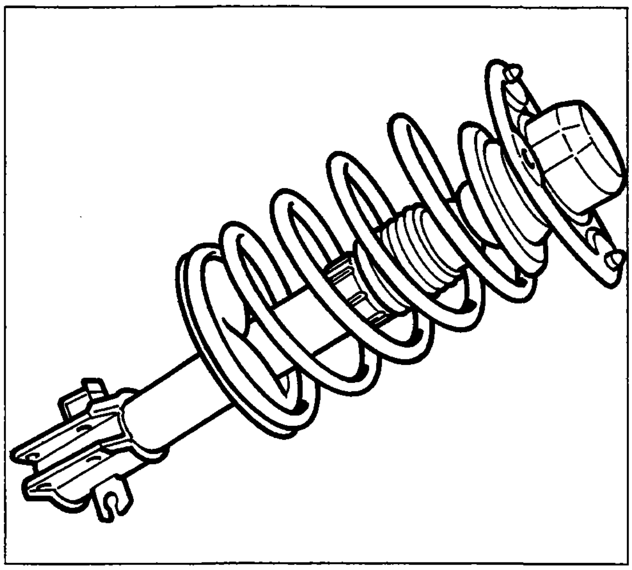
When refitting the anti-roll bar, fit the washers, shown in the insert, with the face (A) facing the rubber buffer (2).
Incorrect assembly could impair the life of the rubber buffer (2).



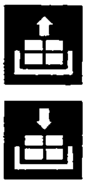
P4A006G01



P4A006G02



P4A006G03



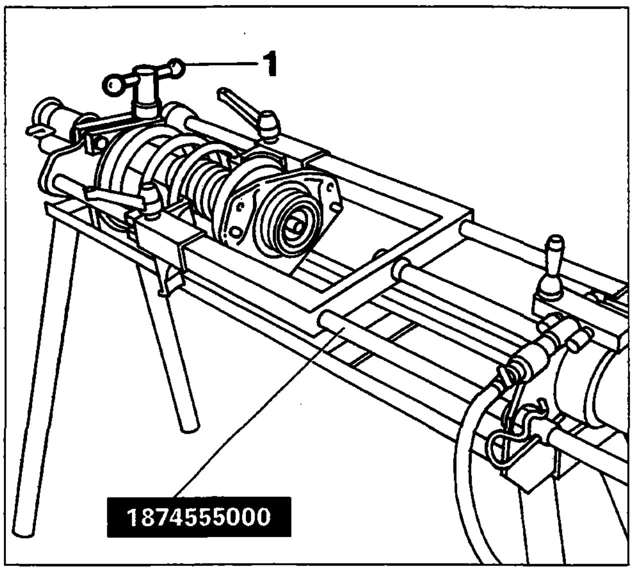
SPRING-DAMPER ASSEMBLY

Removing-refitting

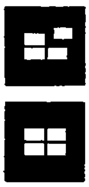
To remove the spring-damper assembly, proceed as follows:

1. undo the bolts securing the damper top plate to the bodywork;
2. undo the bolts securing the damper to the vertical link and remove the coil spring and damper assembly.

Assembly with offset coil spring



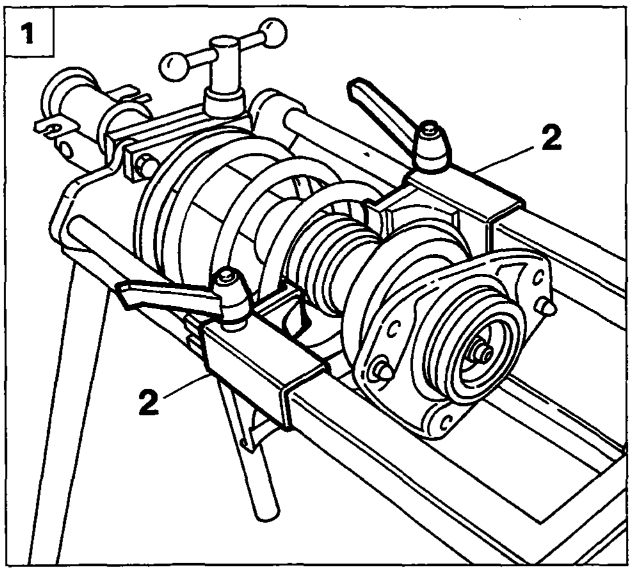
P4A006G04



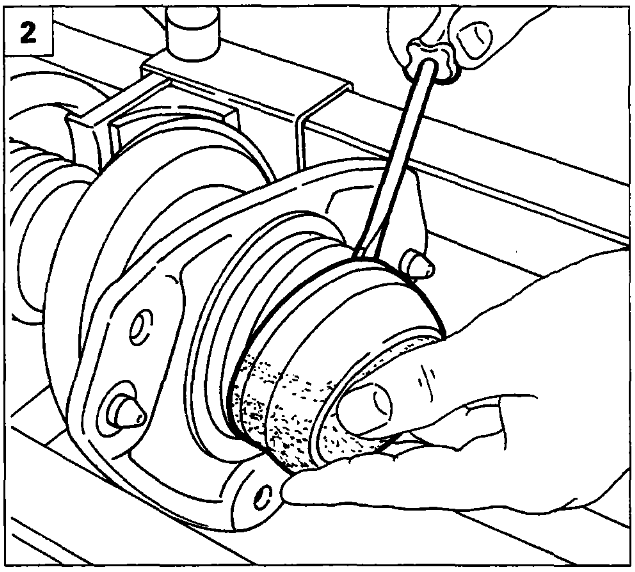
Dismantling-refitting

Detach the coil spring from the damper as follows:

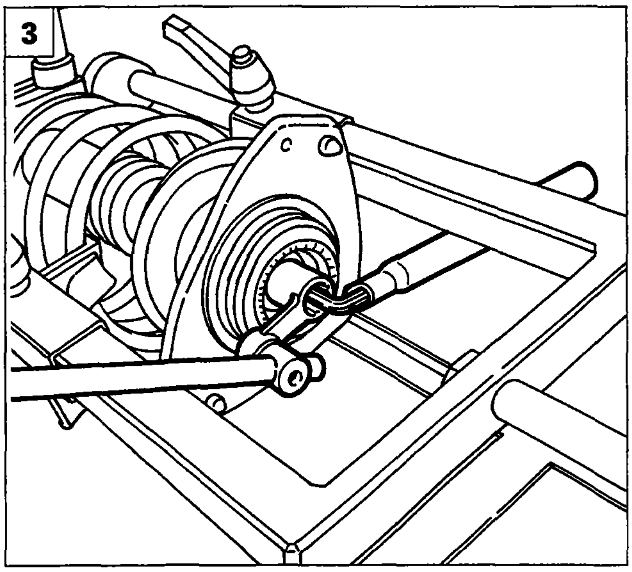
- fit the spring-damper assembly on the pneumatic tool 1874555000 and operate the lever (1) so as to lock the assembly;



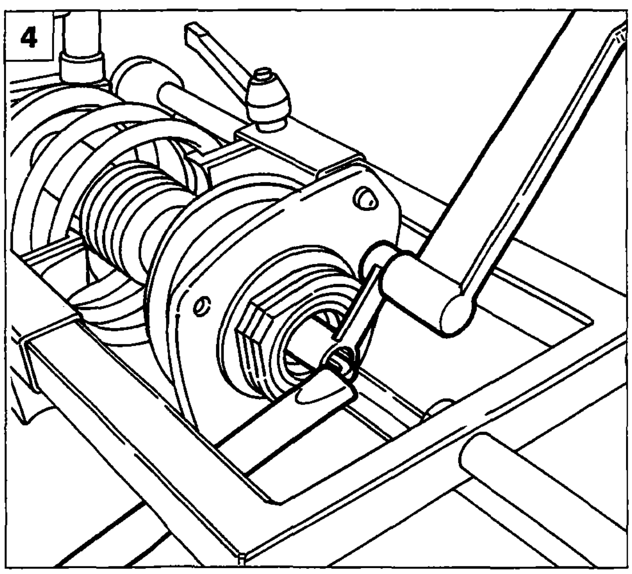
P4A007G01



P4A007G02



P4A007G03



P4A007G04

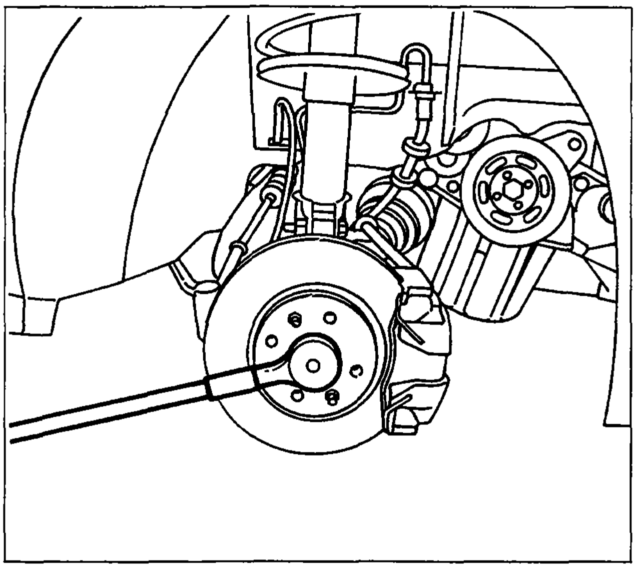
1. adjust the position of the hooks (2), moving them close to the spring, then place the tool under pressure until the spring begins to compress;
2. prise off the dust excluder using a screwdriver;
3. undo the nut securing the top plate to the damper stem and remove the plate, then withdraw the spacer, spring and end-of-travel stop.

10 daNm

NOTE *The coil springs are divided into two categories, identifiable by means of a strip of paint on the central coil. Springs of the same category must be fitted.*

4. Refit the components in reverse order, tighten the damper stem nut to the correct torque then refit the dust excluder.

VERTICAL LINK AND WHEEL HUB

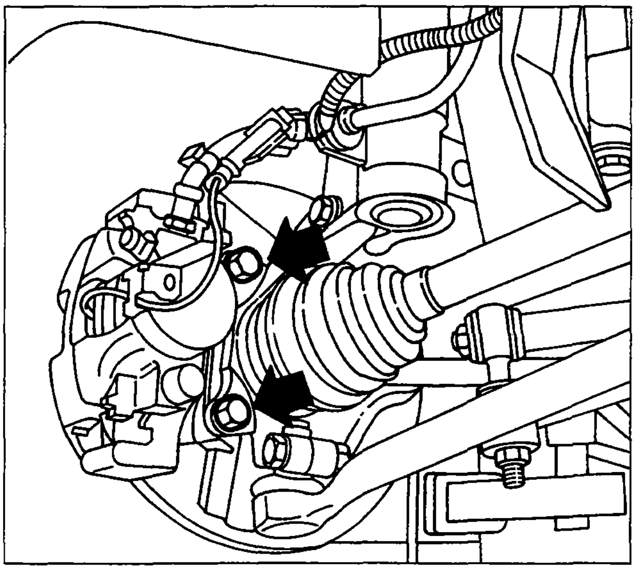


P4A008G01

Removal

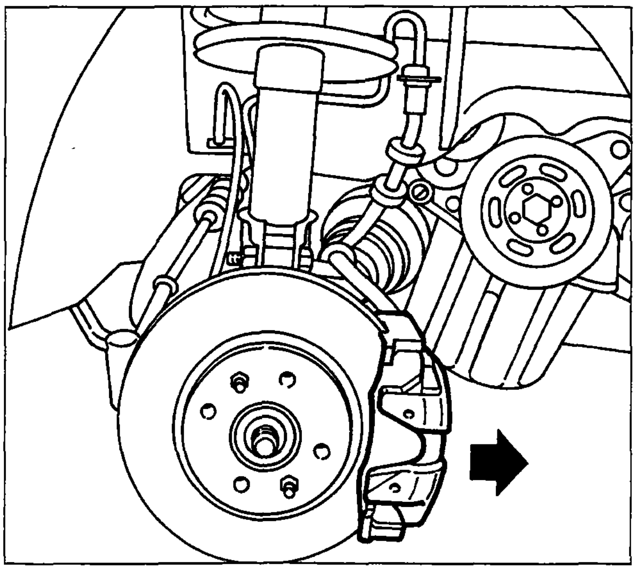
To remove the front vertical link and wheel hub, proceed as follows:

- undo the nut securing the front wheel hub to the stub axle;



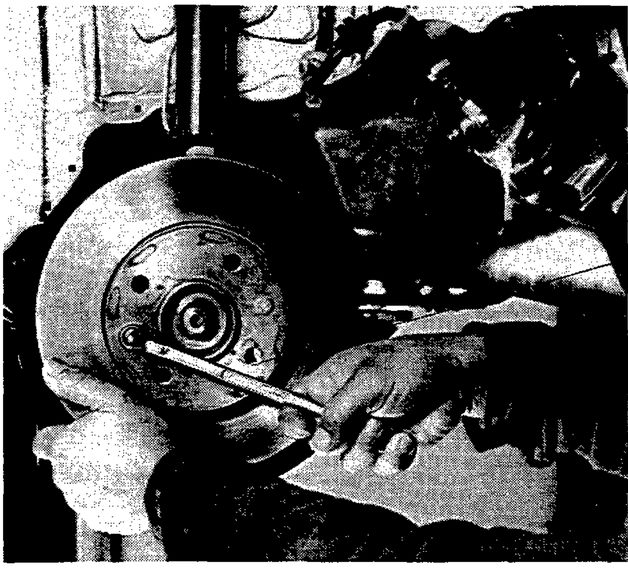
P4A008G02

- undo the bolts securing the brake caliper assembly to the vertical link;

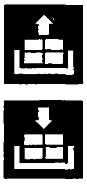


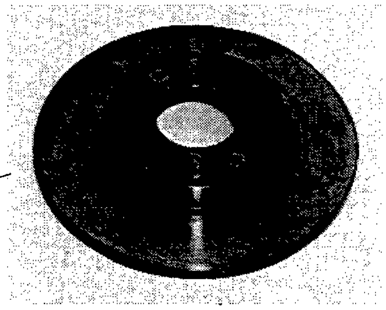
P4A008G03

- withdraw the brake caliper complete with mounting bracket and secure it in the wheelarch without disconnecting the brake pipe;



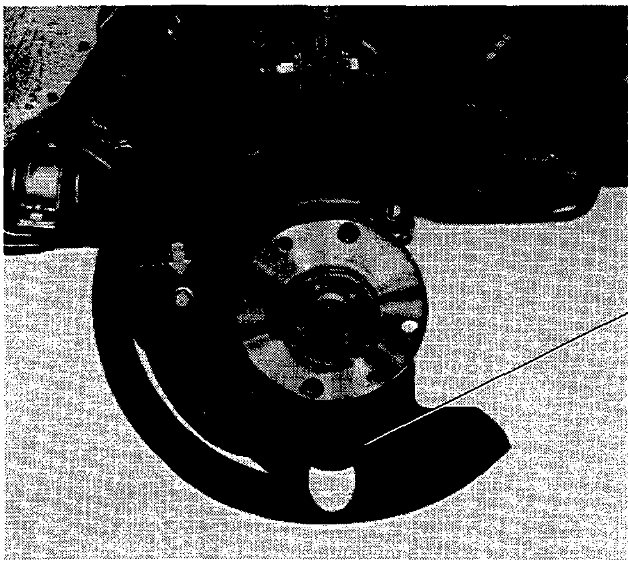
P4A009G01



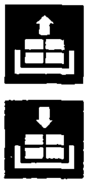


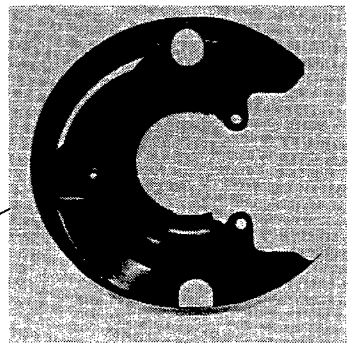
P4A009G02

- undo the bolts and remove the brake disc;



P4A009G03

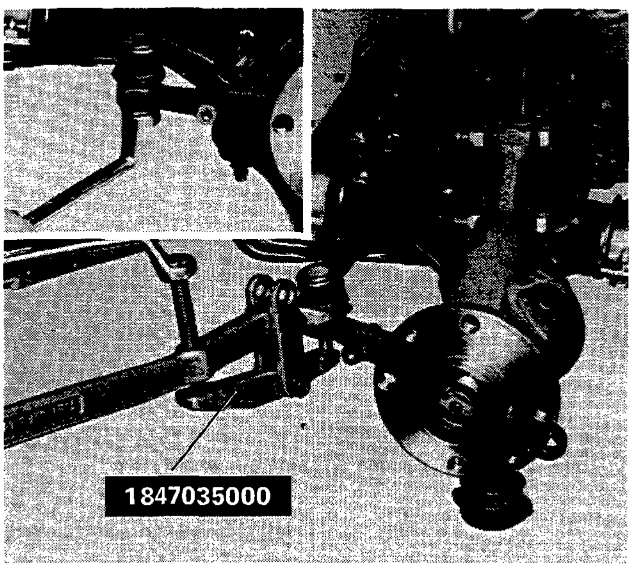




P4A009G04

- undo the screw and remove the dust shield;

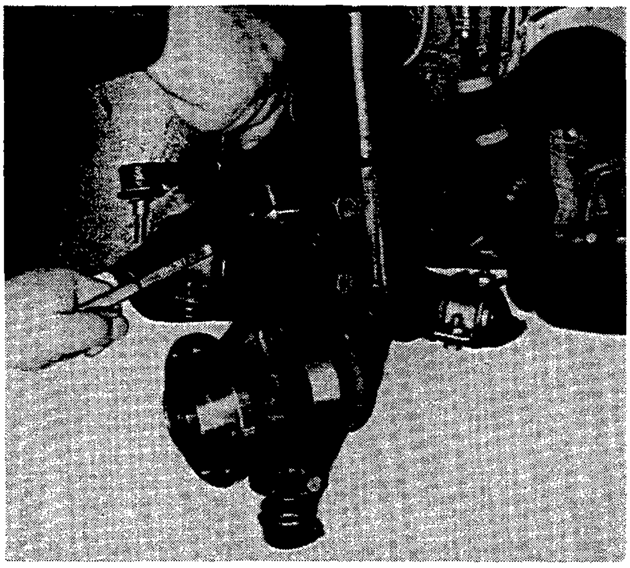
P4A009G06



P4A009G05

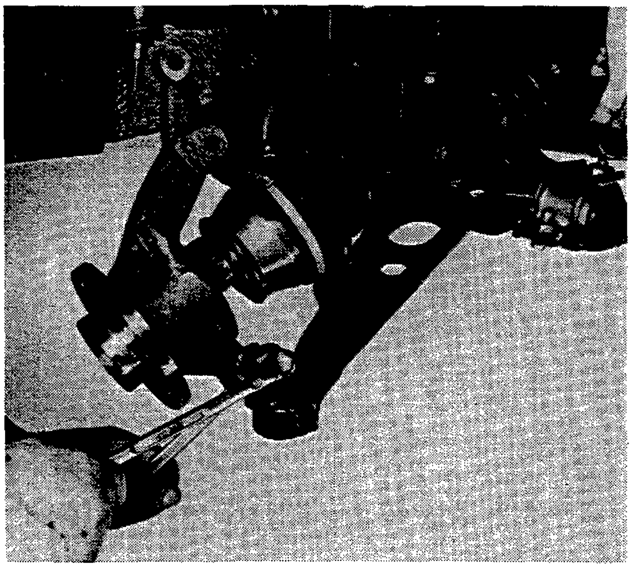
- undo the nut securing the balljoint pin to the tie-rod end, then remove the pin using tool 1847035000;

44.



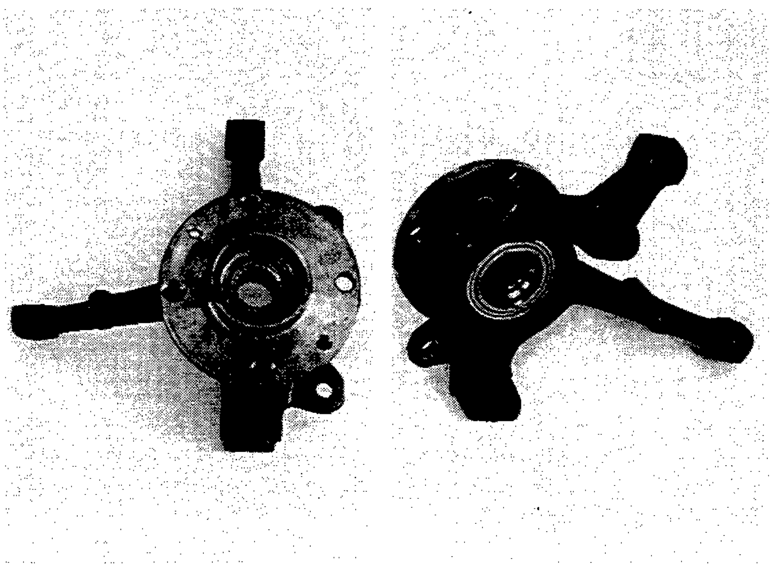
P4A010G01

- undo the bolts securing the spring-damper assembly to the vertical link;



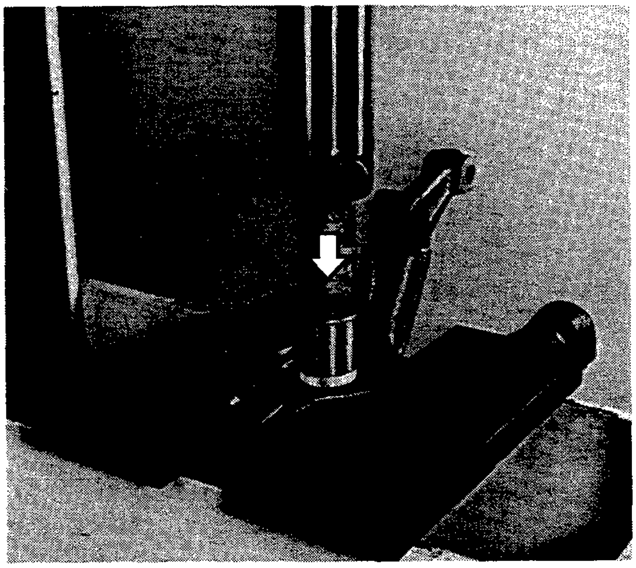
P4A010G02

- undo the bolt securing the wishbone ball-joint to the vertical link and remove the vertical link.



P4A010G03 P4A010G04

Front and rear views of vertical link complete with hub



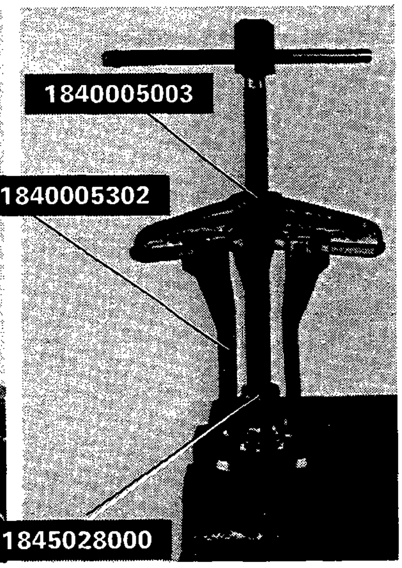
P4A011G01

Dismantling

To dismantle the vertical link and wheel hub, proceed as follows:

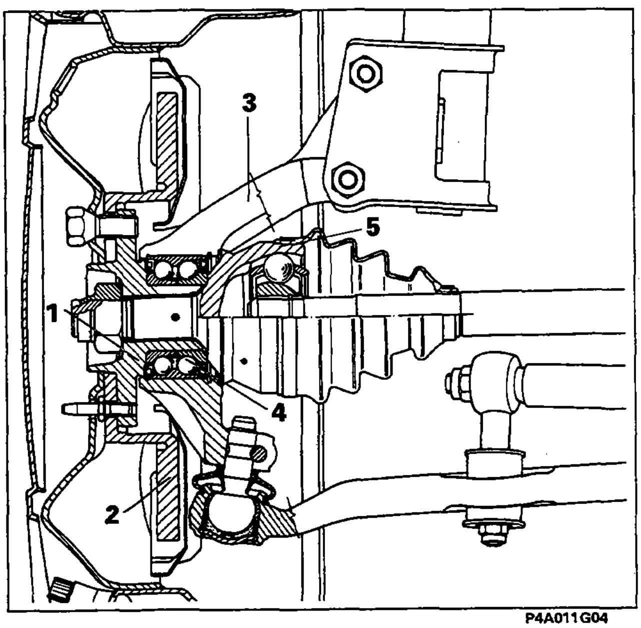
- dismantle the hub from the vertical link using a press;

P4A011G02



P4A011G03

- using a chisel, separate the bearing inner ring from the hub, then withdraw the bearing using the tools shown;

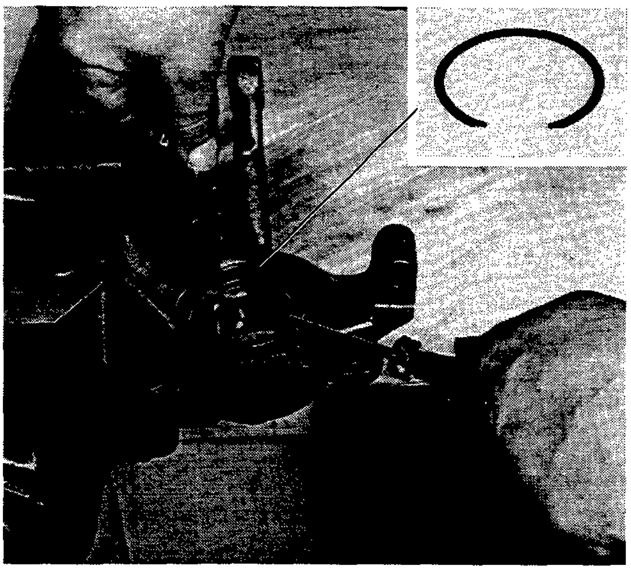


P4A011G04

Longitudinal section of front wheel hub assembly and disc brake

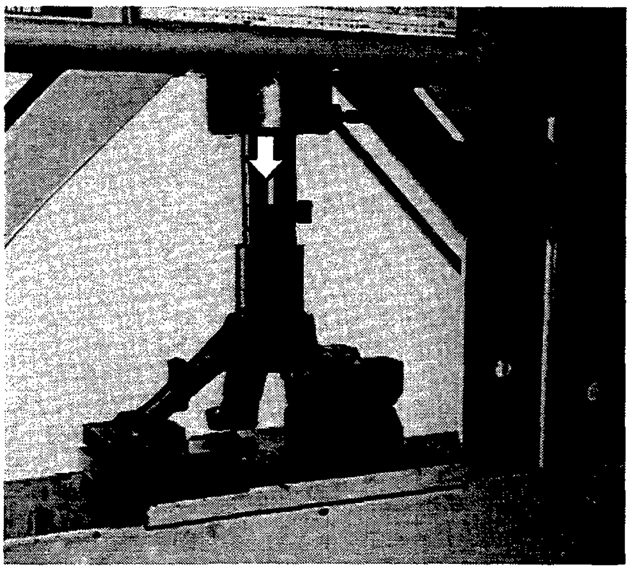
1. Wheel hub
2. Brake disc
3. Vertical link
4. Ball bearing
5. Constant velocity joint

P4A012G02



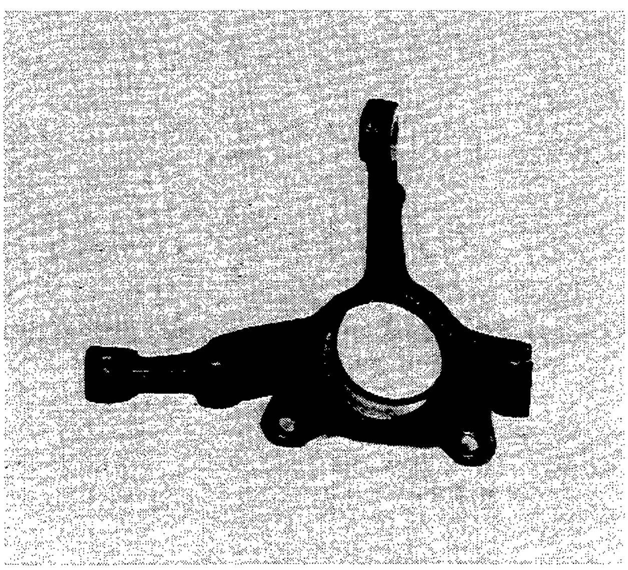
P4A012G01

- dismantle the circlip securing the bearing outer race;



P4A012G03

- dismantle the bearing outer race from the vertical link using a press.

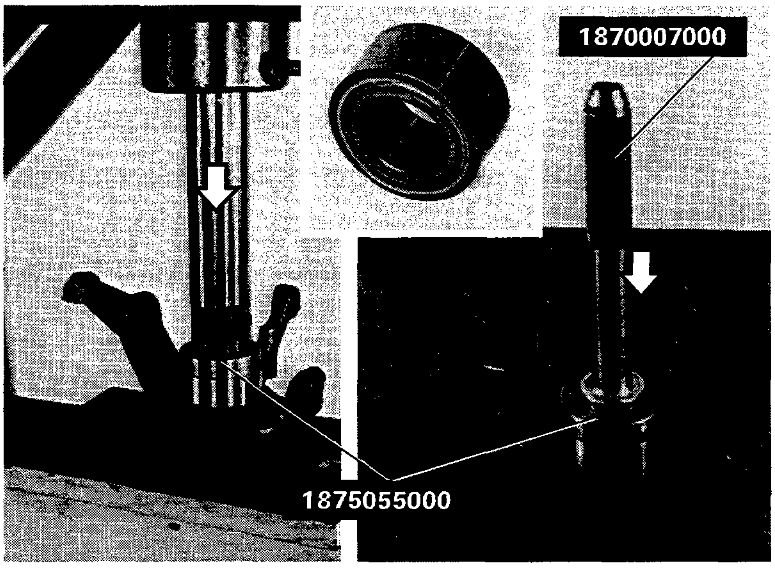


P4A012G04

Checking front vertical link

Check that the inner surfaces do not show signs of seizure and that the arms have not sustained visible impact and do not show signs of breakage, otherwise the complete vertical link will need to be replaced.

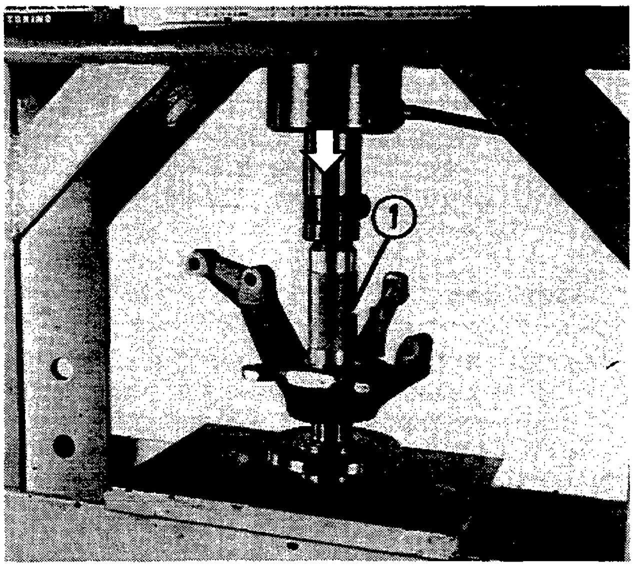
P4A013G04



P4A013G01 P4A013G02

Refitting

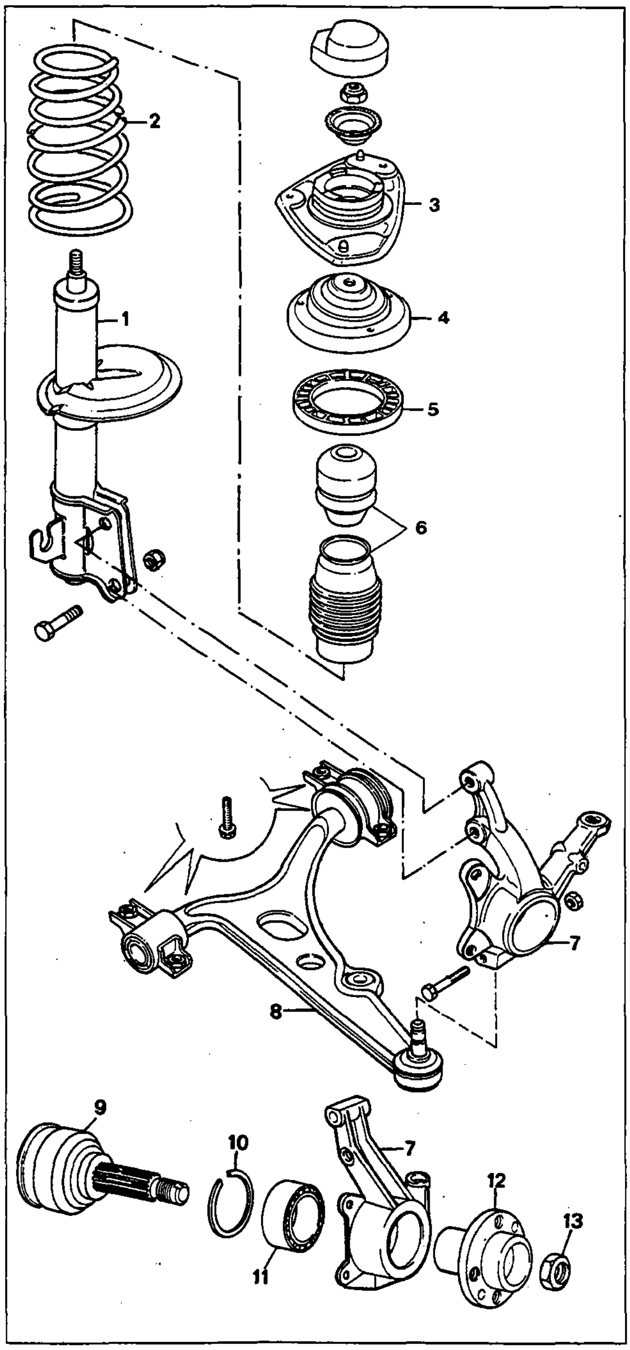
The bearing can be refitted on the vertical link either using a press, or using the handle 1870007000.
Then fit the bearing circlip.



P4A013G03

Fit the hub in the bearing on the vertical link using a press, supporting the bearing inner race with a cylinder (1) of suitable diameter.

44.



P4A014G01

COMPONENTS OF THE FRONT SUSPENSION SUPPLIED AS SPARE PARTS

Components of the damper top mounting

Check that the components have no faults that might impair their efficiency.

Damper

If faults attributable to the damper are found, the entire damper assembly should be replaced.

Coil spring

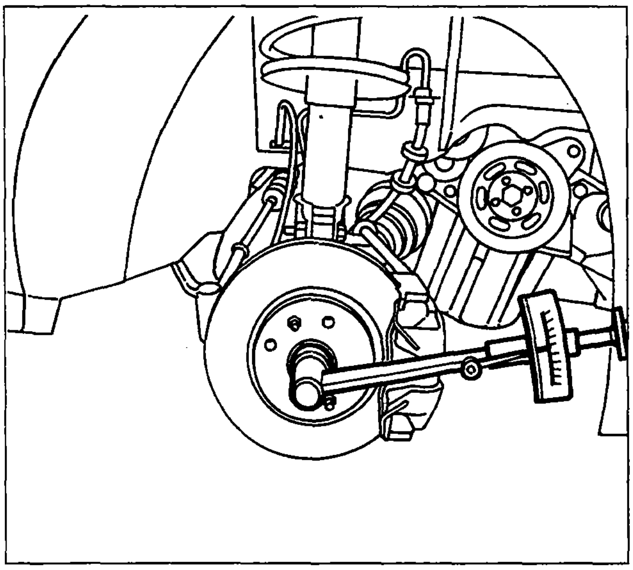
Make sure that it has no cracks or deformations that might impair its efficiency.

NOTE *The coil springs are divided by means of a yellow or green paint strip on the central coil. Coils of the same category should be fitted.*

Wishbone

Check that the wishbone is not deformed, that the balljoint head does not have excessive play, that the dust excluder is not damaged and that the rubber bushes are not worn, otherwise the complete wishbone will need to be replaced.

1. Damper
2. Coil spring
3. Damper top plate
4. Spacer
5. Rubber buffer
6. Tube and end-of-travel stop
7. Vertical link
8. Wishbone
9. Constant velocity joint + stub axle
10. Bearing circlip
11. Ball bearing
12. Wheel hub
13. Wheel hub nut

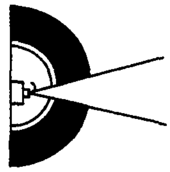


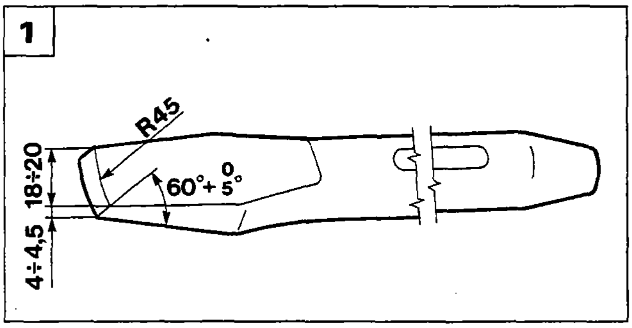
P4A015G01

24 daNm	1370 1581 1747 1929 D
28 daNm	1998 1910 TD

Fitting hub nut and tightening it to correct torque

The nuts securing the constant velocity joints to the hubs must always be replaced.

Also check:  *Front wheel geometry*

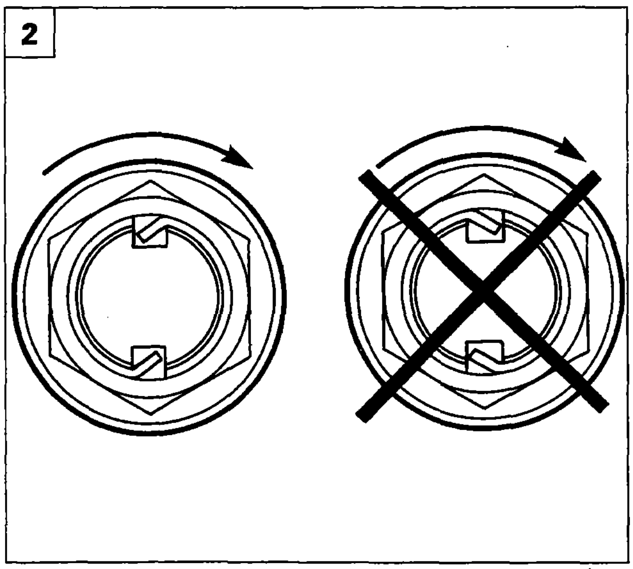


P4A015G02

Staking hub nut

To stake the nut, proceed as described below:

- always use a new nut;
- thoroughly clean the threaded end of the half-shaft using a metal brush, and then with a compressed air jet;



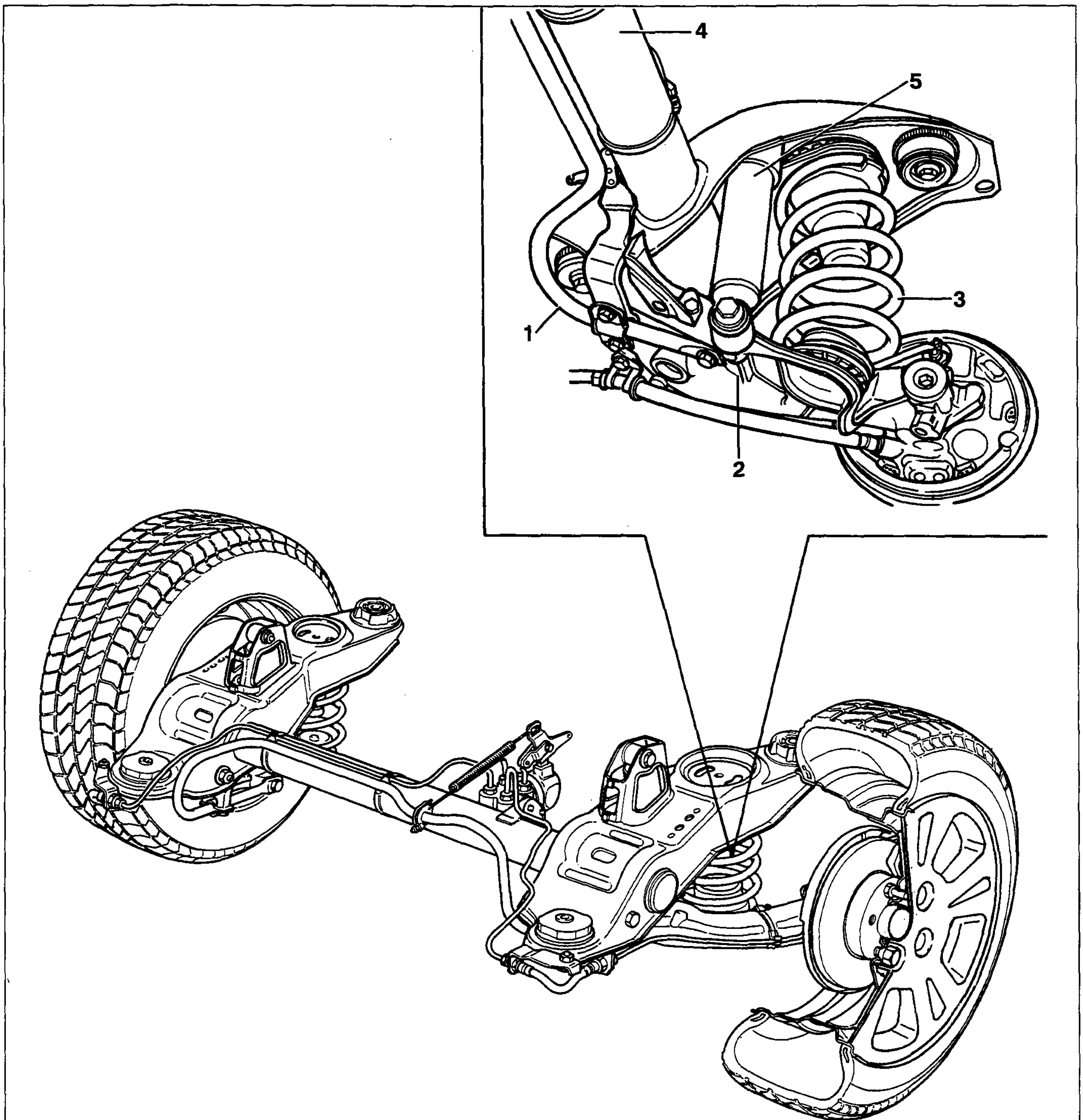
P4A015G03

- clean the thread on the new nut and the threaded end of the half-shaft using paper towel moistened with ethyl alcohol or heptane;
- apply Loctite 270 (or an equivalent product) on the entire threaded part of the half--shaft end;
- tighten the new nut, securing it to the specified torque within 5 minutes of applying the adhesive;
- stake the nut collar using the chisel shown in figure 1 (the chisel should be made on site in accordance with the dimensions shown on the drawing, and taken from article USAG 362 or similar).

The collar should be cut on the notch of the hub on the side opposite that of tightening the nut, so that the safety lug opposes accidental uncrewing (see figure 2).

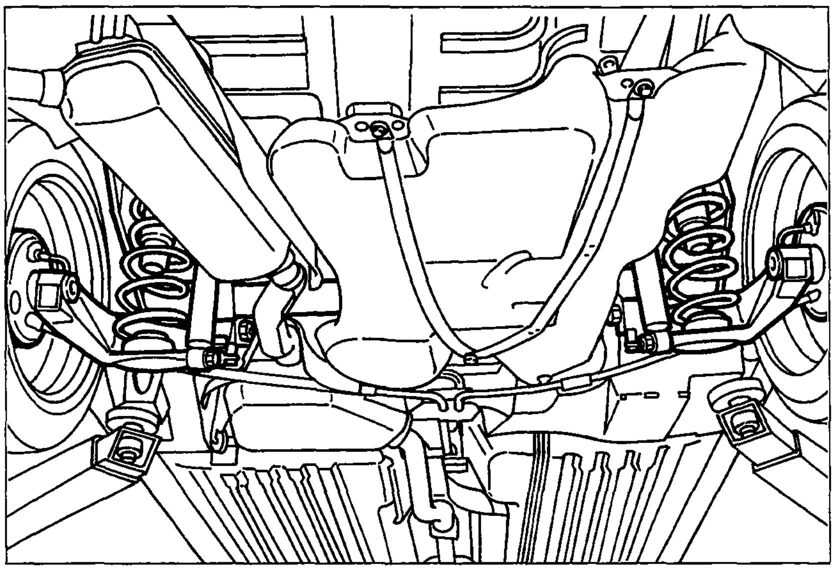
44.

DIAGRAM OF REAR SUSPENSION ASSEMBLY



P4A016G01

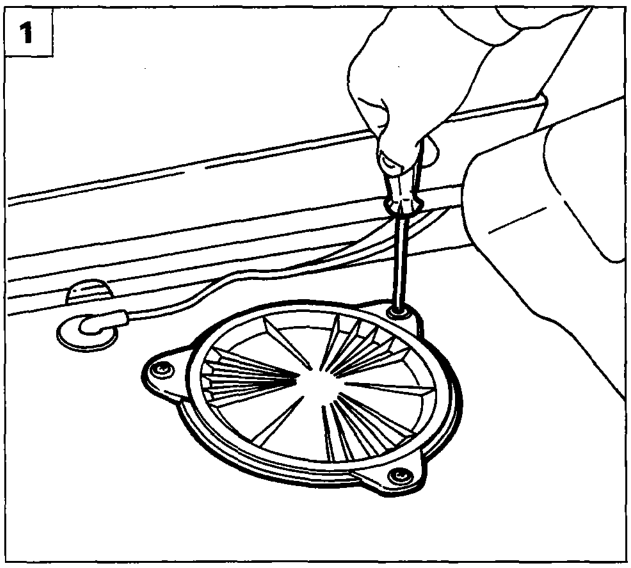
1. Anti-roll bar
2. Trailing arm
3. Spring
4. Torsion bar
5. Damper



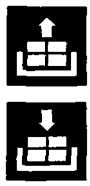
P4A017G01

REMOVING-REFITTING

NOTE *To remove the rear suspension, first remove the fuel tank and the rear section of the exhaust pipe.*



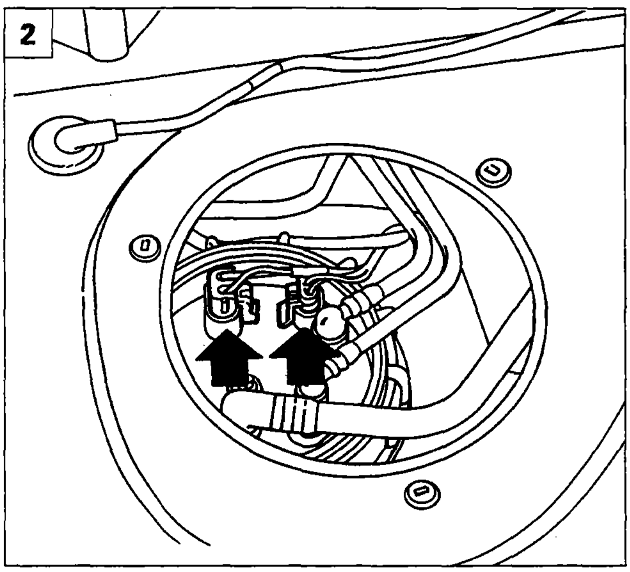
P4A017G02



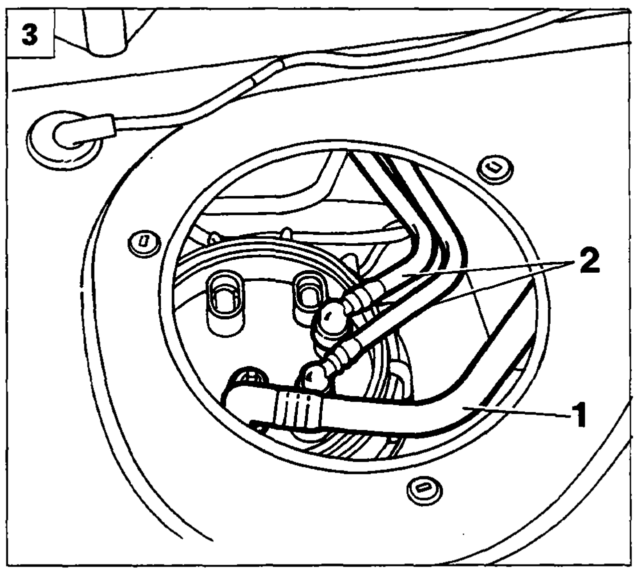
Fuel tank

To remove the fuel tank, proceed as follows:

1. remove the luggage compartment shelf trim and remove the plastic cover;
2. disconnect the two wiring connectors;
3. undo the nut and disconnect the vent pipe (1), then release the retaining lugs and disconnect the fuel delivery and return pipes (2);

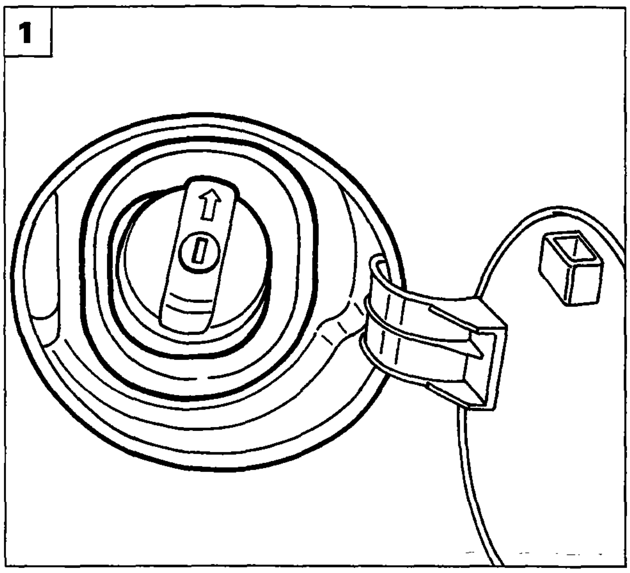


P4A017G03

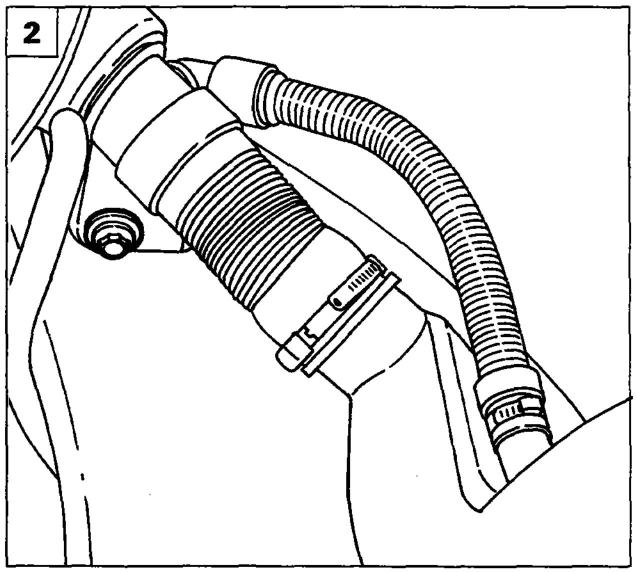


P4A017G04

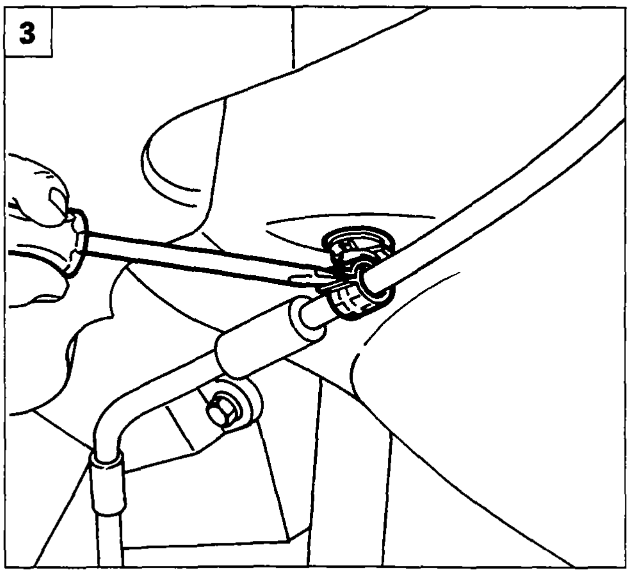
44.



P4A018G01

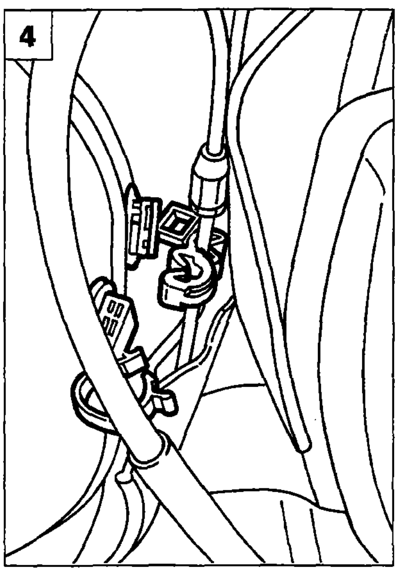


P4A018G02

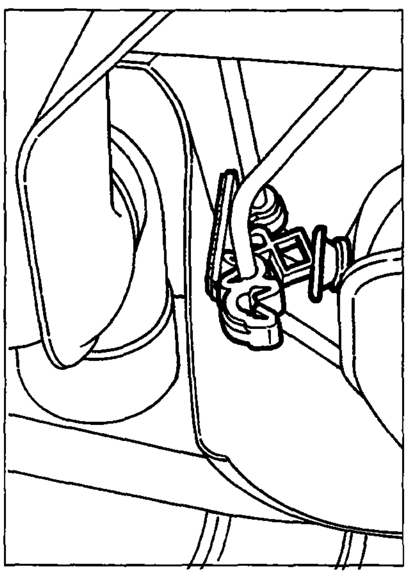


P4A018G03

1. remove the rubber trim from the fuel filler;
2. undo the screw securing the filler to the body shell;
3. open the clips and release the handbrake cables;

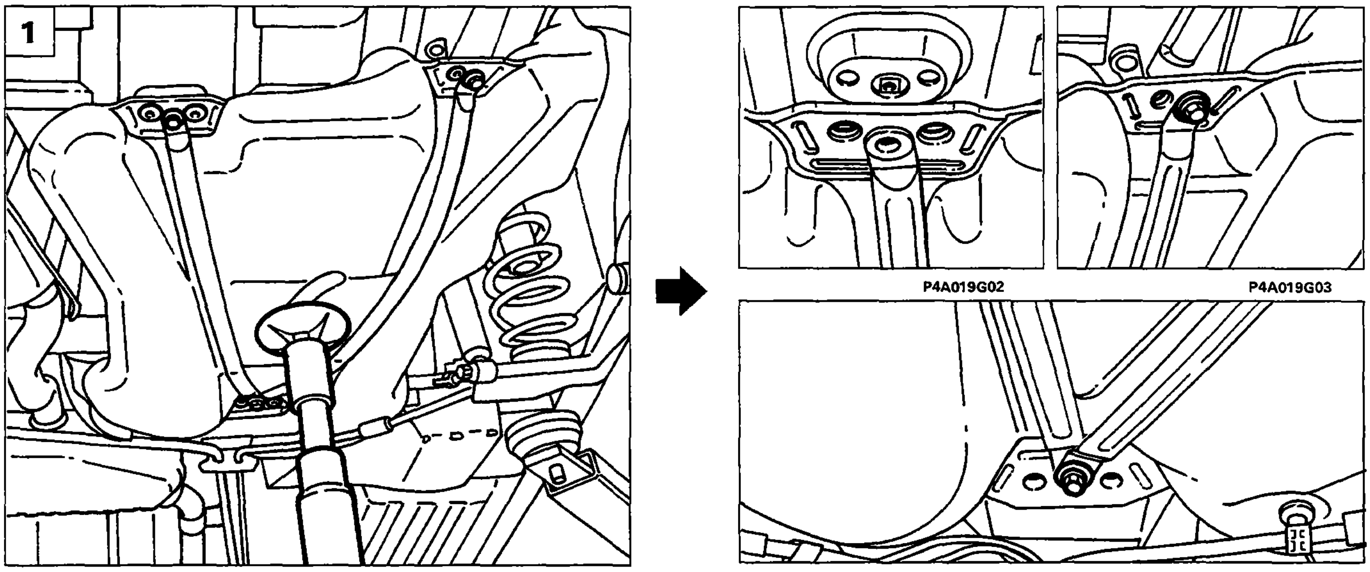


P4A018G04

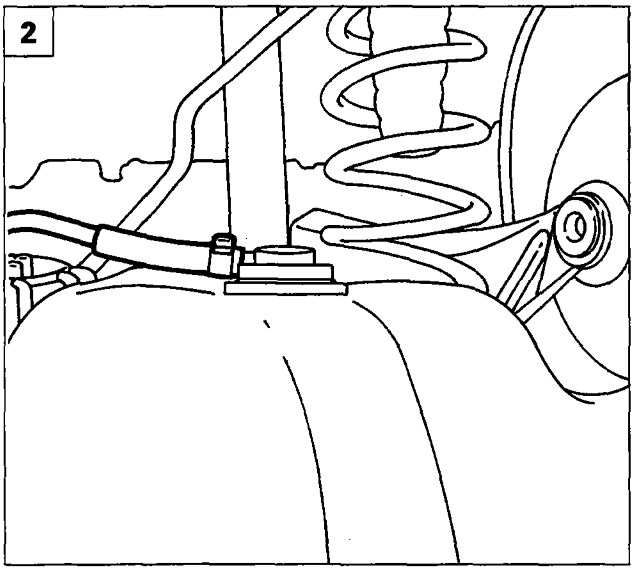


P4A018G05

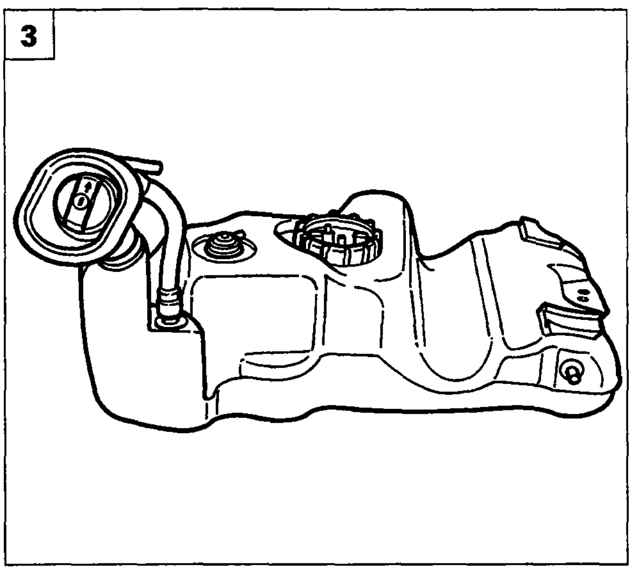
4. disconnect the rear brake pipe attachments from the tank;



P4A019G01 P4A019G02 P4A019G03 P4A019G04



P4A019G05



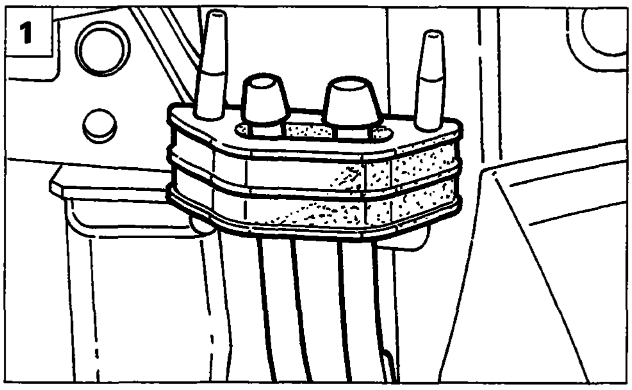
P4A019G06

1. place a column jack under the tank, undo the bolts and remove the attachment buttons shown, then gently lower the fuel tank;

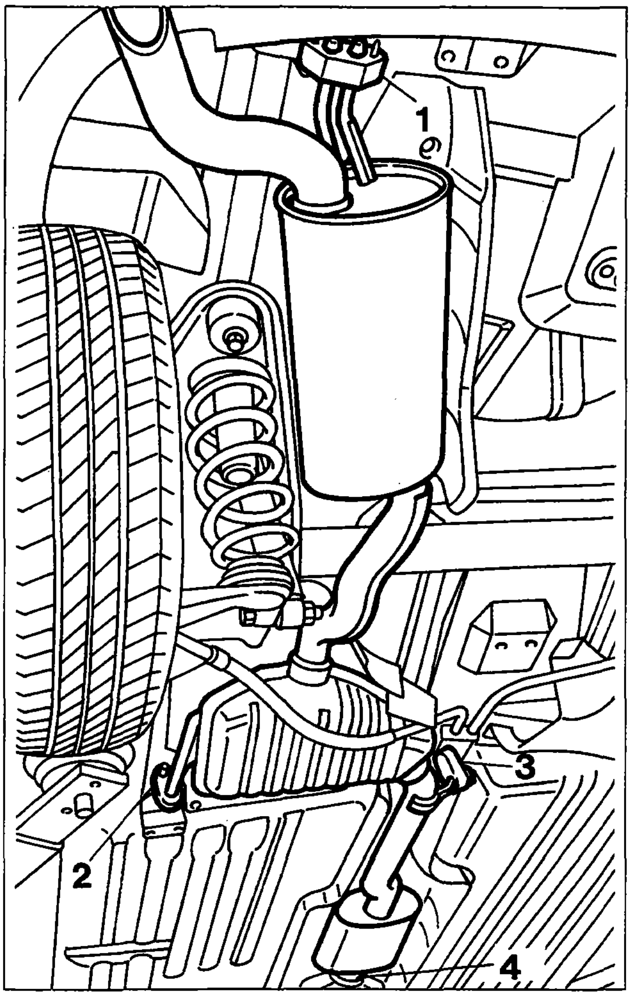
2. open the clip and disconnect the petrol vapour pipe;

3. fully lower the jack and remove the tank.

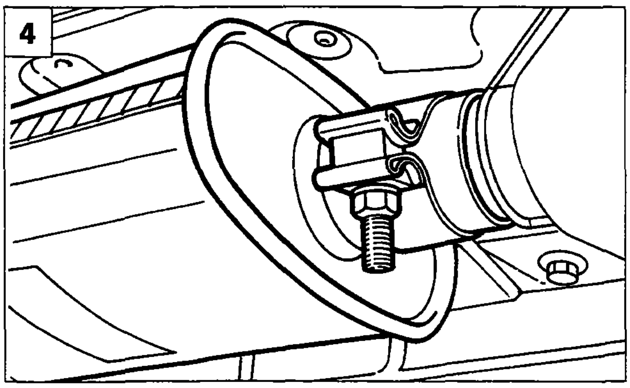
44.



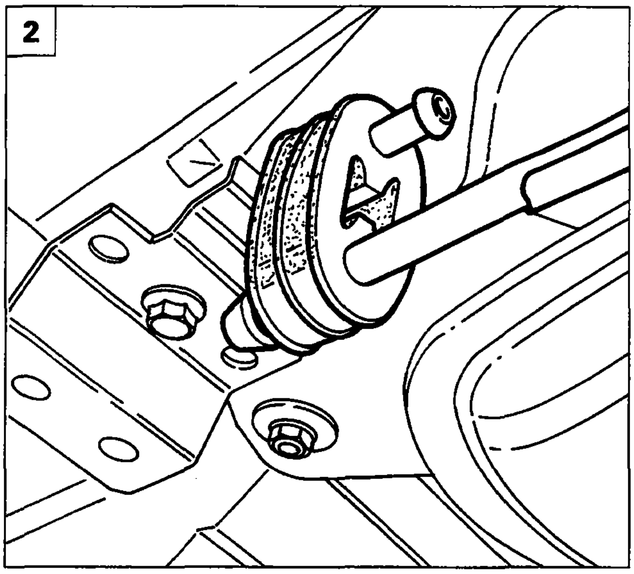
P4A020G02



P4A020G01



P4A020G05

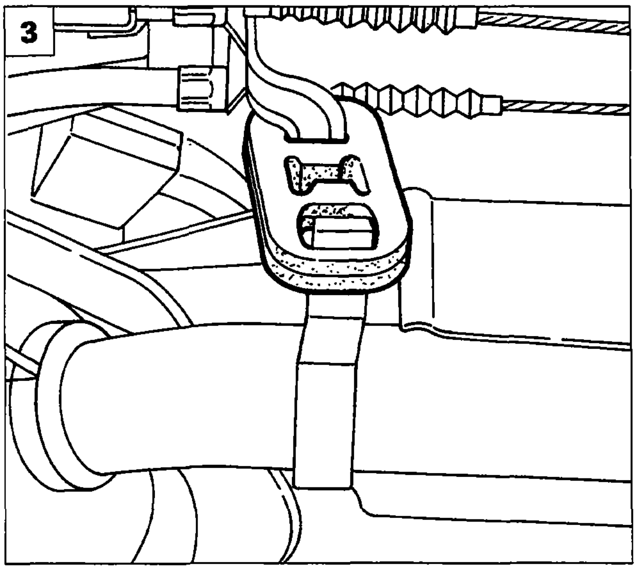


P4A020G03

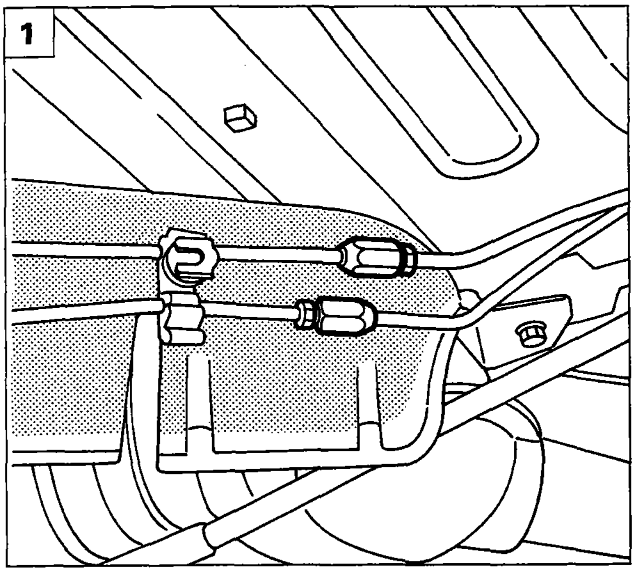
Exhaust pipe

To remove the rear section of the exhaust pipe, proceed as follow:

1. remove the rear rubber grommet;
2. remove the central left rubber grommet;
3. remove the central right rubber grommet;
4. undo the bolt on the exhaust pipe clamp and remove the rear section of the exhaust pipe.



P4A020G04

1


P4A021G01

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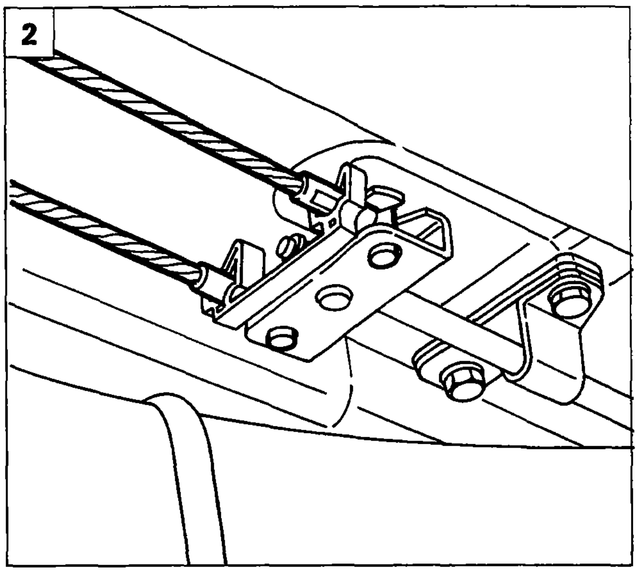

P4A021G02

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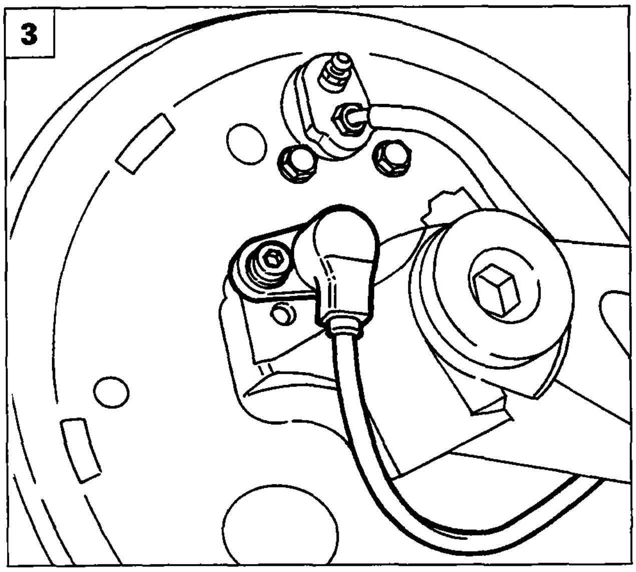

P4A021G03

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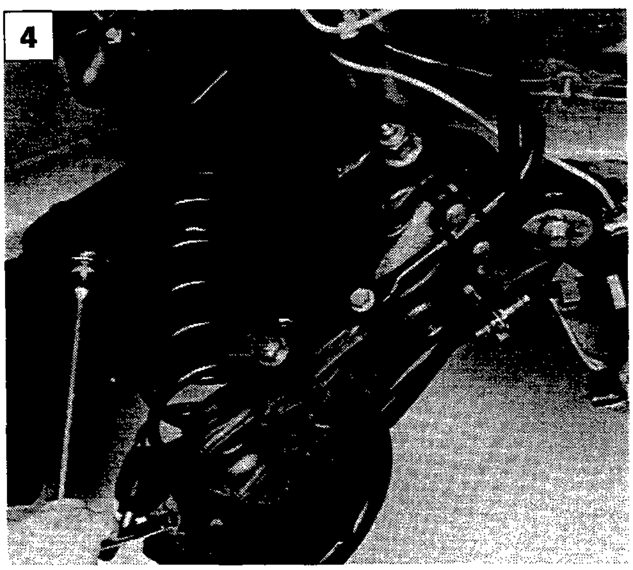
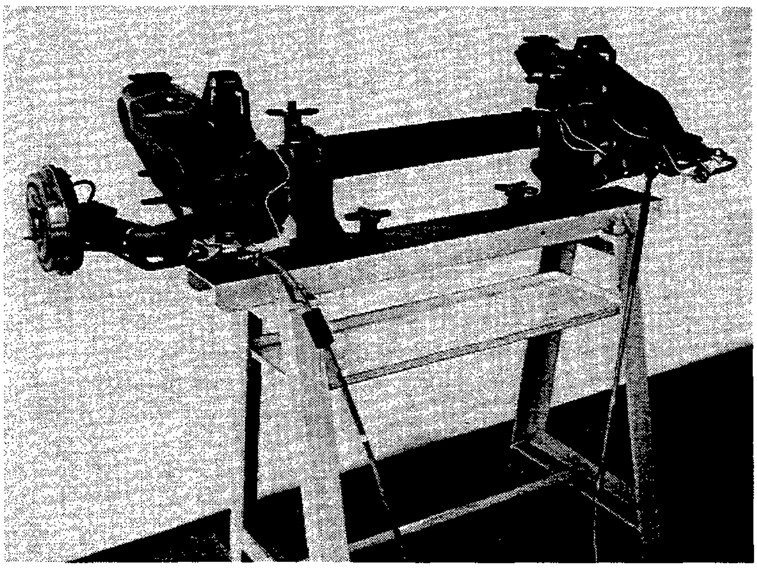


P4A021G04

Suspension assembly

To remove the rear suspension assembly, proceed as follows:

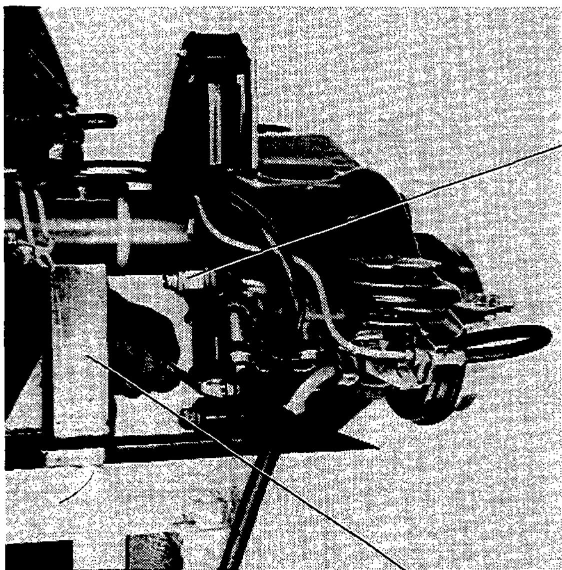
1. disconnect the brake pipe connections;
2. slacken the handbrake cable assembly and disconnect the cables;
3. unscrew and move aside the A.B.S. sensor;
4. place a hydraulic jack under the suspension crossframe and undo the bolts securing the suspension to the body; lower the hydraulic jack and remove the rear suspension assembly.



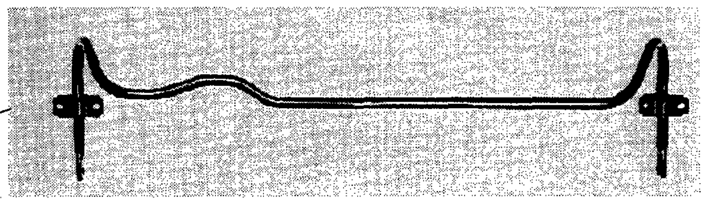
P4A022G01

DISMANTLING-REFITTING

Rear suspension on overhaul stand



P4A022G03

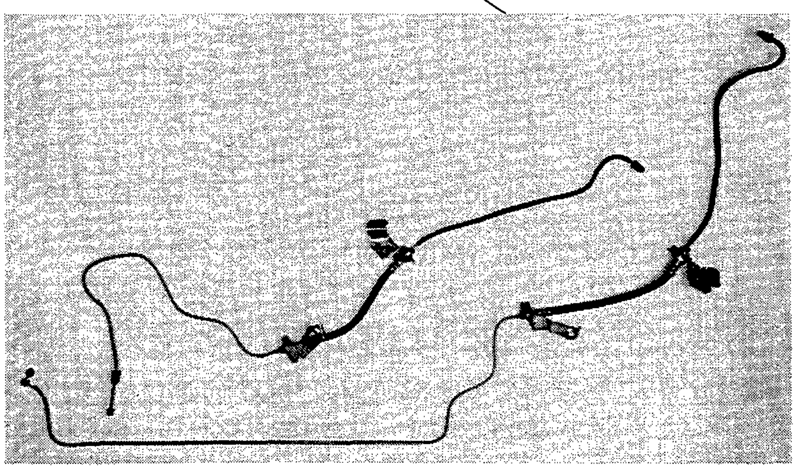


P4A022G02

Dismantling anti-roll bar from attachments on trailing arm

Anti-roll bar

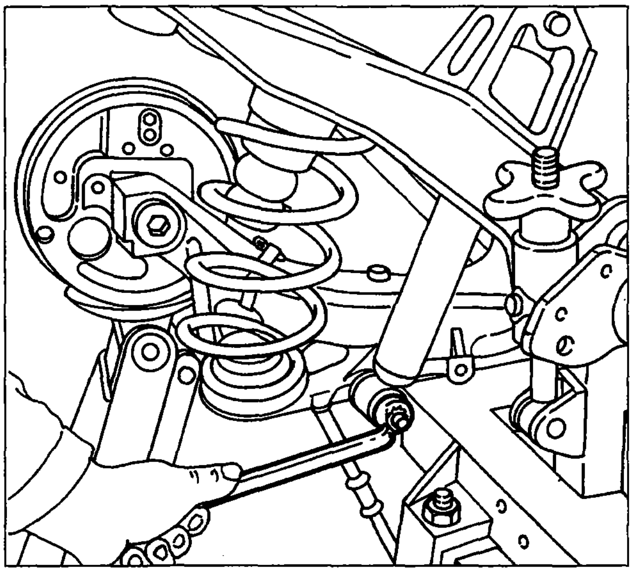
Check that the anti-roll bar is not damaged or deformed, otherwise it will have to be replaced.
Check that the rubber grommets are not damaged.



P4A022G04

Dismantling brake pipes from attachments on rear torsion bar

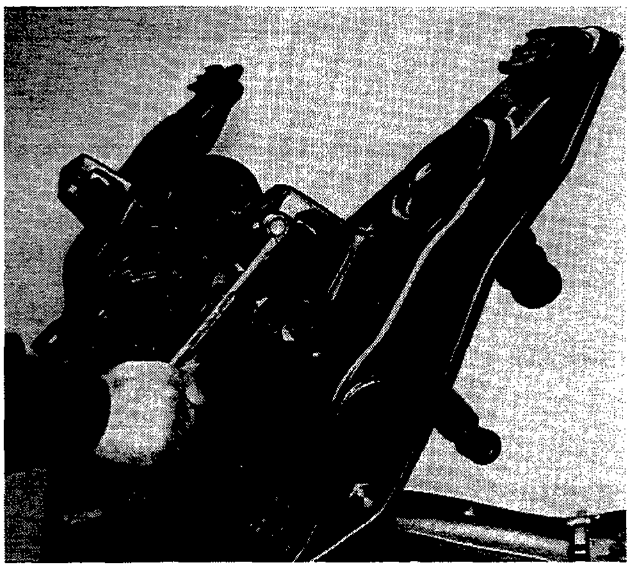
NOTE *Whenever the brake pipes are removed, check with compressed air that they are not blocked.*
They should be replaced if they have dents, constrictions, cracks or worn connections.



P4A023G01

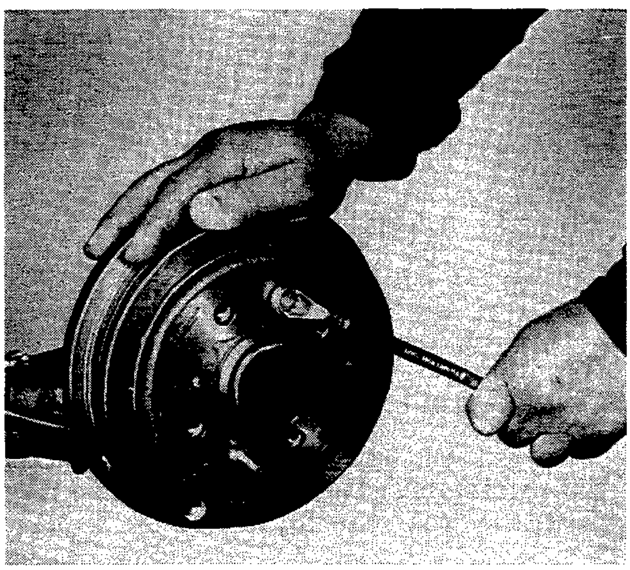
Dismantling damper from anchorage on trailing arm

To remove the damper, compress the rear suspension with a hydraulic jack.



P4A023G02

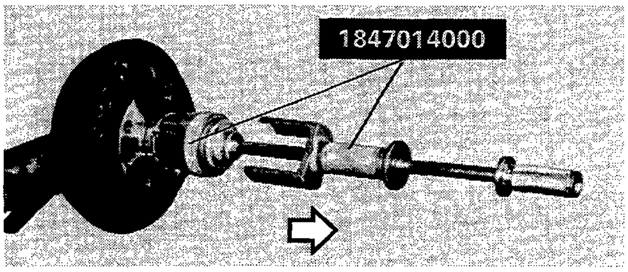
Dismantling damper from anchorage on rear torsion beam



P4A023G03

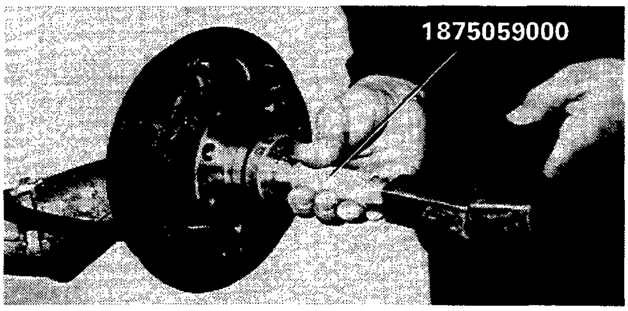
Dismantling - refitting brake drum

44.



P4A024G01

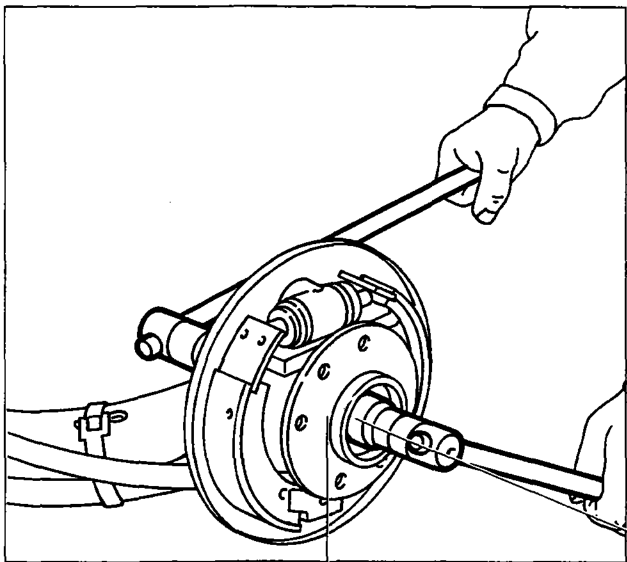
Dismantling dust cap from wheel hub



P4A024G02

Refitting dust cap on wheel hub

NOTE *Before assembly, smear TUTELA MR3 grease around the edge of the cap.*



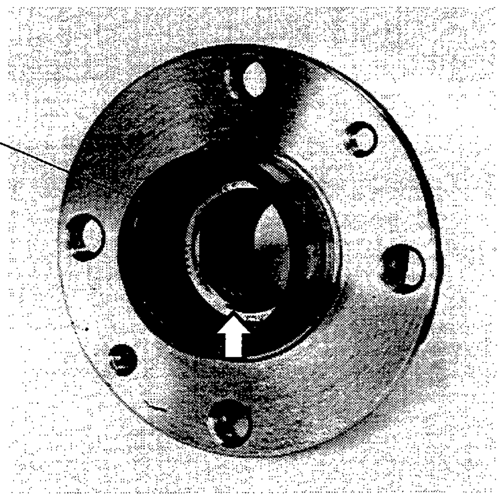
P4A024G03

STUB AXLE - REAR WHEEL HUB

Dismantling-reassembly nut securing stub axle and wheel hub

Whenever the hub nut is removed, it should be replaced with a new one.

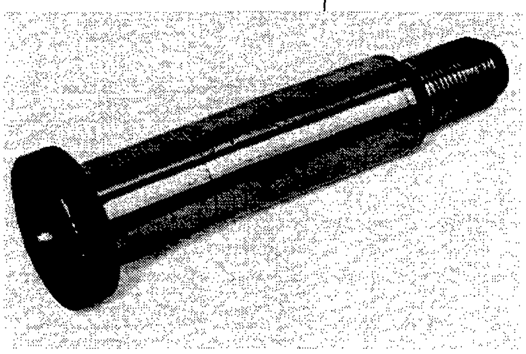
NOTE *The hub nut should be tightened to the correct torque wiht the rear torsion beam fitted to the car.*



P4A024G04

Checking hub

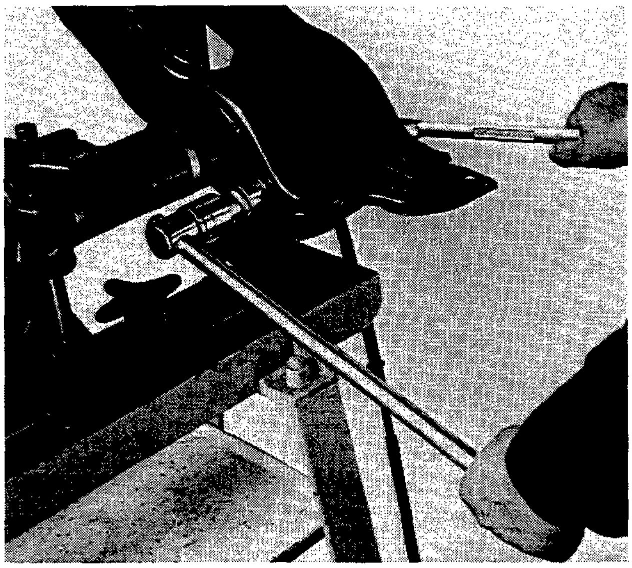
If the wheel bearing (arrowed) is replaced because of noisiness or excessive play, the complete hub must be replaced.



P4A024G05

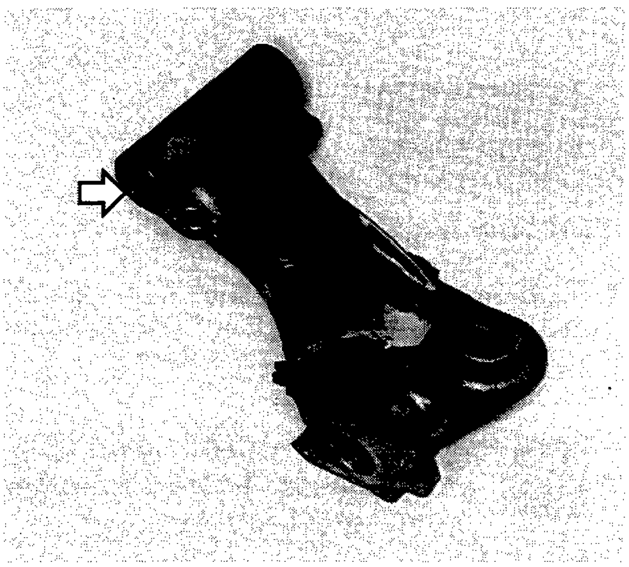
Checking stub axle

The stub axle must not be cracked, deformed or worn, otherwise it has to be replaced.



P4A025G01

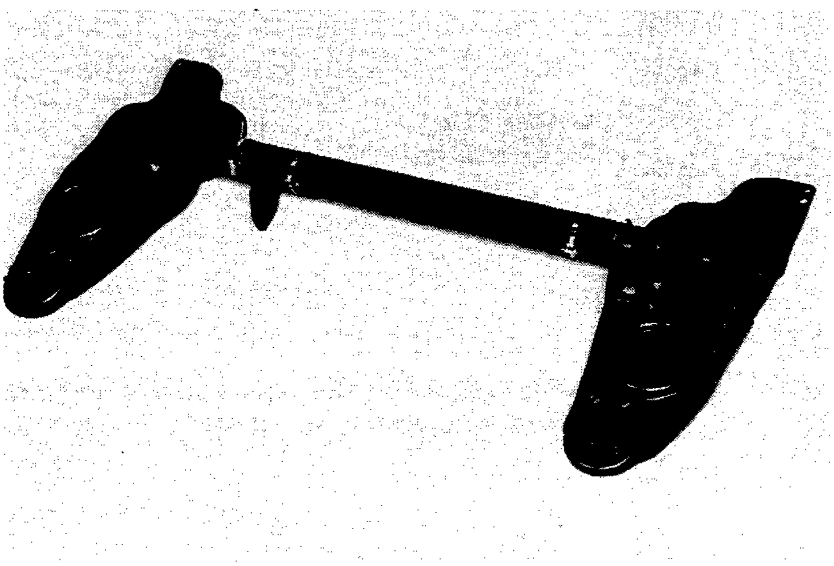
Dismantling trailing arm from rear torsion beam



P4A025G02

Checking trailing arm

Check that the trailing arm is not cracked, deformed or worn (on the surface on the wheel side), otherwise it will have to be replaced. If the bearings and spacer (arrowed) are replaced because of noisiness or excessive play, the trailing arm must be replaced.

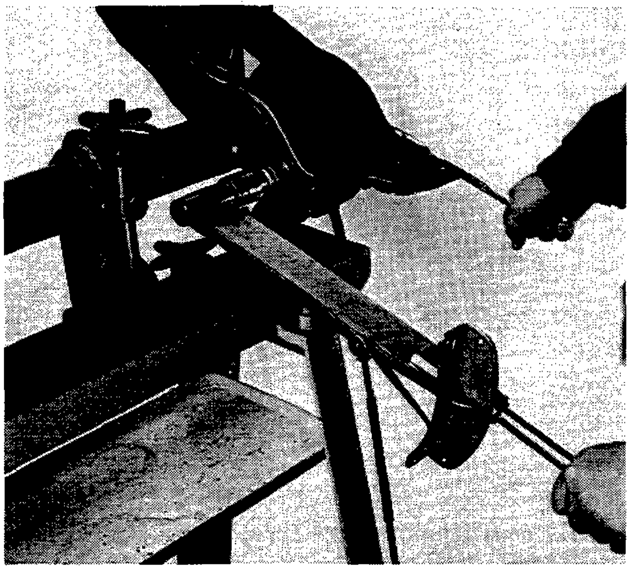


P4A025G03

Checking rear torsion beam

Check that the rear beam is not cracked or deformed, or misaligned between the two side arms, otherwise it will have to be replaced.

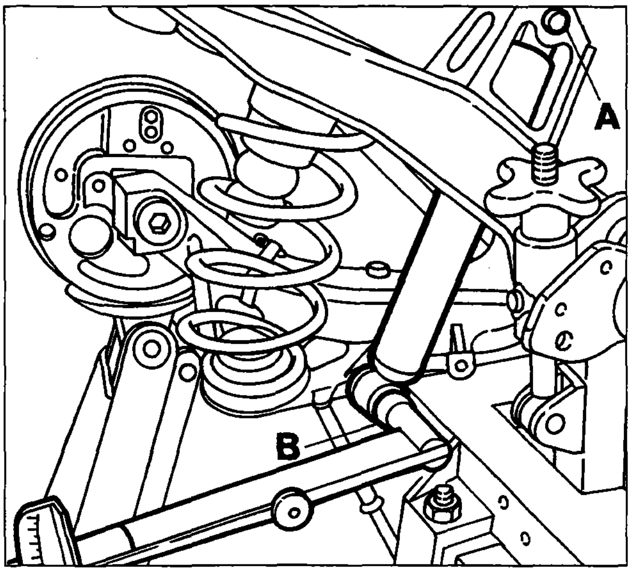
44.



P4A026G01

15 daNm

Fitting trailing arm to rear torsion beam and tightening nut to correct torque



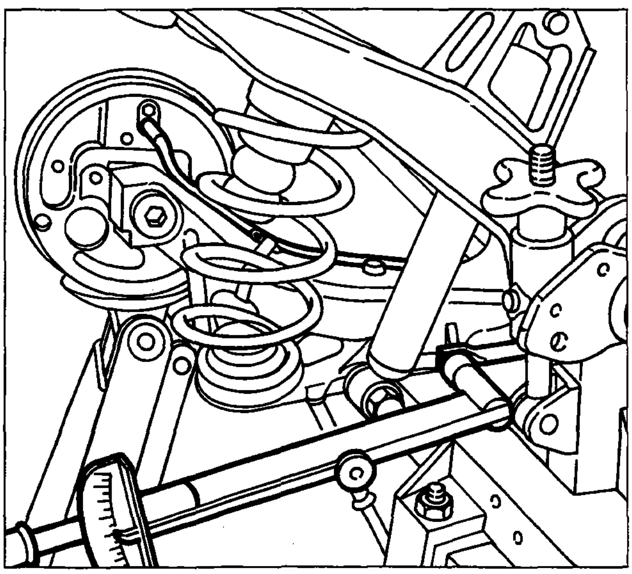
P4A026G02

A 6 daNm
B 8.8 daNm

Refitting damper

Tightening damper top mounting bolt (A) and bottom mounting bolt (B) securing damper to rear suspension assembly

To secure the damper to the trailing arm, compress the rear suspension with a hydraulic jack.

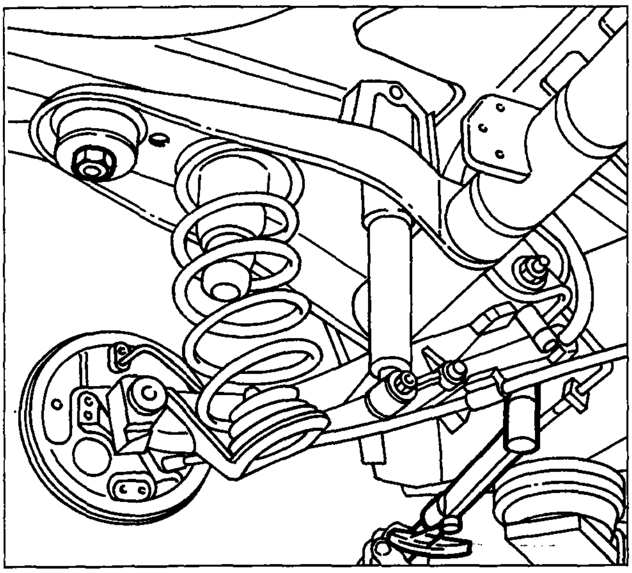


P4A026G03

5.6 daNm

Refitting brake fluid pipe and anti-roll bar on rear suspension assembly

Tightening bolt securing anti-roll bar to trailing arm to correct torque

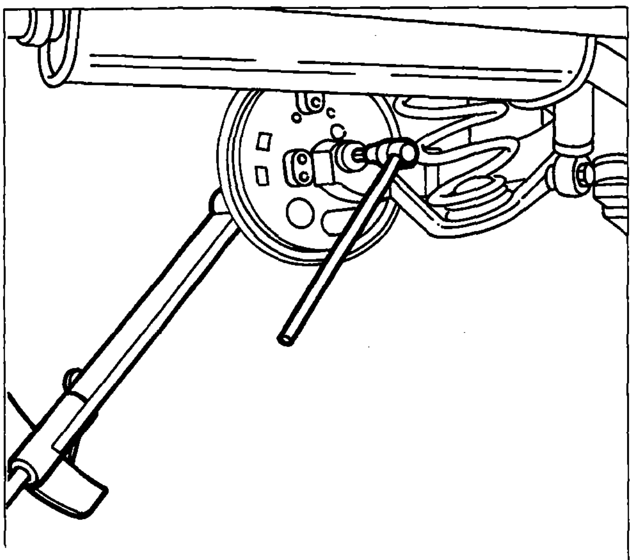


P4A027G01

10.8 daNm

Refitting rear suspension

Tightening bodywork attachment bolts to correct torque



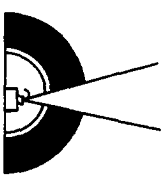
P4A027G02

28 daNm

Tightening nut securing stub axle and wheel hub to correct torque

Also:

Bleed the brakes

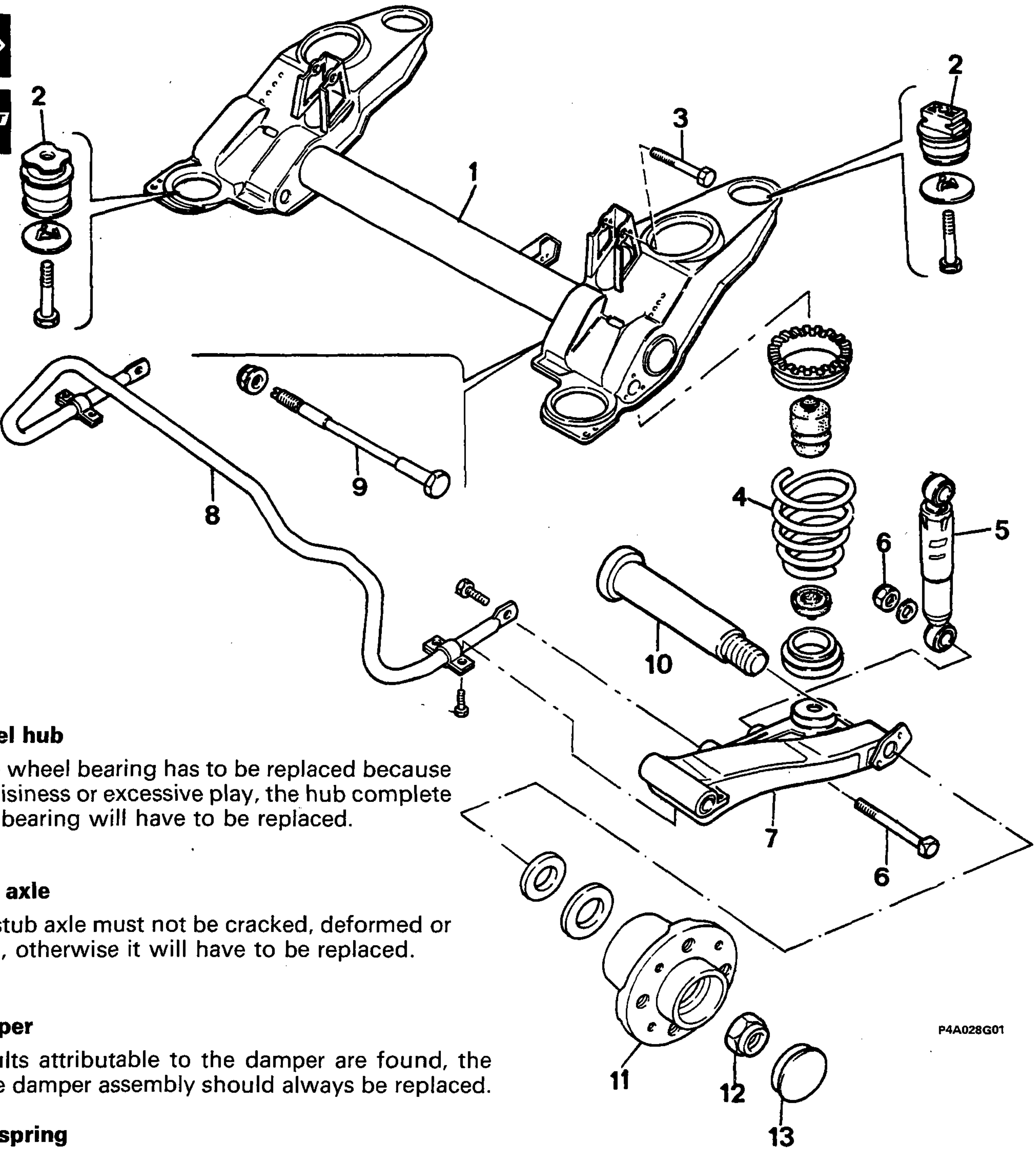


Check the rear wheel geometry

44.

COMPONENTS OF THE REAR SUSPENSION SUPPLIED AS SPARE PARTS

1. Rear torsion beam - 2. Rubber buffers - 3. Damper top mounting bolt - 4. Coil spring - 5. Damper - 6. Bottom nut and bolt securing damper to trailing arm - 7. Cast iron trailing arm - 8. Anti-roll bar - 9. Nut and bolt securing trailing arm to rear torsion beam - 10. Stub axle - 11. Wheel hub - 12. Nut securing stub axle and wheel hub -13. Hub dust cap



Wheel hub

If the wheel bearing has to be replaced because of noisiness or excessive play, the hub complete with bearing will have to be replaced.

Stub axle

The stub axle must not be cracked, deformed or worn, otherwise it will have to be replaced.

Damper

If faults attributable to the damper are found, the entire damper assembly should always be replaced.

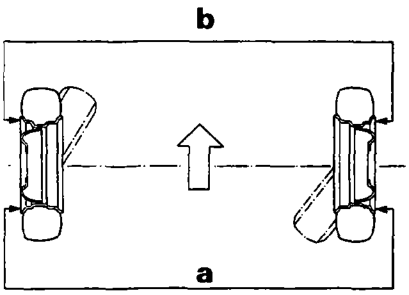
Coil spring

Make sure that it is not cracked or deformed such that its efficiency is impaired.

NOTE *The coil springs are divided into two categories identified by a yellow or green strip of paint on the central coil. Springs of the same category must be fitted.*

FRONT WHEEL GEOMETRY

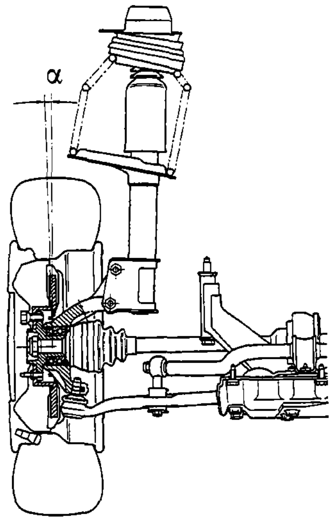
The wheel geometry must be checked after the components that affect it have been subjected to the following checks:
- tyre pressures;
- the eccentricity and out-of-true of the wheel rims must not exceed 3 mm;
- wheel bearing endfloat;
- clearance between vertical link and wishbone balljoint pin;
- tie-rod end play.



P4A029G01

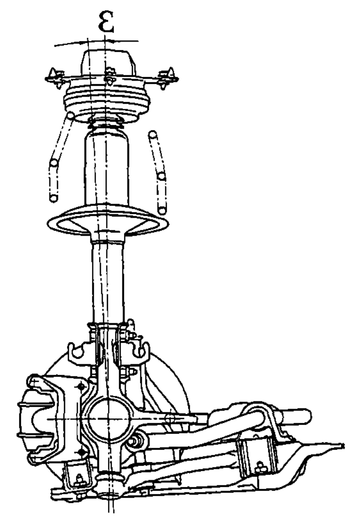
TOE-IN

See data in Sec. 00



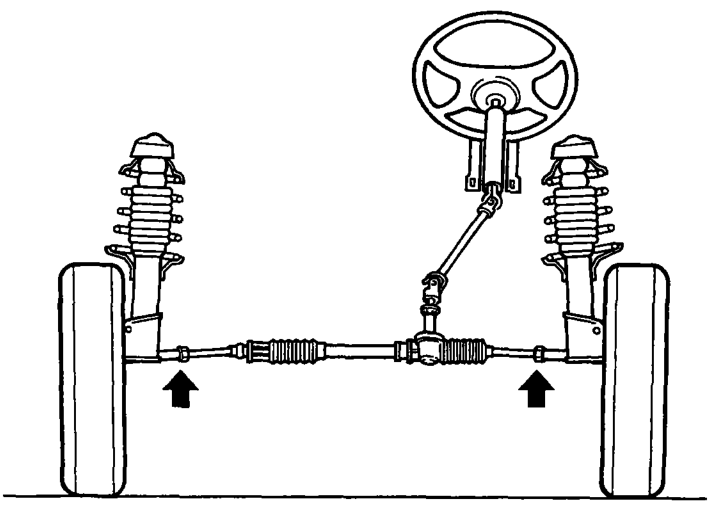
P4A029G02

CAMBER (non adjustable)



P4A029G03

CASTER (non adjustable)



P4A029G04

If, when checking the toe-in, the values measured are not as specified, slacken the steering tie-rod nuts and adjust the steering tie-rods.

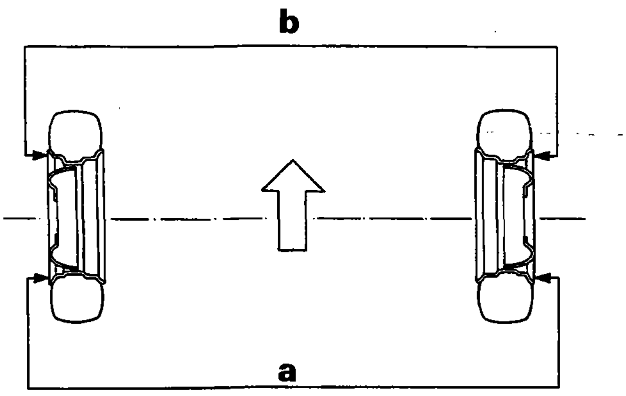
If the wheel camber angle is not as specified, check the vehicle body shell.

Closely follow the instructions below whenever you adjust the front wheel toe-in:
- *undo the clips securing the gaiters on the tie-rods;*
- *check that the gaiter turns freely on the tie-rod; if necessary remove the gaiter and lubricate wth MOLYGUARD SYL 133 silicone grease or a similar product;*
- *tighten the clip after adjusting the toe-in and only after checking that the gaiter is in the correct position.*

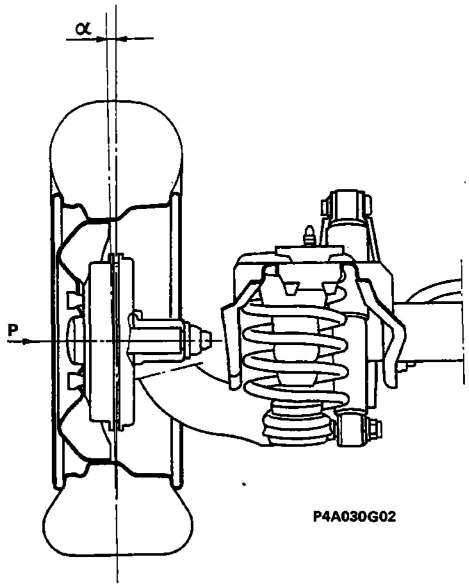
44.

REAR WHEEL GEOMETRY

The wheel geometry must be checked after the following checks have been carried out:
- tyre pressures;
- the eccentricity and out-of-true of the wheel rims must not exceed 3 mm;
- wheel bearing endfloat.



P4A030G01



P4A030G02

TOE-IN (non adjustable)

See data in Sec. 00

CAMBER (non adjustable)

If the rear wheel angles are not as specified, they cannot be adjusted as the rear suspension comprises a rigid torsion beam.