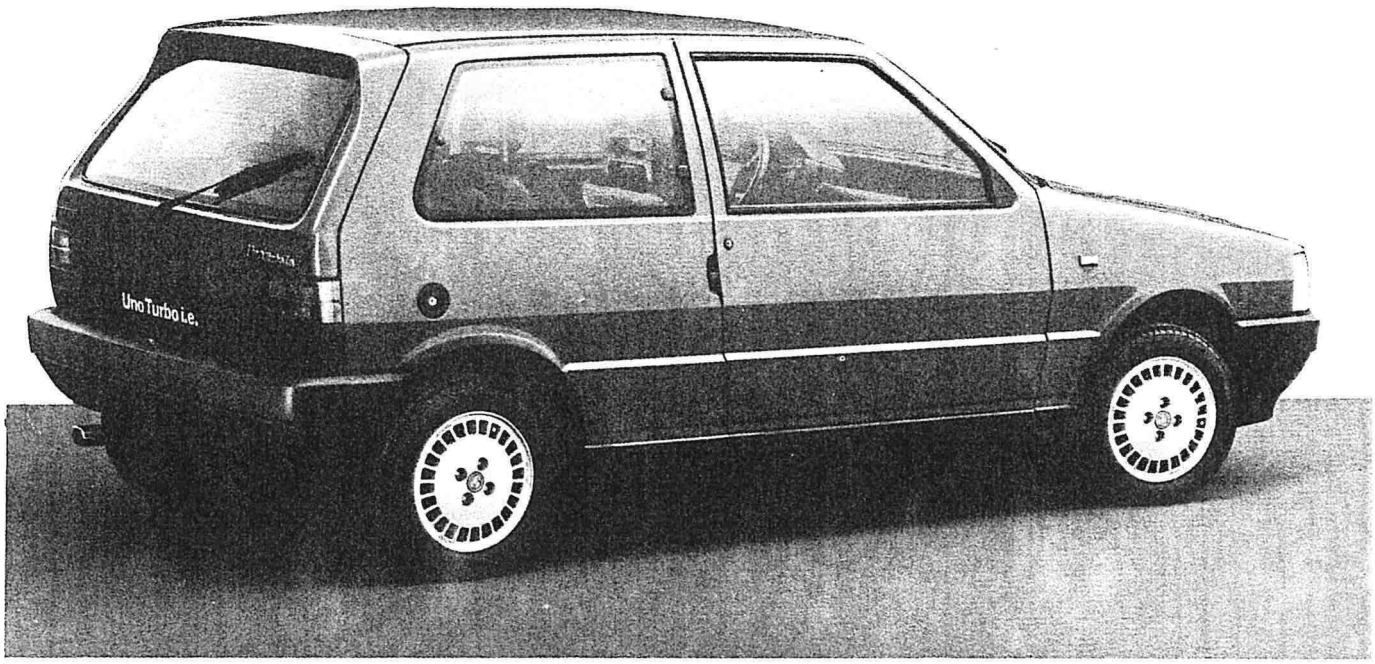
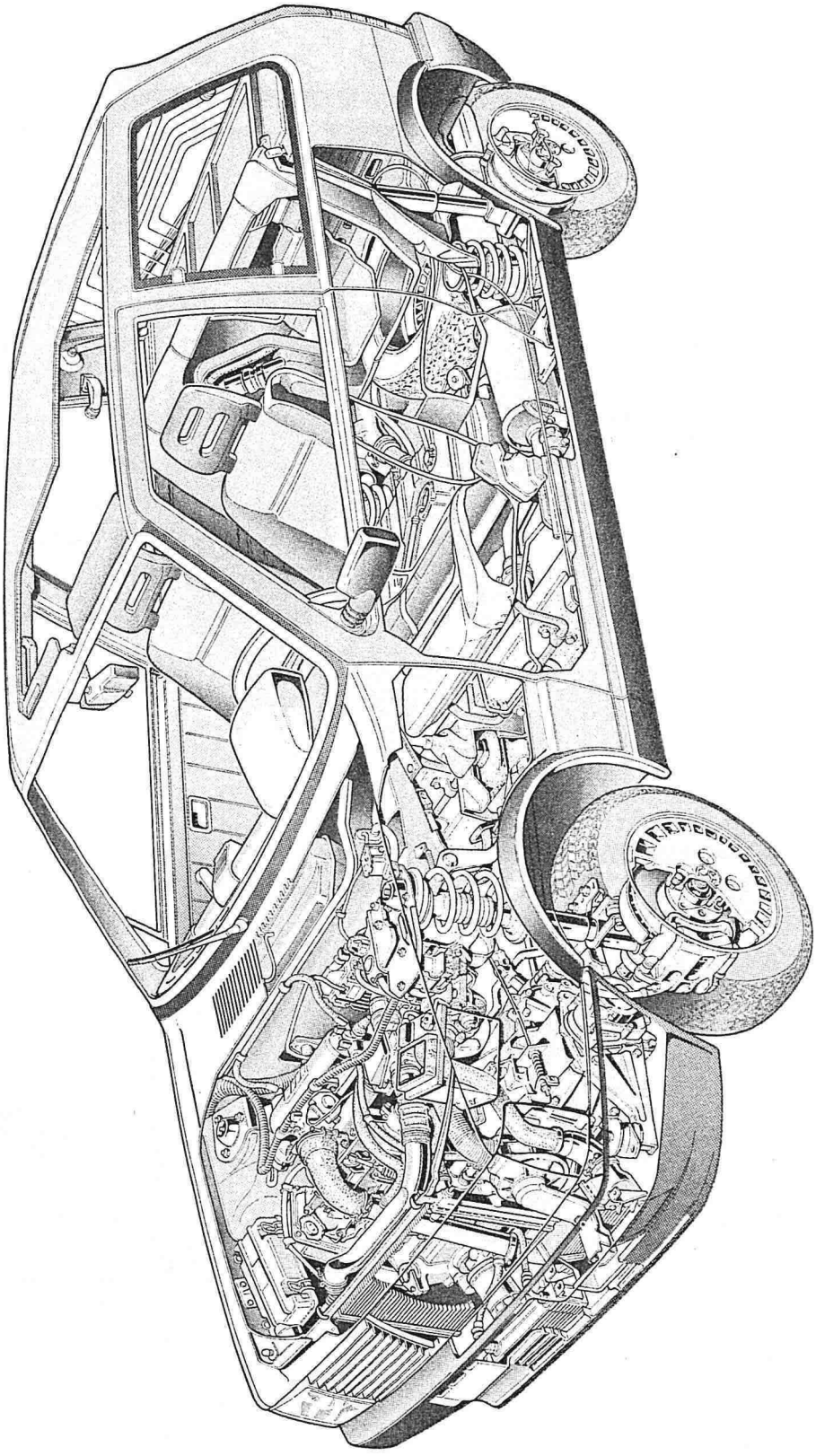
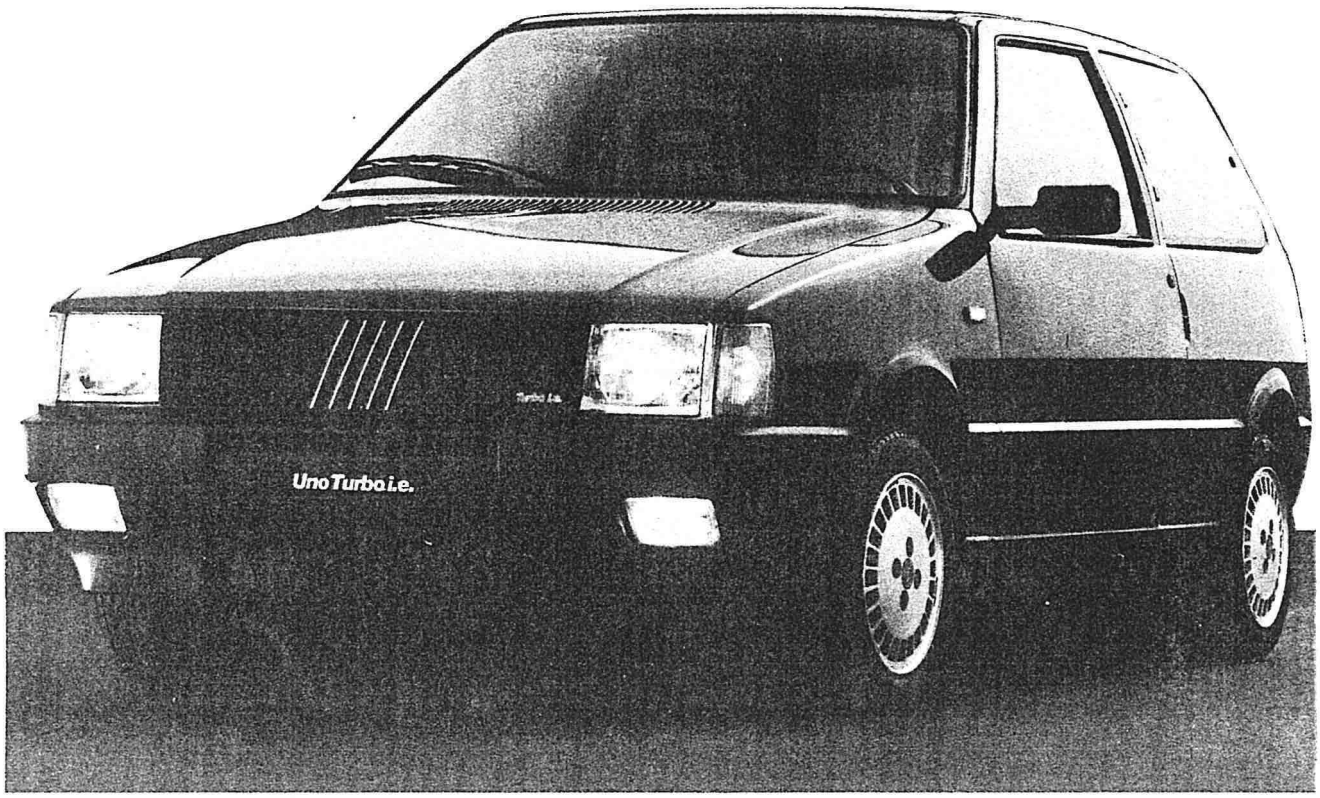
page

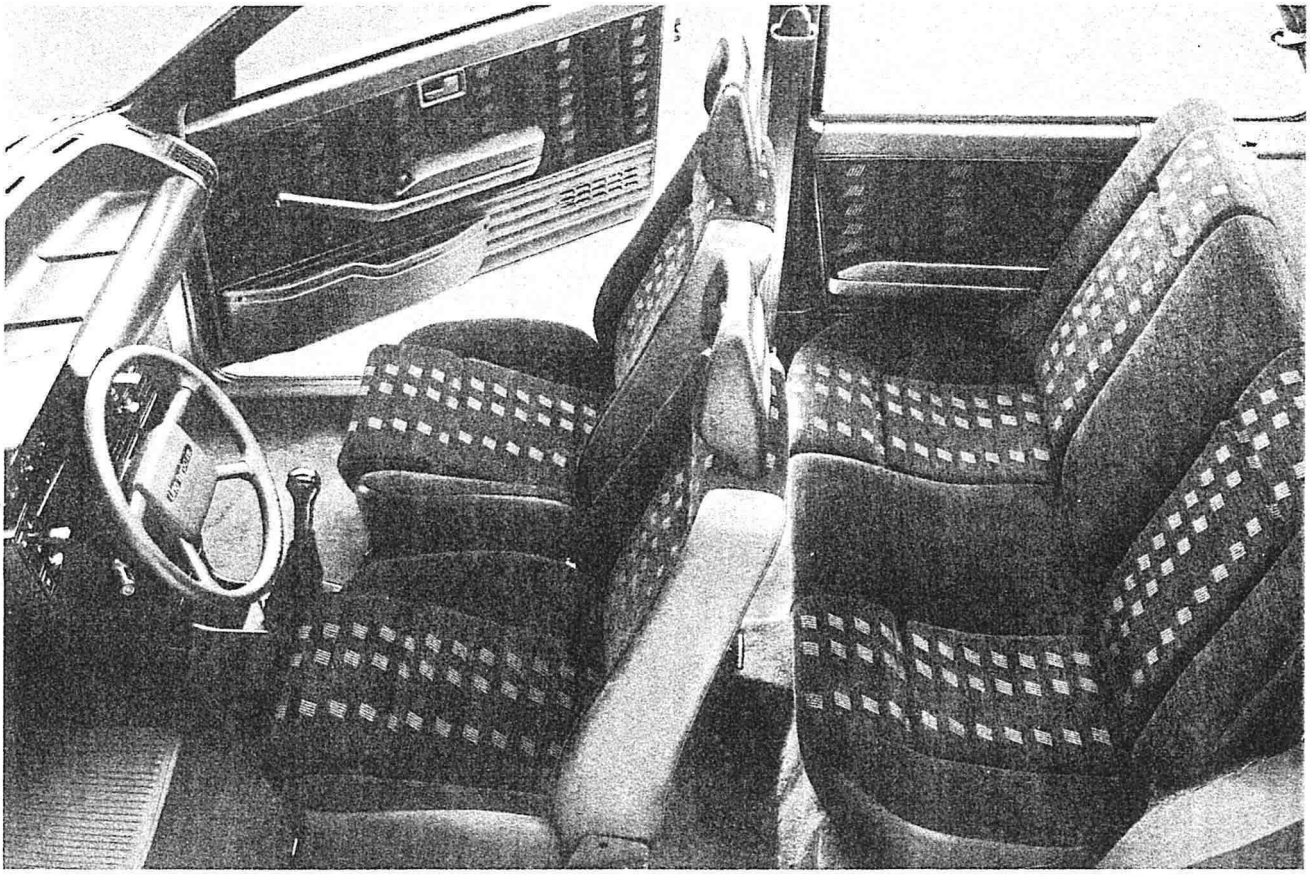
(*) for Clutch - Gearbox-differential - Steering



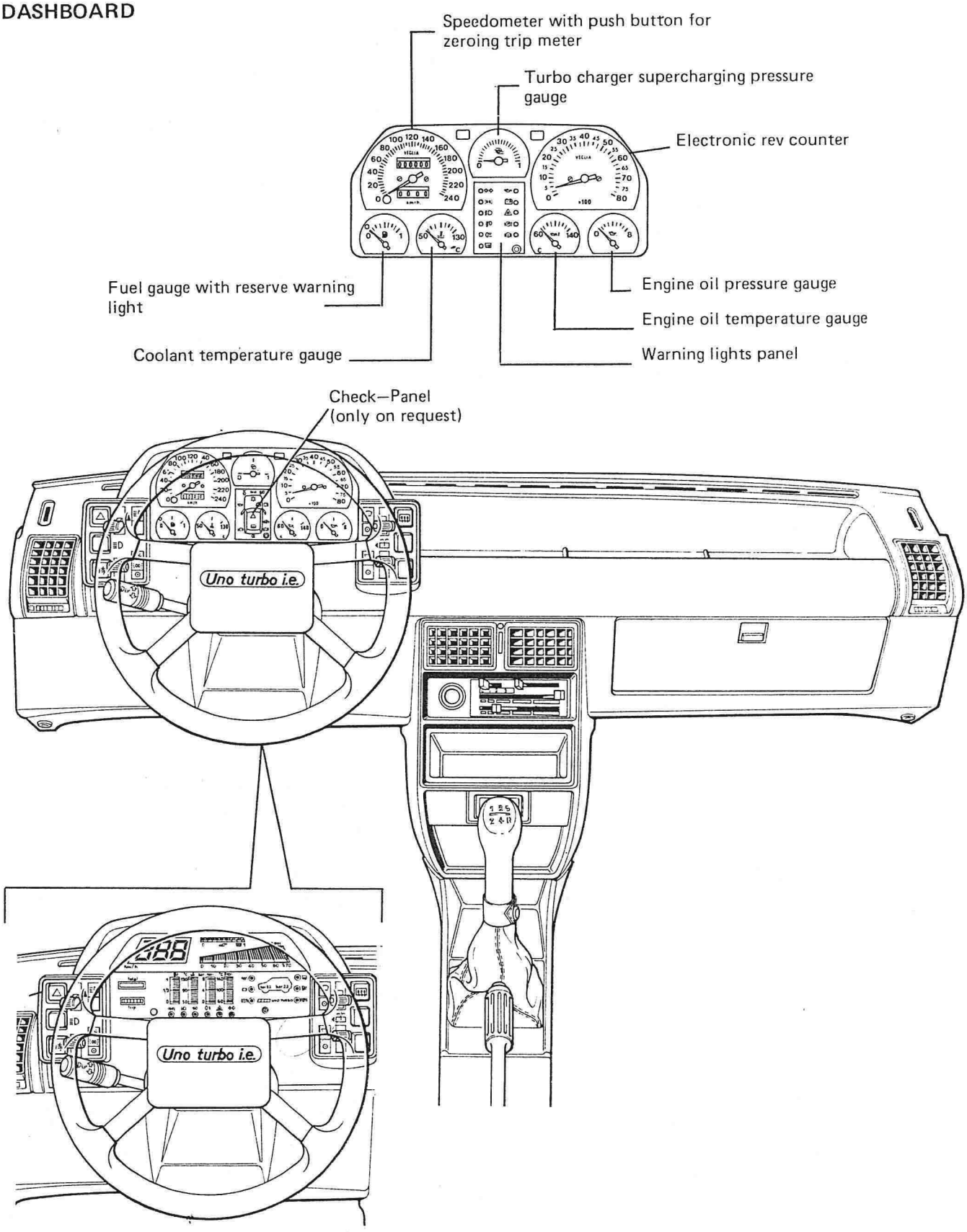


Arrangement of mechanical components in vehicle





DASHBOARD



Solid state dashboard (only on request)

IDENTIFICATION DATA

	CHASSIS	ENGINE	VERSION	3 DOORS	5 Speed gearbox
1300 Turbo	ZFA 146.000	146 A2.000	146 AM 53A	●	●

COLOURS

BODY COLOURS				SEAT MATERIALS AND COLOURS	
METALLIC (OPTIONAL)		PASTEL		CLOTH/IMITATION LEATHER	
Dark Blue	452	Racing Red	112	Red - Black	318
Juniper	461				
Quartz Grey	639	Corfu White	224		
Slate Grey	681	Black	601		
Grey	683				

OPTIONAL EQUIPMENT (valid for Italian market only)

5 speed gearbox	●
Tinted windows	●
Halogen headlamps	●
Rearscreen wiper	●
Alloy wheels with low profile tyres	●
Head restraints + Reclining front seats	●
Wheel arch liners	✸
Extra external rear view mirror	✸

Split rear seat	✸
Solid - State	✸
Sun roof	✸
Electric windows	✸
Metallic paint	✸
Check - Panel	✸
Inertia reel rear seat belts	✸

● Fitted as standard
✸ Available on request

Introduction
Weights - Dimensions

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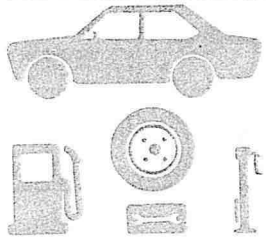
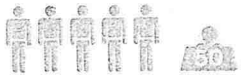
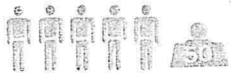
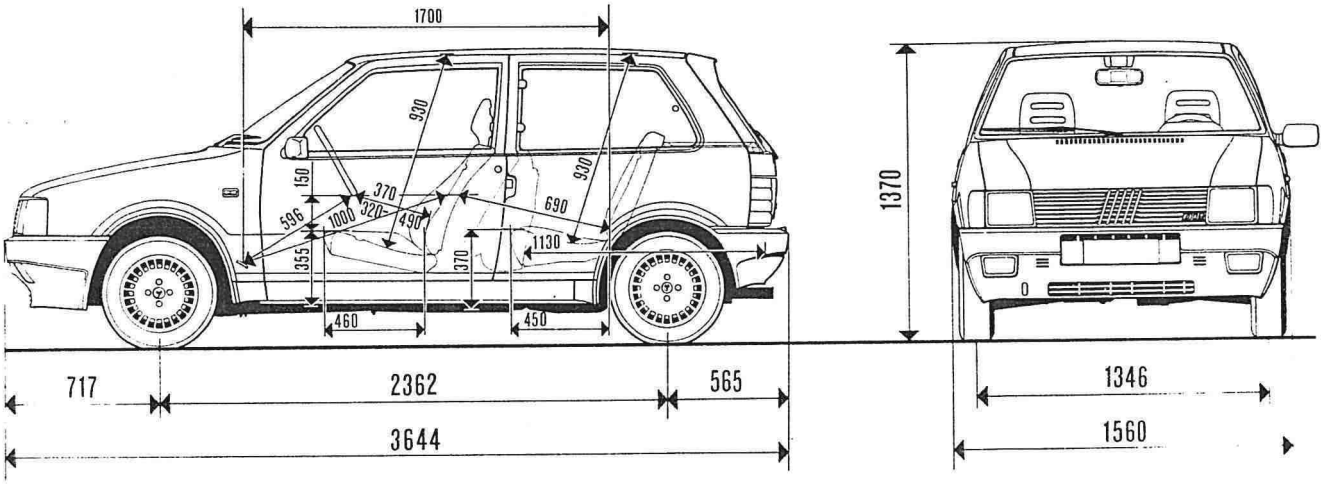
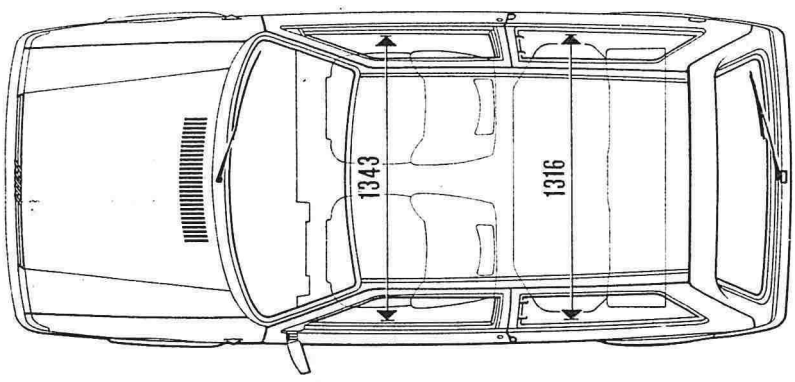
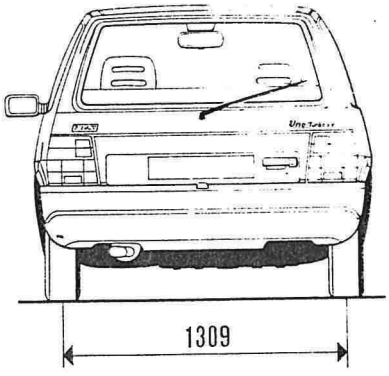
WEIGHTS (in kg)

 Kerb weight	845
Kerb weight + 400 = 	1245
Kerb weight +  	650
	595
	900

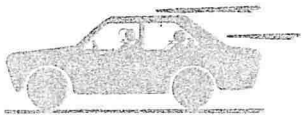
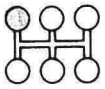
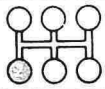
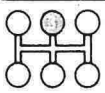
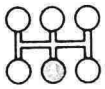
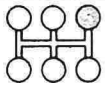
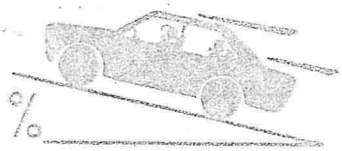
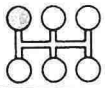
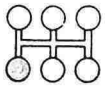
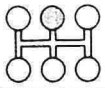
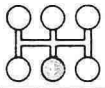
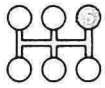
DIMENSIONS

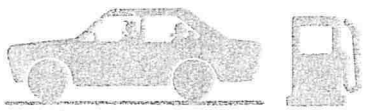






The height refers to an unladen car.
The luggage compartment capacity (according to ISO standards) with the rear seat folded down and the rear shelf removed is 968 dm^3 (34.18 cu ft).

Speed kph (mph) 		45
		80
		125
		175
		200
Maximum climable gradient 		38
		34
		20
		13
		10

EEC fuel consumption figures (litres/100 km) (mpg) 	Urban cycle (A)	8,9
	Constant speed 90 kph (56 mph) (B)	5,8
	Constant speed 120 kph (75 mph) (C)	7,6
	Average consumption (CCMC proposal) $\frac{A+B+C}{3}$	7,4

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Description	Unit		Quantity dm³ (lt)	Quantity (kg)
O.R. (98-100)	(5 ÷ 7,5)		50	–
50% +	Total capacity of cooling system (*)		6,9	–
VS+ Synthesis (SAE 15 W/40)	Total capacity		4,40	3,97
	Partial capacity (periodic replacement)		4,05	3,66
a = TUTELA ZC 90		a	2,94	2,65
b = TUTELA GI/A		b	–	–
TUTELA W 90/M-DA	a / b Self-locking	a	–	–
		b	–	–
a e b = TUTELA W 90/M-DA	a / b / c / d	a	–	–
		b	–	–
c = TUTELA GI/A		c	–	–
d = K 854		d	0,14	0,127
TUTELA DOT 4	Total capacity		0,35	0,35
+	3% / ~ – 10°C 50% / ~ – 20°C 100%		4,75	–

(*) Demineralized water and 50% Paraflu solution

Name of product	Description International designation	Usage
VS+ Super-stagionale SAE 40	Low ash content detergent oil for petrol engines. Service API "SE". Satisfies standard MIL-L-46152. Exceeds European CCMC specifications.	Temperature 0°C ÷ > 35°C
VS+ Super-stagionale SAE 30		Temperature 0°C ÷ < 35°C
VS+ Super-stagionale SAE 20 W		Min. temperature – 15°C ÷ 0°C
VS+ Super-stagionale SAE 10 W		Min. temperature below – 15°C
VS+ Super-stagionale SAE 15 W/40		Temperature – 15°C ÷ > 35°C
VS Turbo Synthesis SAE 15 W/40	Synthetic base detergent oil for petrol engines. Service API "SE". Satisfies standard MIL-L-46152. Exceeds European CCMC specifications.	Temperature – 15°C ÷ > 40°C
VS Diesel SAE 40	Oil for Diesel engines. Service API "CD". Satisfies standard MIL-L-2104 C.	Temperature 0°C ÷ 50°C
VS Diesel SAE 30		Temperature – 5°C ÷ 30°C
VS Diesel SAE 20 W		Temperature – 15°C ÷ 15°C
VS Diesel SAE 10 W		Temperature below – 15°C
VS Diesel Supermultigrado	Oil for Diesel engines. Service API "CD". Satisfies standard MIL-L-2104 C.	Temperature – 20°C ÷ 40°C
TUTELA ZC 90	Non EP SAE 80W/90 oil for gearbox containing anti-wear additives.	Non hypoid gearboxes and differentials.
TUTELA W 90/M DA	SAE 80W/90 EP oil specially for normal and self-locking differentials. Satisfies standard MIL-L-2105 C.	Hypoid differentials. Self-locking diffs. Steering boxes.
TUTELA GI/A	"DEXRON II" oil for automatic transmissions.	Auto. gearboxes. Power assisted steering.
TUTELA JOTA 1	Lithium soap based grease N.L.G.I. N. 1 consistency.	Greasing vehicle except for components particularly exposed to water requiring special greases.
TUTELA MRM2	Lithium soap based molybdenum disulphide water repellant grease, N.L.G.I. 2 consistency.	Universal joints.
TUTELA MR3	Lithium soap based grease N.L.G.I. N. 3, consistency.	Wheel hub bearings, steering rods, var. comp.
TUTELA DOT 4	Hydraulic brake fluid DOT 4, meeting F.M.V.S.S. Standard no. 116.	Hyd. brakes and hyd.lly operated clutch.
K 854	Lithium soap based grease N.L.G.I. 000, consistency containing molybdenum disulphide.	Rack and pinion steering boxes.
SP 349	Special castor oil and sodium soap based grease containing graphite and molybdenum disulphide; compatible with brake fluid and brake circuit rubber seals.	Load proportioning valve. Load proportioning valve bush. Rod and bar control.
Liquido Autofà DP1	Alcool based liquid detergent.	To be used undiluted or diluted for windscreen and headlamp washers.
Liquido Paraflu[11] FIAT	Mono ethylene glycol based anti-freeze for cooling systems.	Cooling circuit percentage to be used 35% up to – 25°C 50% up to – 35°C.

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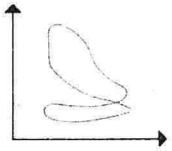
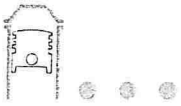
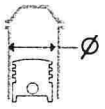
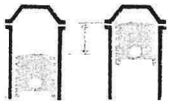
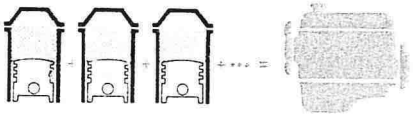
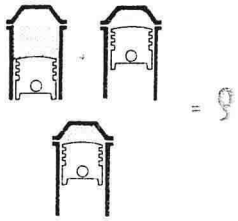
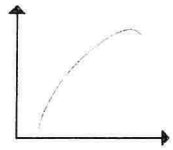
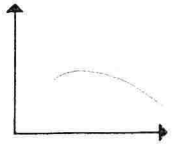
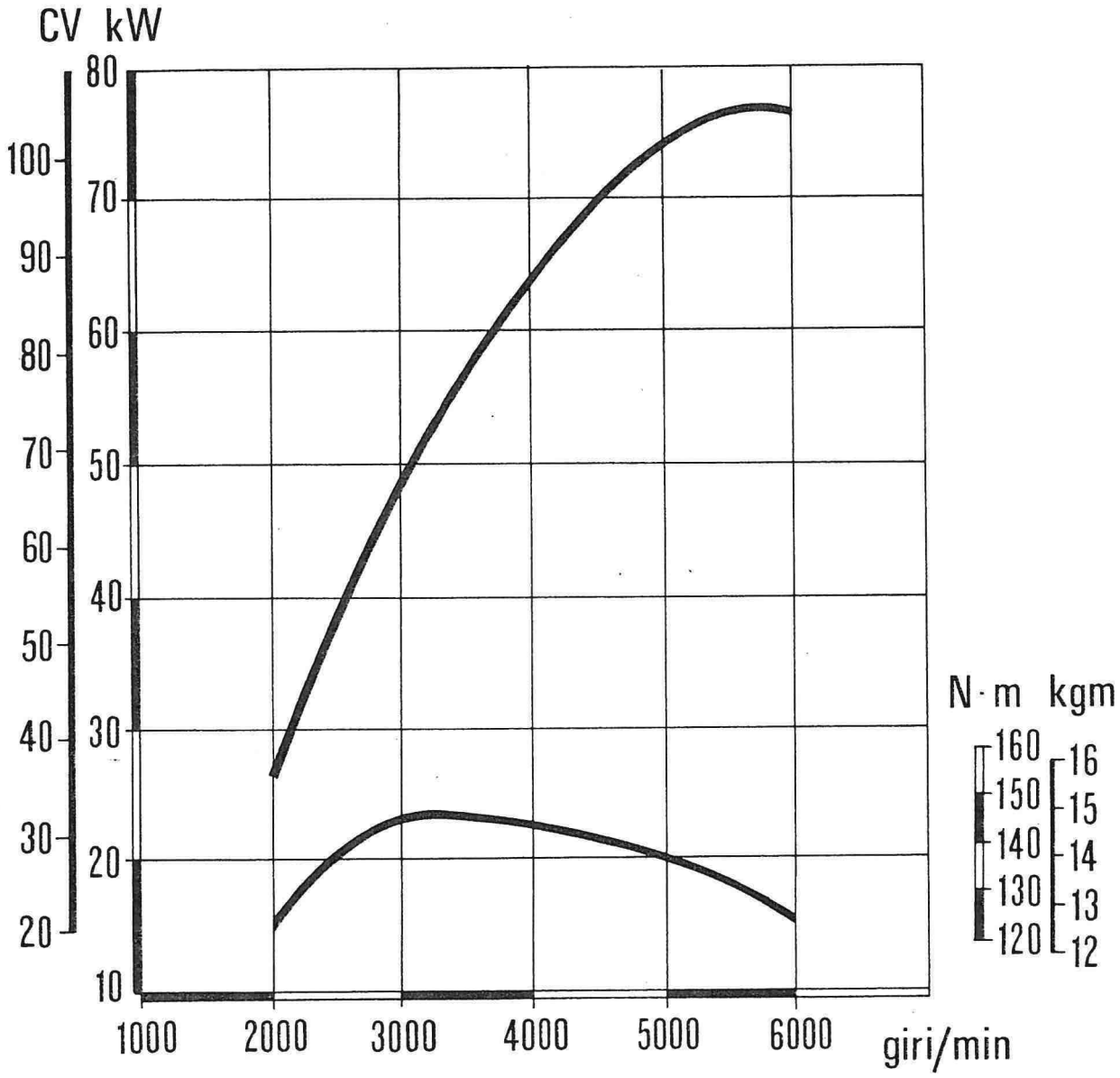
CHARACTERISTICS

	Type		146 A2.000
	Cycle		OTTO 4 stroke
	No. of cylinders		4
	Cylinder liner (bore)	mm	80,5
	Stroke	mm	63,9
	Capacity	cc	1301
	Compression ratio		7,7 ÷ 8
	Max power (EEC)	kW (CV)	77 (105)
		rpm	5750
	Max torque (EEC)	daNm (kgm)	14,7 (15)
		rpm	3200



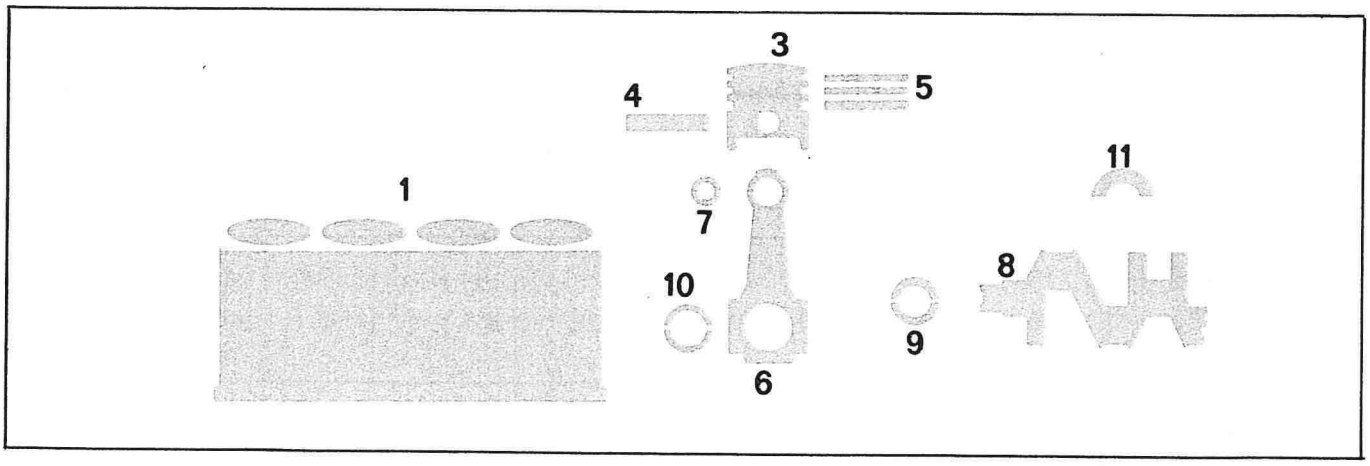
Characteristic power curves from EEC method

The power curve shown can be obtained with the engine overhauled and run in.

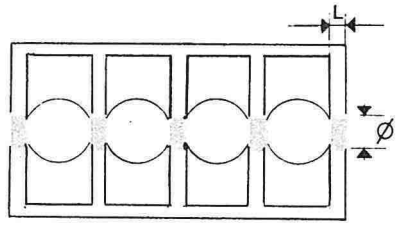
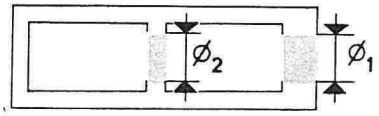
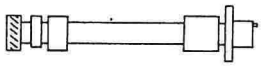
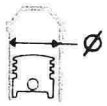
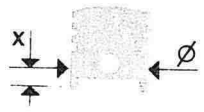
Test speed rpm	Time in minutes	Load on the brakes
800 ÷ 1000 1500 2000	10' 10' 10'	no load no load no load

Test bench test cycle with overhauled engine

NOTE *In 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 actual engine in the car.*



DESCRIPTION — Values in mm

	 Main bearing supports	L	22,140 ÷ 22,200
		Ø	54,507 ÷ 54,520
1		$Ø_1$	38,700 ÷ 38,730
	 Auxiliary shaft bush housings	$Ø_2$	35,036 ÷ 35,066
	 Cylinder bore	Ø (0,010)	80,500 ÷ 80,550
3	 Piston	X	10,5
		Ø A	80,450 ÷ 80,460
		Ø C	80,470 ÷ 80,480
		Ø E	80,490 ÷ 80,500
		Ø >	0,4

DESCRIPTION

Values in mm

3	Difference in weight between pistons		± 2,5 g
3–1	Piston-Cylinder bore		0,040 ÷ 0,060
3	Gudgeon pin housing	1	21,999 ÷ 22,002
		2	22,002 ÷ 22,005
4		1	21,991 ÷ 21,994
		2	21,994 ÷ 21,997
	Gudgeon pin		0,2
4–3	Gudgeon pin - housing		0,005 ÷ 0,011
3	Piston ring grooves	1	1,535 ÷ 1,555
		2	2,010 ÷ 2,030
		3	3,967 ÷ 3,987
5		1	1,478 ÷ 1,490
		2	1,978 ÷ 1,990
		3	3,922 ÷ 3,937
	Piston rings		0,4
5–3	Piston rings - Grooves	1	0,045 ÷ 0,077
		2	0,020 ÷ 0,072
		3	0,030 ÷ 0,085
5–1		1	0,30 ÷ 0,50
		2	0,30 ÷ 0,50
	Opening at end of rings in cylinder bore	3	0,25 ÷ 0,50

Technical data

Engine: cylinder block/crankcase, crankshaft and associated components

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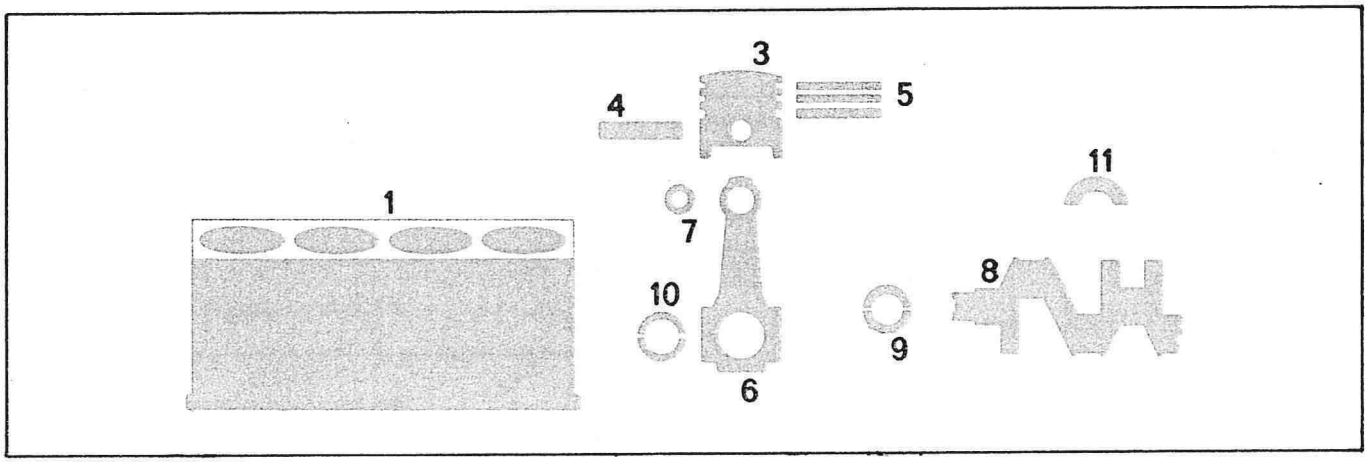

DESCRIPTION

Values in mm

6	$\varnothing_1$ Small end bush housing	$\varnothing_1$	23,939 ÷ 23,972
	$\varnothing_2$ Big end bearing housing	$\varnothing_2$	48,630 ÷ 48,646
7	$\varnothing_2$ $\varnothing_1$ Small end bush	$\varnothing_1$	24,016 ÷ 24,041
		1	22,004 ÷ 22,007
		2	22,007 ÷ 22,010
4–5		Gudgeon pin Small end bush	0,010 ÷ 0,016
7–6		Small end bush Bush housing	0,044 ÷ 0,102
8	Main journals $\varnothing_1$	1	50,785 ÷ 50,795
		2	50,775 ÷ 50,785
	Crankpins $\varnothing_2$	A	45,508 ÷ 45,518
		B	45,498 ÷ 45,508
		L	26,975 ÷ 27,025

DESCRIPTION

Values in mm

9	Crankshaft bearings	1	1,833 ÷ 1,842
		2	1,838 ÷ 1,847
		⌀ A B <	0,254 – 0,508
9–8	Crankshaft bearings - Main journals		0,028 ÷ 0,069
10	Big end bearings	A	1,534 ÷ 1,543
		B	1,539 ÷ 1,548
		⌀ A B <	0,254 – 0,508
10–8	Big end bearings - Pins		0,026 ÷ 0,070
11	Thrust washers	S	2,310 ÷ 2,360
		s A B >	0,127
11–8	Crankshaft end float		0,055 ÷ 0,265

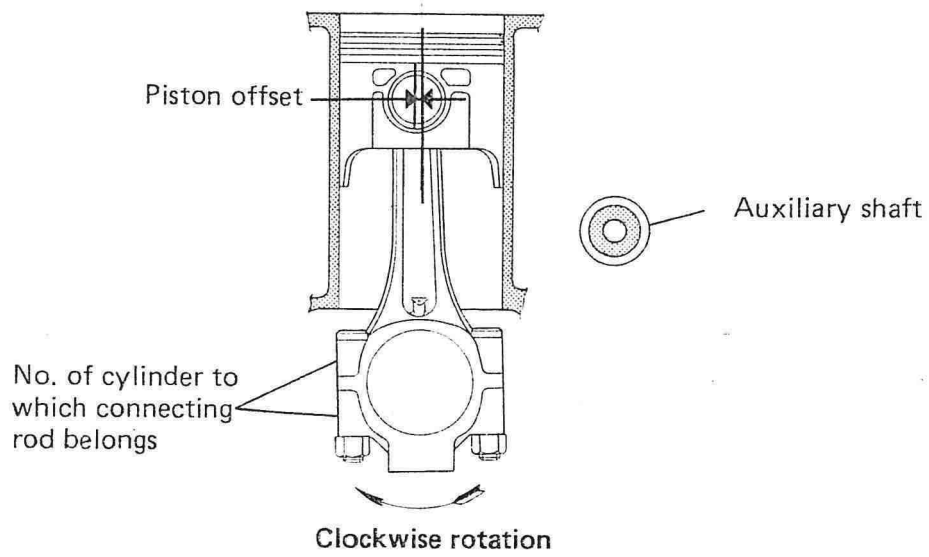

Diagram showing connecting rod-piston assembly and direction of rotation in engine

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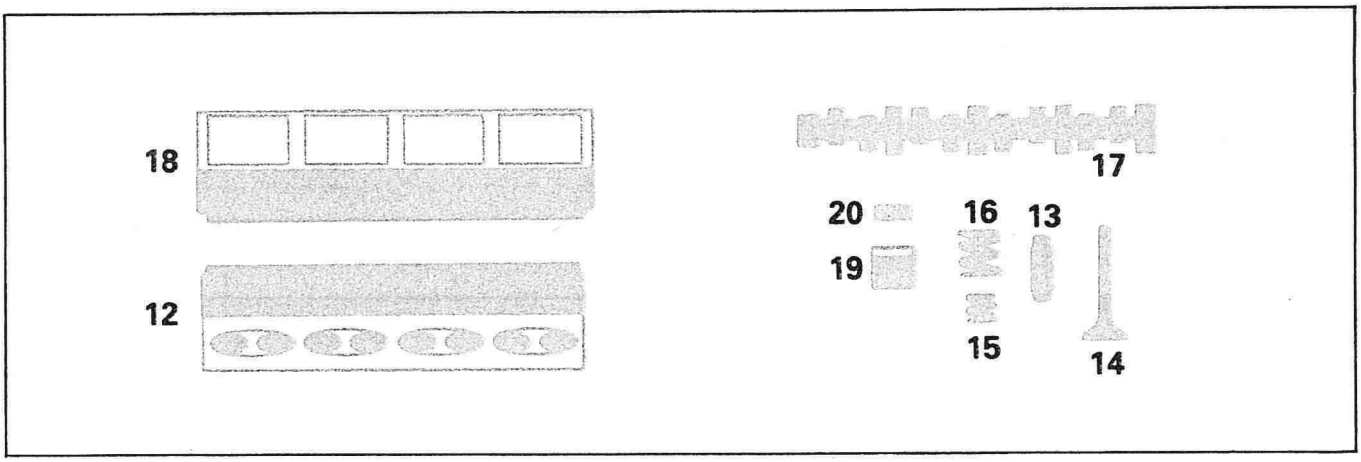
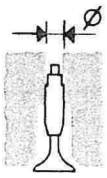
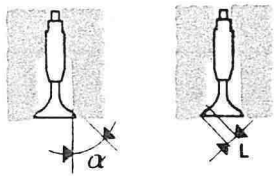
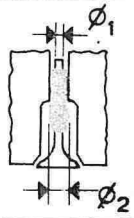
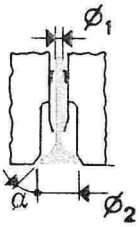


DESCRIPTION

Values in mm

	Valve guide bores in cylinder head	Ø	13,950 ÷ 13,977
12 	Valve seats		45° ± 5′
			45° ± 5′
		L	~ 2
13 	Valve guides	$Ø_1$ 	8,022 ÷ 8,040
		$Ø_2$	13,998 ÷ 14,016
		$Ø_1$ 	0,05 – 0,10 – 0,25
12 – 13 	Valve guide - Bore in cylinder head		0,011 ÷ 0,066
14 	Valves 	$Ø_1$	7,974 ÷ 7,992
		$Ø_2$	43,300 ÷ 43,700
		α	45° 30′ ± 5′
	 (sodium)	$Ø_1$	7,974 ÷ 7,992
		$Ø_2$	32,850 ÷ 33,450
		α	45° 30′ ± 5′

DESCRIPTION

Values in mm

13 — 14	Valves - Valve guides	0,030 ÷ 0,066
15	P_1	14,6 ± 0,5 daN
	H_1	31
	P_2	27,6 ± 1,17 daN
	H_2	21,5
16	P_1	38,1 ± 1,5 daN
	H_1	36
	P_2	58,4 ± 2,45 daN
	H_2	26,5
17 Camshaft bearings	$Ø_1$	29,944 ÷ 29,960
	$Ø_2$	47,935 ÷ 47,950
	$Ø_3$	48,135 ÷ 48,150
	$Ø_4$	48,335 ÷ 48,350
	$Ø_5$	48,535 ÷ 48,550
Cam lift		8,000
		8,000
18 Camshaft bearings in camshaft housing	$Ø_1$	29,990 ÷ 30,014
	$Ø_2$	47,980 ÷ 48,005
	$Ø_3$	48,180 ÷ 48,205
	$Ø_4$	48,380 ÷ 48,405
	$Ø_5$	48,580 ÷ 48,605
Tappet housings	Ø	37,000 ÷ 37,025
17 — 18	Camshaft bearings - Cylinder head support	0,030 ÷ 0,070

Technical data

Engine: cylinder head and valve gear components

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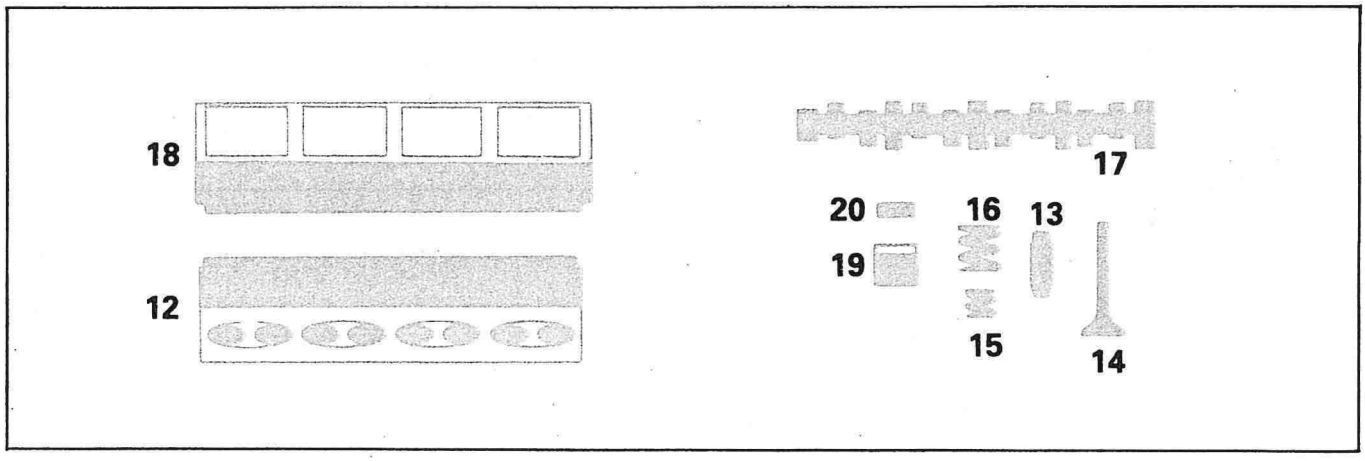
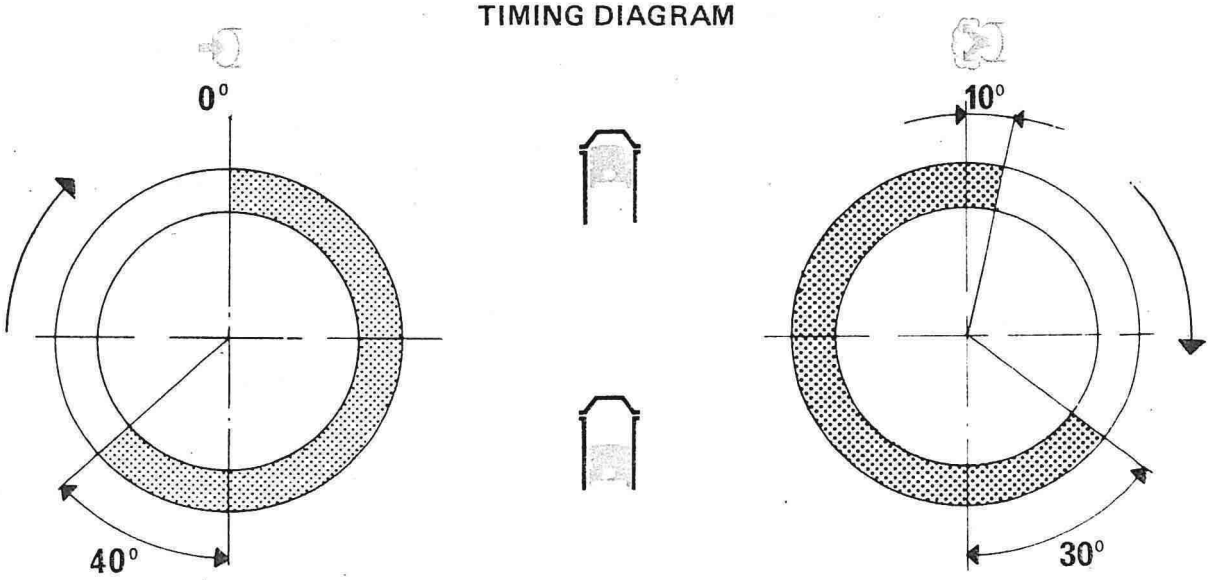


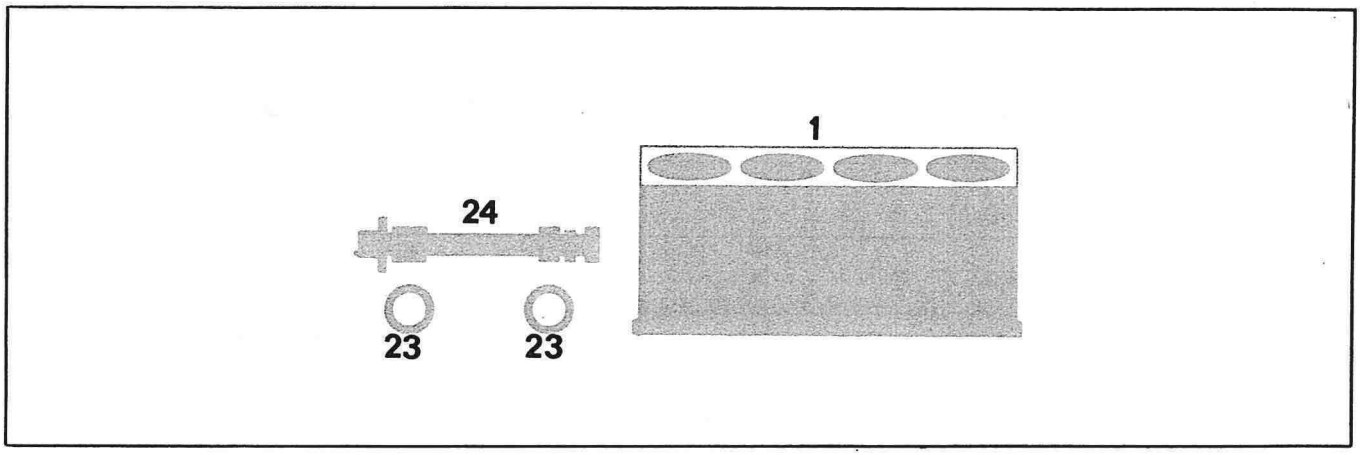
DESCRIPTION

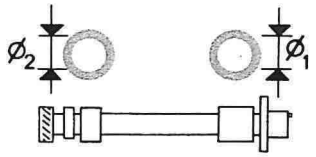
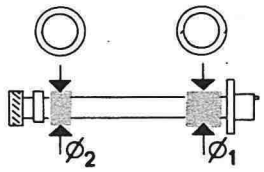
Values in mm

19	Tappet Ø	36,975 ÷ 36,995
19 – 18	Tappet Housing	0,005 ÷ 0,050
20	Shim s (0,05)	3,25 ÷ 4,70
17–20	to check timing	0,80
		0,80
	operational clearance	0,40 ± 0,05
		0,50 ± 0,05

TIMING DIAGRAM





DESCRIPTION		Values in mm
23  Auxiliary shaft bush housings	$\varnothing_1$	35,664 ÷ 35,684
	$\varnothing_2$	32,000 ÷ 32,020
24  Auxiliary shaft bearings	$\varnothing_1$	35,593 ÷ 35,618
	$\varnothing_2$	31,940 ÷ 31,960
23-1 Shaft bushes - Housings		must be an interference fit
24-23 Bearings - Bushes	$\varnothing_2$	0,040 ÷ 0,080
	$\varnothing_1$	0,046 ÷ 0,091

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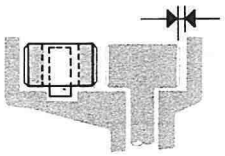
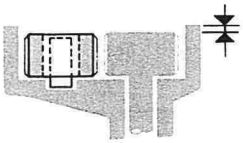
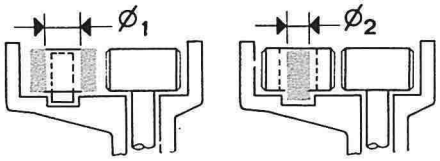
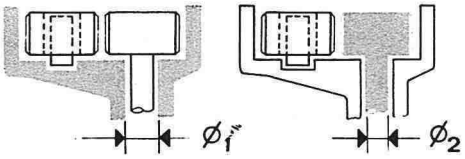
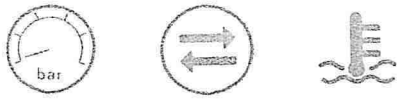
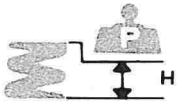
DESCRIPTION		Values in mm
Oil pump type		gears
Pump operated		through auxiliary shaft
Oil pressure valve regulation		incorporated in oil pump
	between edge of gears and pump casing	0,080 ÷ 0,150
	between upper side of gears and pump cover	0,020 ÷ 0,105
		0,017 ÷ 0,057
		0,016 ÷ 0,055
	between drive gear and driven gear	0,31
Total capacity filter		cartridge
Insufficient oil pressure sender unit		electrical
 100°C Operating pressure at temperature of 100° C		3,4 ÷ 4,9 bar
	Oil pressure relief valve spring — P	8,83 daN
	H	22,5
Thermostatic switch for sending oil to the radiator	opens at	76° ÷ 80°
	completely open at	⩾ 84°

COOLING SYSTEM Description

Cooling circuit		Coolant circulation via centrifugal pump, radiator and fan operated by 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	95°C	
	valve travel	⩾ 7,5	
Clearance between impeller blades and pump casing		0,8 ÷ 1,3	
Pressure for checking water tightness		0,78 bar	
Pressure for checking calibration of spring loaded overflow valve for expansion tank		0,78 bar	

FUEL SYSTEM Description

Electric fuel pump: type	Bosch 0580464024
Flow rate capacity	120 litres/hour
Current absorption during operation	6 ÷ 7 A
Maximum supply pressure	~ 7 bar
Pressure regulator	Bosch 0.280.160.213
Operating pressure at 12 V on engine when idling	3 ± 0,06 bar

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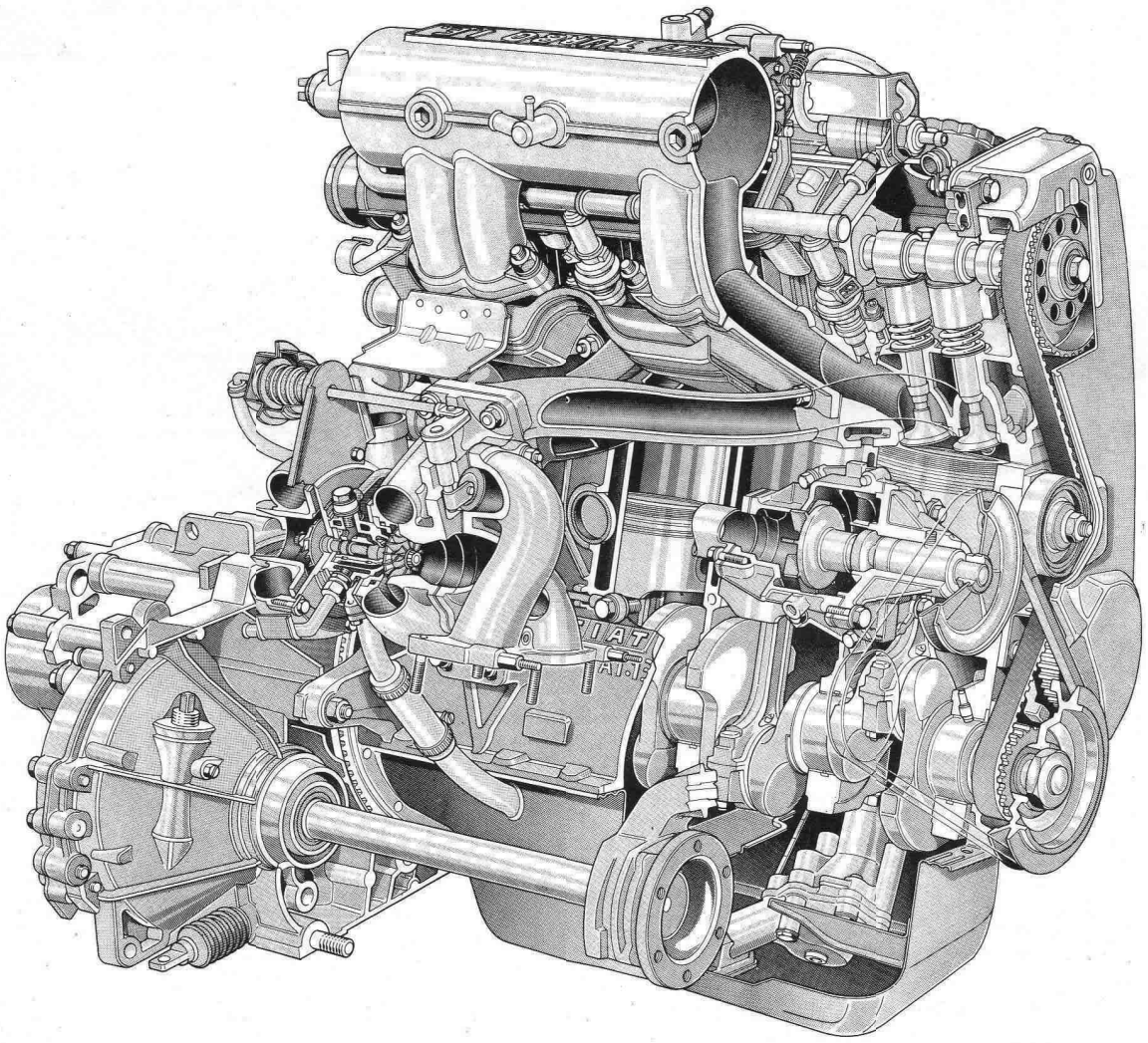
BOSCH LE2–JETRONIC FUEL INJECTION SYSTEM	Bosch ref. no.	Quantity
Air flow meter	0.280.200.046	1
Supplementary air valve	0.280.140.179	1
Butterfly valve switch	0.280.120.314	1
Coolant temperature sender unit sensor	0.280.130.026	1
Electronic control unit	0.280.000.336	1
Electric fuel supply pump	0.580.464.024	1
Injectors (yellow point) at 12 V	0.280.130.026	4
Pressure regulator	0.280.160.213	1

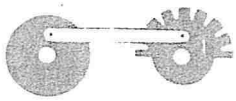
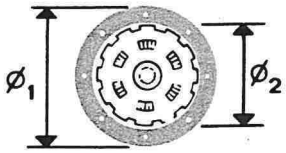
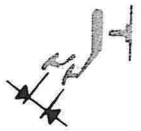
SUPERCHARGING

Turbocharger with waste gate valve and intercooler	IHI VL 2	1

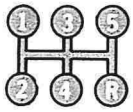
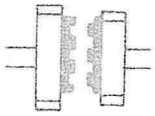
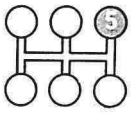
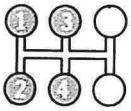
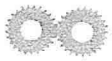
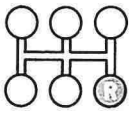
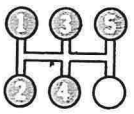
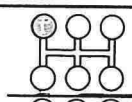
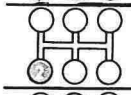
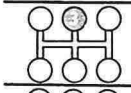
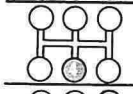
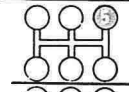
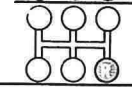
Diagram showing part cross section of engine

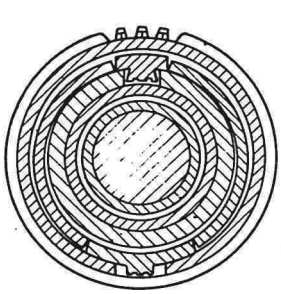


Values in mm

Type		 dry, single plate
 Operating mechanism		 diaphragm spring
Spring loading		450 daN
 Lining	$\varnothing_1$	190
	$\varnothing_2$	134
 Clutch pedal setting		0 ÷ 5 mm above the level of the brake pedal
Clutch release		mechanical

GEARBOX

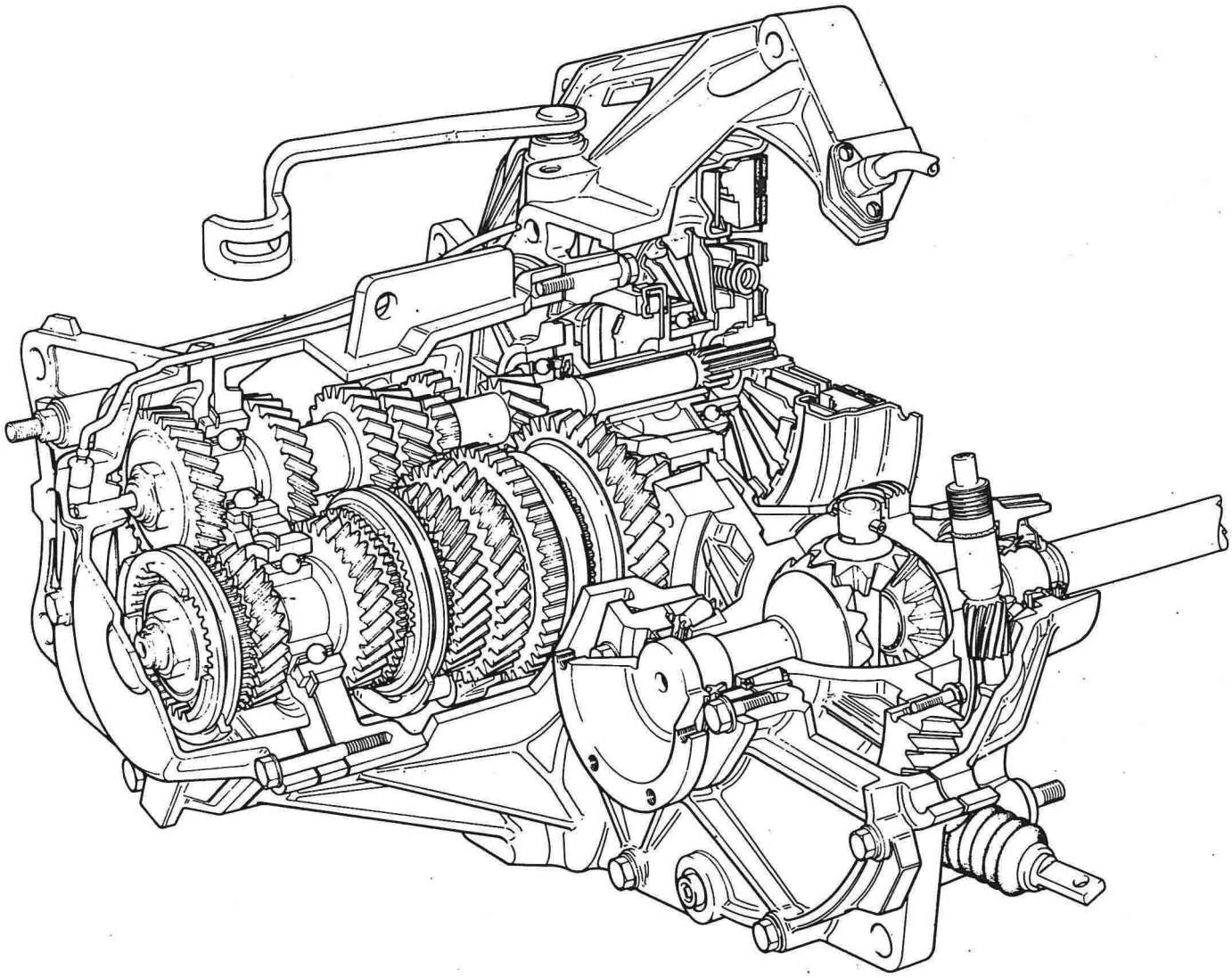
Gears		
 Synchronizers	spring ring (Porsche type) 	
	baulk ring type 	
 Gears	straight toothed 	
	helical toothed 	
 Gear ratios		4,091
		2,235
		1,469
		1,043
		0,863
		3,714



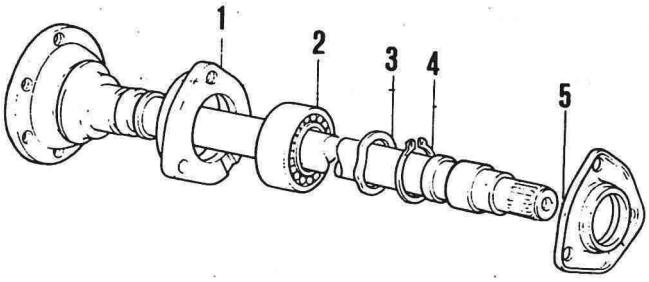
Cross section A-A
Spring ring (Porsche type) synchronizer

Cross section B-B
Cone synchronizer

LONGITUDINAL SECTION OF GEARBOX



View of gearbox, partial cross section

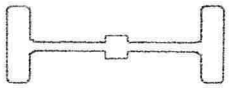
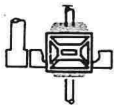
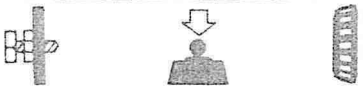
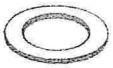
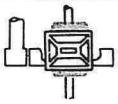


Exploded view of intermediate shaft components

1. Bearing retainer plate
2. Ball bearing
3. Flexible washer
4. Circlip
5. Bearing cap

NOTE *The intermediate shaft ball bearing should be fitted cold to the shaft on the press taking care to only apply force on the bearing inner race.*

DIFFERENTIAL

  Final drive ratio	17/61 (3,588)
  Ratio at the wheels 	14,678
	8,019
	5,270
	3,742
	3,096
	13,325
 Differential internal box bearings	 conical roller bearings
 Adjustment of bearing pre-loading	 by shims
 Thickness of shims	1,70 ÷ 2,60
 Interference to obtain exact bearing pre-loading	0,12
  Clearance between planet and satellite gears	no adjustment is carried out

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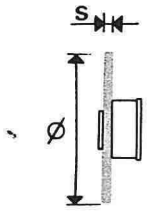
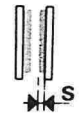
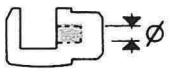
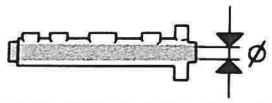
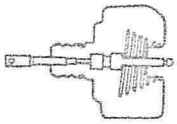
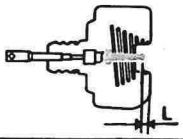
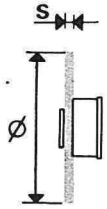
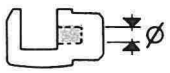
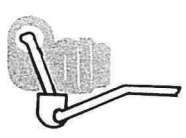
FRONT BRAKES

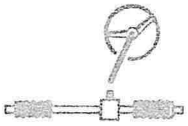
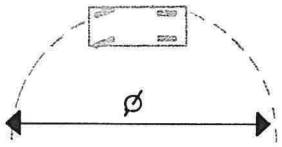
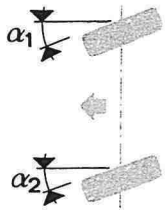
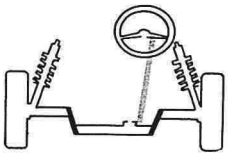
Values in mm

	Disc ø	240
	s	19,90 ÷ 20,10
	s (worn)	18,55
	s < allowed	18,2
	Brake pads s < allowed	1,5
	Caliper ø	48
	Master cylinder (pump) ø	22,225 (7/8")
	Servo brake	Master-Vac 7" hydro-pneumatic servo acting on all four wheels
	Distance of hydraulic piston push rod from master cylinder support plate L	0,825 ÷ 1,025

REAR BRAKES

	Disc ø	227
	s	10,70 ÷ 10,90
	s (worn)	9,70
	s < allowed	9
	Brake pads s < allowed	1,5
	Caliper ø	34
	Load proportioning valve	acting on rear wheels
	Ratio (reduction) 	0,34

s = thickness

Type	 rack and pinion
Ratio — no. of turns lock to lock	3,42
Ratio — rack travel	130
 Minimum turning circle	9,4
 Steering angle — outer wheel α_1	31° 27′
Steering angle — inner wheel α_2	36° 43′
 Steering column	 two piece with universal joints

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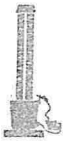
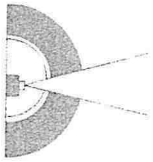
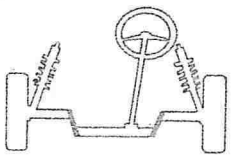
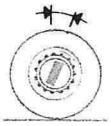
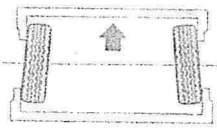
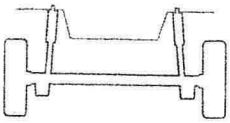
 Tyre  Front	Type	175/60 HR 13"
	average load	2,2 bar
	heavy load	2,3 bar
Rear	average load	2,2 bar
	heavy load	2,5 bar
 Rim	Type	5 1/2 J x 13" AH2



unladen car (*)

WHEEL GEOMETRY

 Front suspension 	camber (**)	25' ± 30'
	caster	2° 15' ± 20'
	toe in	1 ± 1
 Rear suspension 	camber	0°

(*) With tyres inflated to correct pressure and vehicle in running order.
(**) Angles cannot be adjusted.

Front suspension: independent, Mc Pherson type with track control arms connected by two flexible bushes to a cross member and floating stabilizer bar.
Offset coil springs and double action hydraulic telescopic shock absorbers.
For life joints.

COIL SPRING

Part number	7559895
Diameter of wire	12,1 ± 0,05 mm
No. of turns	4
Direction of coil	clockwise
Height of spring released	334 mm
Height of spring under a load of 285 ± 12 daN	205 mm
The springs are subdivided into two categories identifiable by a mark: — Yellow (*) for those under a load of 185 ± 12 daN having a height of: — Green (*) for those under a load of 285 ± 12 daN having a height of:	 ⩾ 205 mm ⩽ 205 mm

(*) Springs of the same category must be fitted.

SHOCK ABSORBERS

Type: telescopic, gas (low pressure) double acting		BOGE – WAY ASSAUTO
Part number		7549536
Travel	mm	155,5
Maximum extension	mm	498,5 ÷ 502,5

Rear suspension: by torsion beam axle consisting of longitudinal tubular arms and a connecting cross member.
Coil springs and double acting telescopic gas filled shock absorbers.

COIL SPRING

Part number	7549540
Diameter of wire	13,2 ± 0,05 mm
No. of turns	4
Direction of coil	clockwise
Height of spring released	231 mm
Height of spring under a load of 303 ± 15 daN	155 mm
The springs are subdivided into two categories identifiable by a mark: – Yellow (*) for those under a load of 303 ± 15 daN having a height of: – Green (*) for those under a load of 303 ± 15 daN having a height of:	 > 155 mm ⩽ 155 mm

(*) Springs of the same category must be fitted.

SHOCK ABSORBERS

Type: telescopic gas filled (low pressure) double acting	Boge	Way – Assauto	Monroe
Part number	5972898		
Colour	black	grey	green
Travel mm	196		
Maximum extension mm	496 ÷ 500		

STARTER MOTOR	M. Marelli E 95 — 0,9 kW - 12 V Bosch 94 - 0,8 kW - 12 V
ALTERNATOR	Bosch K1 - 14 V - 65 A 23
VOLTAGE REGULATOR	Bosch EL - 14 V - 4 C
BATTERY	12 V - 45 Ah - 225 A
IGNITION SYSTEM	Microplex static advance electronic ignition M. Marelli MED 603 B
IGNITION DISTRIBUTOR	DT 402 AX
IGNITION COIL	M. Marelli BAE 209 BK
IGNITION COIL WITH CONTROL UNIT	M. Marelli AEI 500 B
SPARK PLUGS	Bosch FR 6 DTC

Technical data
Electrical equipment: starting
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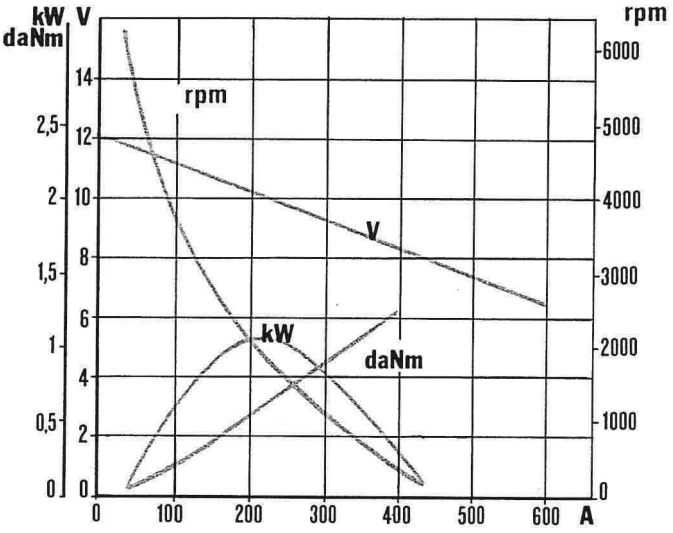
STARTER MOTOR			M. Marelli E 95 - 0,9 kW - 12 V	Bosch 94 - 0,8 kW - 12 V
Voltage			12 V	
Nominal power			0,9 kW	0,8 kW
Rotation, pinion side			clockwise	
No. of poles			4	
Field coil			series	
Engagement			free wheel	
Operation			solenoid	
End float of armature shaft			0,15 ÷ 0,45 mm	
Data for bench test	Operating test (*):			
	current	A	⩽ 220	190
	speed	rpm	⩾ 1800	1850
	voltage	V	9,8	10,4
	torque developed	daNm	0,5	0,5
	Engagement test (*):			
	current	A	⩽ 480	380 ÷ 420
	voltage	V	7,1	8,5
	torque developed	daNm	⩾ 1,37	1,29
	Free running test (*):			
	current	A	⩽ 40	30 ÷ 40
	voltage	V	11,6	11,8
	speed	rpm	⩾ 7000	10.000 ÷ 11.000
Relay	Winding resistance (*)	pull in	0,39 ÷ 0,41	0,38 ÷ 0,40
		hold in	1,19 ÷ 1,29	1,76 ÷ 1,80
Lubrication	Internal splines and bushes		VS+ SAE 10 W	
	Sleeve and intermediate disc		TUTELA MR3	

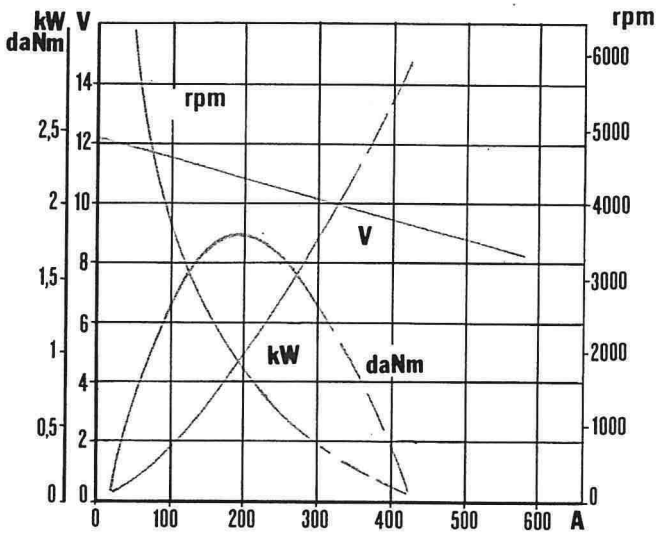
(*) Data obtained at an ambient temperature of 20° C.

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

STARTER MOTOR – TYPICAL CURVES

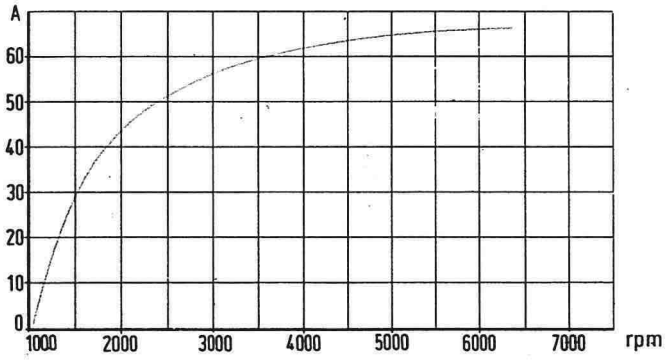


Marelli E 95 - 12 V - 0,9 kW



Bosch ∅ 94 - 12 V 0,8 kW

ALTERNATOR – TYPICAL OUTPUT CURVE
(at a constant voltage of 13.5 V with bedded in brushes)



Bosch K1 - 14 V - 65 A 23

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ALTERNATOR

Type		Bosch
Make		K1 – 14 V – 65 A 23
Nominal voltage	V	14
Maximum current	A	65
Cut in speed	rpm	1060
Current delivery on battery at 7000 rpm	A	⩾ 65
Field winding resistance between the slip rings (*)	Ω	2,61 ÷ 3,19
Direction of rotation (seen from control side)		clockwise
Transmission ratio motor/ alternator		1 : 2
Diode rectifiers		bridge

VOLTAGE REGULATOR

Type		Built in electronic Bosch EL – 14 V – 4C
Alternator speed for test	rpm	6000
Thermal stabilization current	A	32,5
Test current	A	6,5 ÷ 58,5
Regulation voltage (*)	V	13,9 ÷ 14,5

BATTERY

Nominal voltage	V	12
Capacity (20 hour discharge)	Ah	45

(*) Data obtained at an ambient temperature of 20° C.

STATIC ADVANCE ELECTRONIC IGNITION CONTROL UNIT

Type	M. Marelli Microplex
Firing order	1 - 3 - 4 - 2

IGNITION CONTROL UNIT

Type		M. Marelli
Make		MED 603 B
Built in rotor arm resistance	Ω	800 ÷ 1200
Advance on engine at 850 rpm		10° ± 2°
Maximum advance		38° ± 2°

IGNITION UNIT with coil

Type		M. Marelli
Make	ignition unit with electronic power module	AEI 500 B
	ignition coil	BAE 209 BK
Ohmic resistance of primary winding at 20° C	Ω	0,31 ÷ 0,37
Ohmic resistance of secondary winding at 20° C	Ω	3330 ÷ 4070

RPM SENSOR

Make and type		M. Marelli SEN 8 E
Sensor resistance	Ω	612 ÷ 748
Distance between sensor and flywheel teeth	mm	0,25 ÷ 1,3

TDC SENSOR

Make and type		M. Marelli SEN 8 D
TDC (Top Dead Centre) resistance on pulley	Ω	612 ÷ 748
Distance (gap) between TDC sensor and crankshaft pulley teeth	mm	0,4 ÷ 1

SPARK PLUGS

Make and type		Bosch FR 6 DTC
Electrode gap	mm	0,7 ÷ 0,8

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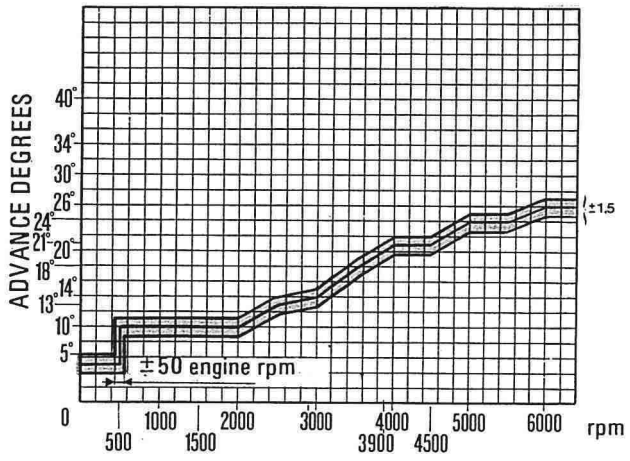
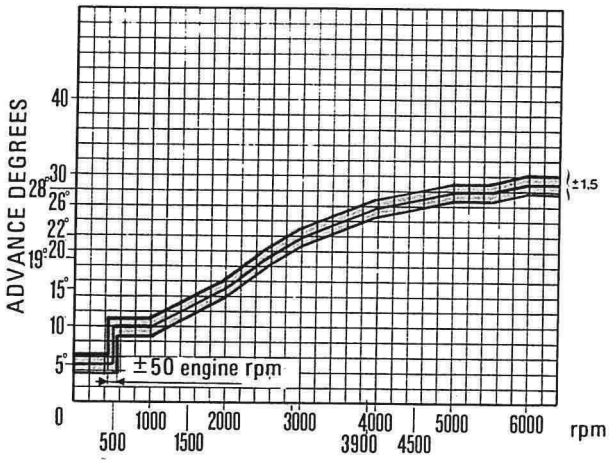
TYPICAL IGNITION ADVANCE CURVES FOR THE MICROPLEX SYSTEM DEPENDING ON THE PRESSURE IN THE INLET MANIFOLD (obtainable with a flywheel with 122 teeth)

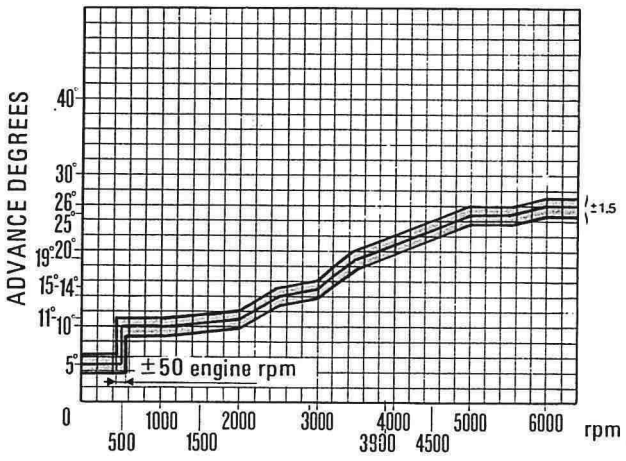
a 0,600 bar (450 mmHg)



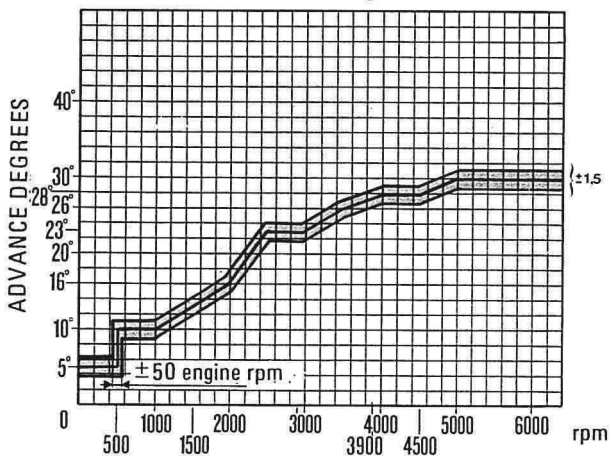
a 0,400 bar (300 mmHg)



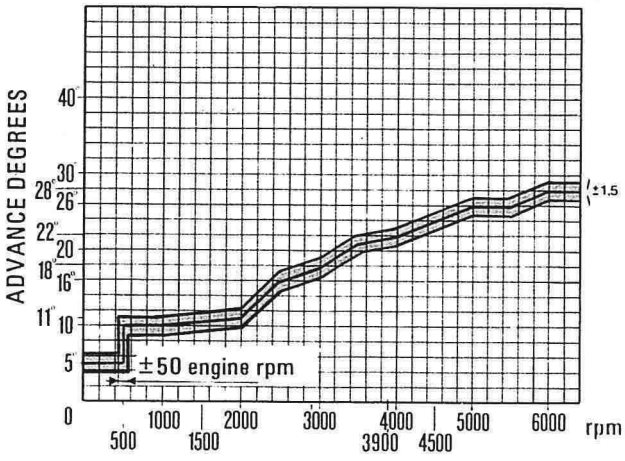
a 0,533 bar (400 mmHg)



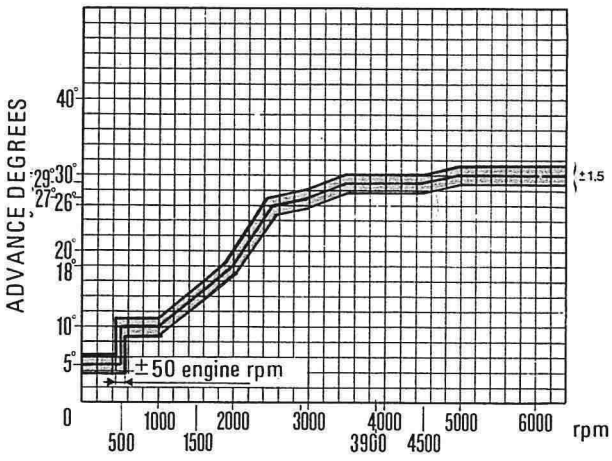
a 0,333 bar (250 mmHg)



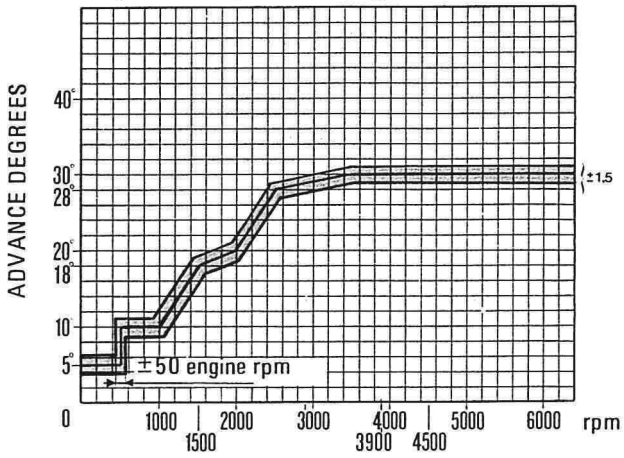
a 0,466 bar (350 mmHg)



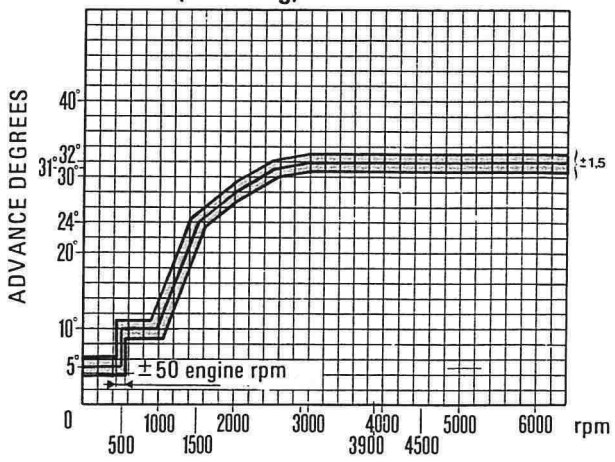
a 0,266 bar (200 mmHg)



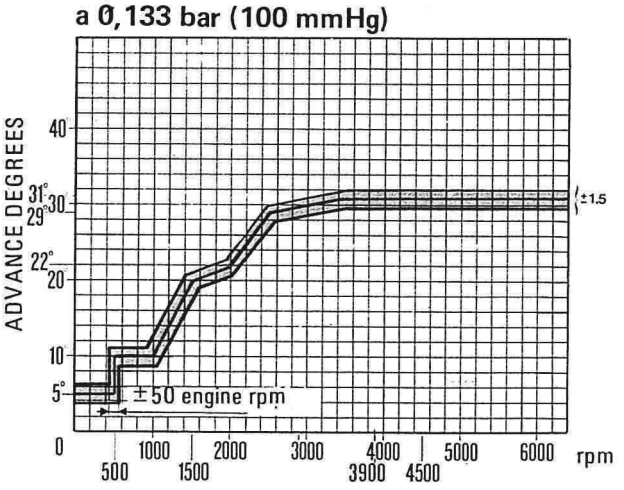
a 0,200 bar (150 mmHg)



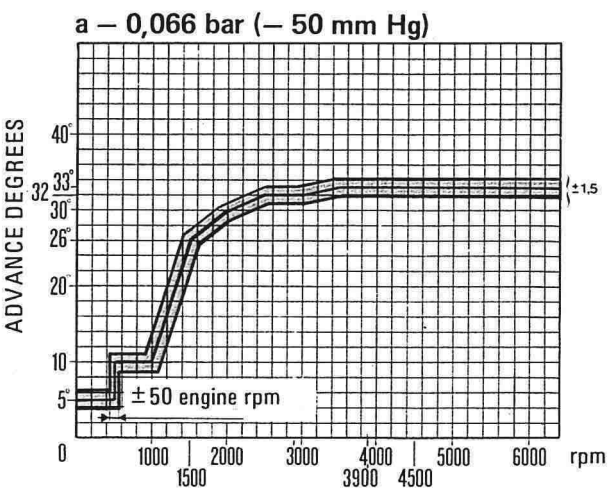
a 0 bar (0 mmHg)



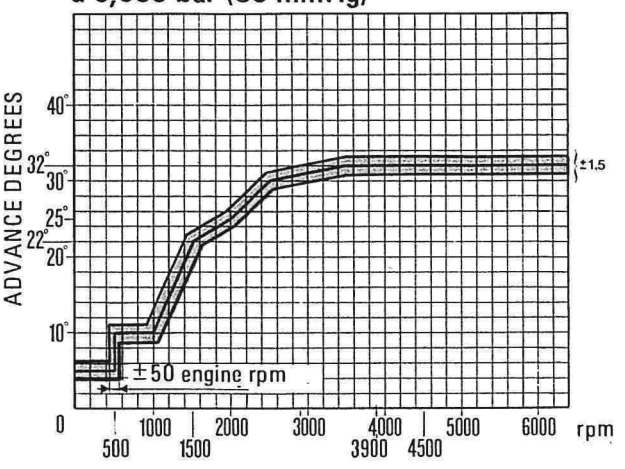
a 0,133 bar (100 mmHg)



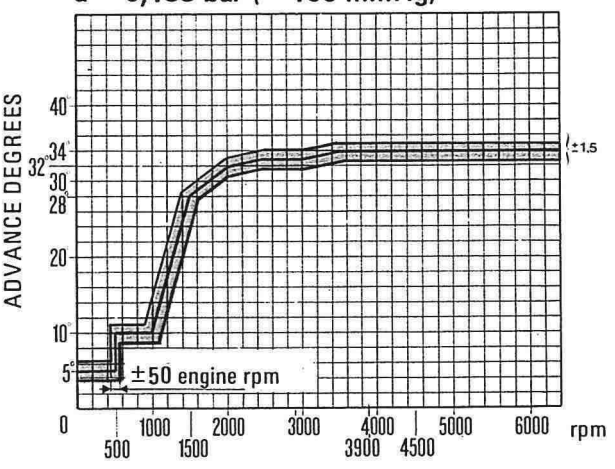
a – 0,066 bar (– 50 mm Hg)



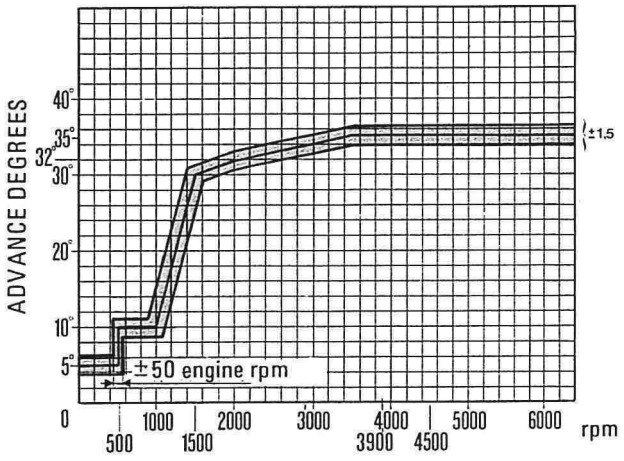
a 0,066 bar (50 mmHg)



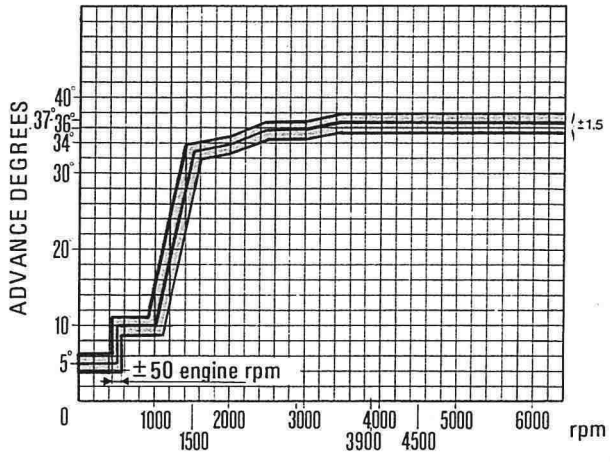
a – 0,133 bar (– 100 mmHg)



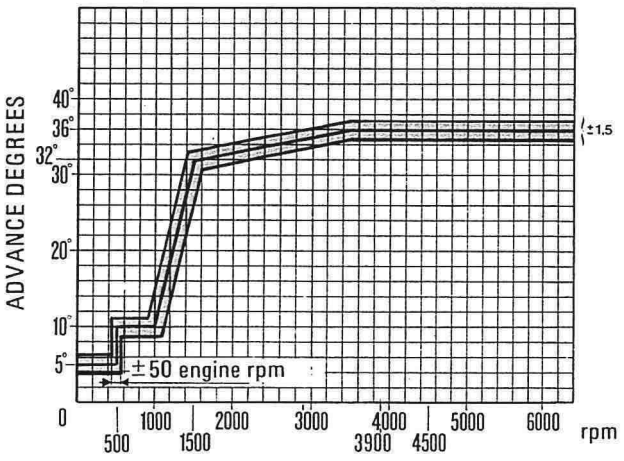
a — 0,200 bar (— 150 mmHg)



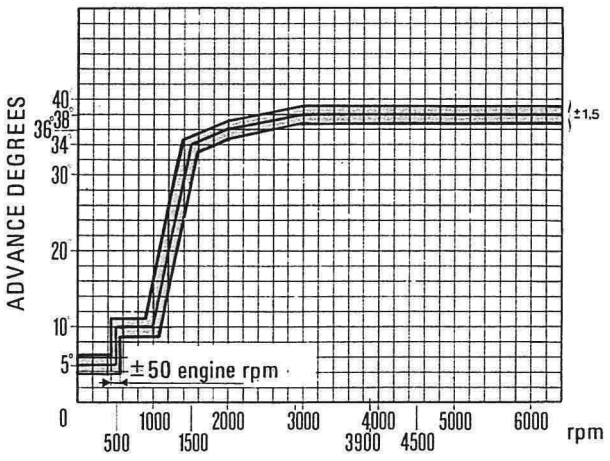
a — 0,333 bar (— 250 mmHg)



a — 0,266 bar (— 200 mmHg)



a — 0,400 bar (— 300 mmHg)



CLUTCH

1870210000 Clutch disc centering pin.

GEARBOX – DIFFERENTIAL

1840206000 Percussion extractor.

1855035000 Spanner for removing-refitting gearbox with engine fitted in car.

1855087000 Spanner for gearbox oil drain plug.

1870007000 Grip for tools.

1870100002 Drift for fitting 5th speed synchronizer circlip (to be used with 1870100003).

1870100003 Tool for fitting 5th speed synchronizer circlip (to be used with 1870100002).

1870225002 Drift for fitting synchronizer circlip (to be used with 1870225003).

1870225003 Tool for fitting synchronizer circlip to be used with 1870225002).

1870296000 Tool for fitting gear selector rod seal.

1870301000 Tool for fitting gear selector rod seal.

1870575000 Support for gearbox-differential unit whilst removing-refitting (to be fitted to the hydraulic jack).

1870595000 Support for engine in vehicle whilst removing gearbox-differential.

STEERING

1847035000 Steering rod ball joint extractor.

1874247000 Tool for fitting steering box rod bush.

1871001014 Support for gearbox-differential unit whilst overhauling.

1874140001 Pliers for staking nuts (to be used with special tools).

1874140005 Tool for staking wheel hub nuts (to be used with 1874140001).

1875016000 Tool for fitting differential casing seal.

1875017000 Drift for fitting differential bearing rings.

1875069000 Rool for fitting gearbox rod bushes.

1881118000 Pliers for fitting drive shaft boot bands.

1881130000 Pliers for fitting drive shaft boot bands.

1881132000 Pliers for fitting drive shaft boot bands.

1895655000 Tool with dial gauge for measuring thickness of differential bearing adjustment shims (to be used with 1895884000).

1895884000 Dial gauge to be used with 1895655000.

DESCRIPTION	Thread size	Torque daNm
CLUTCH		
Clutch plate to flywheel, bolt	M 6	1,6
Clutch fork, bolt	M 8	2,6
GEARBOX – DIFFERENTIAL		
Selector rod spring retaining cover fixing, bolt	M 8	2,5
Cover to plate lower fixing, nut	M 6	1
Plate and cover to gearbox casing fixing, bolt	M 6	1
Plate and cover to gearbox casing fixing, bolt	M 8	2,4
Plate to gearbox casing fixing, bolt	M 6	1
Gearbox casing to bell housing fixing, bolt	M 8	2,5
Gearbox casing to bell housing fixing, nut	M 12 x 1,25	7,8
Gerabox casing to bell housing fixing, bolt	M 12 x 1,25	7,8
Starter motor mounting, bolt	M 8	2,5
Gearbox casing to bell housing cover fixing, bolt	M 6	1
Reverse idler shaft retaining plate fixing, bolt	M 6	1
Gear selector fork fixing, bolt	M 6	1,8
5th speed gears to main and lay shafts, ring nut	M 20 x 1,5	11,8
Gear selector and engagement rod to lever fixing, bolt	M 6	1,8
Gear engagement control lever mounting fixing, bolt	M 6	1
Crown wheel mounting, bolt	M 10 x 1,25	8,8

DESCRIPTION	Thread size	Torque daNm
Oil seal protective boot cover bolt, clutch bell housing side	M 6	0,78
Differential casing to gearbox casing retaining flange, bolt	M 8	2,5
Speedometer mounting, bolt	M 6	1,2
Oil drain plug	M 22 x 1,5	4,6
Oil filler plug	M 22 x 1,5	4,6
Gear selector spring fixing, bolt	M 6	0,74
Right drive shaft plate to cap fixing, bolt	M 6	1
Reversing lights switch	M 14 x 1,5	4

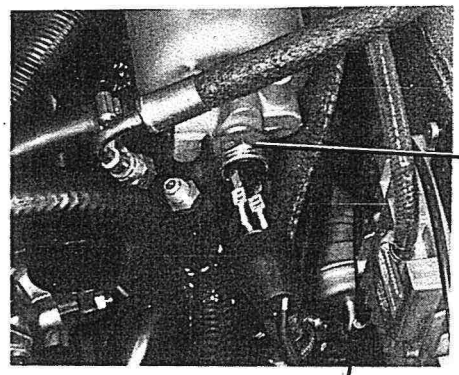
EXTERNAL GEARBOX CONTROLS

Gearbox control lever bridge, "Nyloc" nut	M 6	0,4
Gear selector lever to gear control lever, nut for bolt	M 6	0,7
Lever with gear selector linkage, nut for bolt	M 6	1,1
Linkage to lever on gear selector rod fixing, nut	M 8	1,5
Lever to gear control rod fixing, nut	M 8	1,5
Gear selector lever support bracket to gearbox fixing, nut	M 12 x 1,25	8,8
Gear selector rod (front section), nut for bolt	M 6	0,74

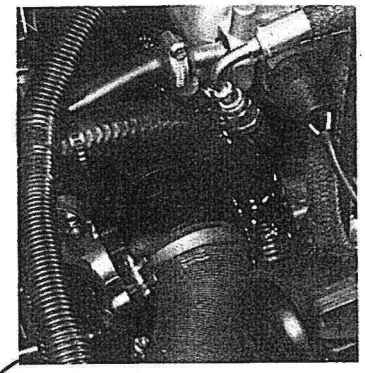
DESCRIPTION	Thread size	Torque daNm
WHEELS		
Steering wheel to shaft fixing, nut	M 16 x 1,25	4,9
Universal joint fork to steering shaft, "Nyloc" nut	M 8	2,7
Steering box to cross member fixing, bolt	M 8	2,4
Ball joint to side steering rod fixing, nut	M 12 x 1,5	3,4
Ball joint to steering knuckle lever fixing, nut	M 10 x 1,25	3,4
Upper steering shaft mounting, nut for bolt	M 6	0,64

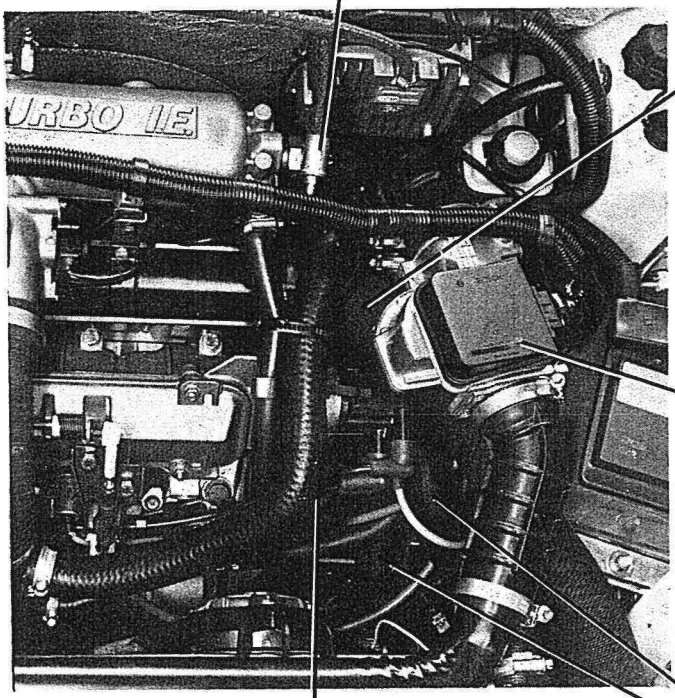
Position the vehicle on the lift.

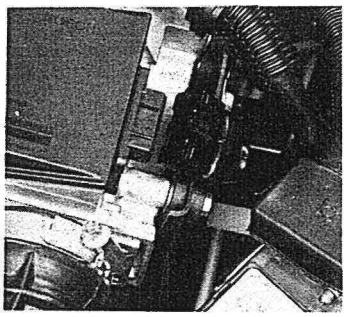
Then proceed as follows:
- Drain the coolant.
- Remove the bonnet lid.
- Disconnect the positive lead from the battery.
- Remove the items illustrated below:

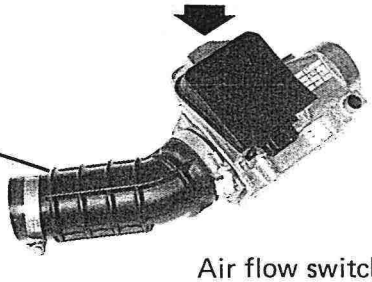


Maximum air pressure switch

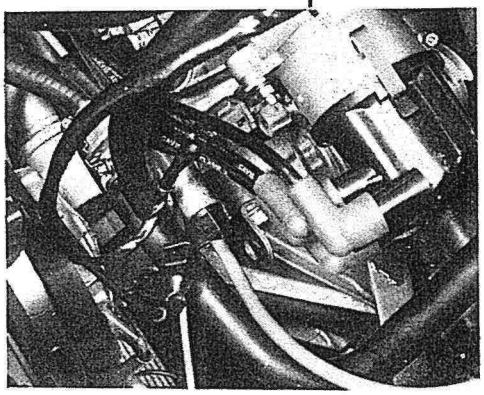


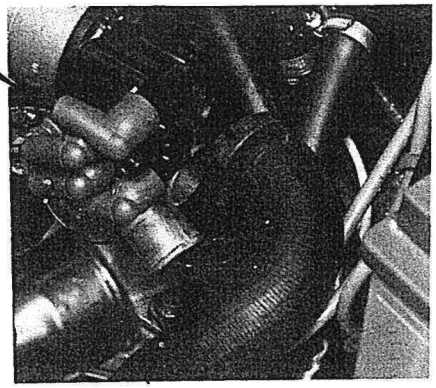






Air flow switch

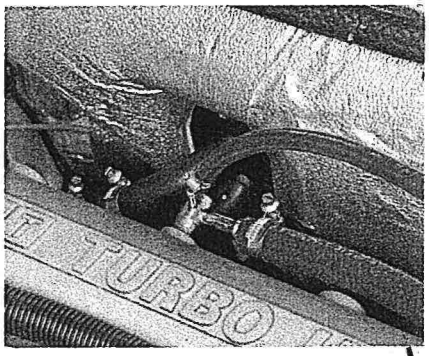


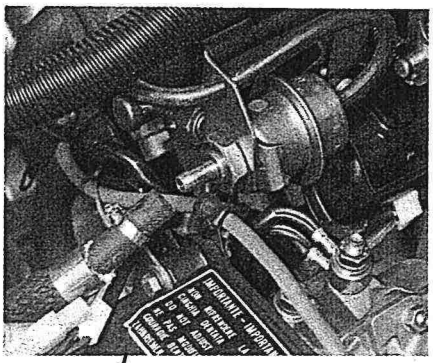


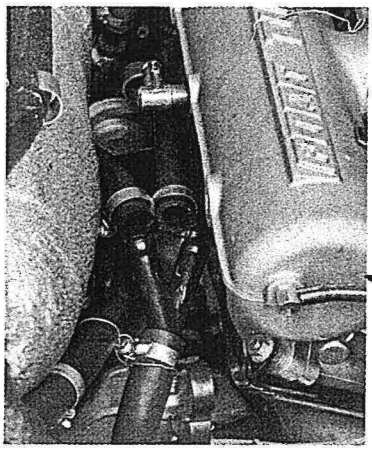
10.

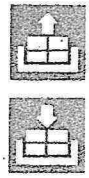
Disconnect the cables:
- from the alternator
- from the starter motor
- from the ignition distributor

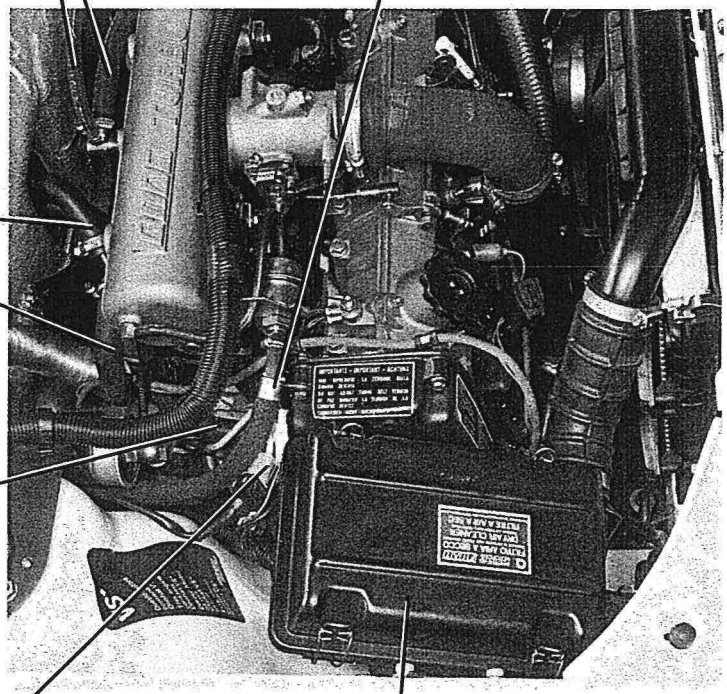
Fuel pressure regulator

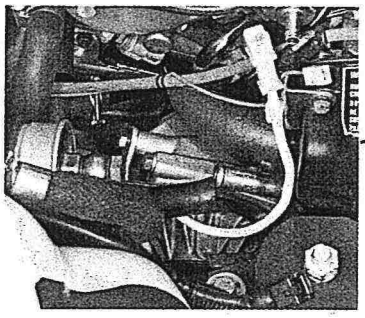


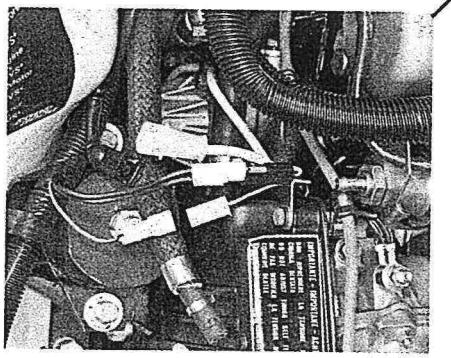


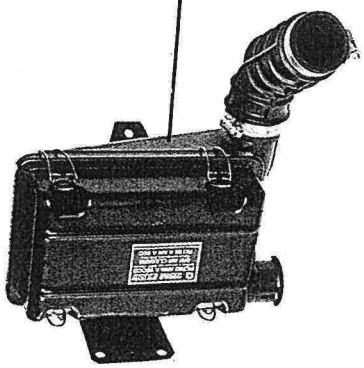






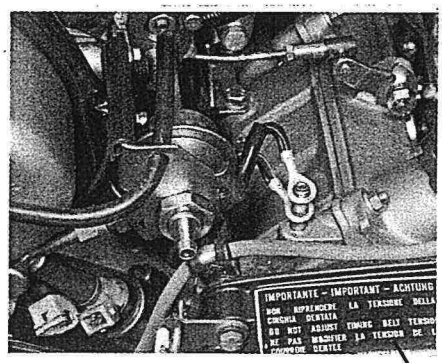


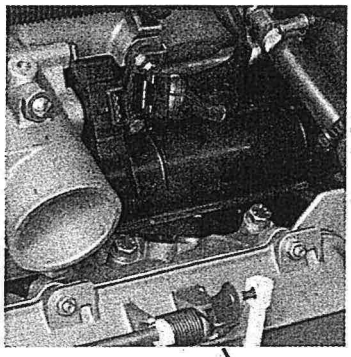


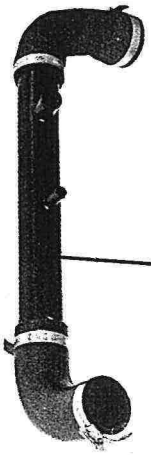


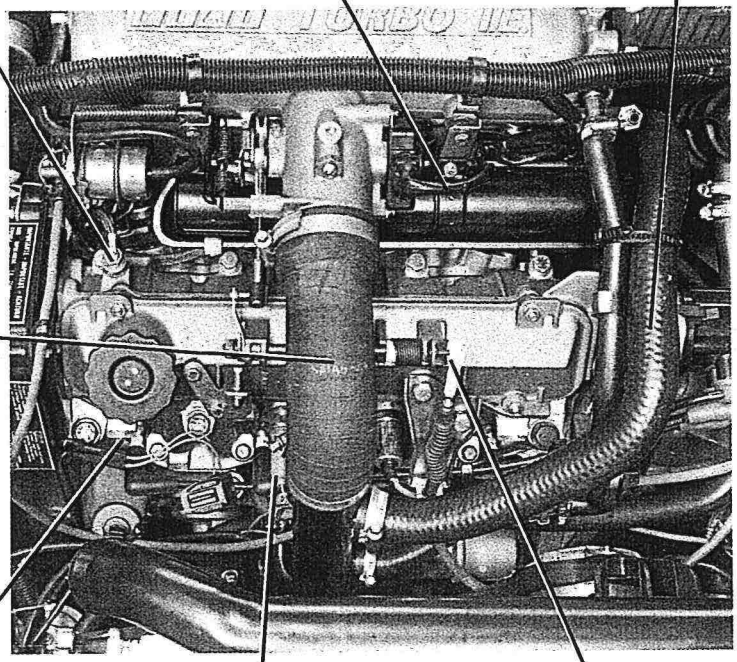
– Disconnect the electrical connection for the oil pressure sender unit.

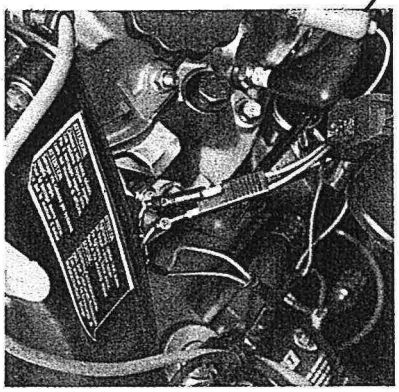
– Disconnect the electrical connections from all the injectors.

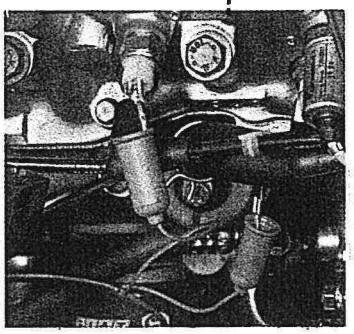




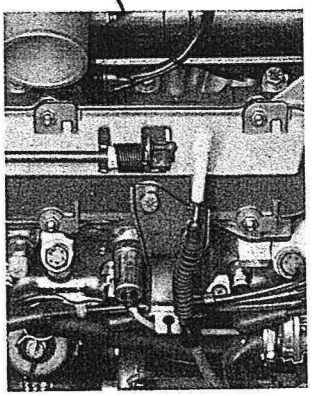








Coolant temperature sender unit



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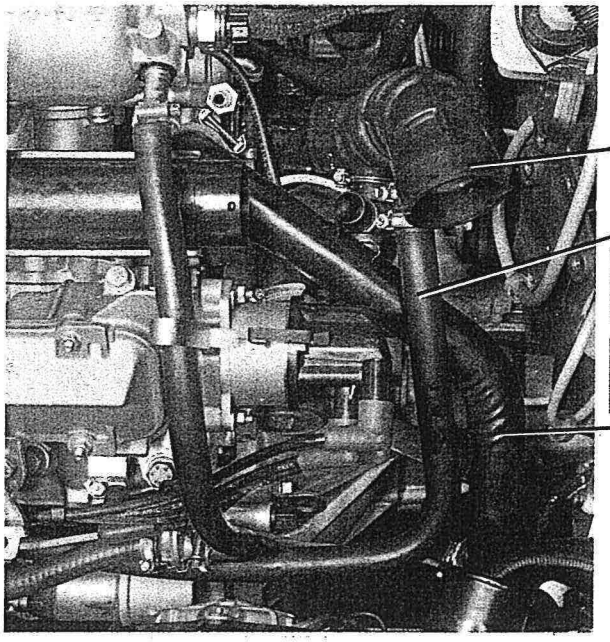
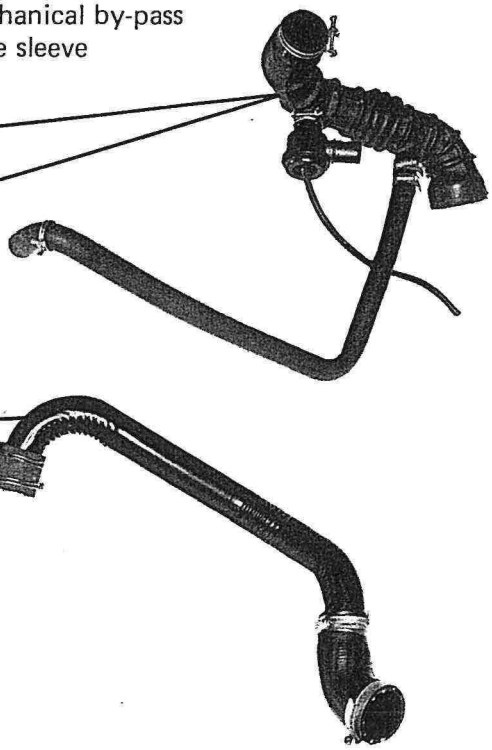
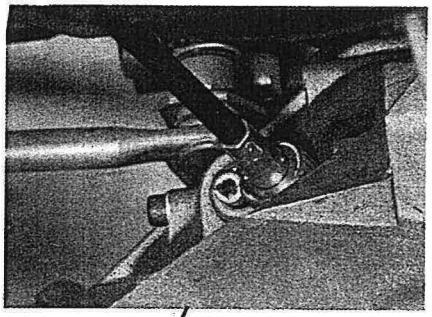
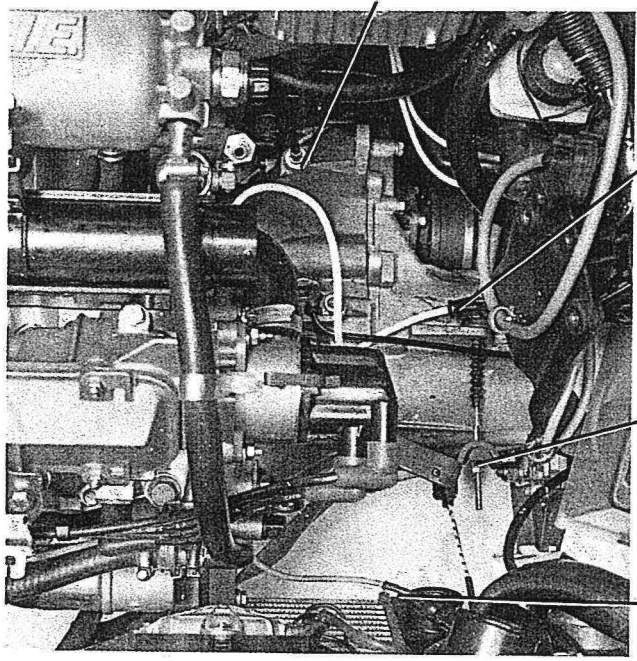


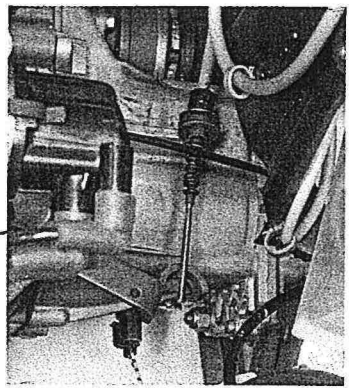
Mechanical by-pass valve sleeve





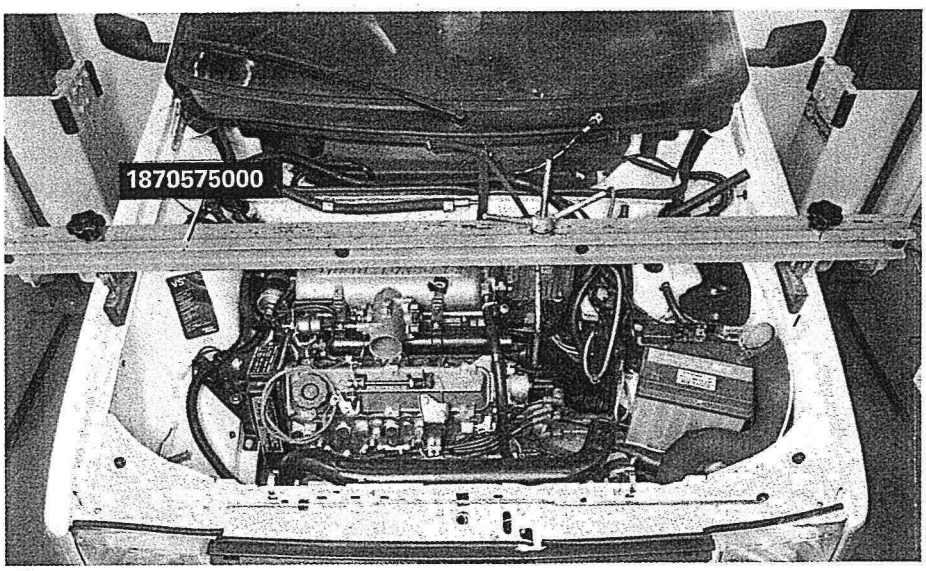


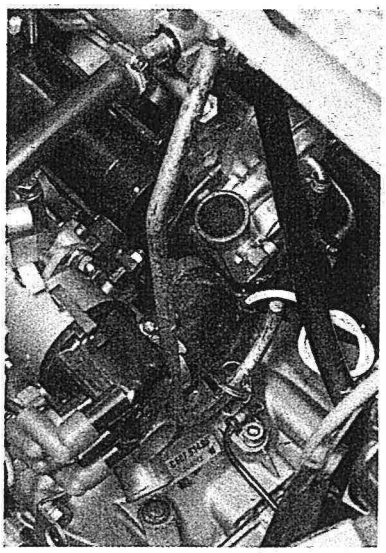
— Disconnect the electrical connection for the rpm sensor



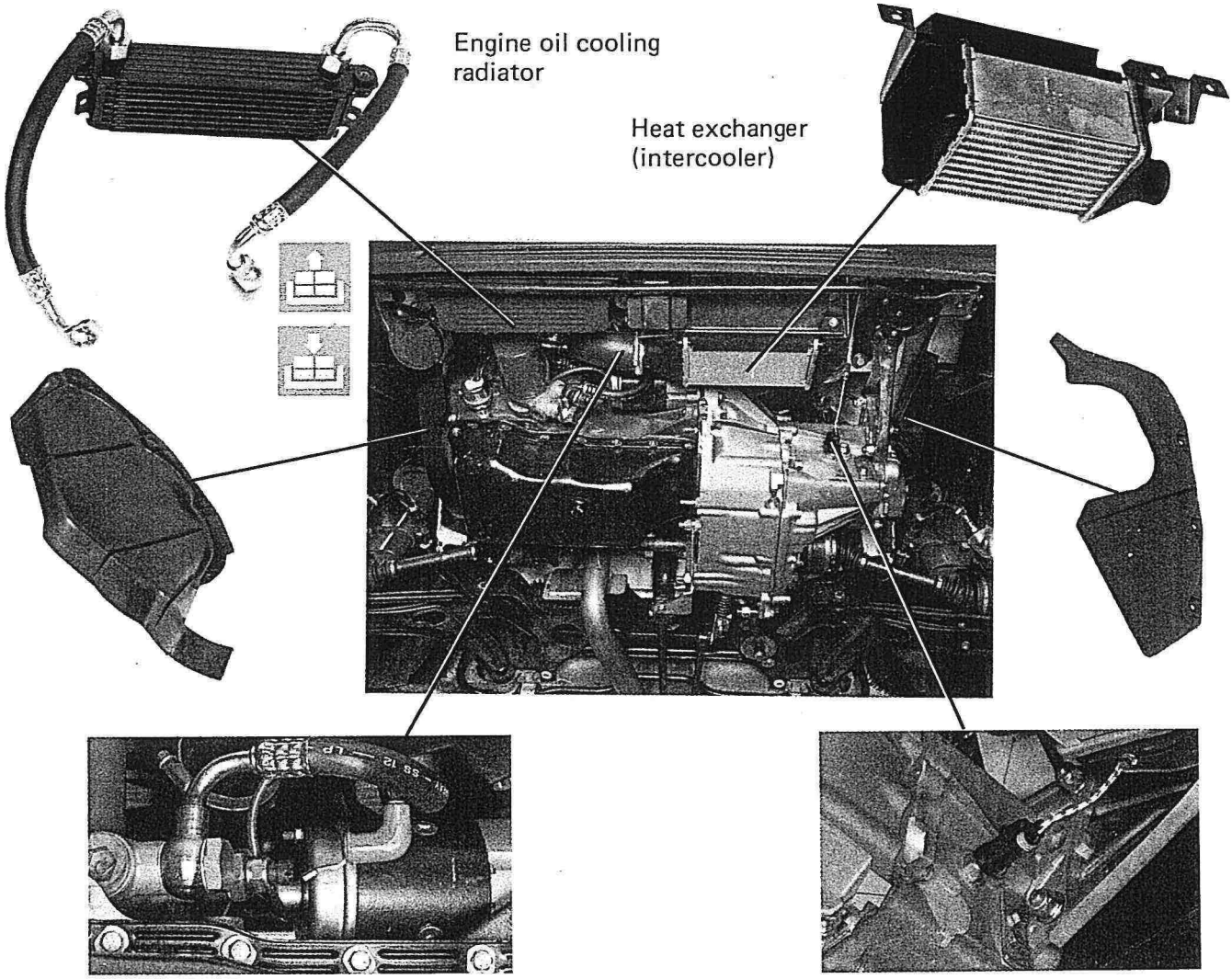
— Disconnect the electrical connection for the detonation sensor

– Remove the front wheels.
– Disconnect the earth cable from the gearbox.
– Fit engine support 1870595000.





– Raise the vehicle and, from beneath, remove the items illustrated below:



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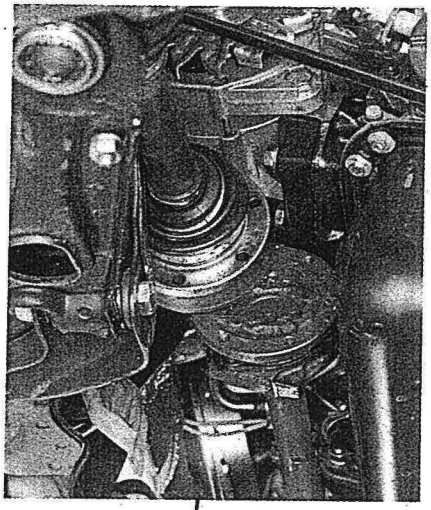
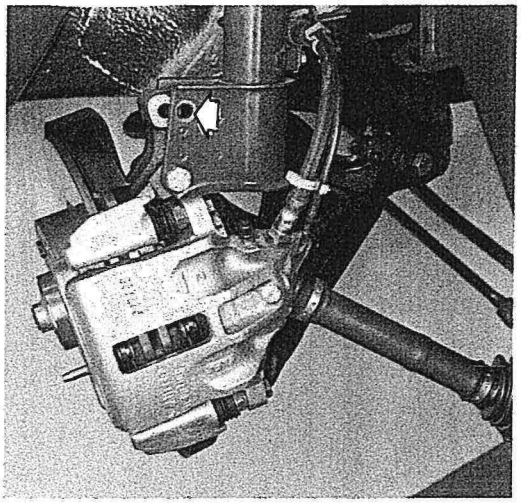
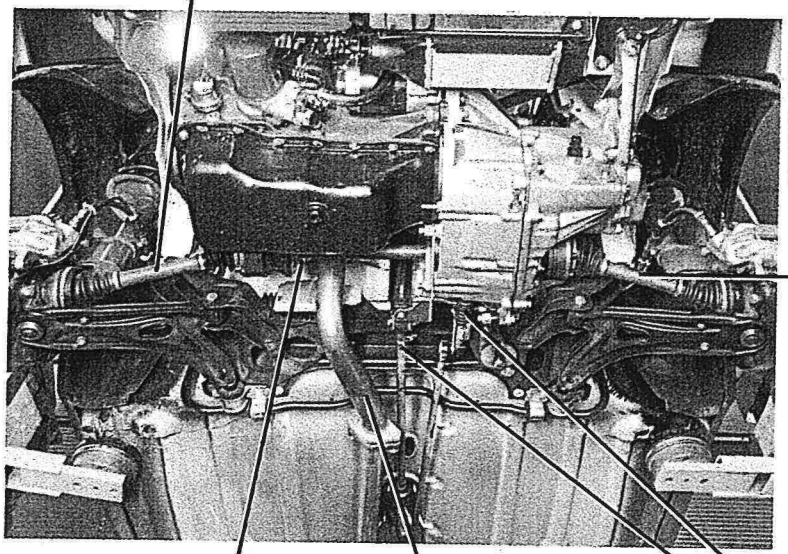
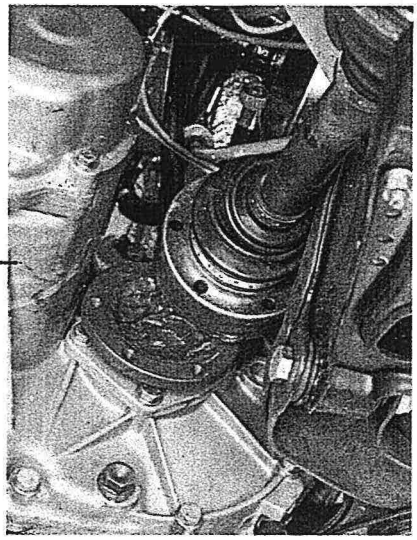
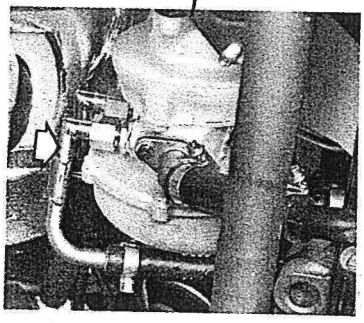




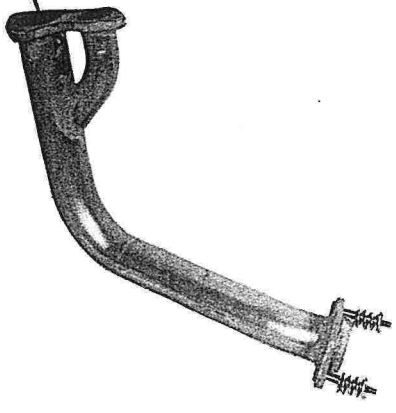
To allow the release of the right drive shaft from the relative flange it is necessary to remove the upper bolt fixing the damper to the shock absorber (shown by the arrow), loosen the lower bolt and position the drive shaft in the engine compartment.

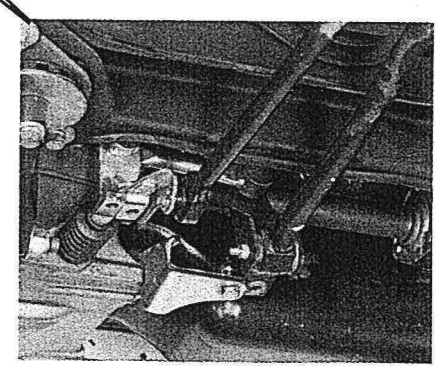


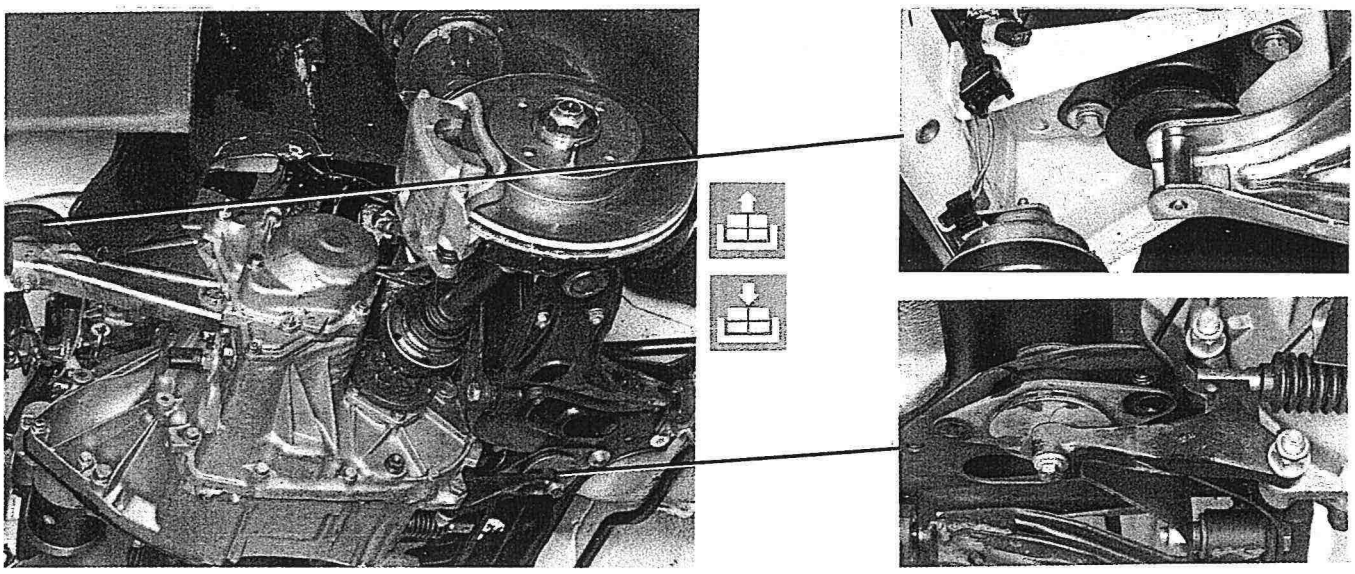




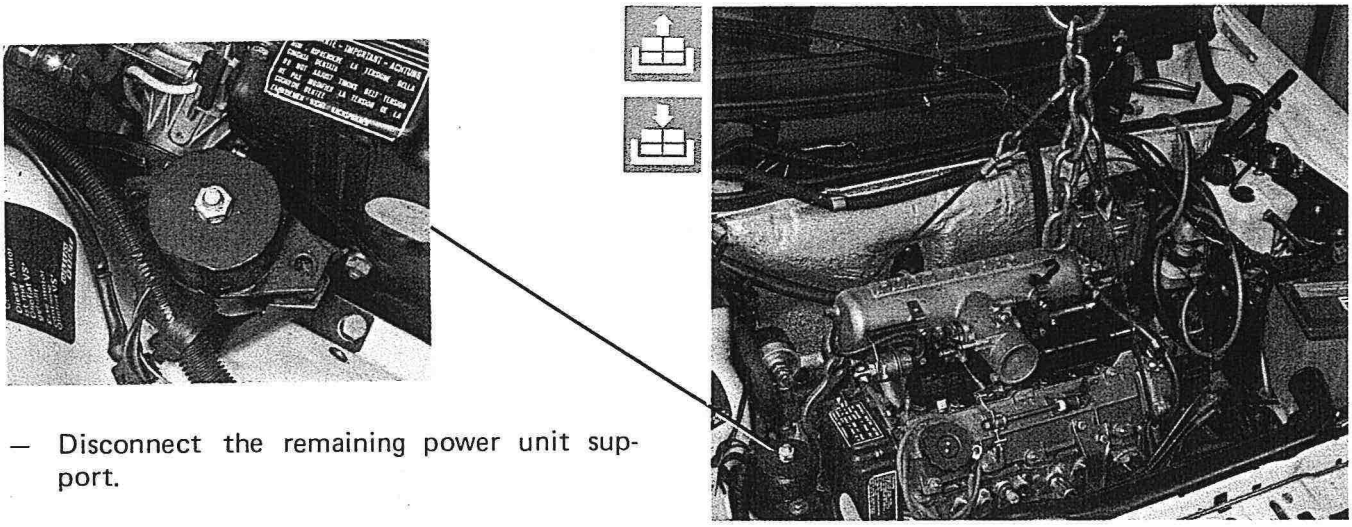
Disconnect the return pipe for coolant from the turbocharger.



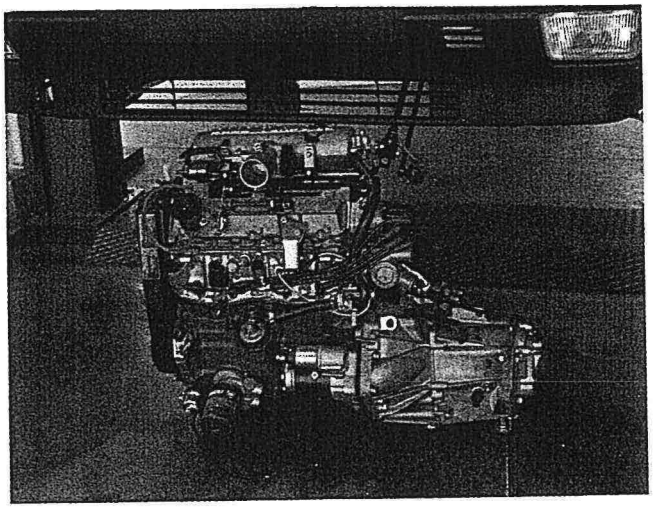




- Lower the lift.
- Position the universal hook 1860592000 in the appropriate attachment brackets on the power unit; then, using the hoist, place the power unit under slight pressure.



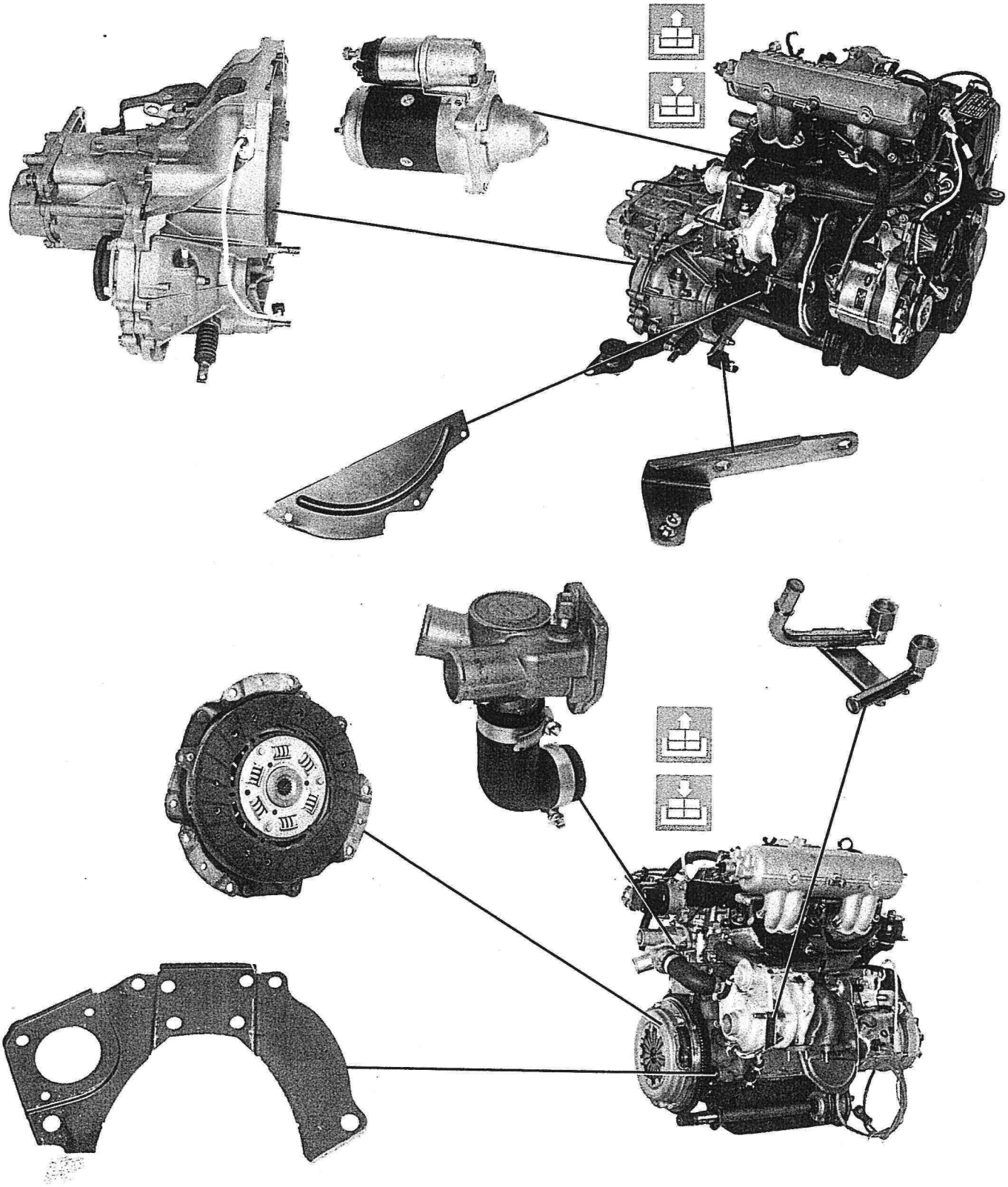
- Disconnect the remaining power unit support.



- Lower the power unit to the ground and release the hoist.
- Raise the lift and extract the power unit.

10.

— Rest the power unit on the support and remove the items illustrated below:

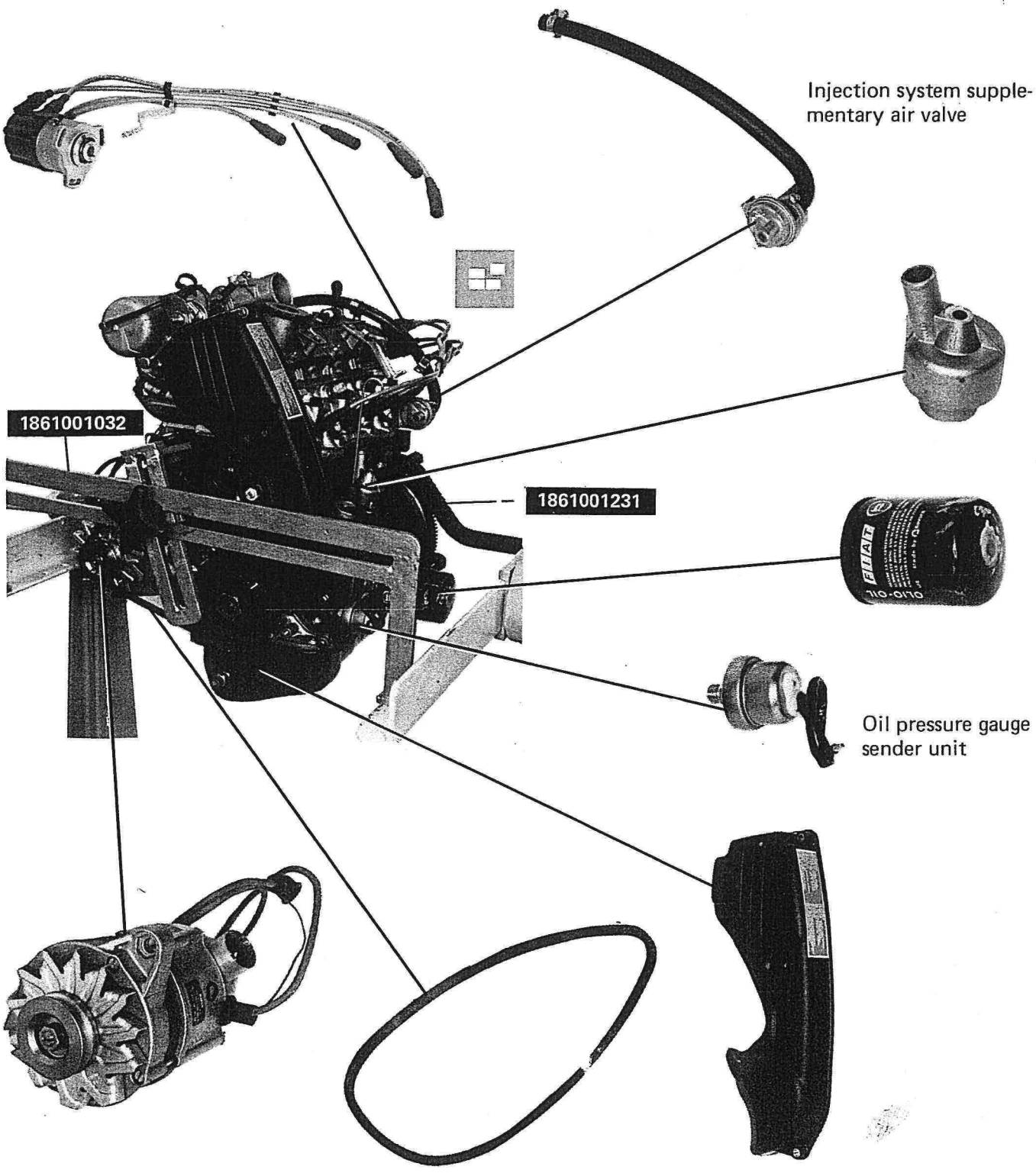


NOTE *To refit the power unit simply reverse the order of the operations described for the removal.*

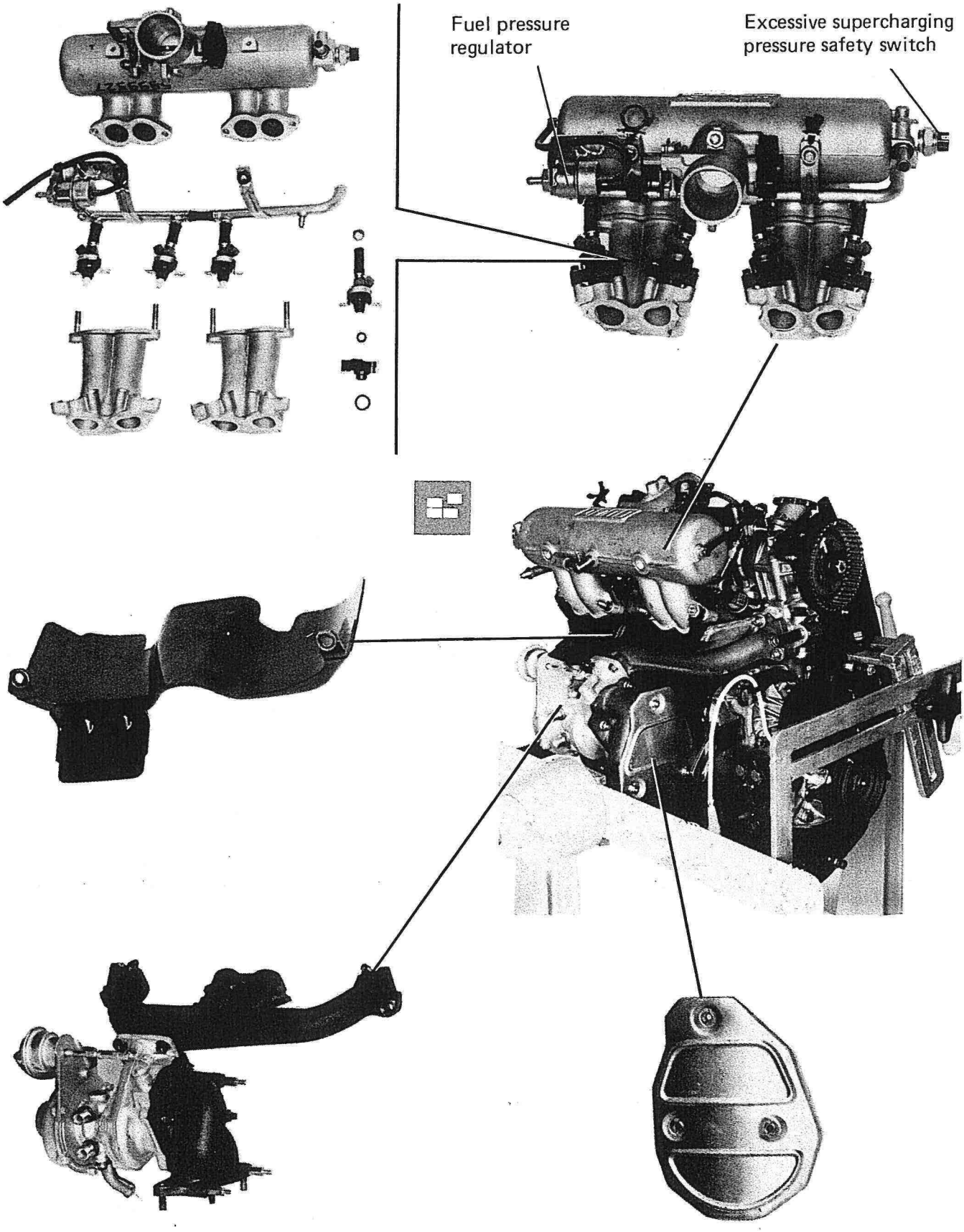
Clutch pedal height.

Order of operations

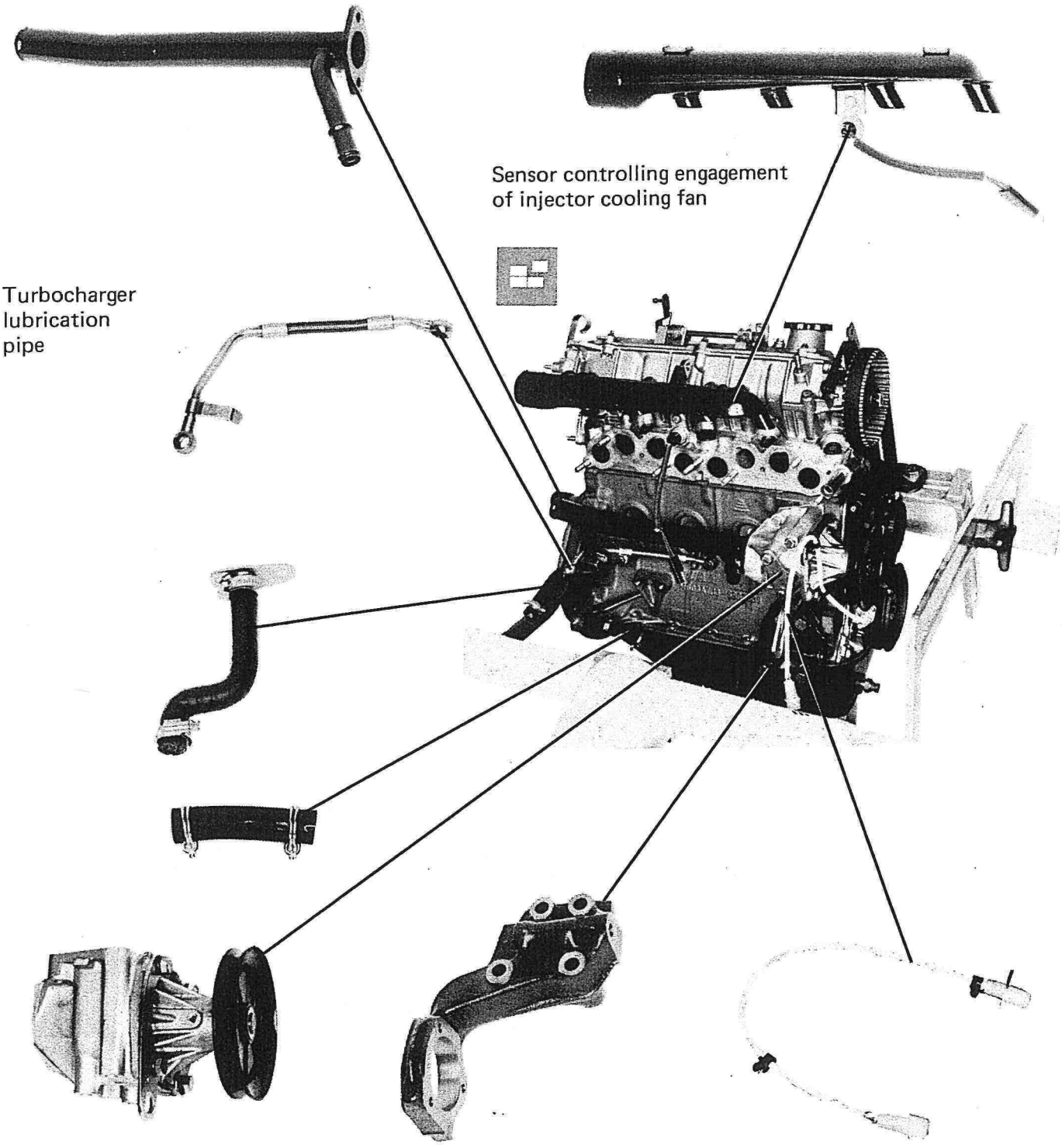
- Drain the engine oil (using spanner 1850113000) whilst the engine is raised off the ground by the hoist.
- Position the engine on the rotating stand using brackets 1861001231 (flywheel side) and 1861001032 (timing side).
- Then, remove the components illustrated below:



10.

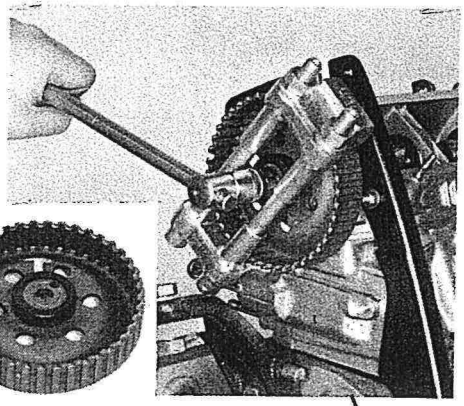


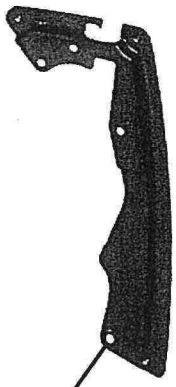
IHI – VL2 turbocharger with wastegate valve

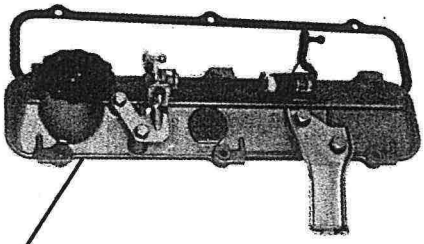


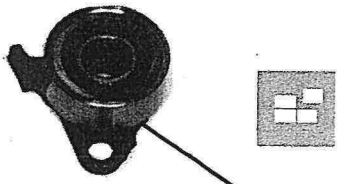
10.

Use tool 1860473000 to remove the camshaft pulley

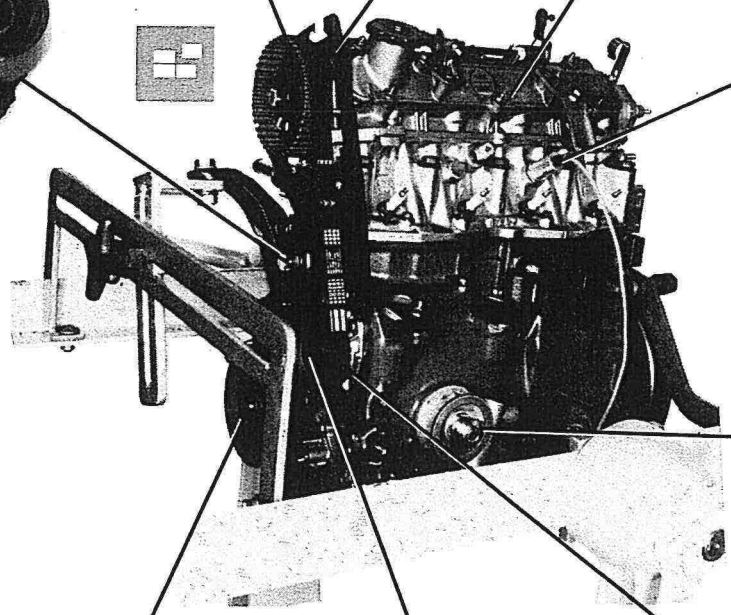


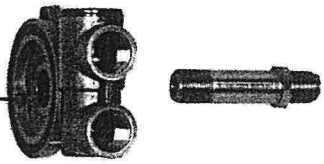




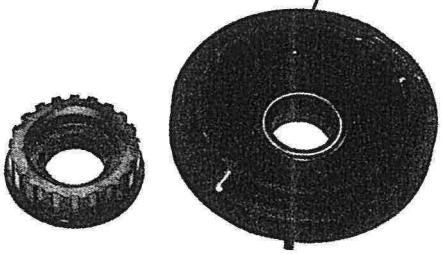


Microplex electronic ignition detonation sensor

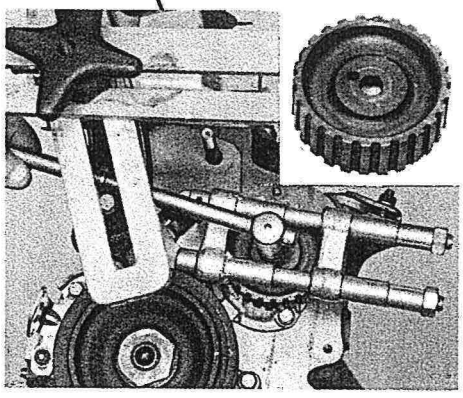




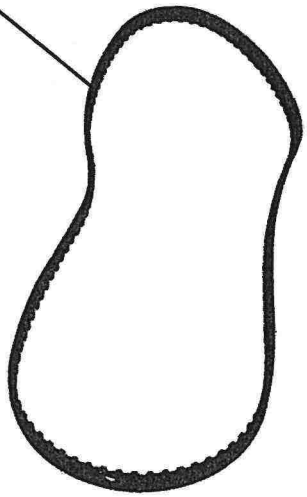
Oil filter mounting with thermostatic valve for engine oil cooling

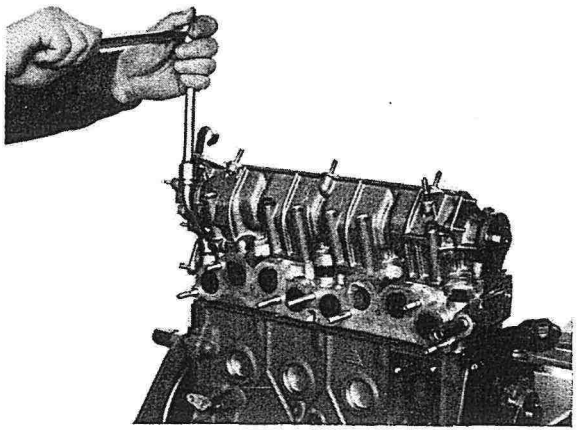


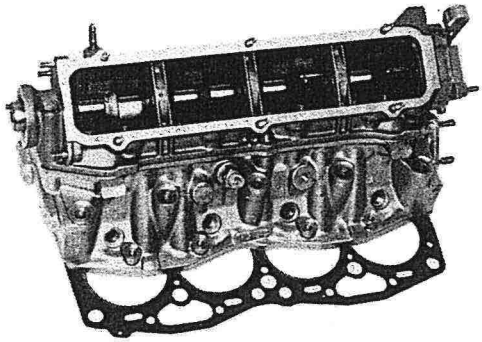
Use tool 1867029000 (flywheel lock) to remove the pulley fixing nut

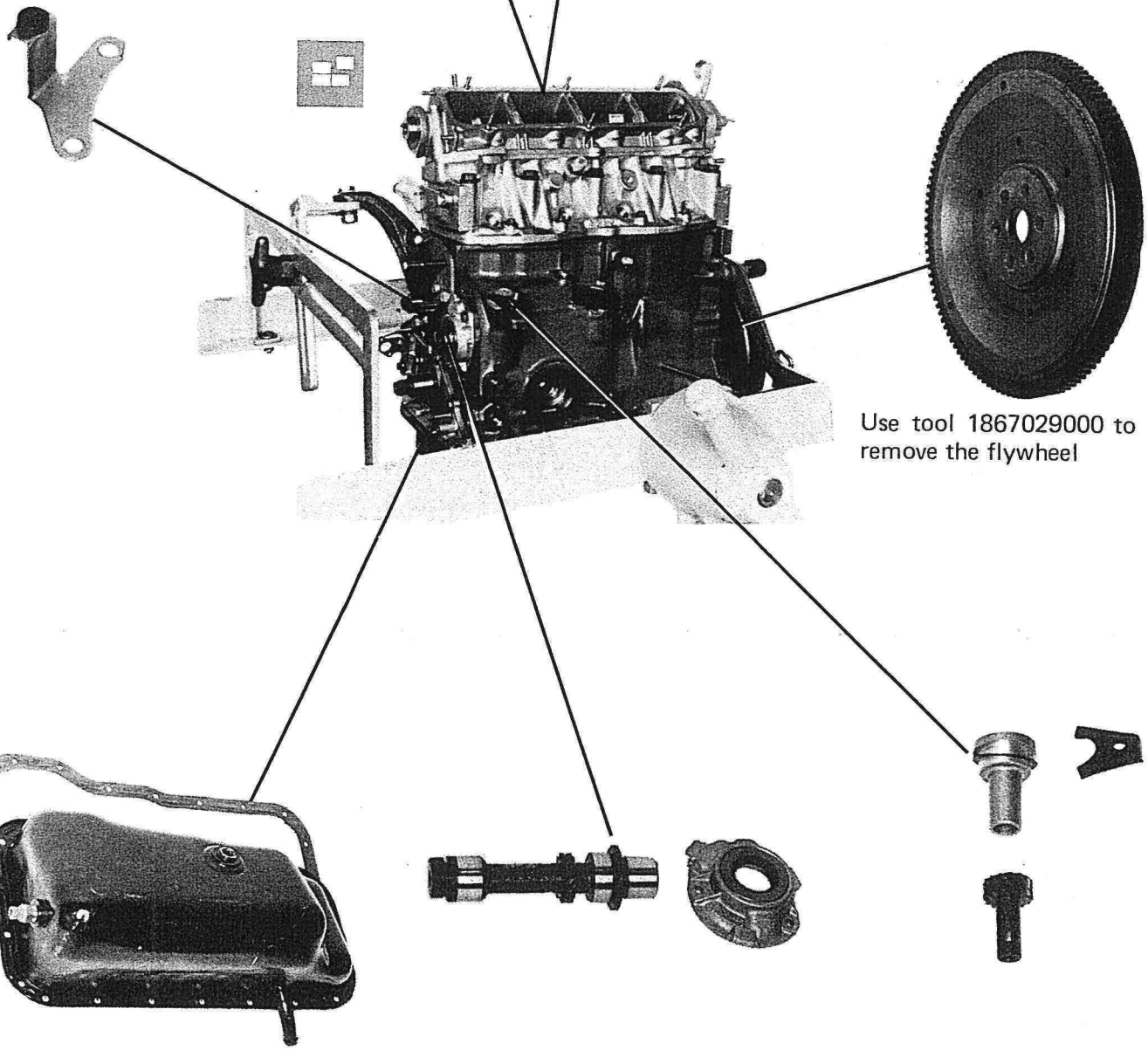


Use tool 1860473000 to remove the auxiliary shaft control gear



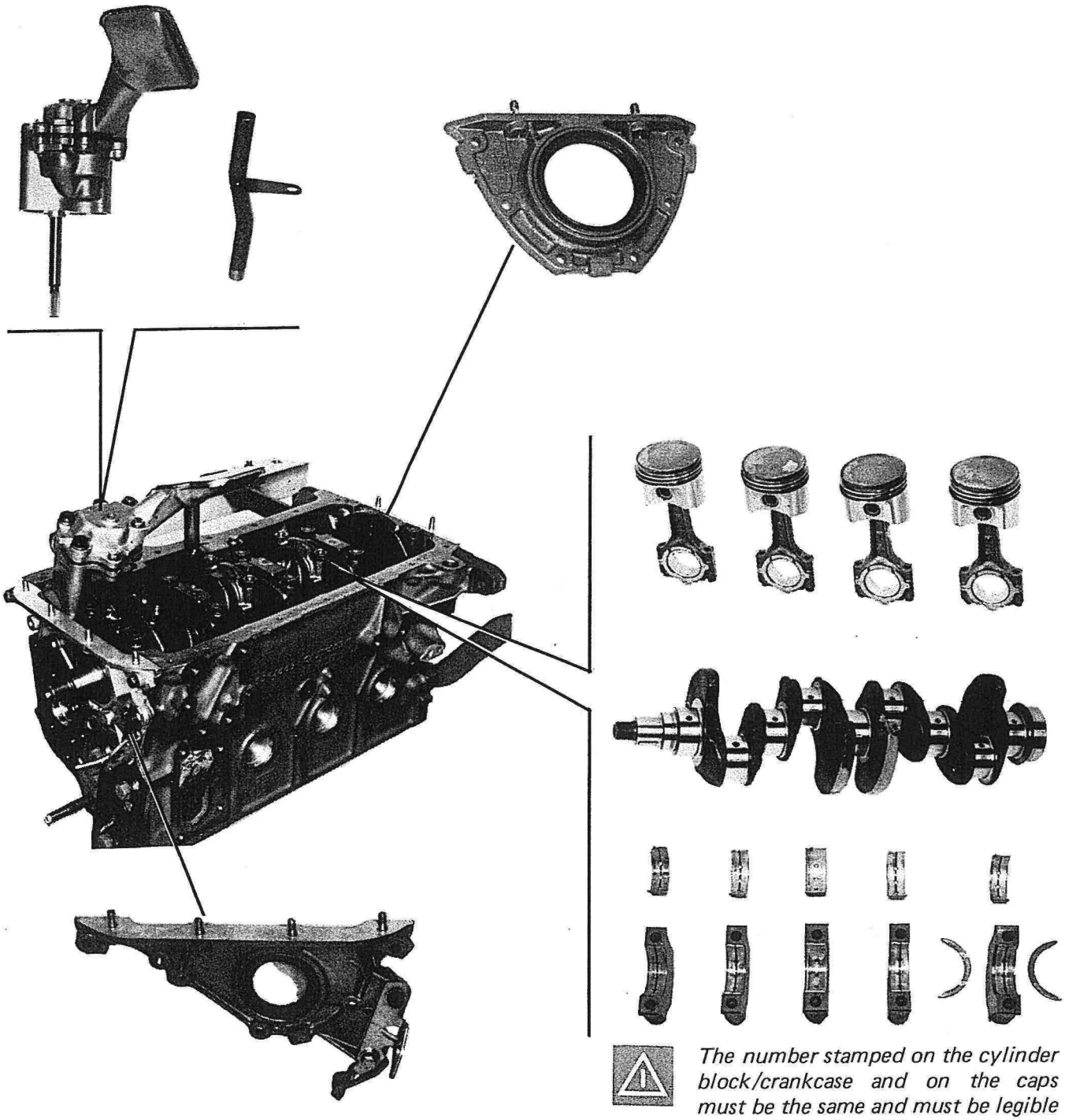






Use tool 1867029000 to remove the flywheel

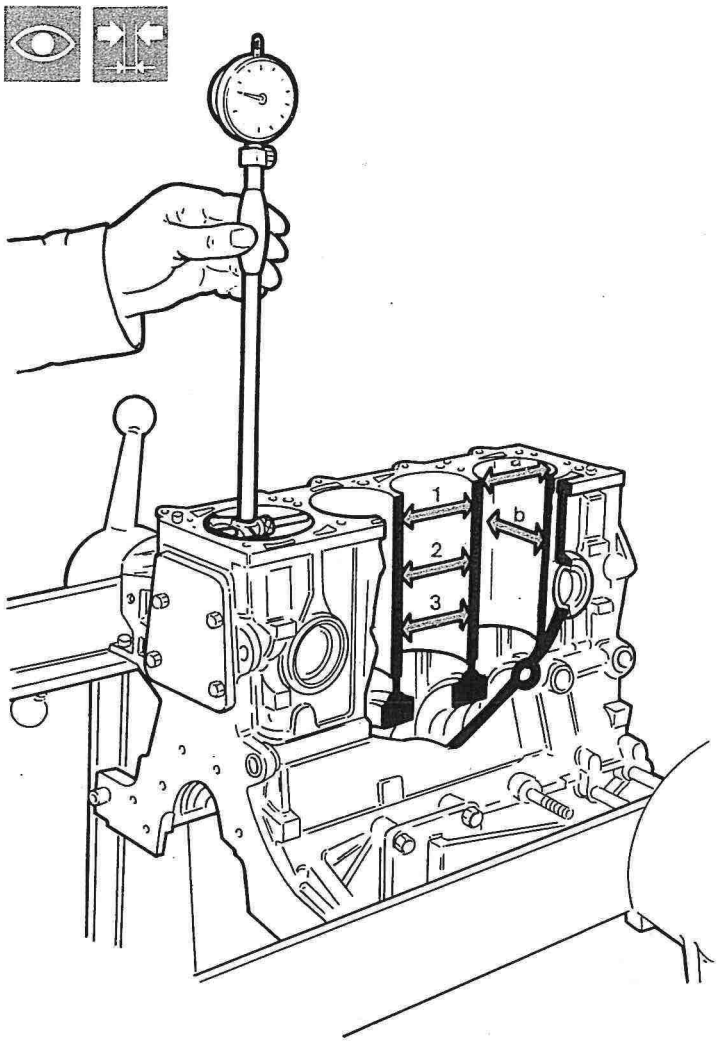
10.



The number stamped on the cylinder block/crankcase and on the caps must be the same and must be legible from the flywheel side.
The position of each cap is given by a set of reference marks which start from the timing side.

NOTE *After dismantling the engine, carry out an accurate check on the various dismantled components. The chapters which follow contain instructions for the main checking and measuring operations necessary in determining whether the components are suitable to be re-used.*
They also contain the refitting sequences and procedures as well as the special tools to be used which facilitate the operation of reassembling the engine.

CYLINDER BORES AND CYLINDER BLOCK/CRANKCASE

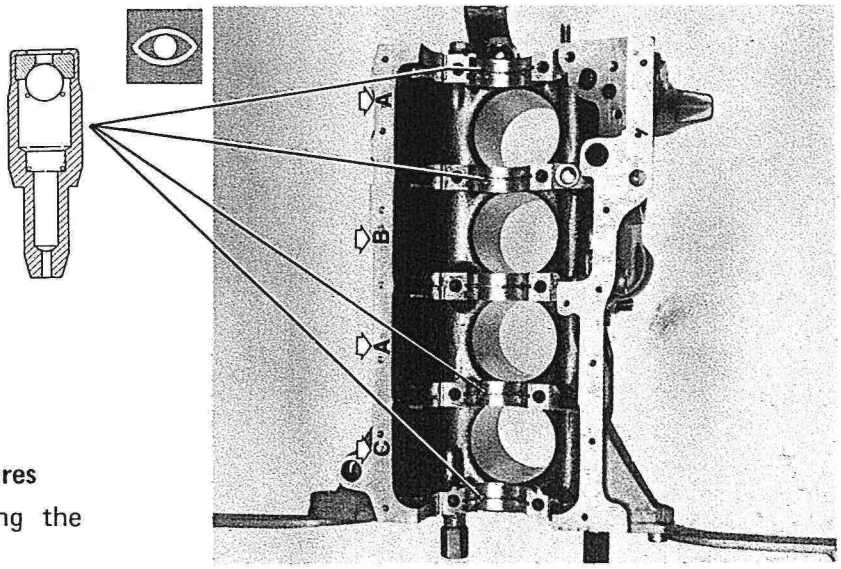


Checking and measuring cylinder bores

Measure the maximum ovality, taper and wear of the cylinder bores.
Visually inspect all the sliding surfaces.
Cylinder bores are available in 0.10 mm grades:

A – B – C – D – E

NOTE *The tolerances allowed for regrinding cylinder bores are: taper - difference between 1st and 3rd measurement: ± 0.005 mm; ovality - difference between a and b: ± 0.05 mm.*
If the cylinders need reboring, the same oversize must be used.

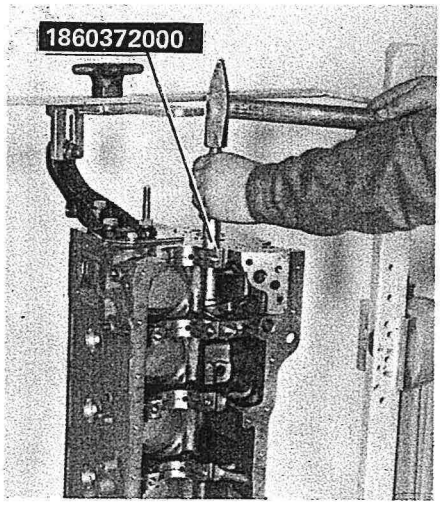


Location of spray nozzles for cooling pistons

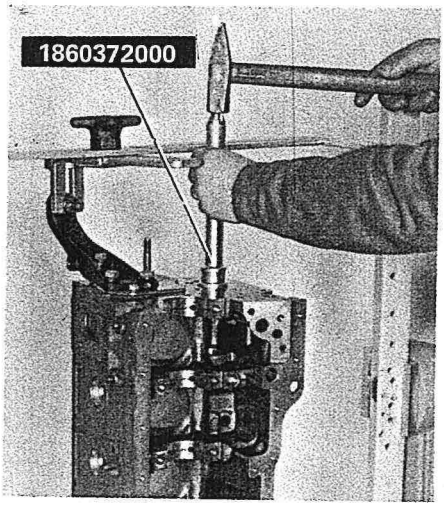
NOTE *Operation commences when the engine oil pressure reaches a minimum value of 1.2 bar.*

Selection of normal diameter cylinder bores

The arrows show the letters indicating the class to which the cylinder bores belong.

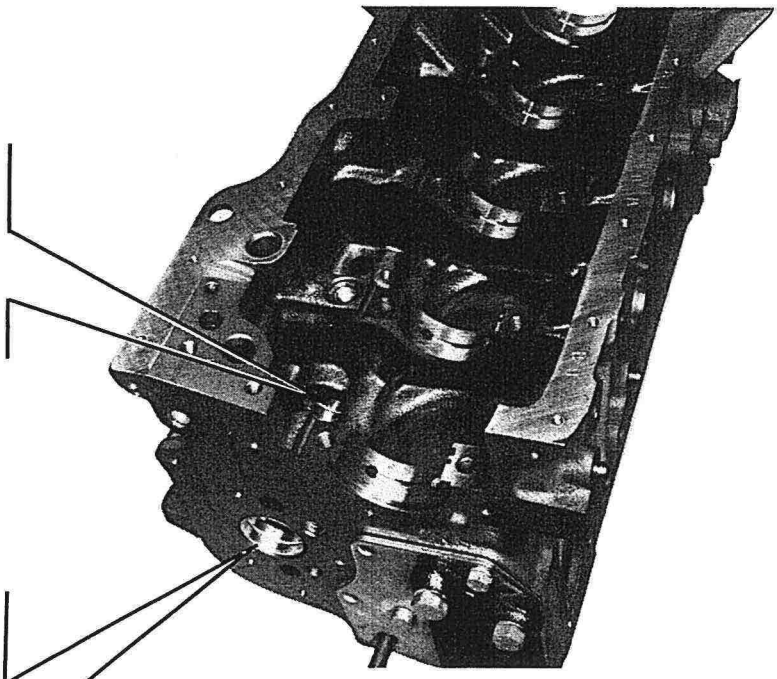


Removing-refitting flywheel side bush



Removing-refitting timing side bush

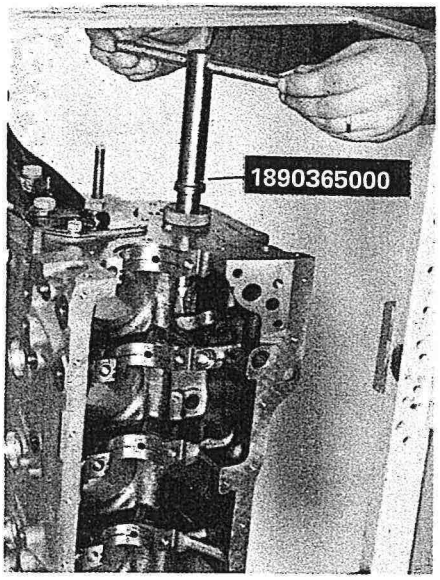
CYLINDER BLOCK/CRANKCASE

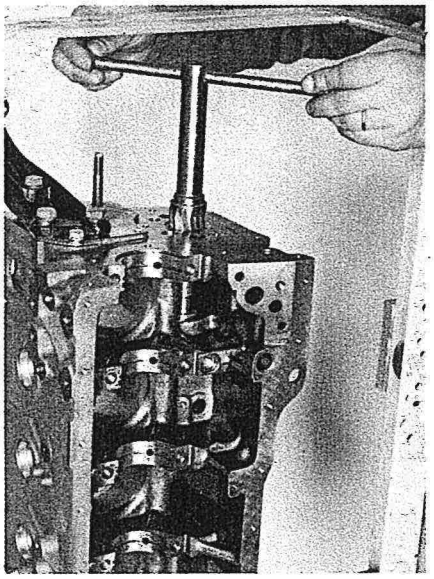


Checking auxiliary shaft bush housings

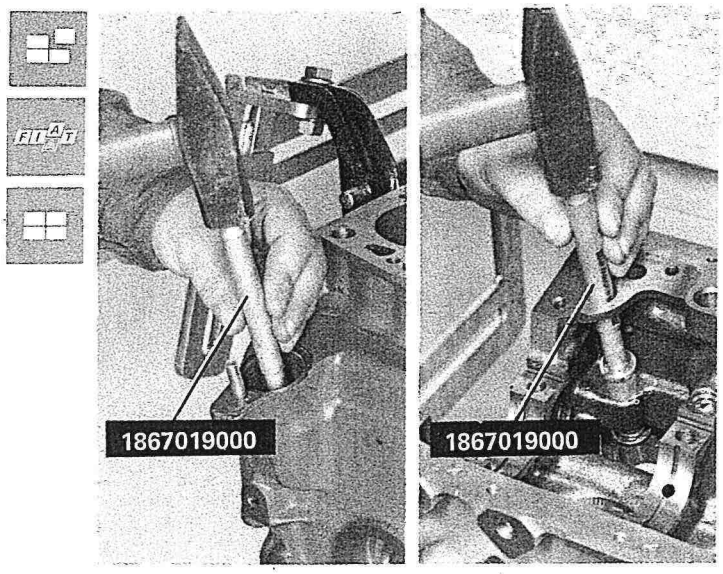
NOTE *If there is any ovality or scoring on the inner surfaces, replace the bushes.*

When carrying out the fitting operation, turn the bush so that the oil lubrication hole corresponds with the relevant channel in the cylinder block/crankcase.



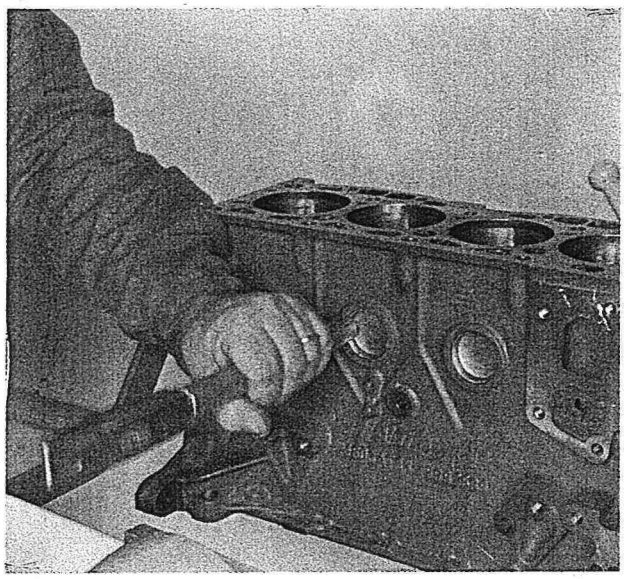


Reaming flywheel and timing side bushes



Removing and refitting bush for oil pump and distributor control gear

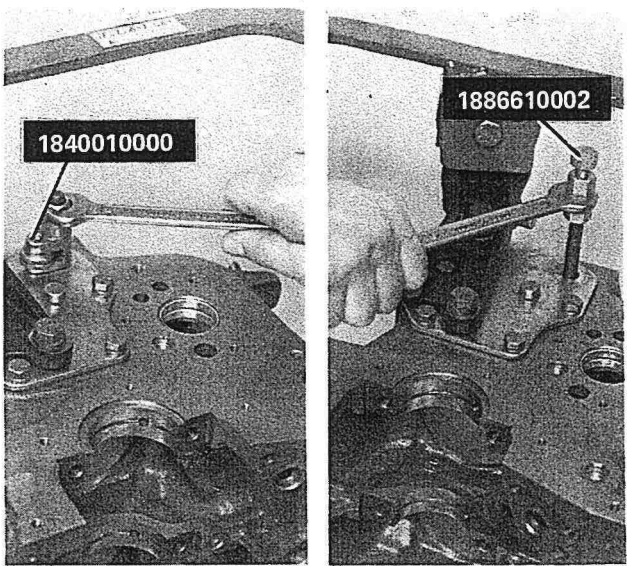
If the bush is scored or there is excessive ovality, it should be replaced.



Fitting plugs in cylinder block using an ordinary drift

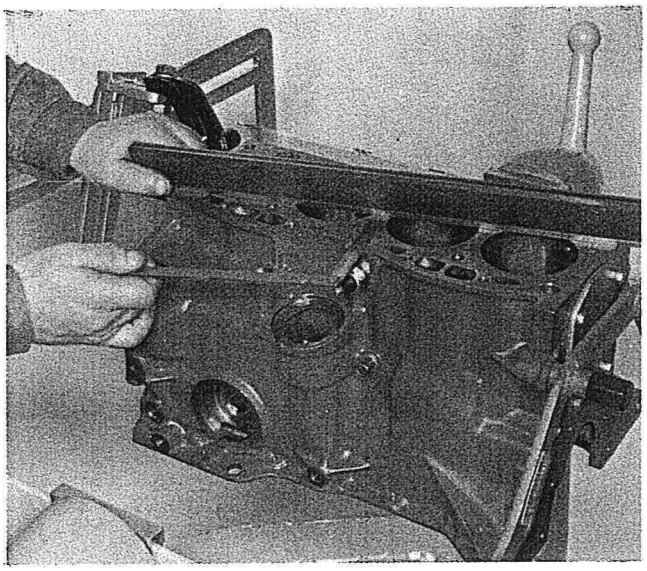
The plugs for the waterjacket can be removed using an ordinary steel drift.

Before fitting the plugs, smear some sealant on the surfaces in contact with the cylinder block.



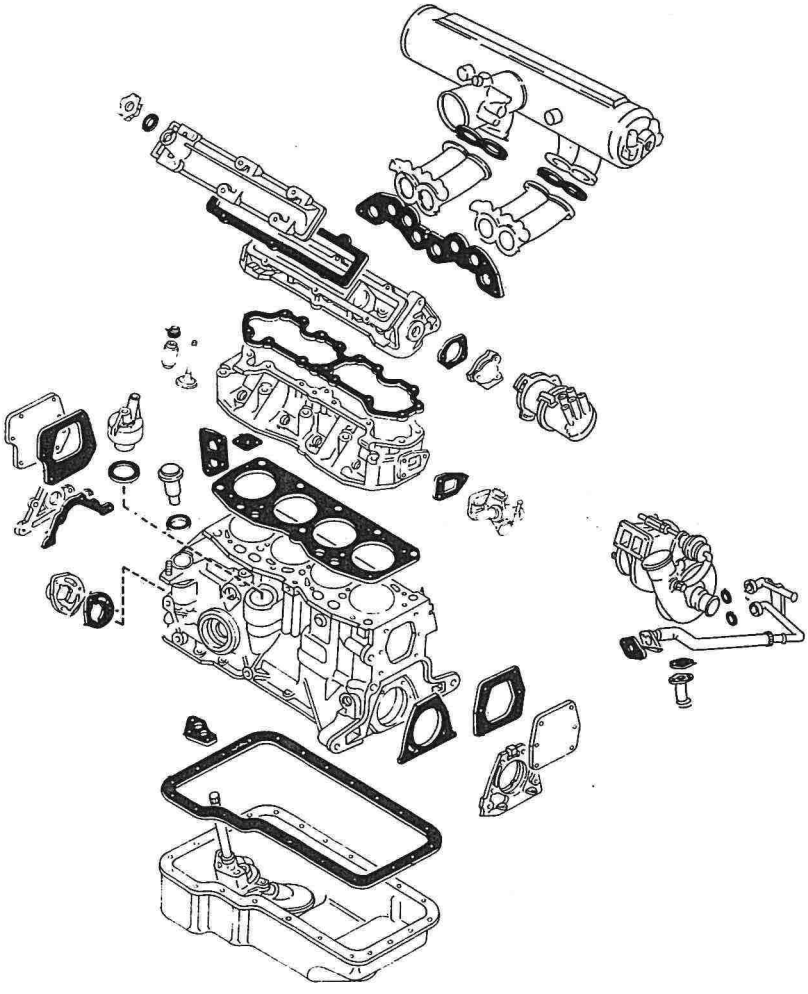
Removing-refitting studs

10.



Checking cylinder head support surface using straight edge and feeler gauge

NOTE *The maximum deformation of the cylinder head support surface should not exceed 0.1 mm.*



Gasket set for overhauling engine

The gasket must be replaced each time a component is removed.

CRANKSHAFT

NOTE *In order to improve its properties of mechanical resistance and resistance to wear, the crankshaft has undergone a nitriding treatment.*
When the main journals or crankpins have to be ground, after undersizes, the shaft should once again undergo the nitriding treatment to avoid the possibility of it breaking in use. This treatment should be carried out at specialist workshops specifying that "Tuftriding" is required.
After this operation, the crankshaft should no longer be straightened. It is necessary, however, to check that the deformation is within the prescribed tolerance or else it must be replaced.

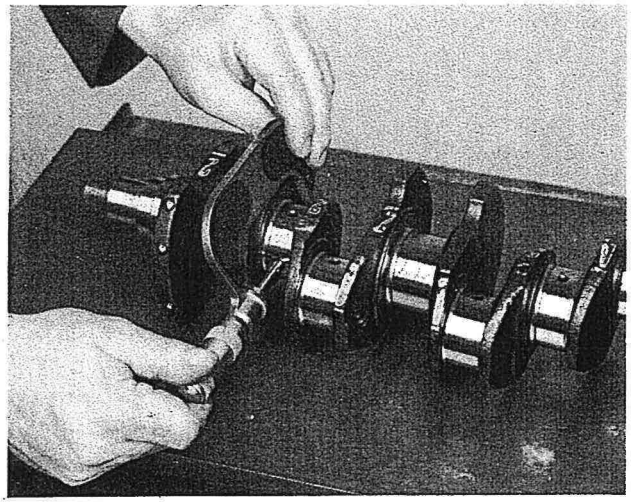
Measuring main journals and crankpins

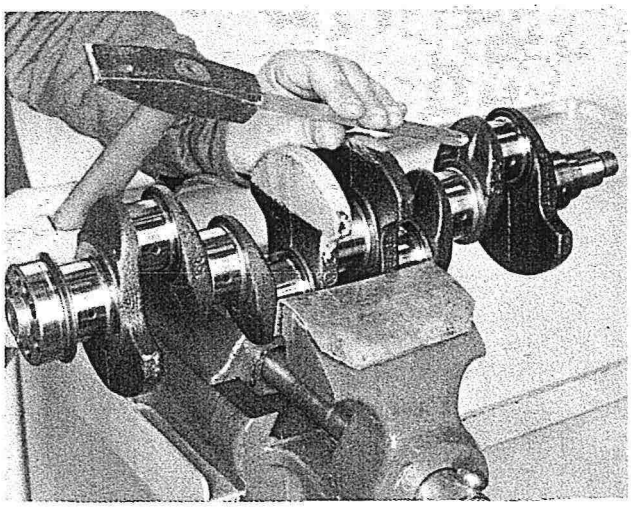
The following undersizes are available: 0.254 and 0.508 mm.

NOTE *Check the ovality of the main journals and crankpins. If it is more than 0.02 mm, or if the surfaces show signs of excessive scoring, the journals and pins have to be ground.*
When grinding crankshaft main journals and crankpins the tolerances allowed are:

ovality	*± 0.005 mm*
taper	*± 0.005 mm*
non alignment of main journals	*± 0.025 mm*
non alignment of crankpins	*± 0.125 mm*

All journals and pins are always ground to the same undersize class so as not to alter the balance of the shaft.

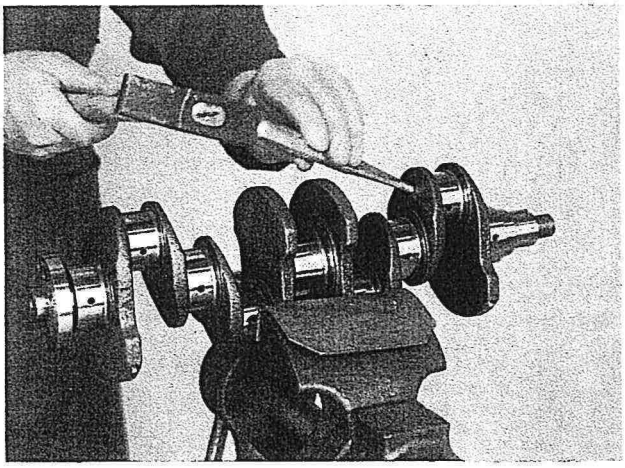




Fitting oil plugs using a drift

In the case of grinding journals and pins, it is vital to carefully wash the lubrication channels.

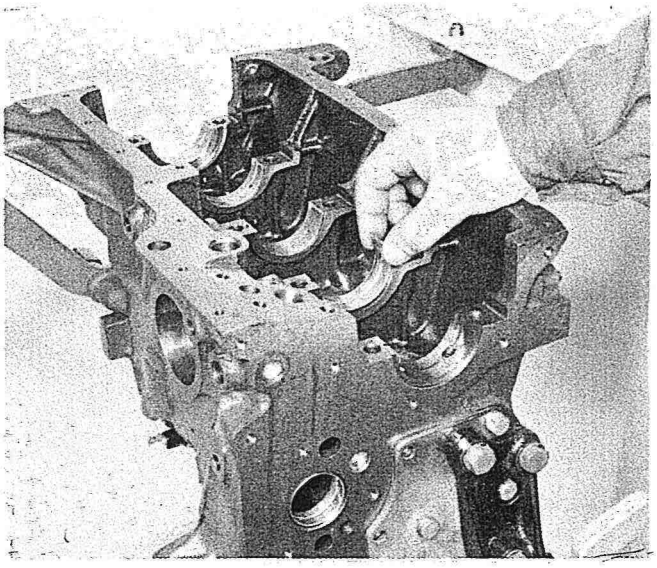
NOTE *The oil plugs can be removed using an ordinary steel drift.*



Staking oil plugs

This operation is carried out using an ordinary steel drift.

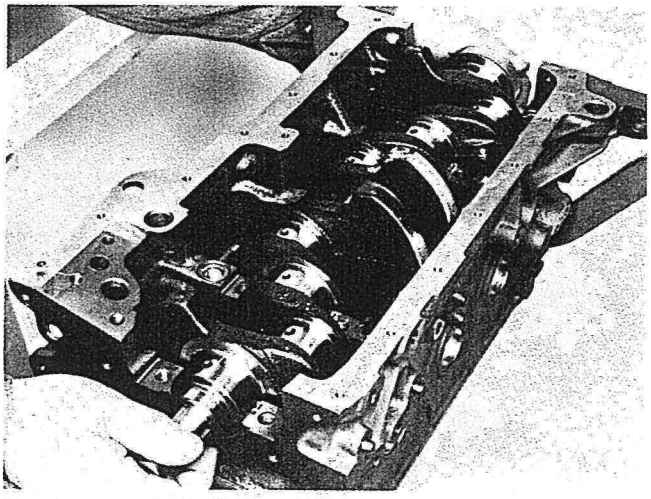
10.



CRANKSHAFT BEARINGS

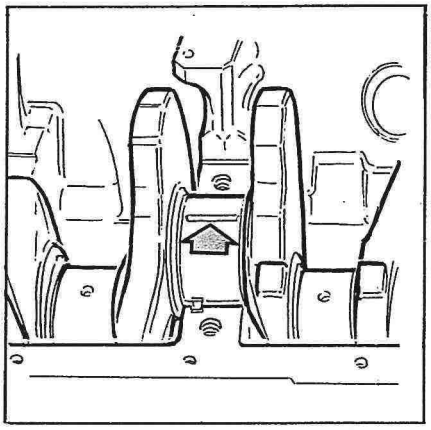
Checking and fitting

Never carry out any adjustments to the half bearings. If there is any scoring or traces of seizing, they must be replaced. Carefully clean the components when fitting.
Carefully clean the external surfaces of the half bearings and the relevant mountings when fitting.
Crankshaft bearings are available as spares with the following undersize internal diameters: 0.254 and 0.508 mm.



Fitting crankshaft

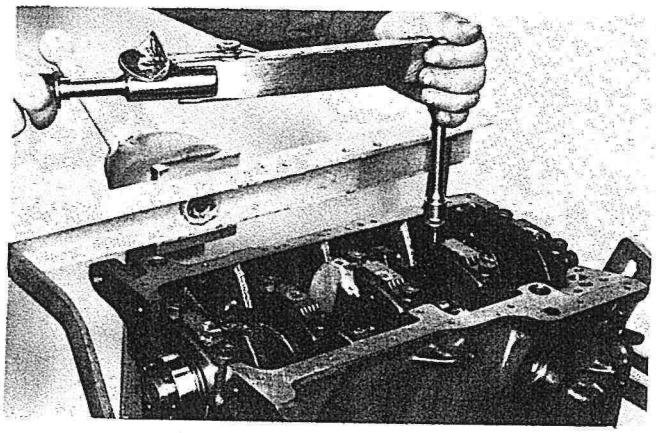
MEASURING BEARING CLEARANCE



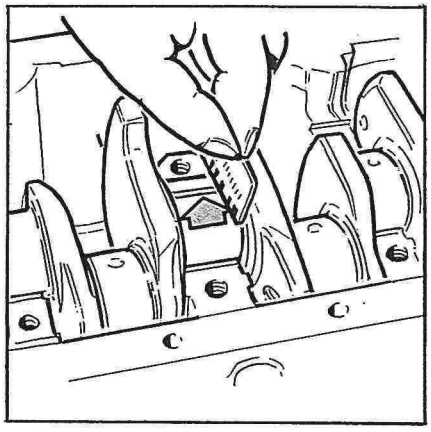
Plastigage (calibrated wire) for measuring bearing clearance

NOTE

The arrow shows the calibrated wire.



Tightening bolts securing main bearing caps to torque



Measuring clearance using plastigage

8 daNm

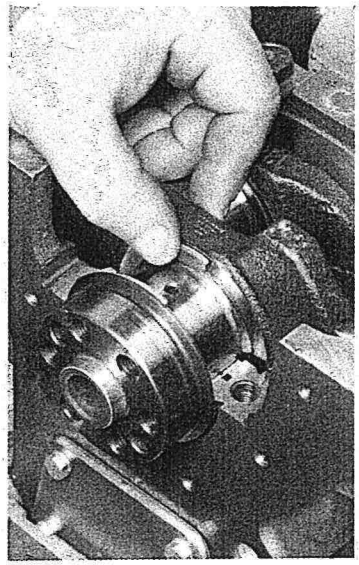
0,028 - 0,069

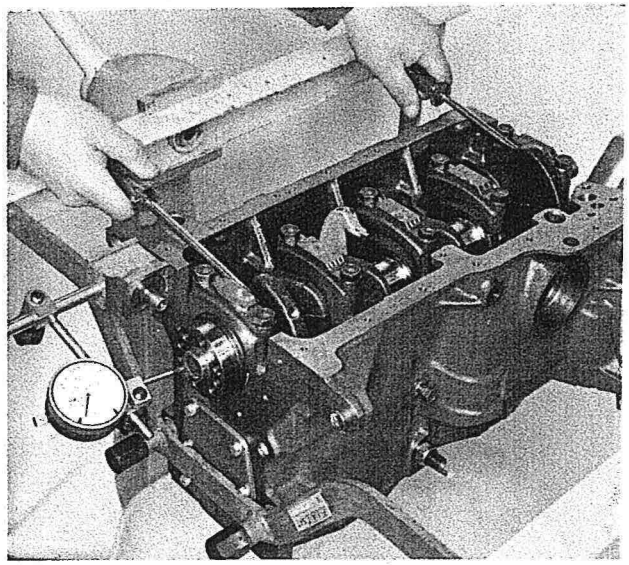
NOTE *Check the journals one at a time without removing the shaft during the checking operation.*

Lubricate the parts concerned with engine oil before fitting, then retighten the bolts fixing the main bearing caps to torque.

THRUST WASHERS

0,055 ÷ 0,265





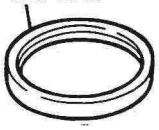
Fitting thrust washers on flywheel side bearing and measuring crankshaft end float

Refit the thrust washers with the splined surfaces facing the crankshaft.

Lubricate the parts concerned with engine oil before fitting.

CRANKSHAFT REAR COVER

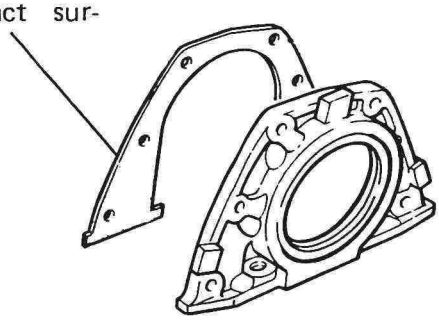
Lubricate the seal

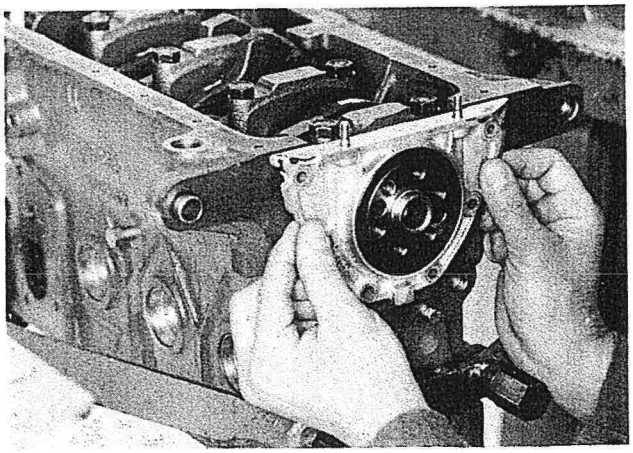


Fitting gasket

The seal can be removed using an ordinary steel drift.

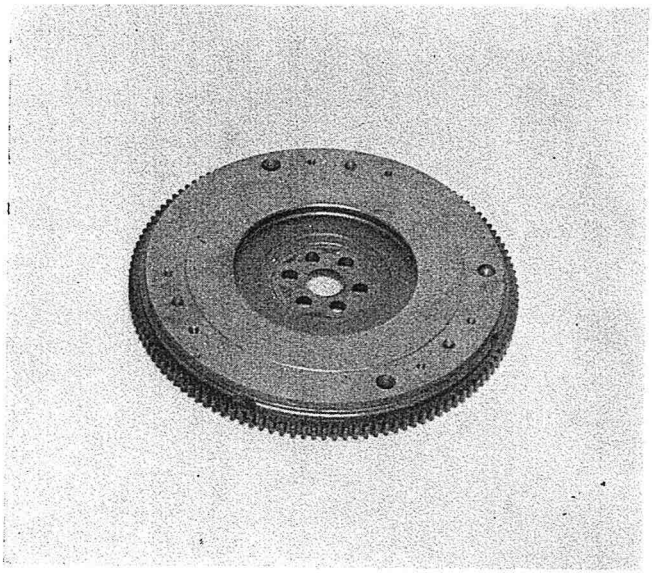
Slightly lubricate the gasket contact surfaces





Fitting cover

10.

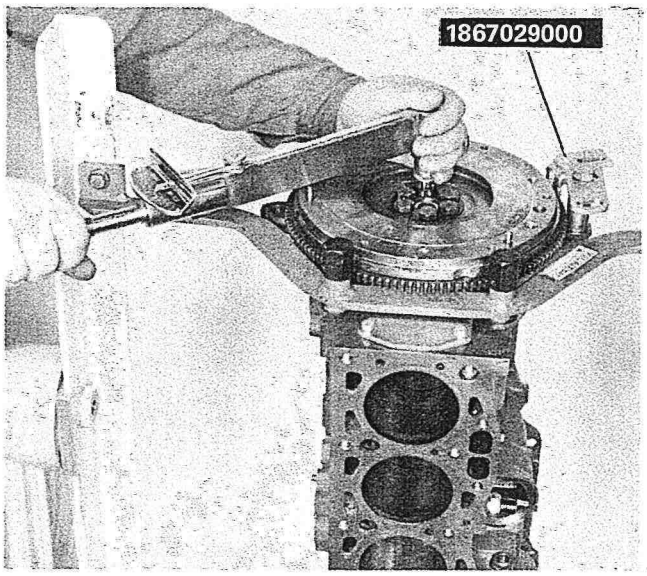


FLYWHEEL

Checking clutch disc support surface

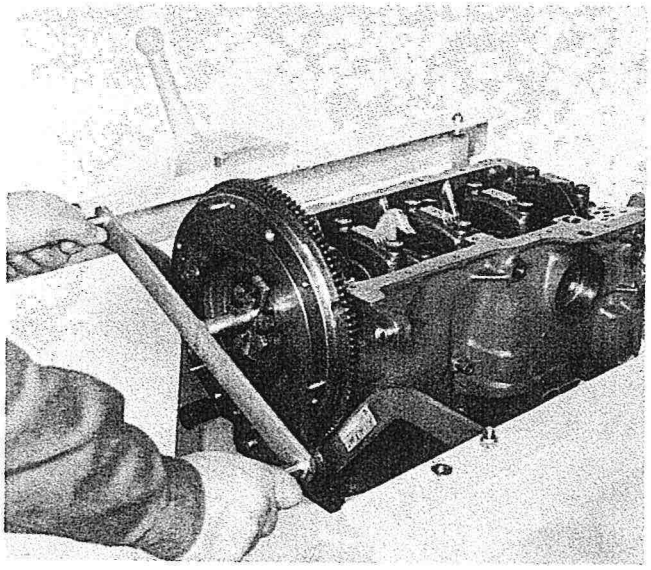
If there is any scoring on the surfaces, they must be skimmed.

NOTE *If the ring gear needs replacing, heat the new one in the oven to 80° C and fit it on the flywheel with the bevel on the internal diameter turned towards the actual flywheel.*
Use an ordinary steel drift when removing.



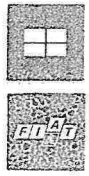
8,3 daNm

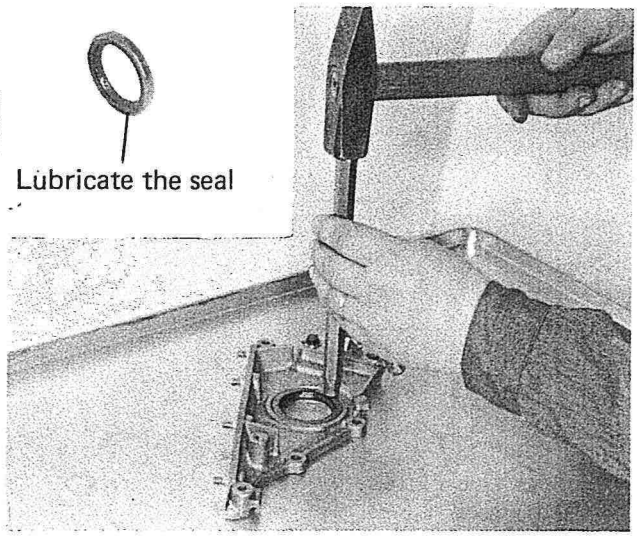
Fitting flywheel and tightening to torque using torque wrench



Fitting crank for rotating crankshaft

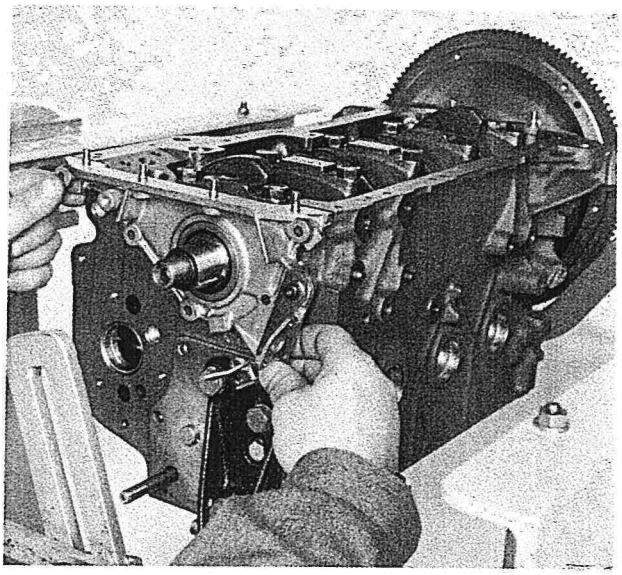
CRANKSHAFT FRONT COVER



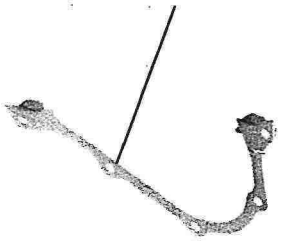


Fitting seal on crankshaft front cover

The seal can be removed using an ordinary steel drift.

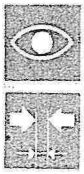


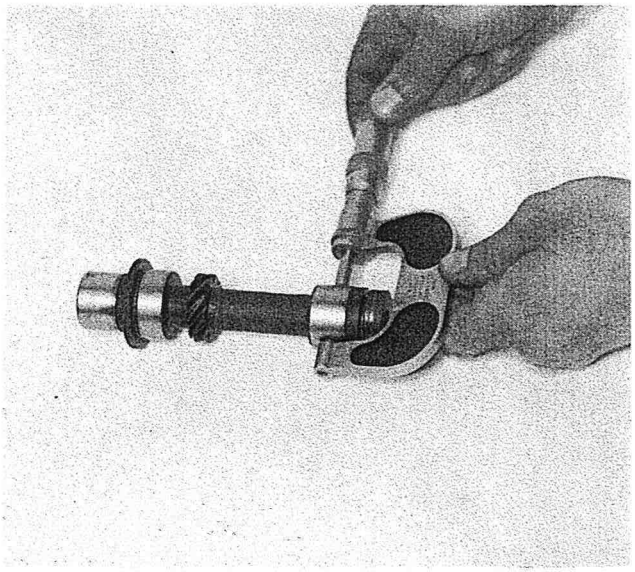
Slightly lubricate the gasket contact surfaces



Fitting front cover

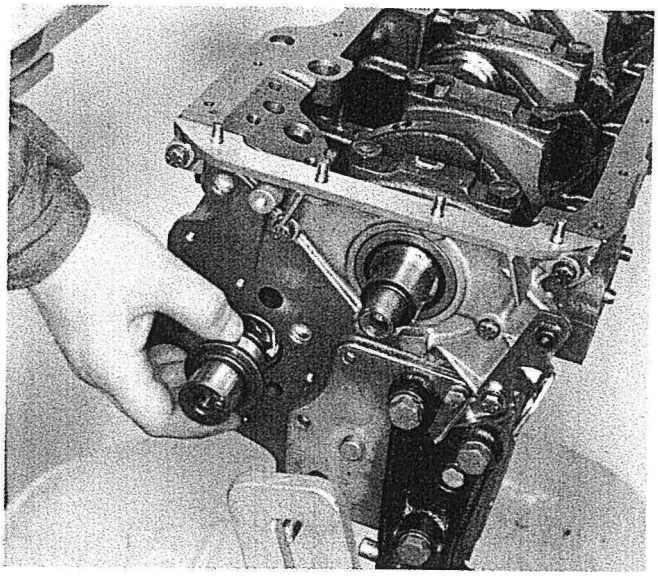
AUXILIARY SHAFT





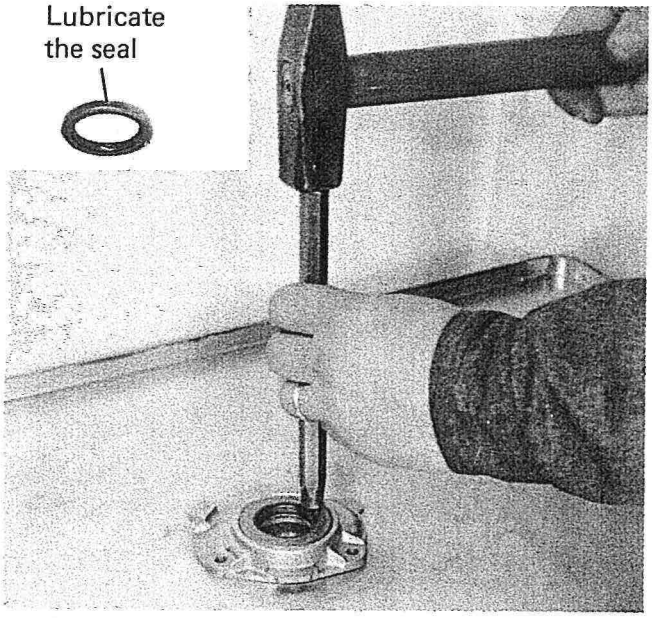
Measuring auxiliary shaft bearings

NOTE *There must not be any traces of seizing or scoring on the surface of the bearings or the gear, or the actual shaft will have to be replaced.*



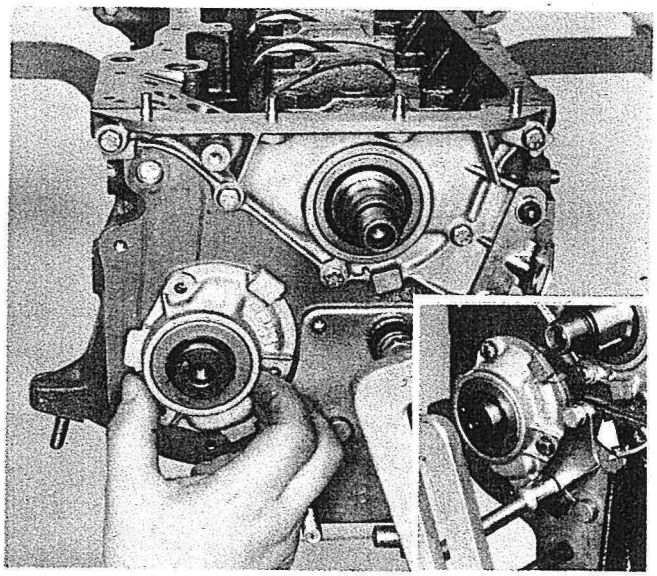
Fitting shaft

AUXILIARY SHAFT COVER



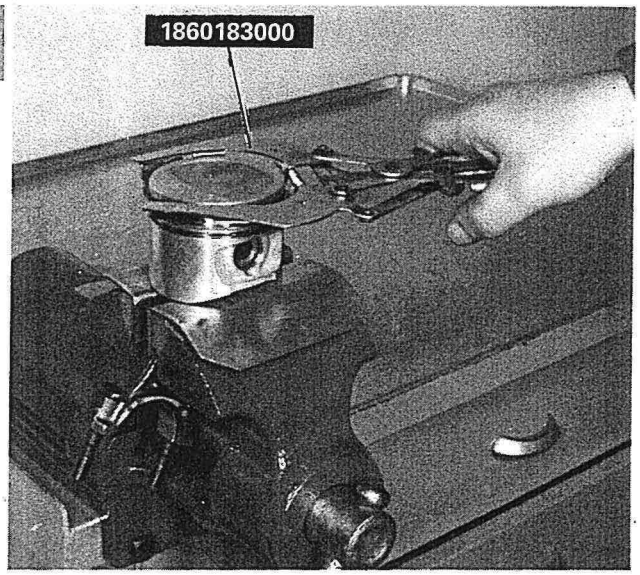
Fitting seal on auxiliary shaft cover

The seal can be removed and refitted using an ordinary steel drift.

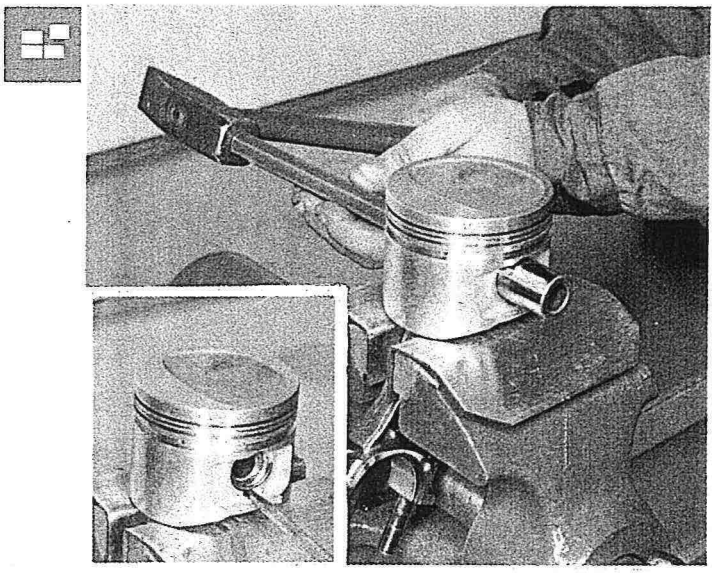


Fitting timing cover support plate and cover (shown by arrow)

CONNECTING ROD – PISTON ASSEMBLY



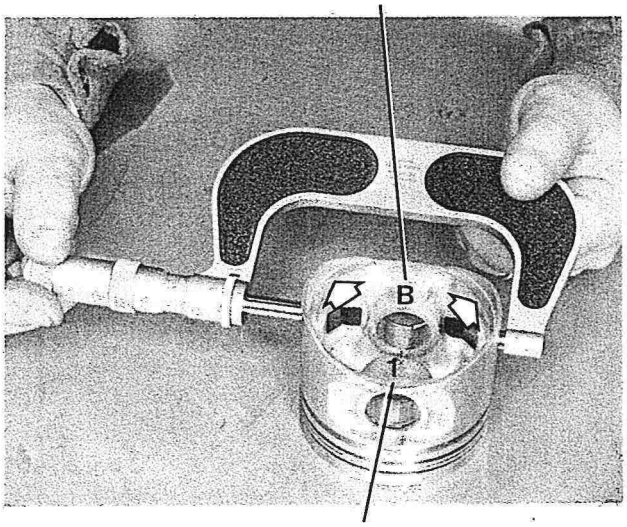
Removing piston rings



Removing gudgeon pin on the press

NOTE *If the components are free from faults, they can be reused; care must be taken to mark parts belonging to the same group.*

Letter showing piston grade



Number showing gudgeon pin category

Measuring piston diameters

– Normal: graded like the cylinder bores in five grades of 0.01 mm:

A – B – C – D – E

as spares only A – C – E

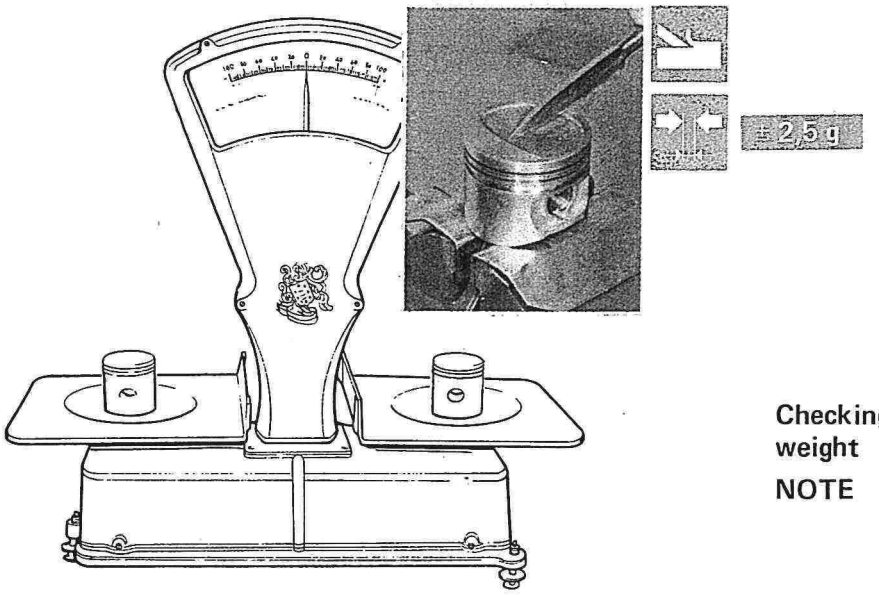
– Oversize:

0.4 mm

with no graded bores or gudgeon pin sizes.

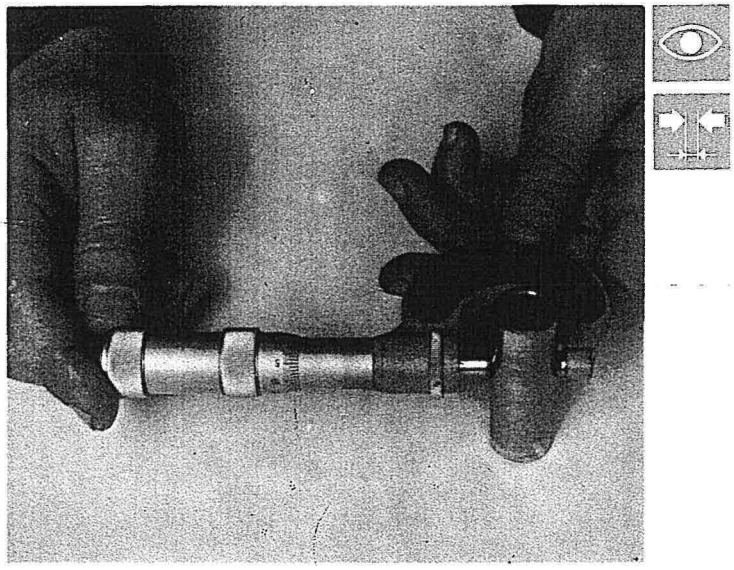
NOTE *The arrows show the areas where any excess weight must be removed from.*

10.



Checking prescribed tolerance for the piston weight

NOTE *Before checking the weight of the piston, clean any carbon deposits from the piston crown using a scraper.*

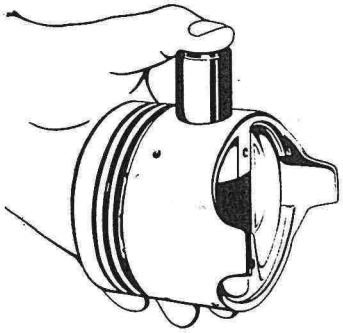


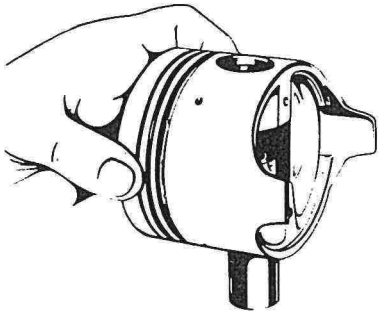
GUDGEON PINS

Measuring gudgeon pin diameter

The normal gudgeon pins are graded and mated to the pistons.

The gudgeon pin should be a push fit in the piston

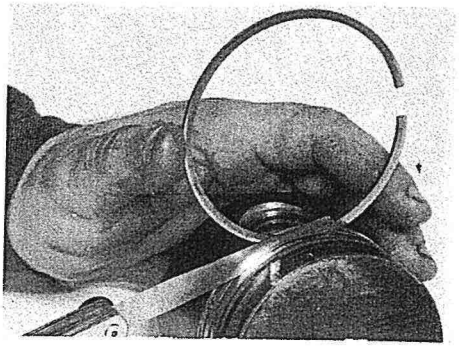




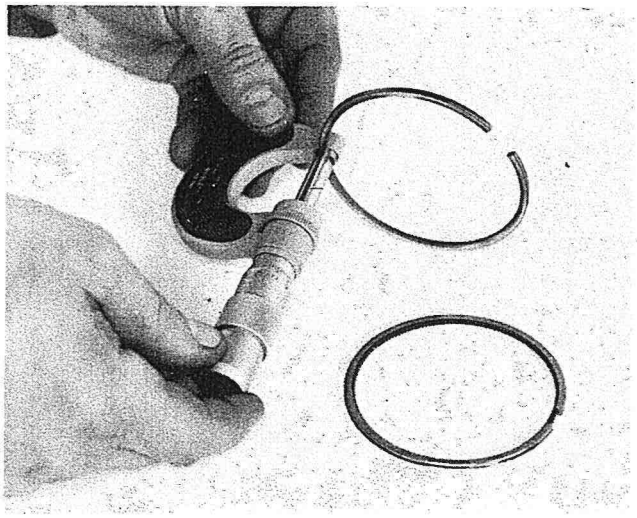
The gudgeon pin should not come out of the piston

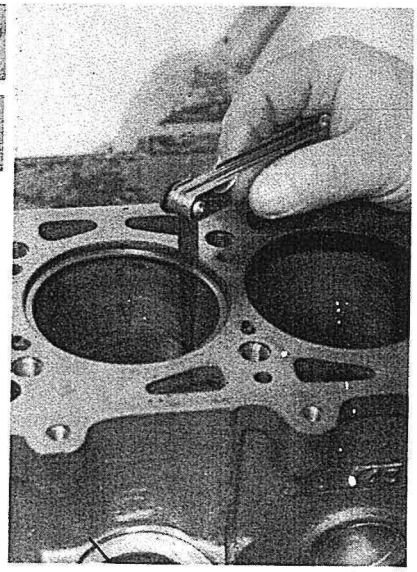
Conditions for a correct gudgeon pin - piston fit

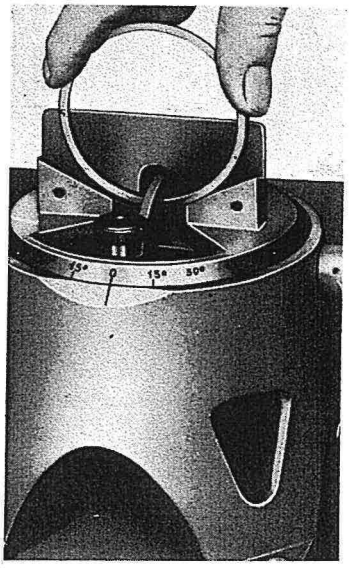
PISTON RINGS



Measuring thickness of oil scraper rings and checking clearance between 2nd and 3rd rings and grooves



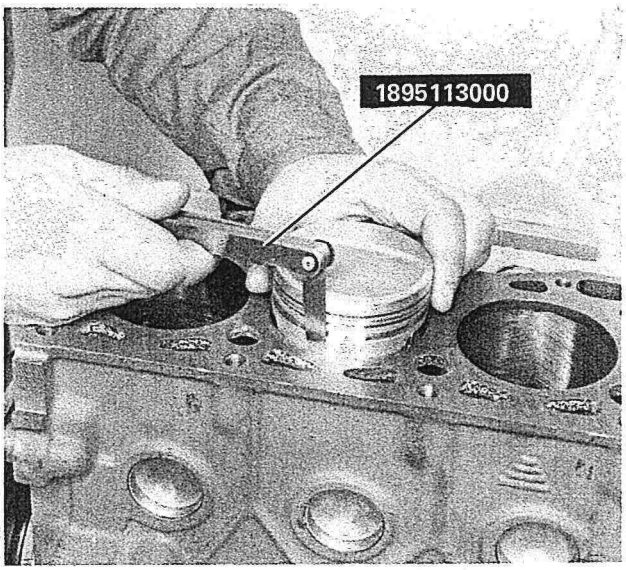




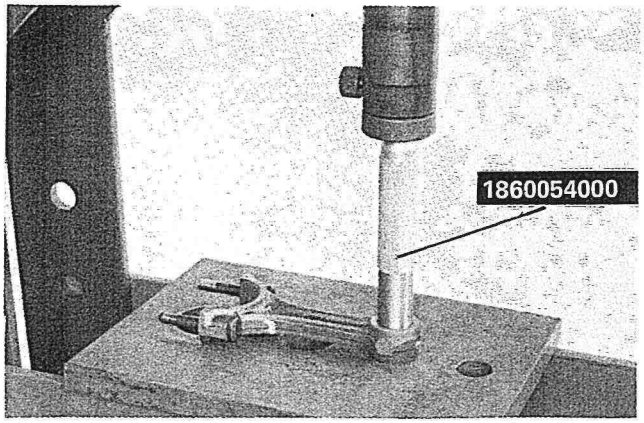
Checking and measuring clearance between edges of piston rings and gapping the piston rings using a tool

The piston rings are also available as spares in oversizes of 0.4 mm.

0,040 ÷ 0,060



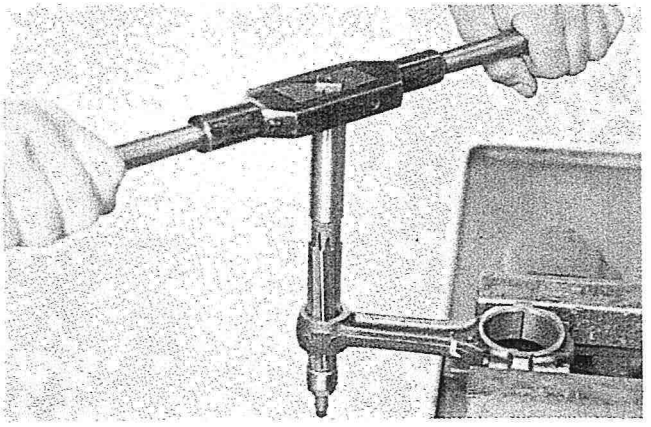
Checking clearance between piston and cylinder bore



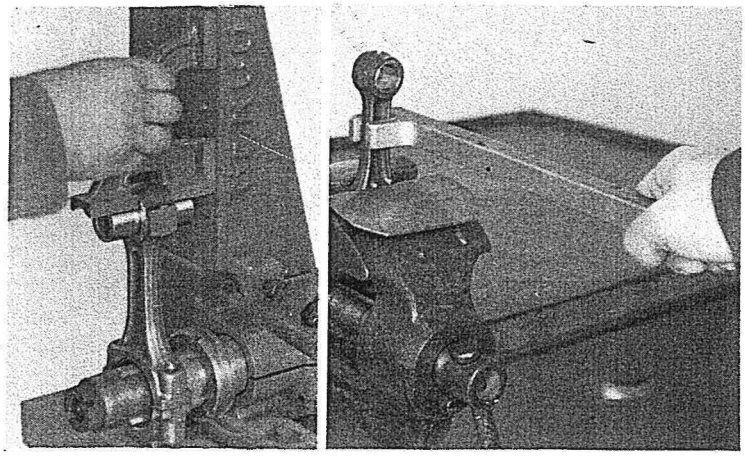
CONNECTING RODS

Removing and refitting bush in small end on the press

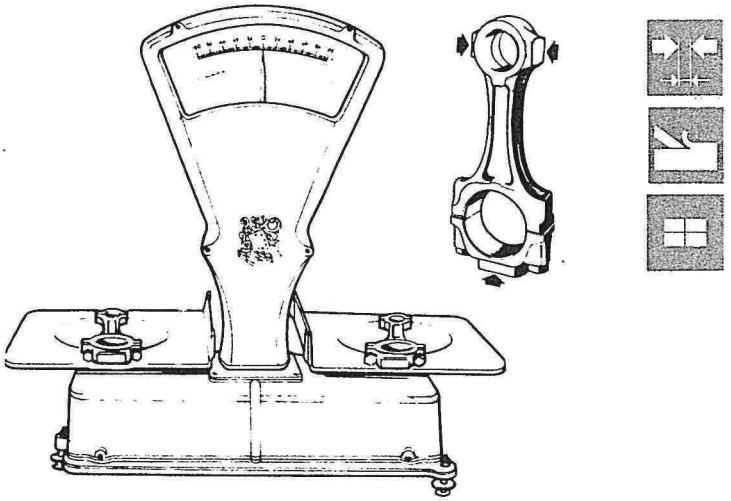
When fitting the bush in the small end, ensure that the lubrication hole in the bush coincides with the one in the small end. Any excess weight on the connecting rods is removed by removing material from both the small and big ends.



Grinding bush fitted in small end using expandable reamer



Connecting rod alignment check and stem straightening



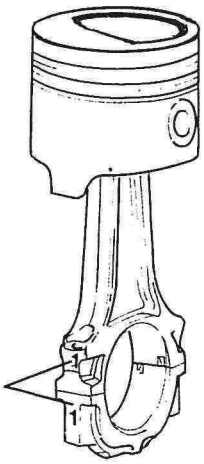
Checking weight of connecting rods and areas for removing excess weight from

The arrows show where to remove excess weight from.

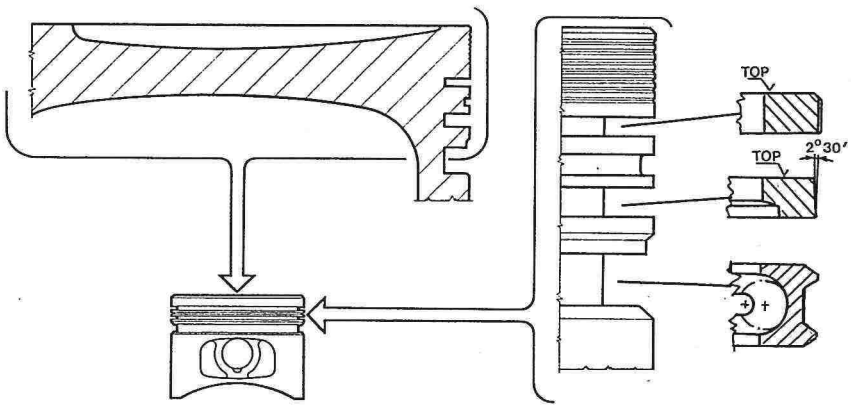
FITTING CONNECTING ROD – PISTON ASSEMBLY

Diagram showing connecting rod - piston assembly

If the connecting rod has to be replaced, the matching number should be stamped on the area opposite the bearing retainer notches.
When fitting, the notch in the piston crown should be opposite the number on the connecting rod.



Number of cylinder to which connecting rod belongs



Fitting and positioning piston rings on pistons

NOTE *Cross section of piston rings and detail of piston finish aimed at reducing the passage of combustion gases and the overspill of oil between the combustion chamber and the engine oil sump.*

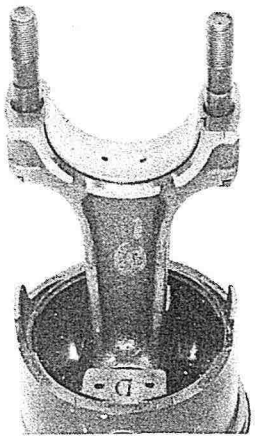
The piston rings should be fitted with the work "TOP" upwards. After fitting, turn the piston rings so that they are offset about 120° from each other.

BIG END BEARINGS

Fitting big end bearings

NOTE *Big end bearings are available as spares with undersize diameters of 0.254 and 0.508 mm.*

Do not carry out any adjustments to the bearings. Ensure that there is no ovality of the big end housing. If this is not the case, replace the faulty connecting rod. Carefully clean the external surfaces of the bearings and the relevant housings when fitting.



10.

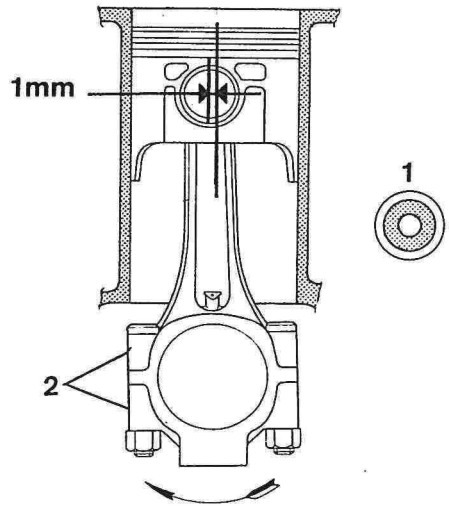


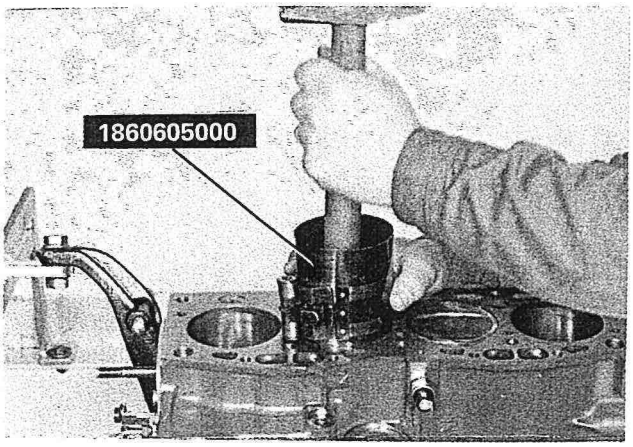
Diagram showing connecting rod - piston assembly and direction of rotation in engine

1. Auxiliary shaft
2. Area where matching number of connecting rod to cylinder bore is stamped

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

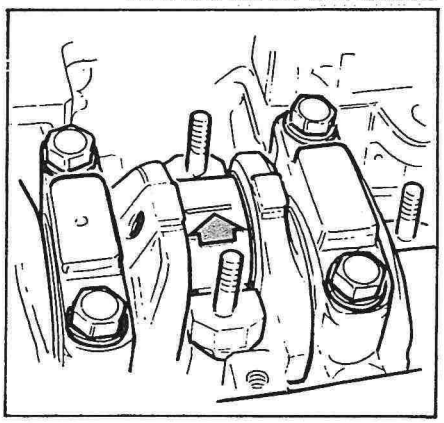
1 mm = Gudgeon pin offset on the piston

NOTE *The connecting rod - piston assembly should be fitted in the cylinder block with the number (2) turned in the opposite direction to the engine rotation.*



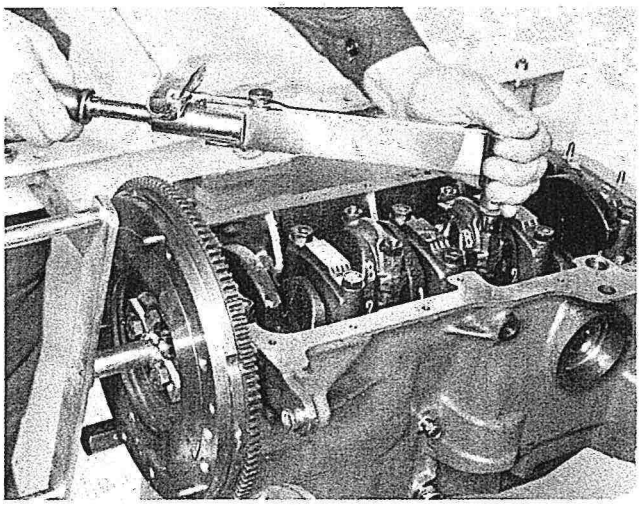
Fitting connecting rod - piston - gudgeon pin assembly in cylinder bore

MEASURING BEARING CLEARANCE

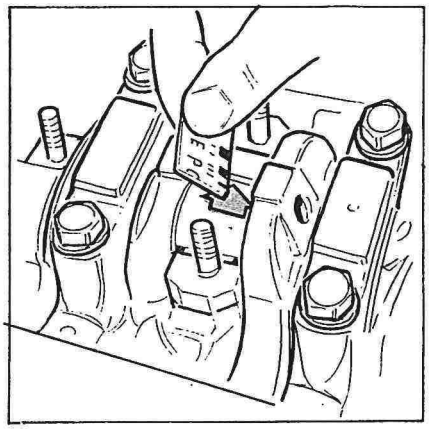


NOTE *The arrow shows the calibrated wire.*

Measuring bearing clearance using plastigage



Tightening nuts for bolts fixing con rod caps to torque



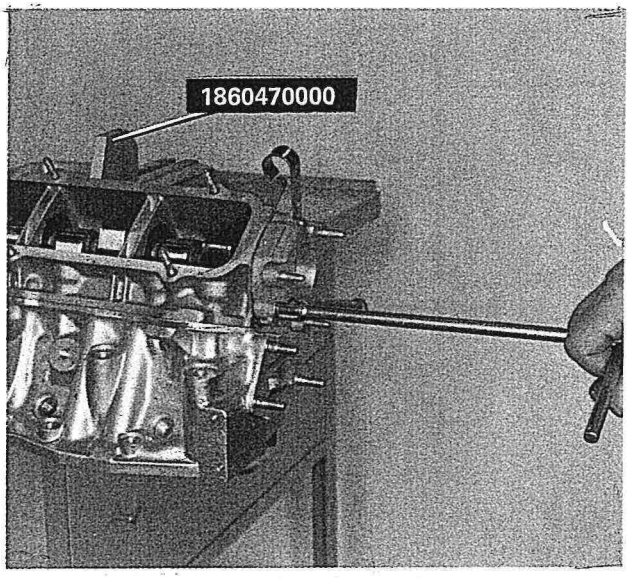
5,1 daNm

0,026 ÷ 0,070

Measuring bearing clearance using special gauge

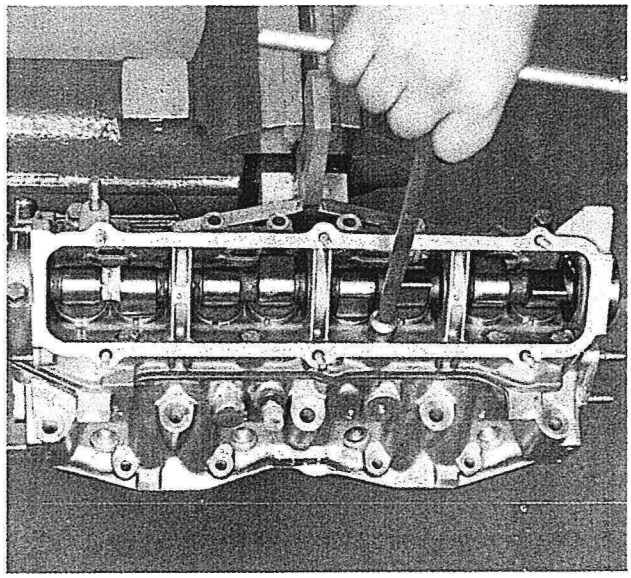
NOTE *Check the bearings, one at a time without rotating the crankshaft.*

Lubricate the parts concerned with engine oil before fitting; retighten the bolts securing the con rod caps to torque.

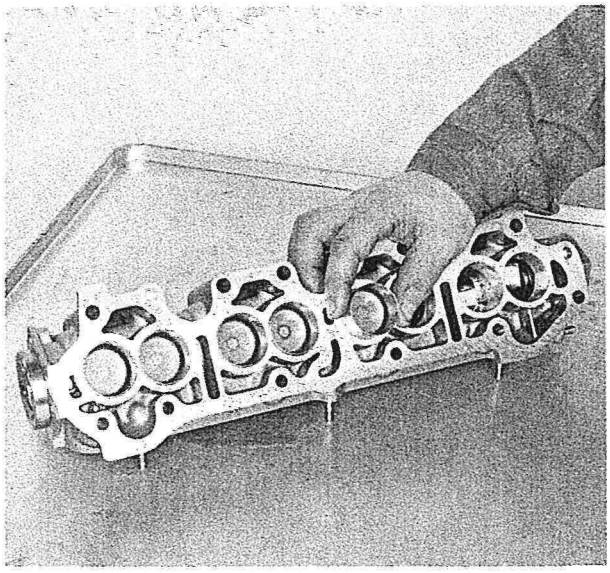


Removing ignition distributor rear cover

NOTE *Before commencing the removal and overhauling operations, fix the cylinder head to tool 1860470000.*



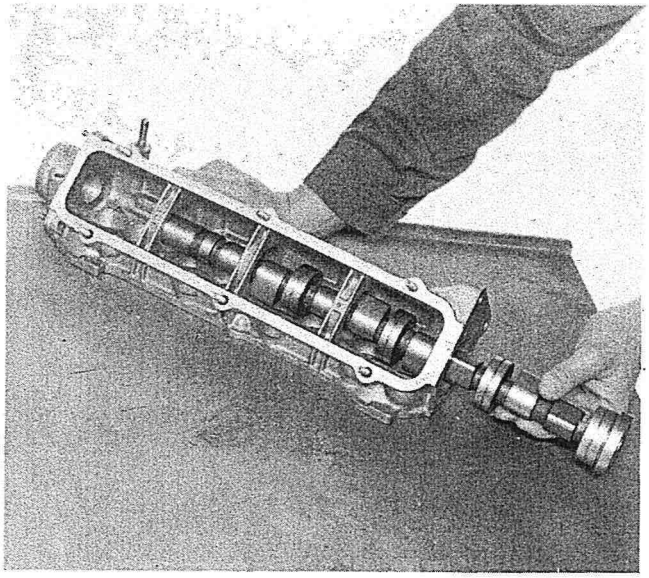
Removing camshaft housing



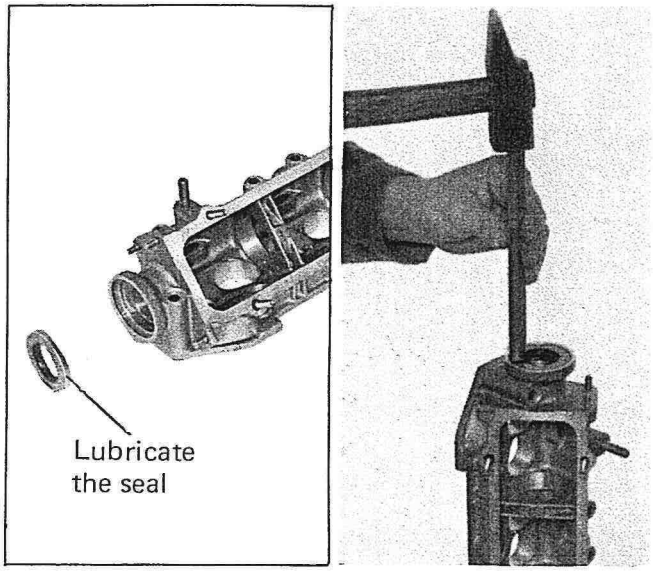
Removing tappets

Ensure that each tappet is matched to the correct housing when refitting.

10.



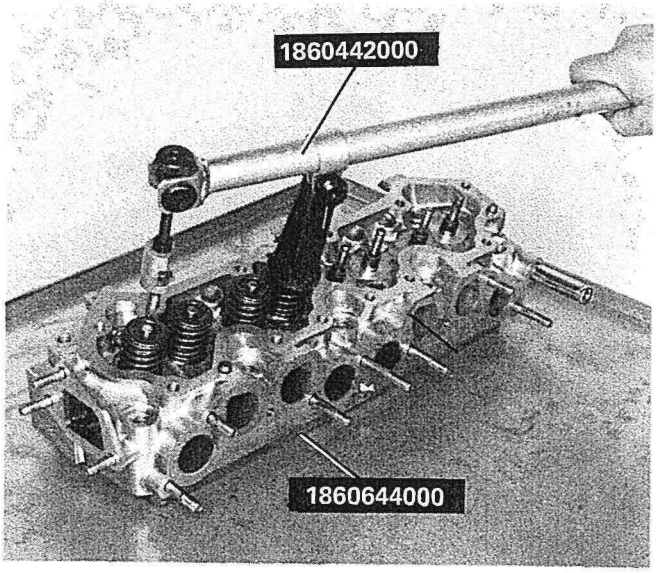
Removing camshaft



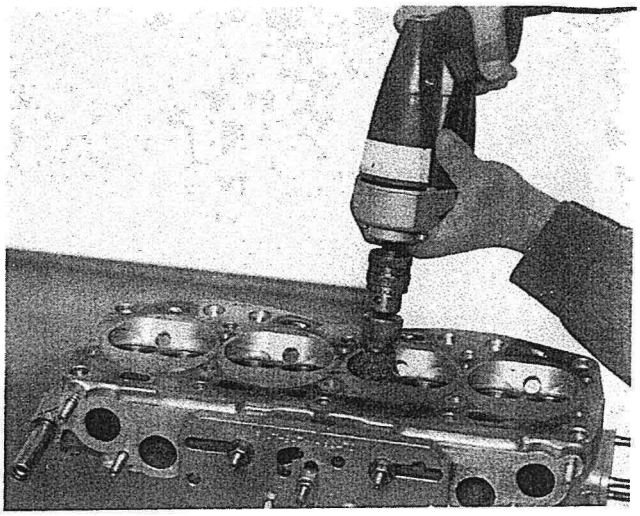
Fitting camshaft housing seal

The seal is removed and refitted using an ordinary drift.

NOTE *There must not be any traces of wear or scoring on the camshaft bearing housings or the camshaft housing has to be replaced.*

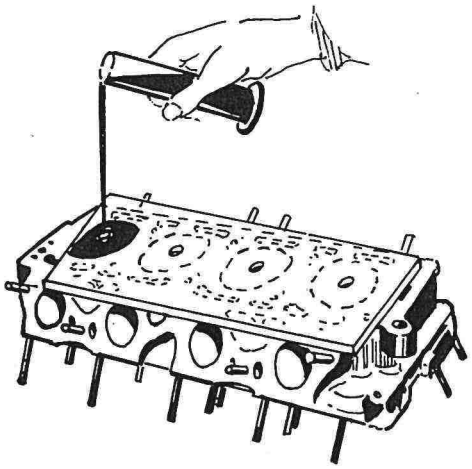


Removing cotters, caps, springs and valves



De-carbonizing and cleaning valve seats and ports

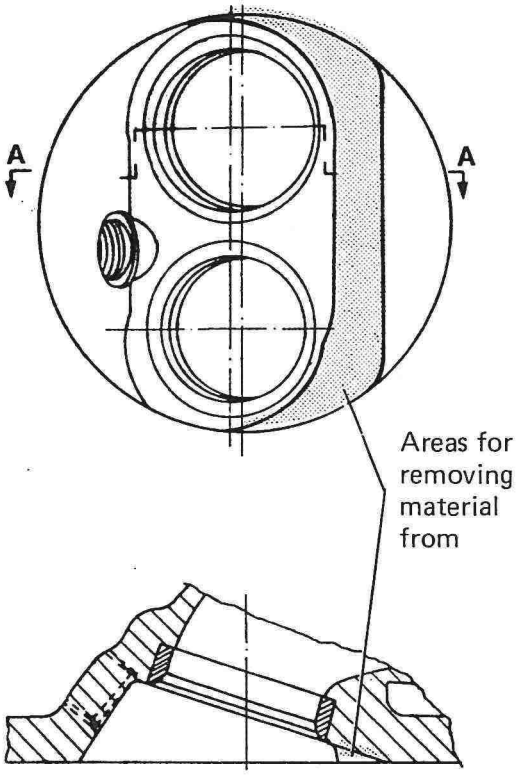
CYLINDER HEAD SUPPORT SURFACE GRINDING



It is permissible to reface the cylinder head support surface.
The maximum permissible volume for the combustion chambers is 32.89 cc.

Measuring combustion chamber volume

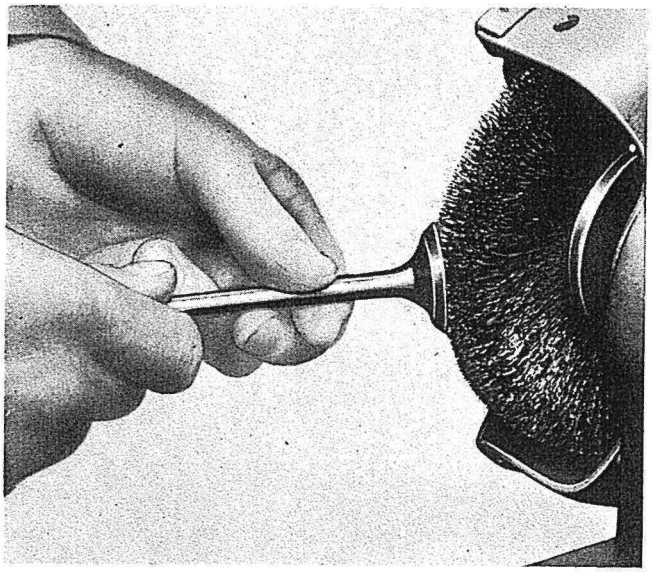
To check the volume of the combustion chamber after the valves and the spark plugs have been fitted, fill a test tube with VS 20 or 30 engine oil and make a note of the amount of oil used. Then leave the oil to rest in the test tube for around 10 minutes. After having filled the combustion chamber leave the oil to rest in the test tube for around 10 minutes. Measure the amount of oil remaining: the difference between the amount in the test tube before and after filling the chamber is the volume of the actual chamber.



Areas for removing material from

If the amount measured is less than 32.89 cc., it is necessary to alter this value by removing material from inside the actual chamber.
The areas where material can be removed from are shown in the diagram.

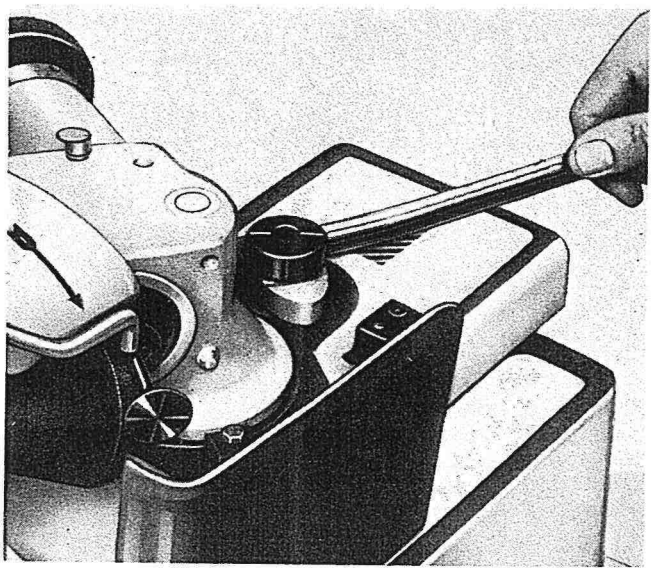
10.



VALVES

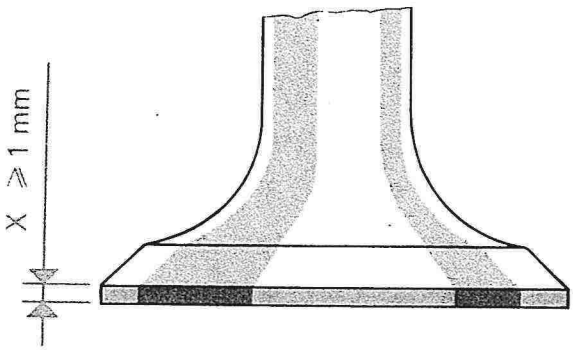
De-carbonizing valves

Check that there are no grooves or signs of seizing in the valve stem; also check that the diameter of the valve stem is within the prescribed values using a micrometer.



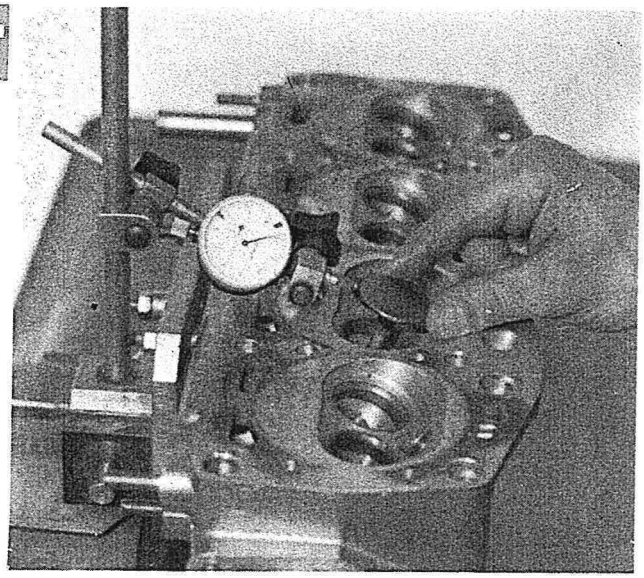
Refacing a valve using a grinder

The valve face must be cut to 45° 30′ and the valve seat refaced removing as little material as possible. If there are signs of notches on the upper edge of the valve stem, face it using a grinder and remove as little material as possible.



Checking distance (X)

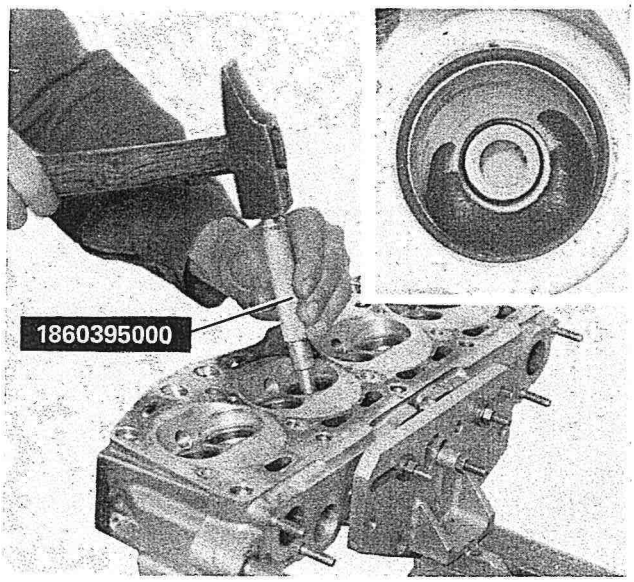
After carrying out the previous operations, check that thickness (X) of the valve at the edge of the valve head is not less than 1 mm, otherwise it must be replaced.



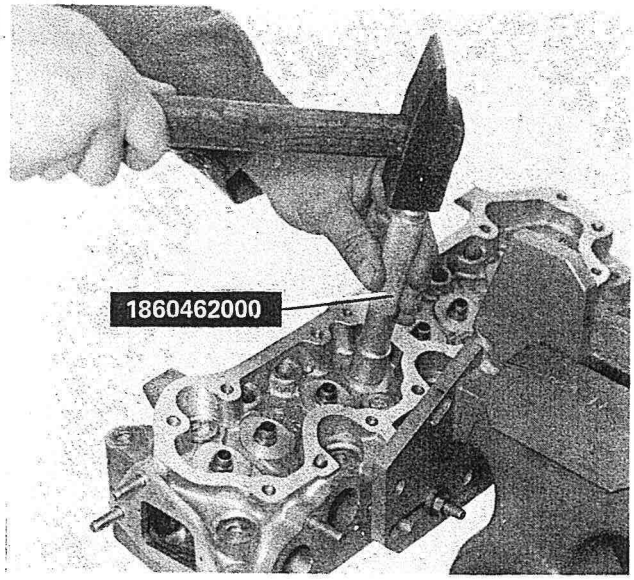
Checking clearance between valve stem and relative valve guide

NOTE *If the clearance between the valve stem and the valve guide (as measured in the diagram) is greater than 0.25 mm, it is necessary to replace the valve guide.*

VALVE GUIDES



Removing a valve guide

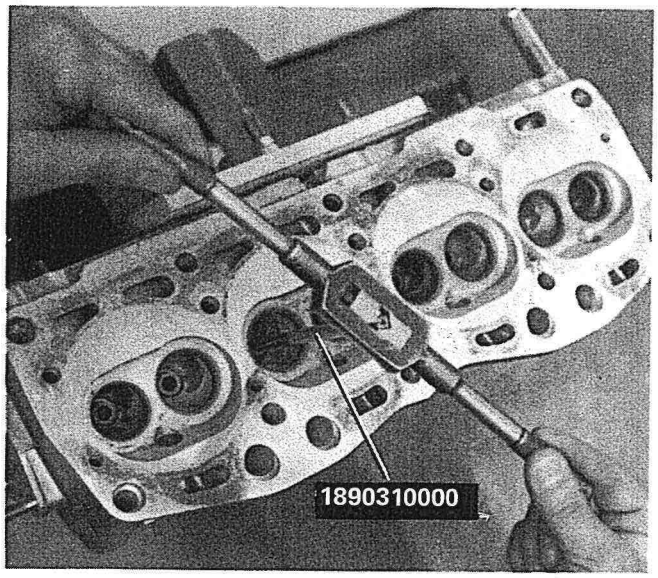


Refitting a valve guide

Valve guides are available as spares in 0.05 - 0.10 - 0.25 mm external diameter oversizes.

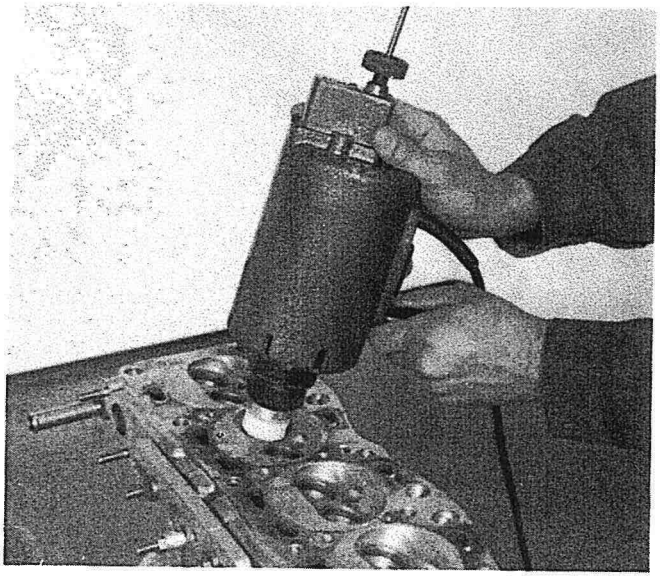
NOTE *Before fitting new valve guides, heat the cylinder head to 100° – 120° C.*

10.



Reaming valve guide inner surface

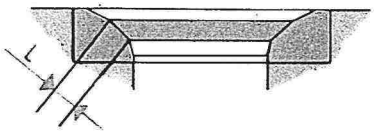
This should be carried out to clear the valve of any distortion suffered during fitting.

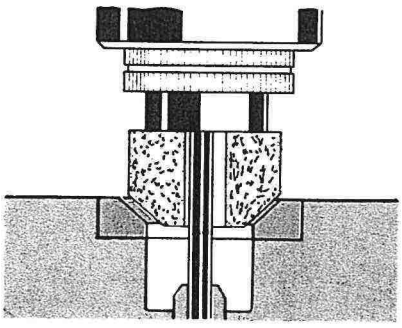


Refacing valve seats on cylinder head

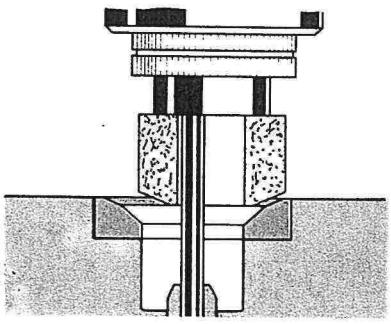
NOTE *The valve seats are refaced on the cylinder head every time the valves or valve guides are refaced or replaced.*

L = Valve seat refaced at 45° and reduced to the width prescribed.

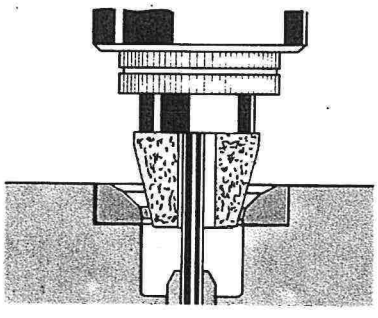




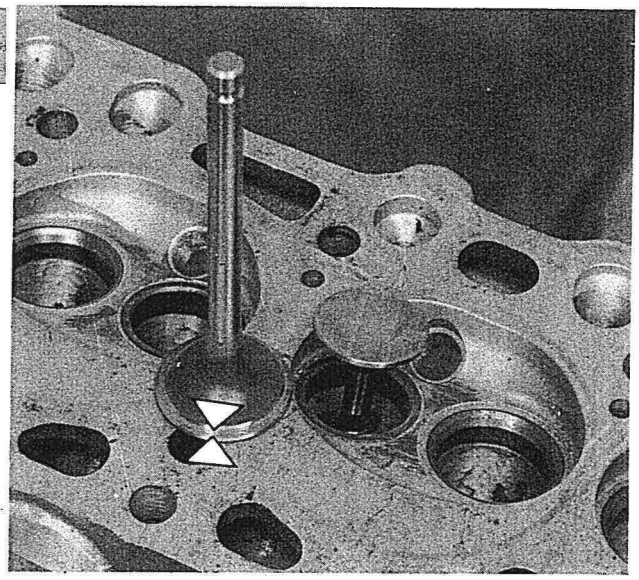
Valve seat grinding with grinder at 44° 30'



Reducing a valve seat from the top with grinder at 20°

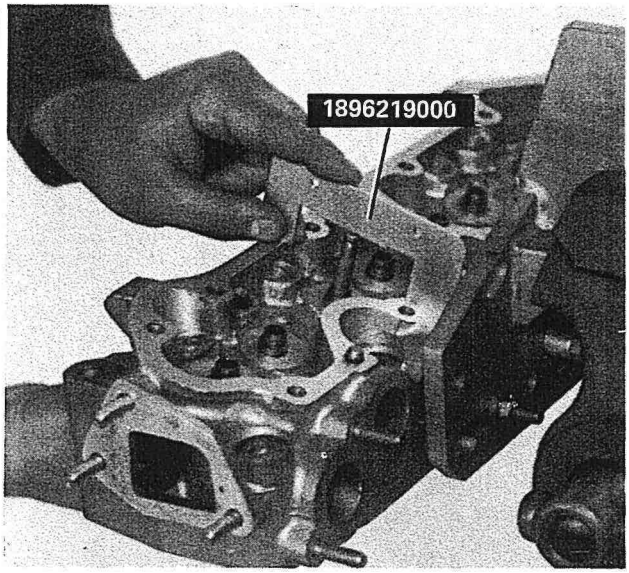


Reducing a valve seat from the bottom with grinder at 75°



Checking valve for correct seating

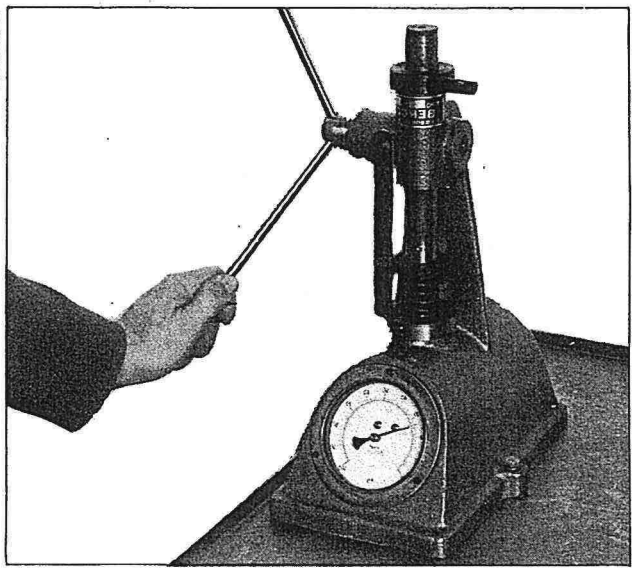
NOTE *If the seating is not well centered, recut the valve seat until this will happen.*



Checking valve stem height after facing (inlet and exhaust valves)

NOTE *If it is too high, shorten the valve stem by facing.*

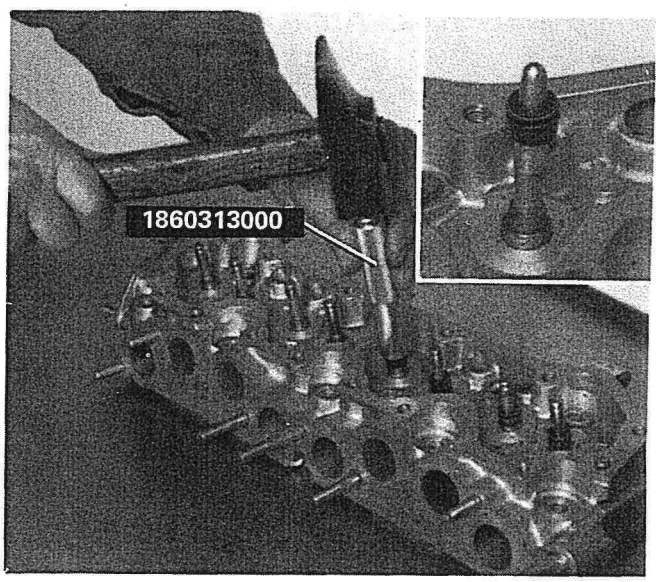
SPRINGS



Valve spring load test

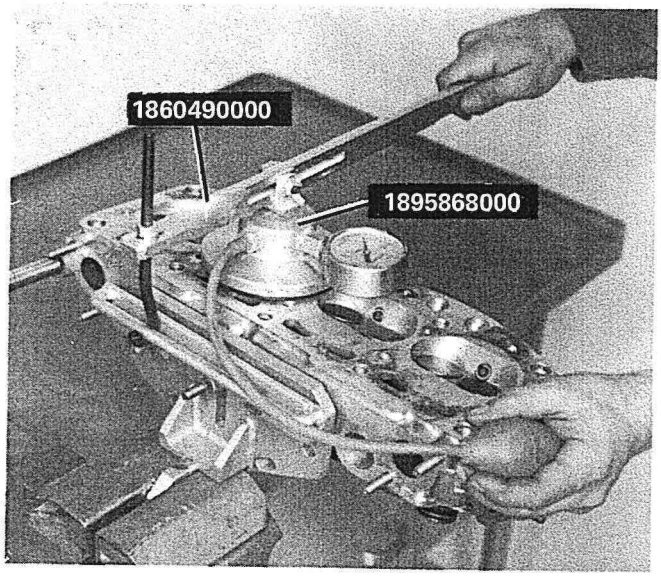
NOTE *Before fitting, the internal and external valve springs must be checked to ensure that the minimum loads are within the prescribed values.*

10.



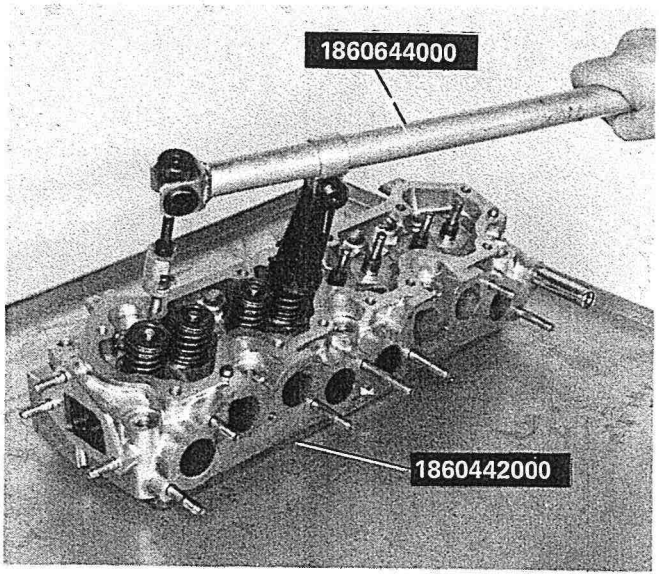
Fitting oil seals on valve guides

Lubricate the parts concerned with engine oil before fitting.



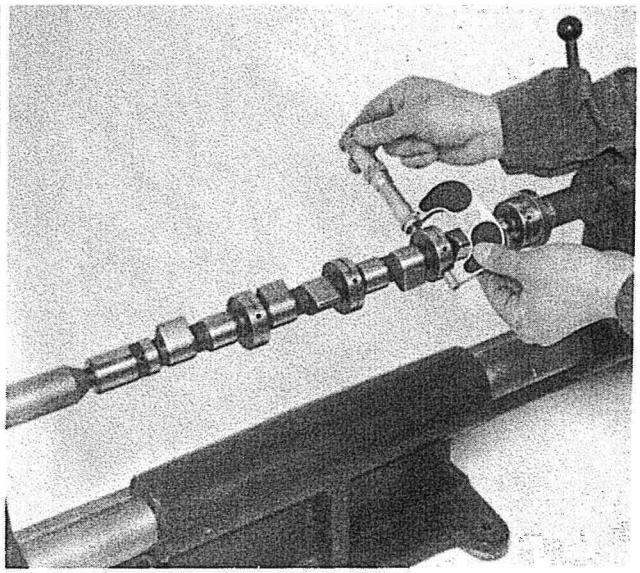
Valve leakage test

NOTE *The test is carried out with the spark plugs fitted.*



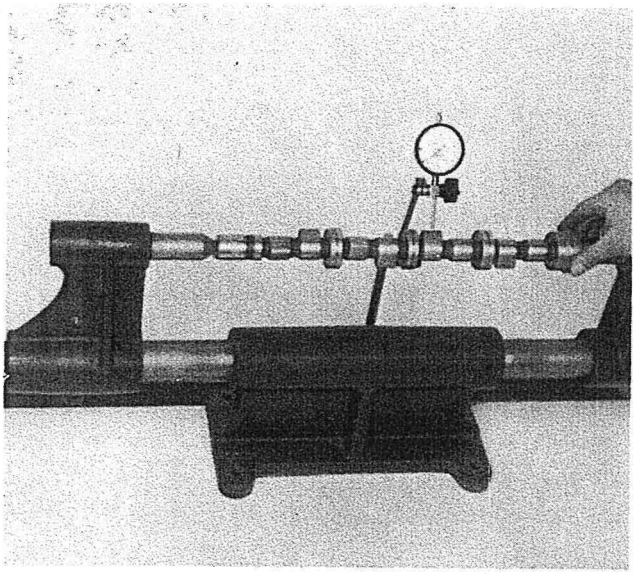
Fitting valves, caps internal and external springs and cotters

CAMSHAFT



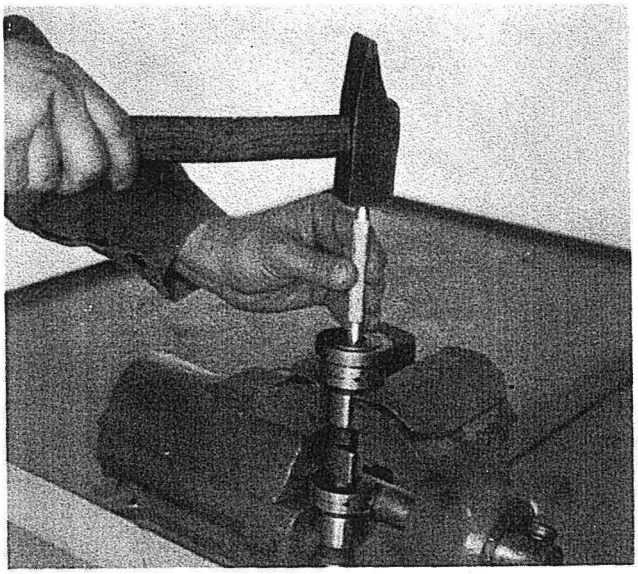
Measuring camshaft bearings

NOTE *The surfaces of the cams and the bearings must not show any traces of seizing or grooves or the camshaft must be replaced.*



Cam lift measurement

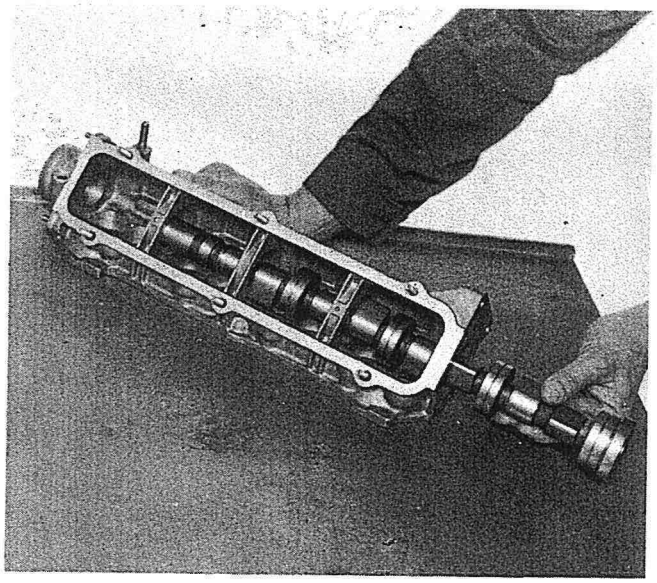
Excess wear of even one single cam means that the camshaft has to be replaced.



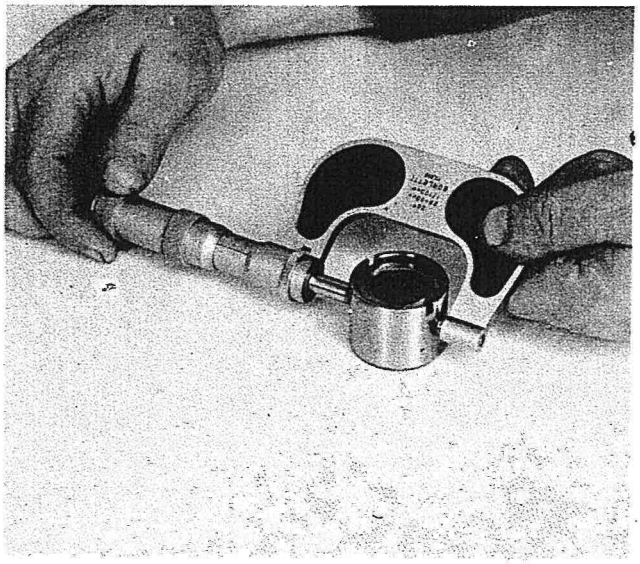
Fitting camshaft plug

NOTE *The plug can be removed using an ordinary drift.*

10.



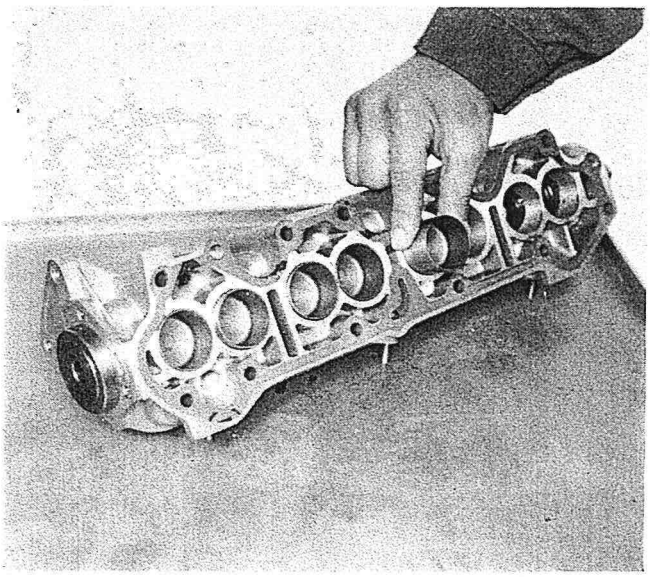
Removing camshaft



TAPPETS

Checking tappet diameter

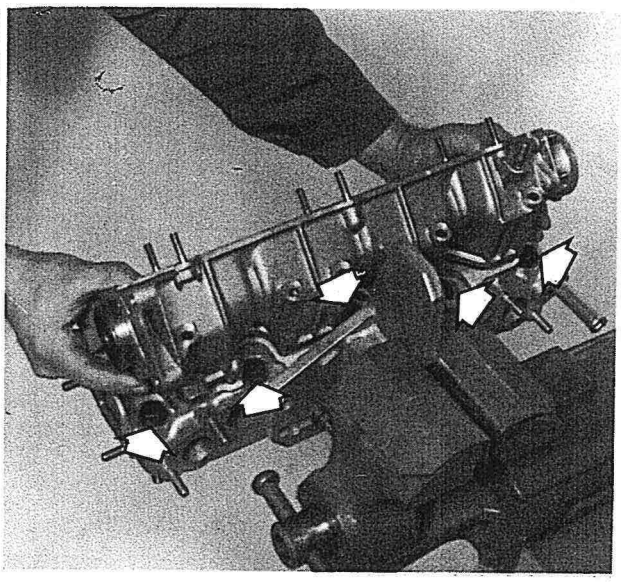
If there is excessive ovality, the tappet must be replaced.



Fitting tappets

If the tappet housings are extremely worn, replace the camshaft housing.

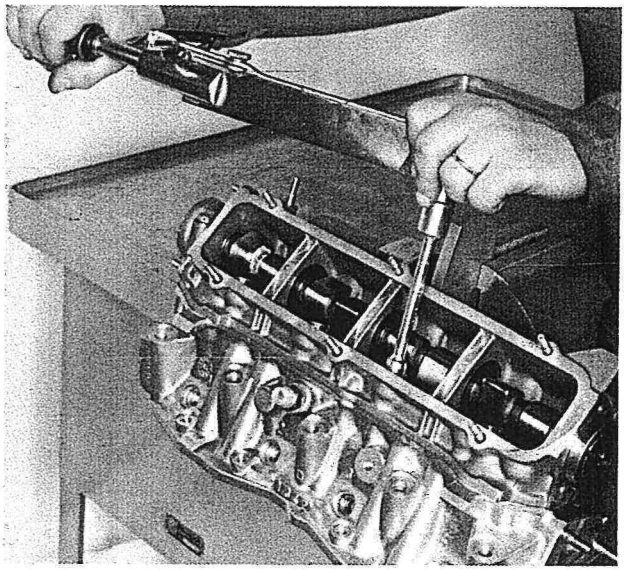
Lubricate the parts concerned with engine oil before fitting.



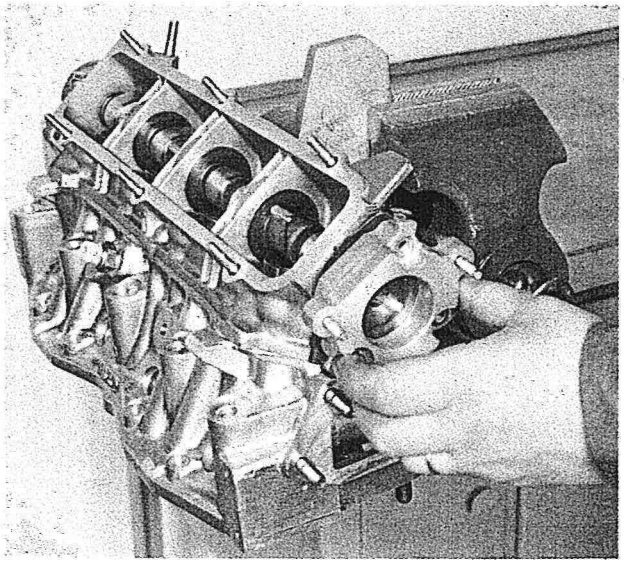
Fitting camshaft housing on cylinder head

Position the cylinder head fixing bolts (manifold side) in their housings **before** *fitting the camshaft housing.*

2 daNm

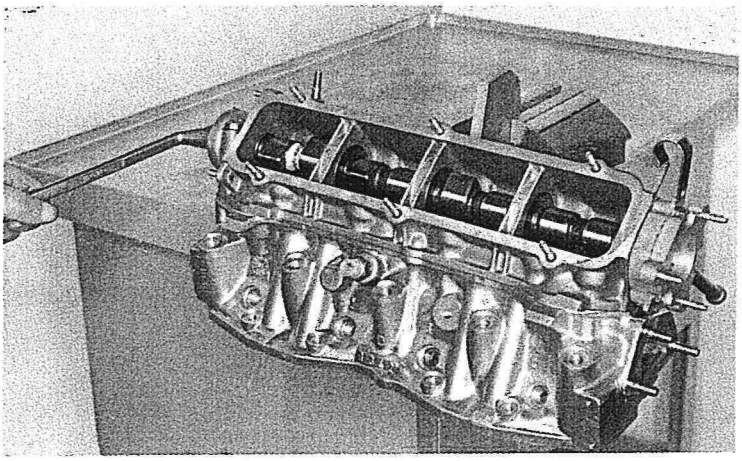


Tightening camshaft housing fixing bolts



Fitting ignition distributor rear cover

10.

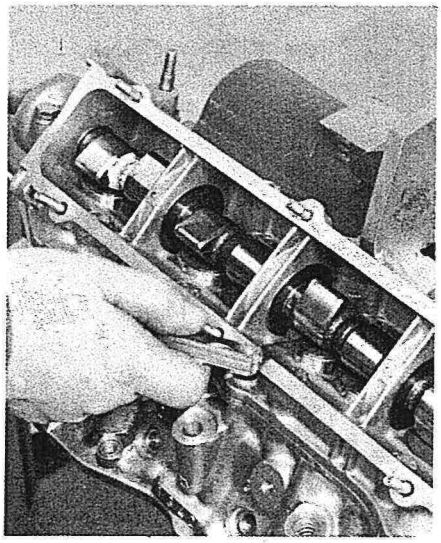


ADJUSTING TAPPET CLEARANCE

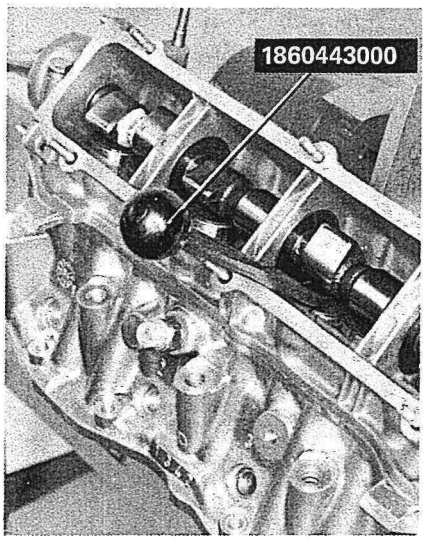
0,40 ± 0,05

0,50 ± 0,05

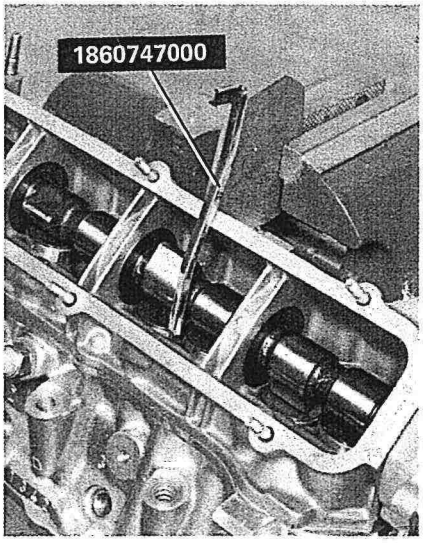
Rotate the camshaft until the cam is in a perpendicular position (upwards) to the tappet shim to be checked; then carry out the measurement.



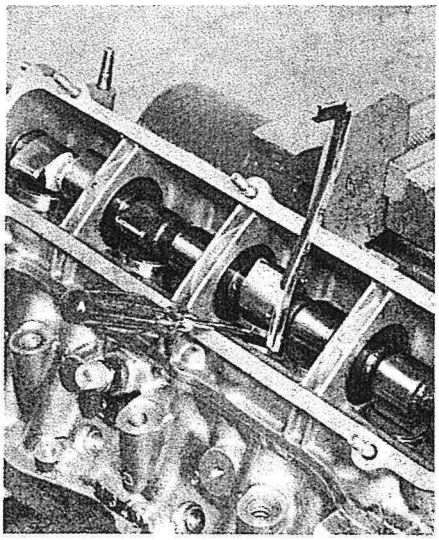
Checking clearance between tappet and cam



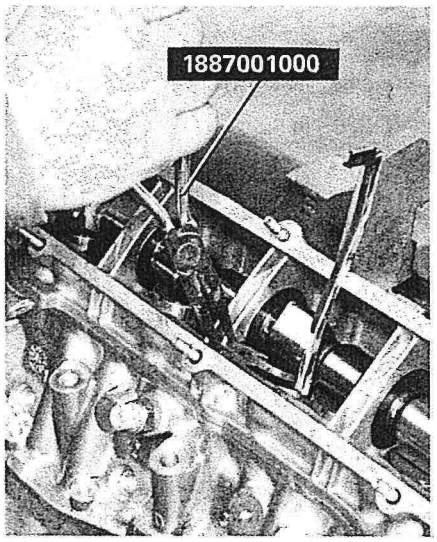
Fitting pressure lever for positioning tool 1860747000



Inserting tool 1860747000 for retaining tappet whilst removing shim

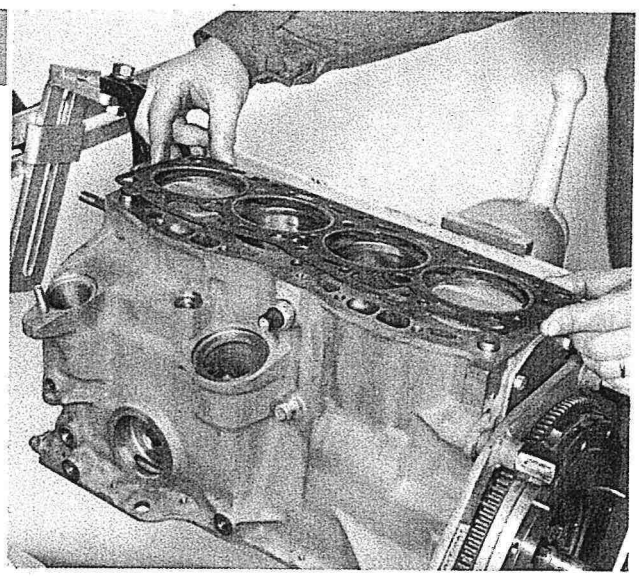


Remove the shim from the tappet using a screwdriver or steel point



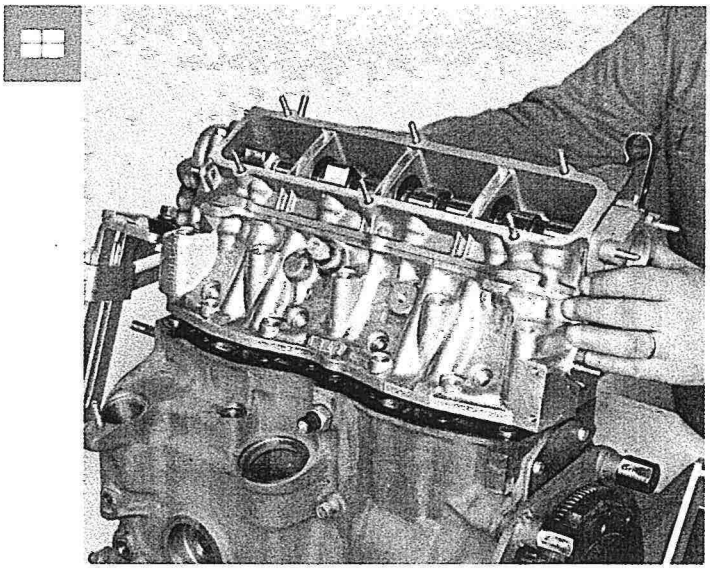
Removing tappet adjustment shim using pliers 1887001000

NOTE *Replace the shim removed with another of a suitable thickness to give the correct valve clearance.*
Carry out the same operation for the other shim when adjusting.



Fitting cylinder head gasket

Position the cylinder head gasket with the writing "ALTO" facing towards the operator.
ASTADUR type cylinder head gaskets have been fitted. These gaskets, on account of the special material from which they are made, undergo a polymerization process during the operation of the engine so that they become considerably harder during use.



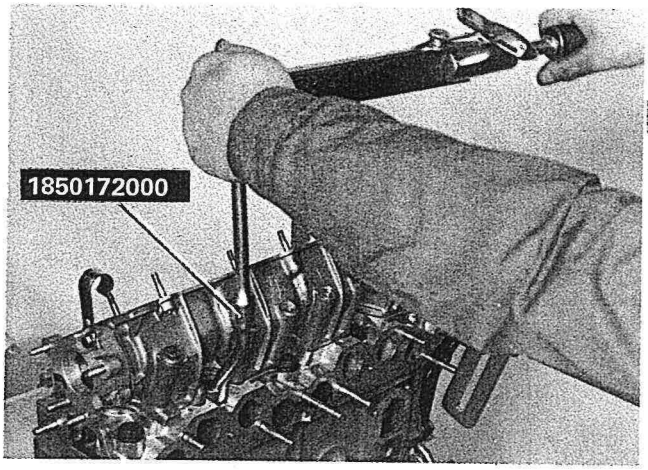
Fitting cylinder head

If the surfaces of ASTADUR type cylinder head gaskets become covered with oil or grease this prevents the polymerization process from taking place. For this reason **it is vital that no part of the gasket is covered in oil or grease.**
Also avoid excessive lubrication of the fixing bolts in order to prevent drips of oil.
In order to ensure that the polymerization process takes place it is necessary to:

- *Keep the gaskets in their original, sealed, nylon covers and only remove them shortly before fitting.*
- *Avoid any oil or grease coming into contact with the gasket and take care that the surfaces of the cylinder head and block are clean.*

NOTE *Where ASTADUR gaskets are fitted it is no longer necessary to tighten the cylinder head nuts and bolts after the first 1000 – 1500 km (600 – 1000 miles).*

10.

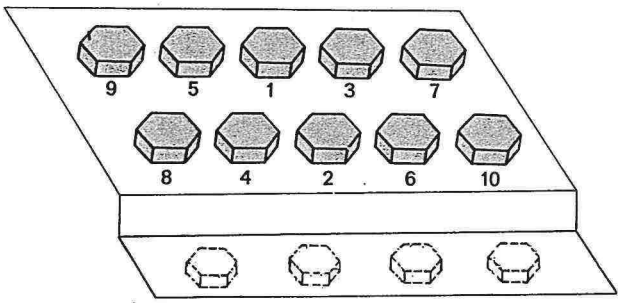


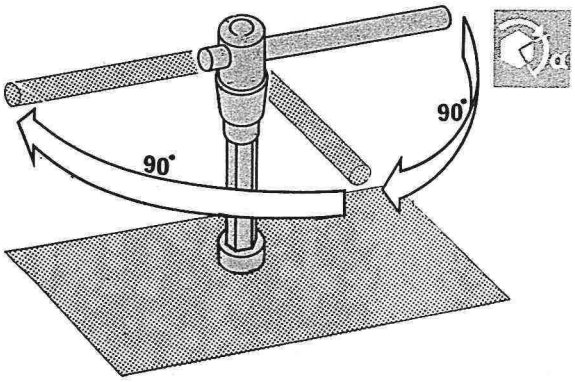
4 daNm

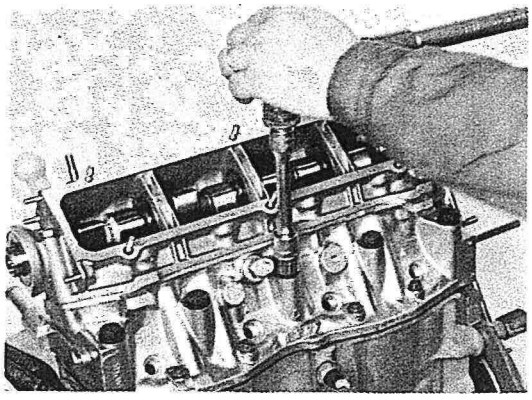
CYLINDER HEAD TIGHTENING

The procedure for correctly tightening the cylinder head is as follows:

- Before fitting, lubricate the bolts and washers, then leave to drain for at least 30 minutes.
- The tightening order shown in the diagram should be followed for all stages.





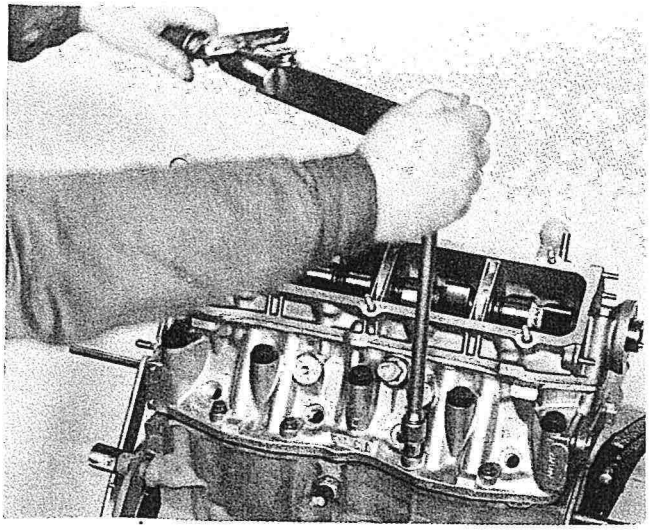


1st stage: Tighten the bolts to a torque of 2 daNm.

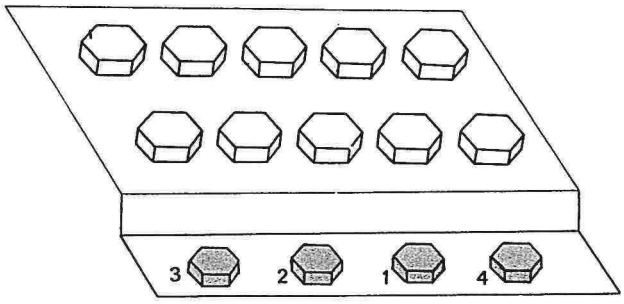
2nd stage: Tighten the bolts using a torque wrench to a torque of 4 daNm.

3rd stage: Further tighten the bolts, using a spanner, by 90°.

4th stage: Further tighten all the bolts in the order given by 90°.

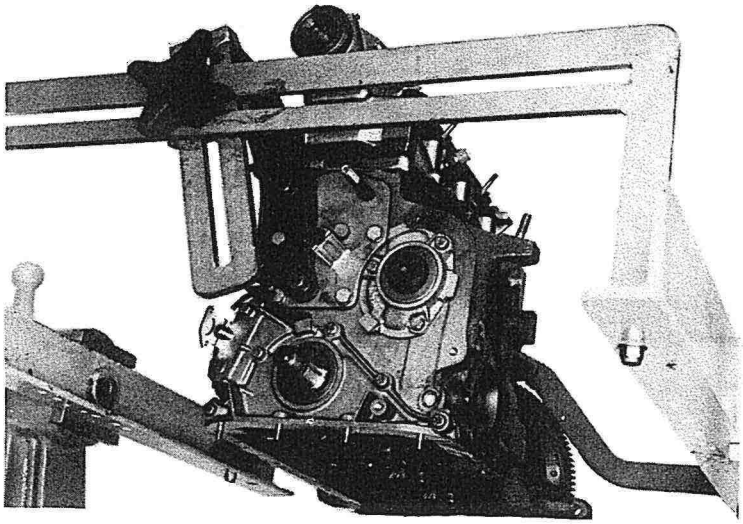


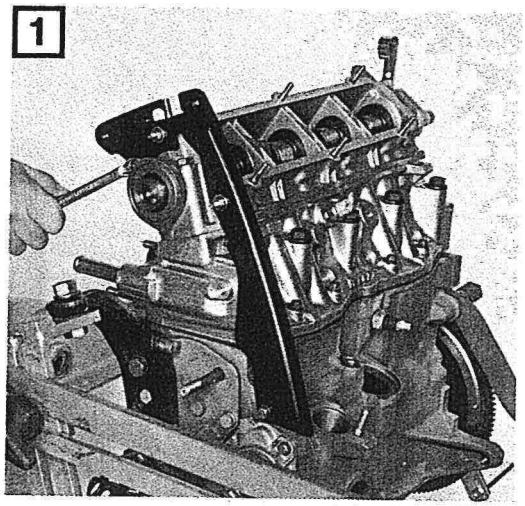
6 daNm

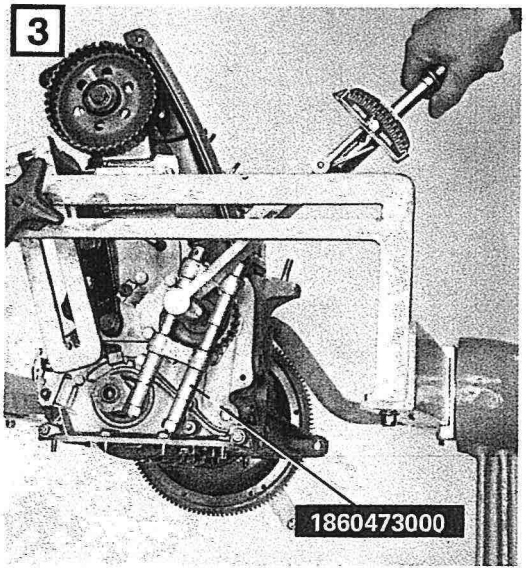


Tightening cylinder head fixing bolts using a torque wrench

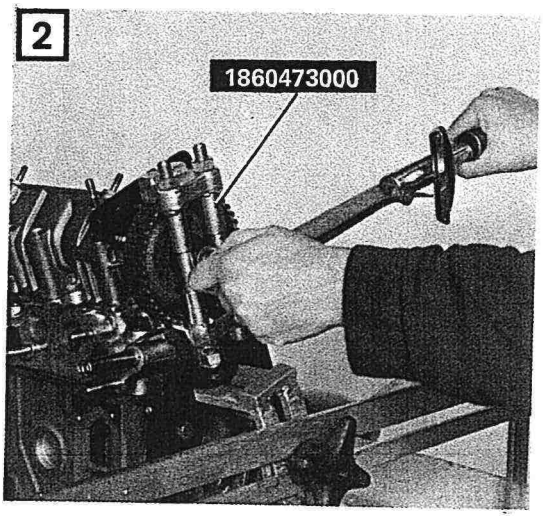
FITTING



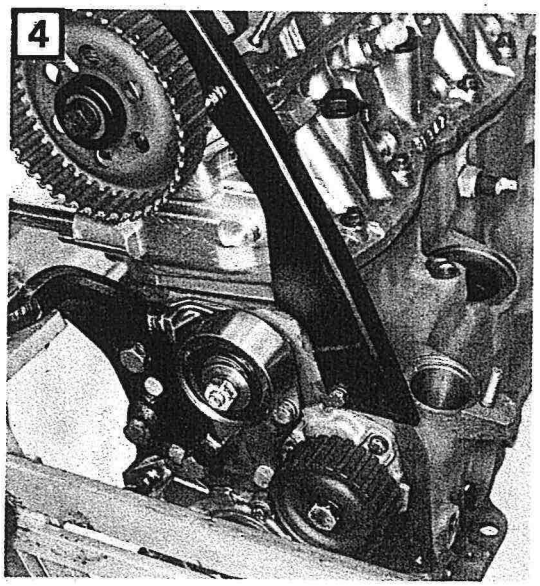




2	8,3 daNm
3	8,3 daNm

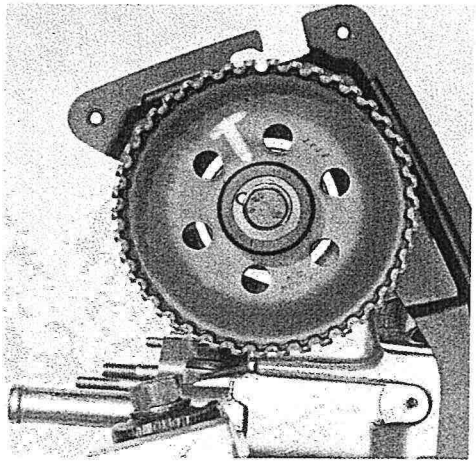


Fitting components in numerical order



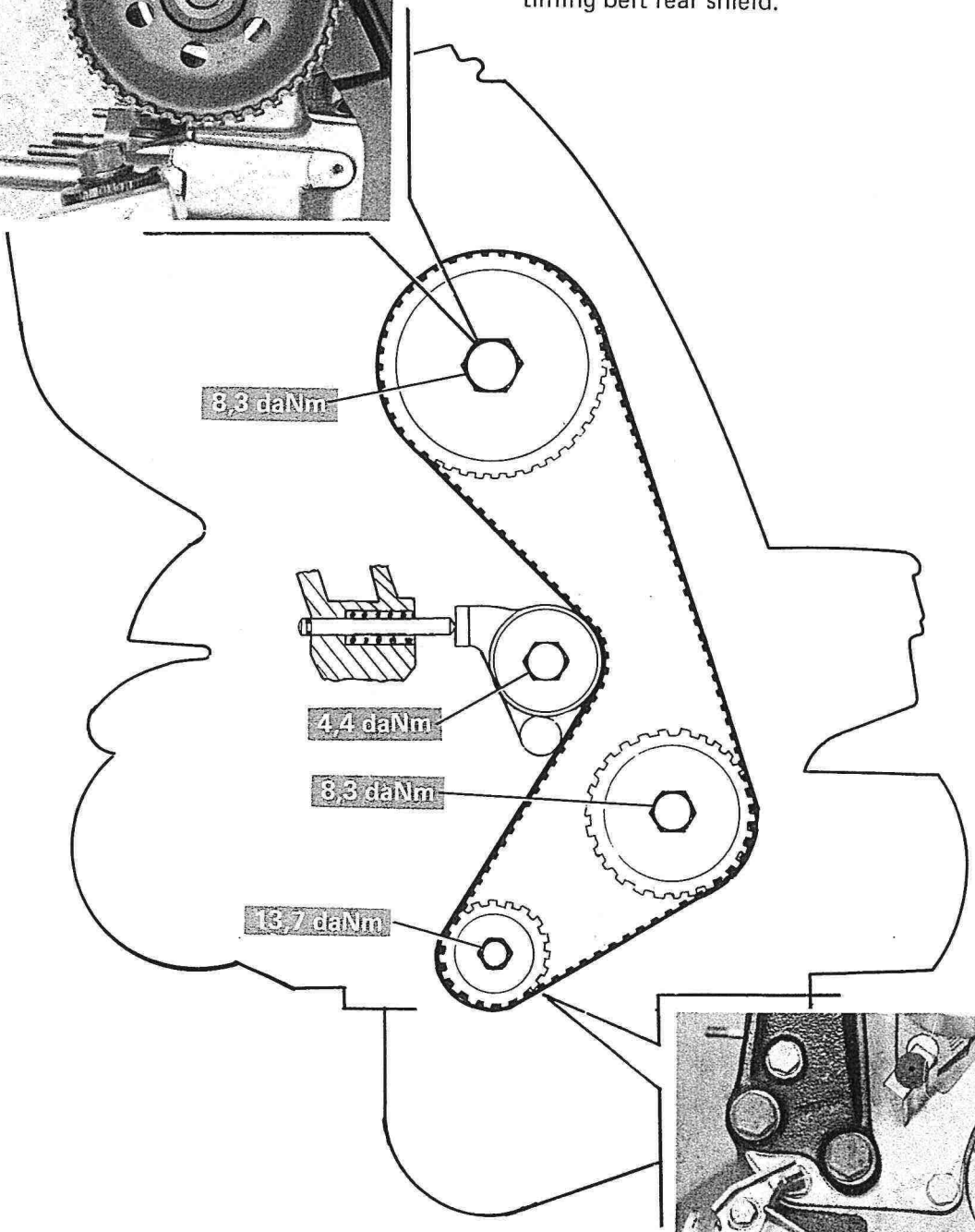
NOTE *To facilitate the fitting of the timing belt, push the belt tensioner bearing against the spring, then temporarily lock the fixing nut in this position.*

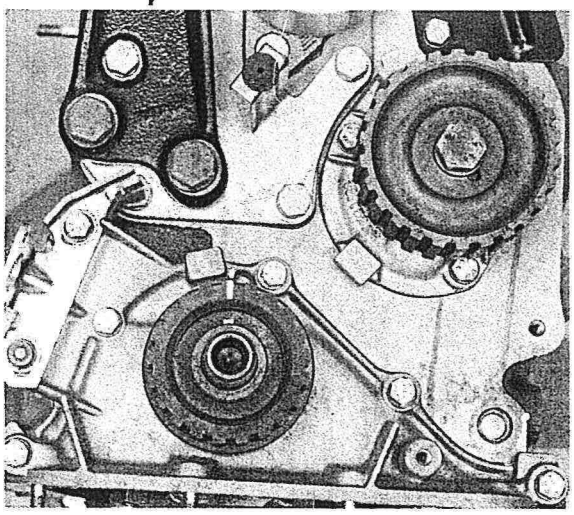
10.



TIMING

Rotate the camshaft so that the reference mark on the timing driven gear is in line with the reference mark on the timing belt rear shield.





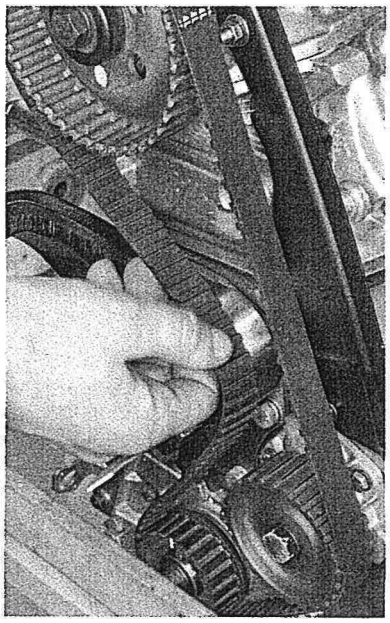
Rotate the crankshaft using the special tool until the reference mark on the drive gear is in line with the reference mark on the front cover.
Fit the belt.

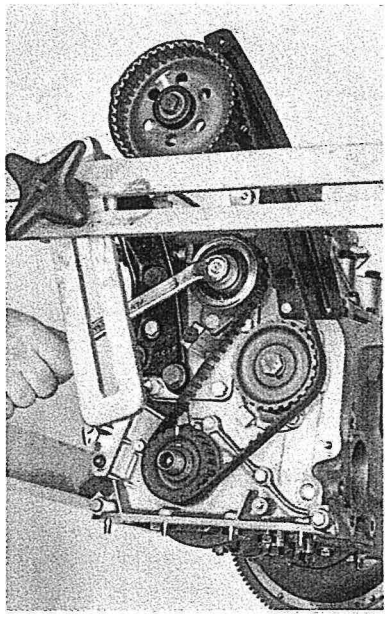
Fitting timing belt and locking belt tensioner

Loosen the nut securing the belt tensioner, rotate the crankshaft in its direction of rotation for one or two revolutions and stop it at TDC. Tighten the nut securing the tensioner to the prescribed torque.
After this, check that the reference marks correspond with each other.

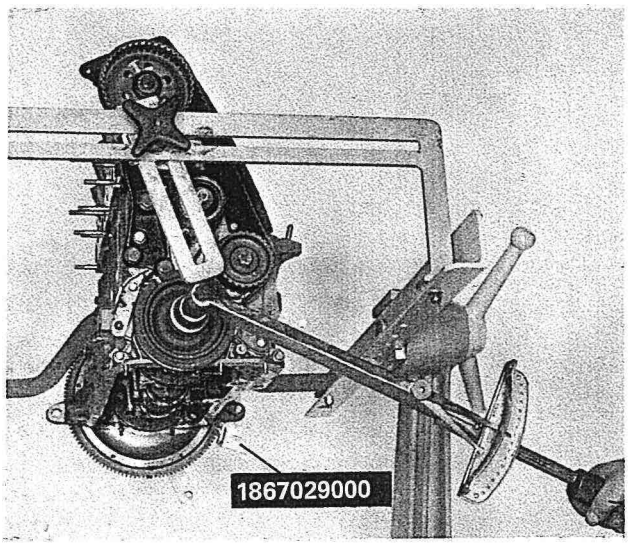
NOTE **Visually inspect the timing belt every 20.000 km (12.500 miles) and replace it if:**
- **It is soaked with oil or coolant.**
- **It shows traces of cracks or broken teeth.**
- **It is broken or has worn teeth.**

The belt must be replaced after operations which necessitate its removal.



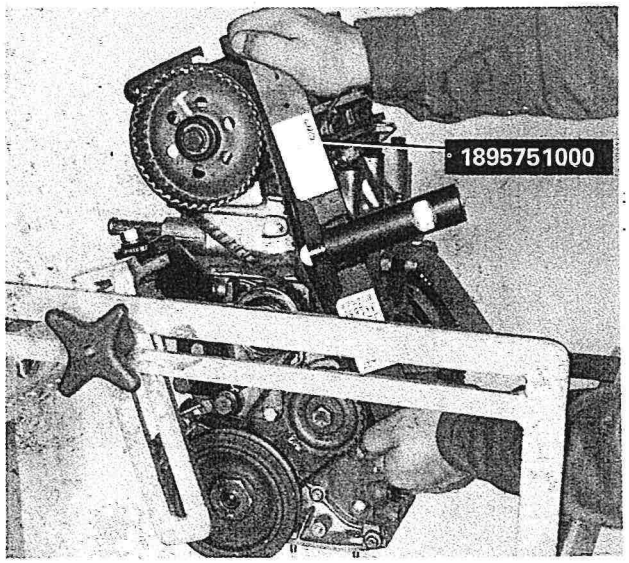


13,7 daNm



Fitting crankshaft pulley

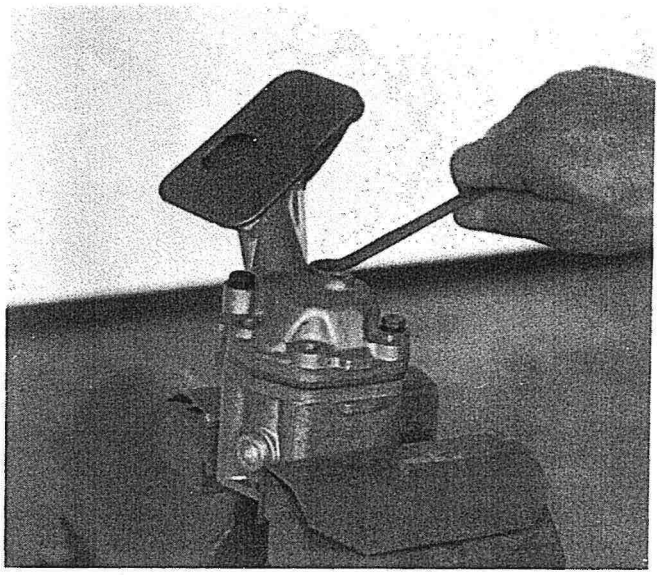
NOTE *Use tool 1867029000 (flywheel lock) when tightening the crankshaft pulley fixing bolt to torque.*



Checking belt tension

Exerting a force on the ends of the tool, position it as shown in the diagram.
Then read off the tension value in kg (2.5).

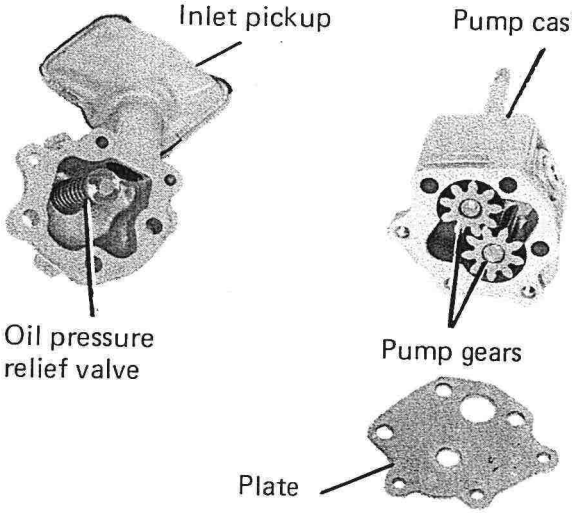
10.



OIL PUMP

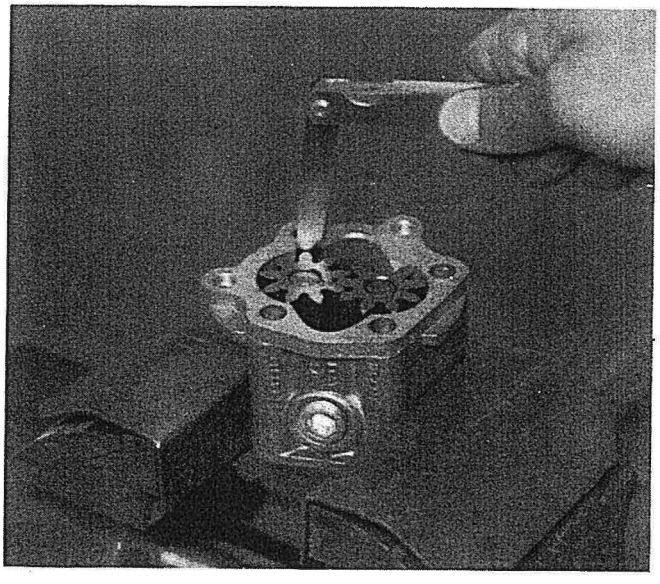
Removing-refitting oil pump

Lubricate the parts concerned with engine oil before fitting.



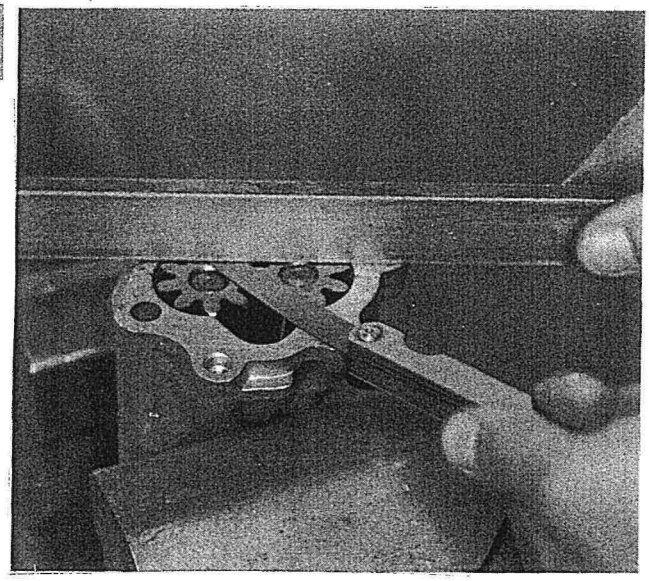
Oil pump components

Check that the surfaces of the plate are flat and that there are no grooves or burrs.



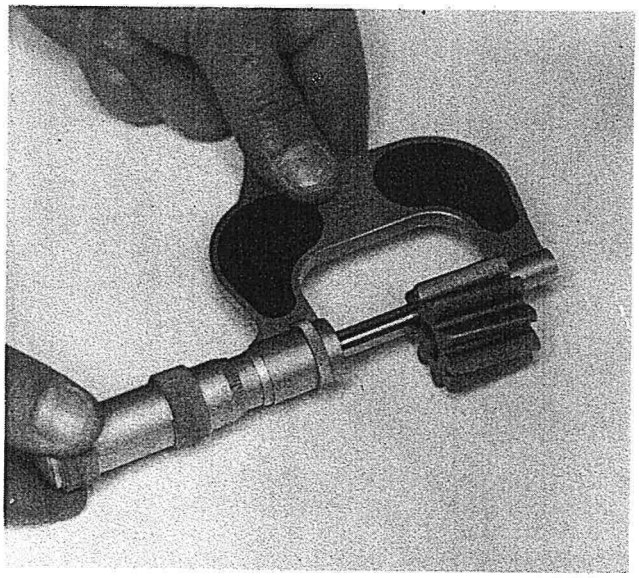
Checking clearance between external circumference of gears and pump casing using feeler gauge

NOTE *The clearance should not exceed 0.180 mm; if it does, replace the oil pump.*



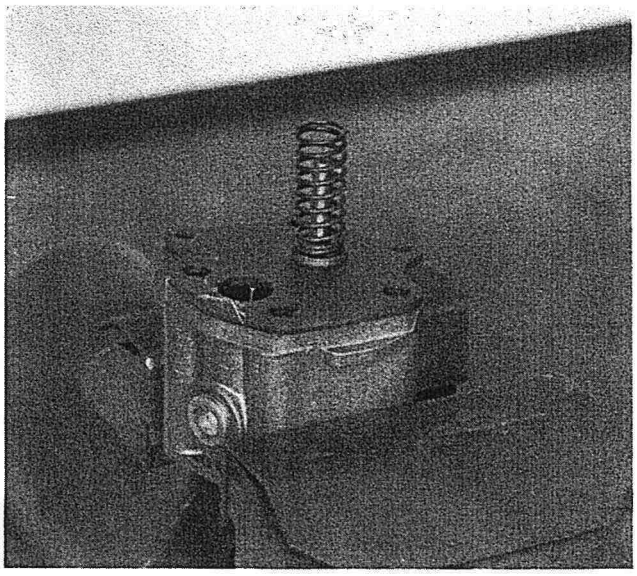
Checking clearance between gears and support surface of cover on pump casing

NOTE *The clearance should not exceed 0.120 mm; if it does, replace the oil pump.*



Measuring gear height

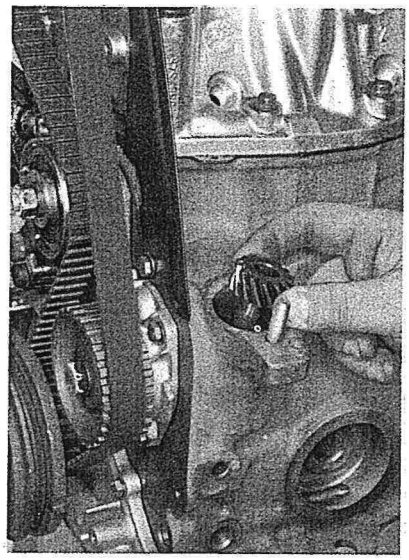
OIL PRESSURE RELIEF VALVE

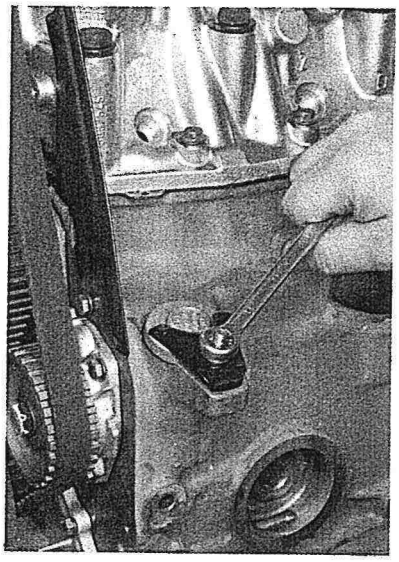


Removing-refitting oil pressure relief valve

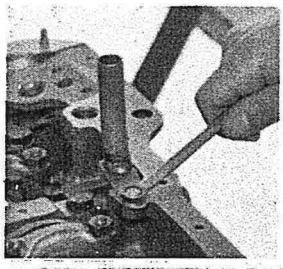
Check that there is no scoring on the valve piston or it has to be replaced. The valve spring should have a height of 22.5 mm under a load of 8.8 daN and a height of 21 mm under a load of 9.5 daN.

10.



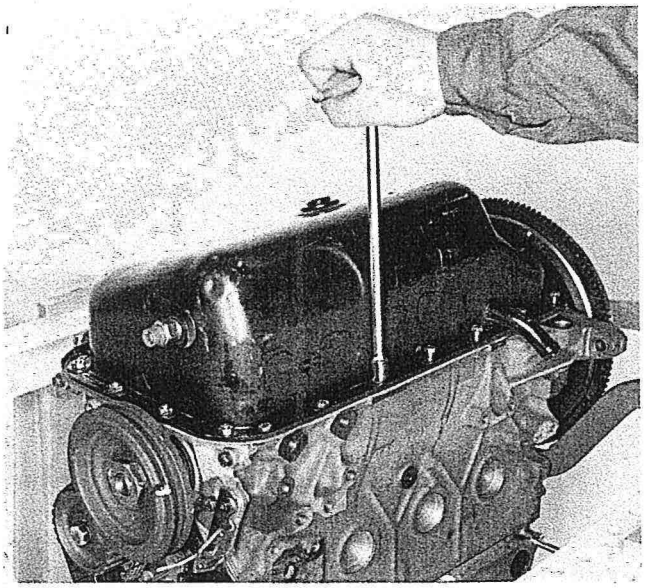


Fitting oil pump control gear and retaining cover

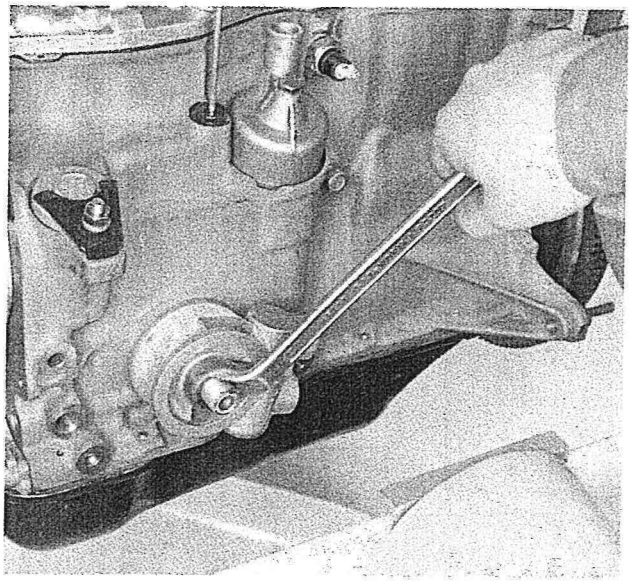


Fitting connecter for oil breather and oil pump in the crankcase

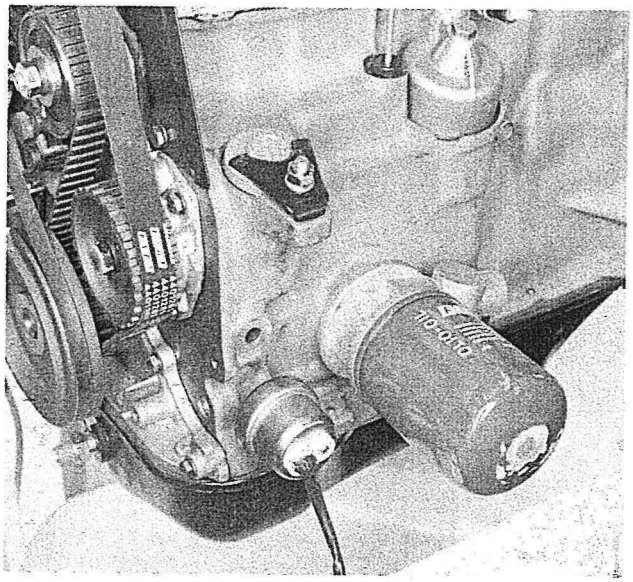
OIL SUMP



Fitting oil sump and gasket



Fitting engine oil cooling thermostatic valve

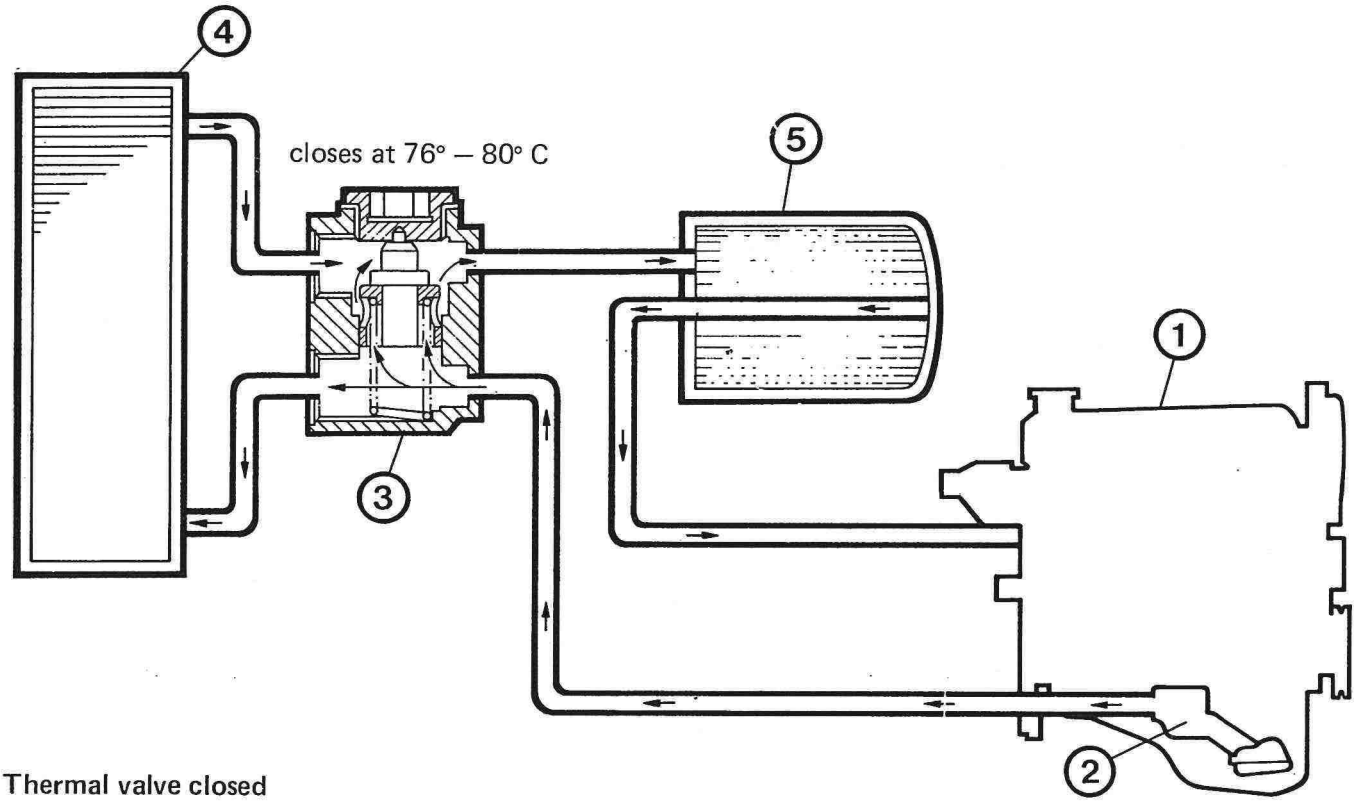


Fitting oil filter and oil pressure sender unit

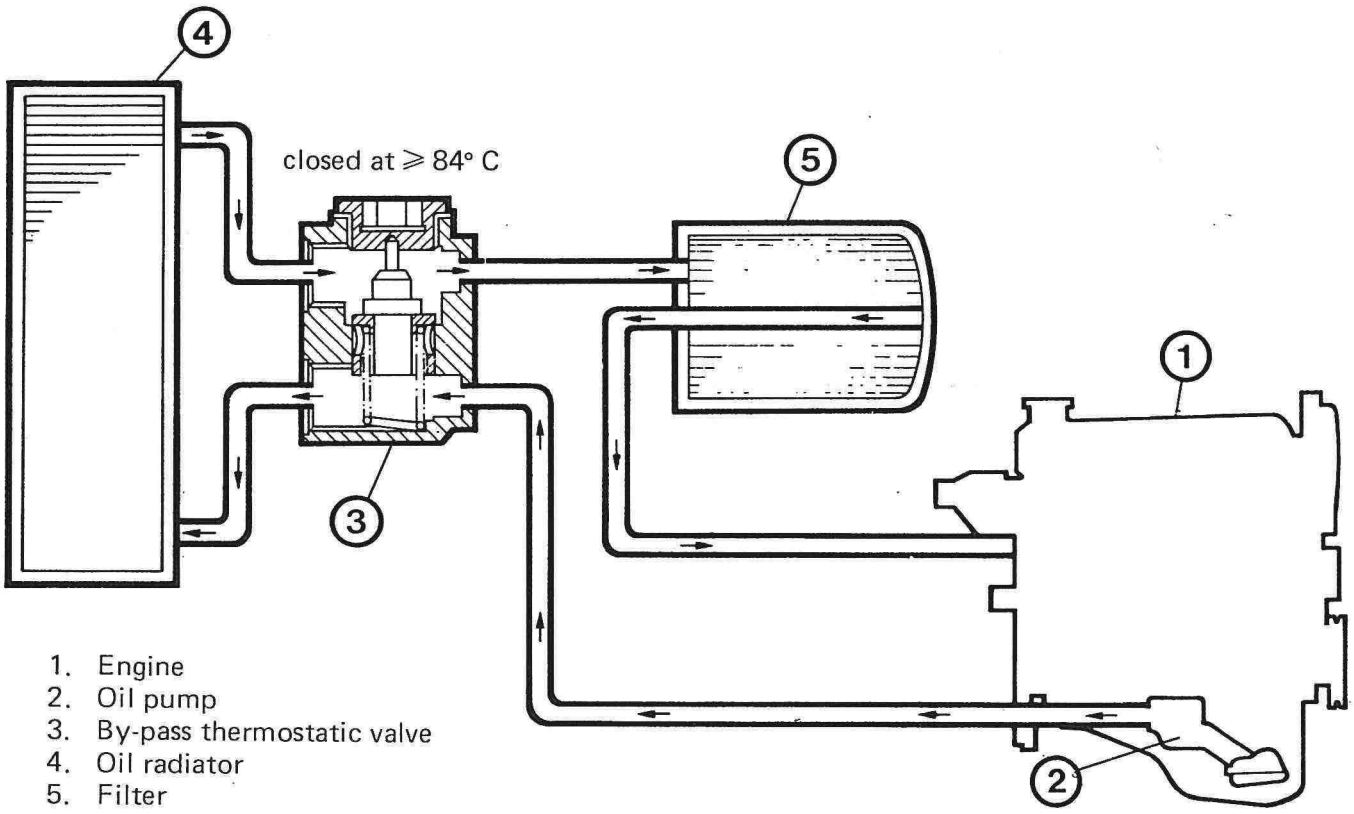
10.

DIAGRAMS SHOWING OPERATION OF ENGINE OIL COOLING THERMOSTATIC VALVE

Thermal valve open



Thermal valve closed



1. Engine
2. Oil pump
3. By-pass thermostatic valve
4. Oil radiator
5. Filter

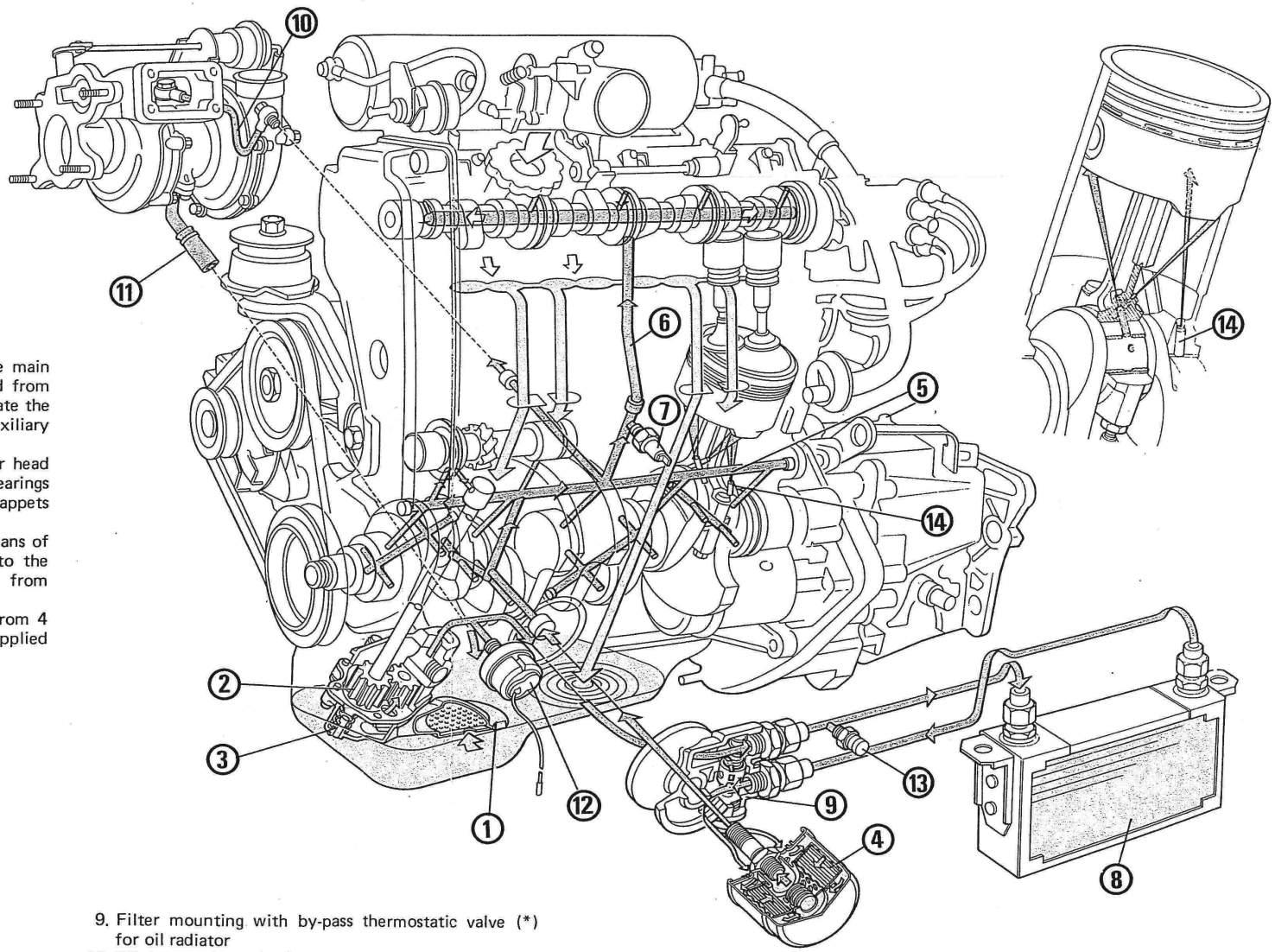
DIAGRAM SHOWING OPERATION OF ENGINE LUBRICATION SYSTEM

Operation

The lubricating oil arrives from the sump and is sent under pressure by the pump through a duct to the total capacity cartridge oil filter.
A **thermal switch** located in the oil filter mounting ensures that:

a. at temperatures below 78° C the oil passes directly into the cartridge filter and from there directly to the engine;
b. at temperatures above 84° C the thermostatic valve opens and allows the oil coming from the cartridge filter to pass into the engine cooling radiator so as to lower the temperature and ensure better lubrication.

The oil, after having been filtered, passes into the main duct (5), located lengthwise in the crankcase, and from there is sent through the secondary ducts to lubricate the crankshaft main journals and crankpins and the auxiliary shaft bearings.
In addition, a vertical duct located in the cylinder head and block ensures the lubrication of the camshaft bearings from which the oil, as it comes out, lubricates the tappets and the shims and finally returns to the sump.
From the main duct (5) the oil is also sent, by means of a partly internal and partly external duct (10) to the turbocharger to lubricate the control shaft and from there it returns to the sump via a return pipe (11).
The four pistons are cooled by four jets of oil from 4 spray nozzles fixed in the crankcase which are supplied by the crankshaft bearing lubrication ducts.



Key

1. Strainer with filter gauze
2. Oil pump with gears
3. Oil pressure relief valve
4. Total capacity cartridge oil filter with safety valve for cutting out filter if filter element is blocked
5. Main duct for supplying oil to various components
6. Oil delivery duct to camshaft
7. Insufficient engine oil pressure warning light switch
8. Engine oil cooling radiator
9. Filter mounting with by-pass thermostatic valve (*) for oil radiator
10. Oil duct to the turbocharger
11. Oil return duct from the turbocharger
12. Engine oil pressure sender unit
13. Engine oil temperature sender unit
14. Oil spray nozzles for cooling pistons

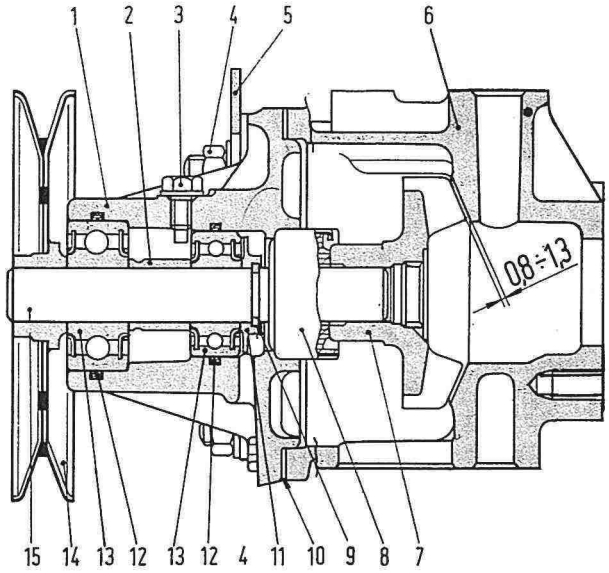
(*) The thermostatic valve is not available as spares; if it is not working properly, replace the oil filter mounting.

Delivery circuit
Return circuit

WATER PUMP

Cross section of water pump

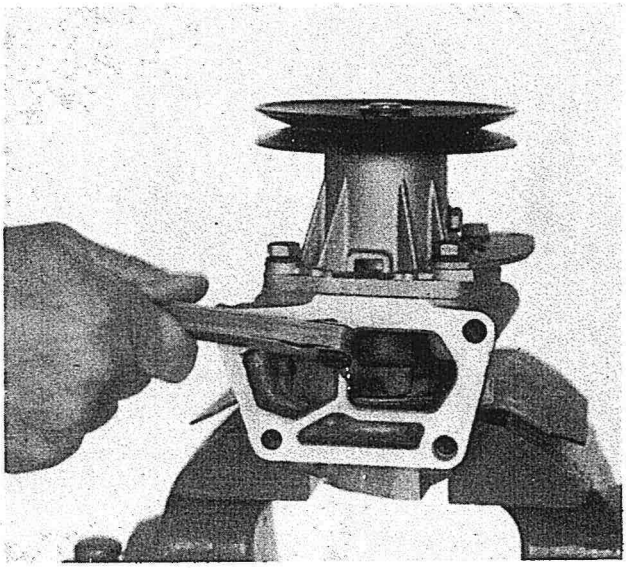
Carefully check that the pump casing is free from distortions and cracks; if it is not, it must be replaced.



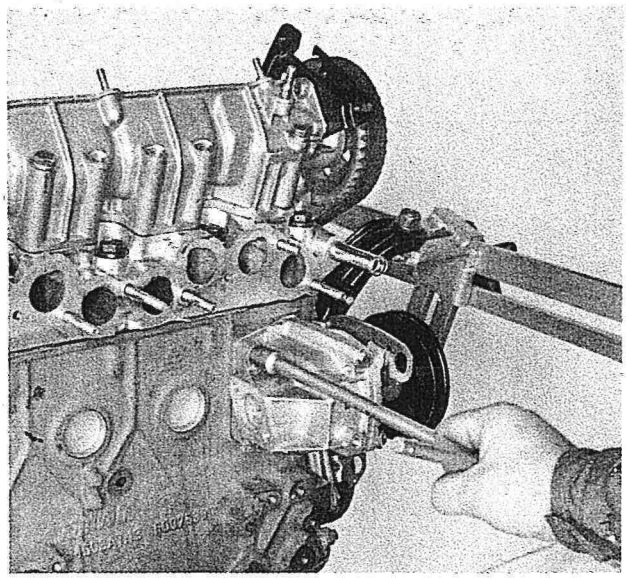
1. Pump cover - 2. Spacer - 3. Screw - 4. Nuts for fixing cover to pump casing - 5. Bracket - 6. Pump cover - 7. Impeller - 8. Seal - 9. Circlip - 10. Seal - 11. Thrust washer - 12. Seals - 13. Ball bearings - 14. Pulley - 15. Control shaft.

0.8 — 1.3 mm = Clearance between impeller and pump casing

0,8 ÷ 1,3 mm

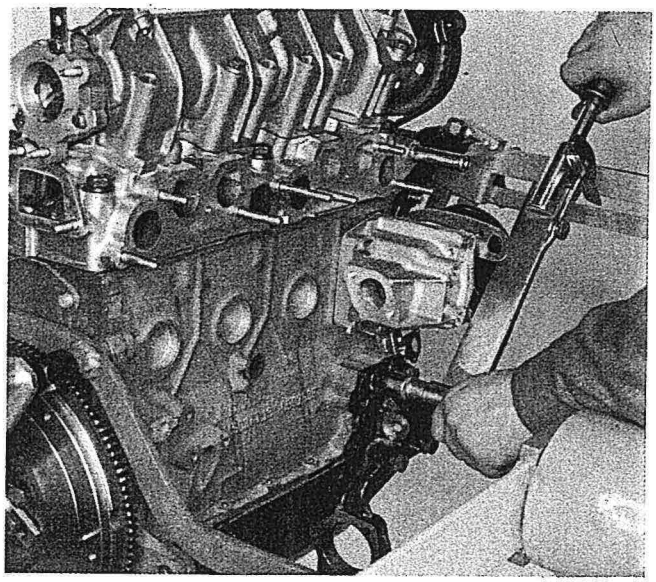


Checking clearance between impeller and pump casing



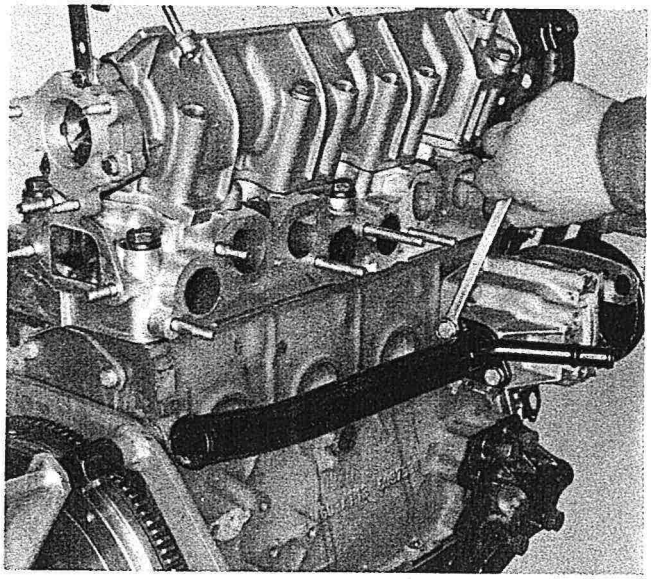
Fitting water pump on engine

10.

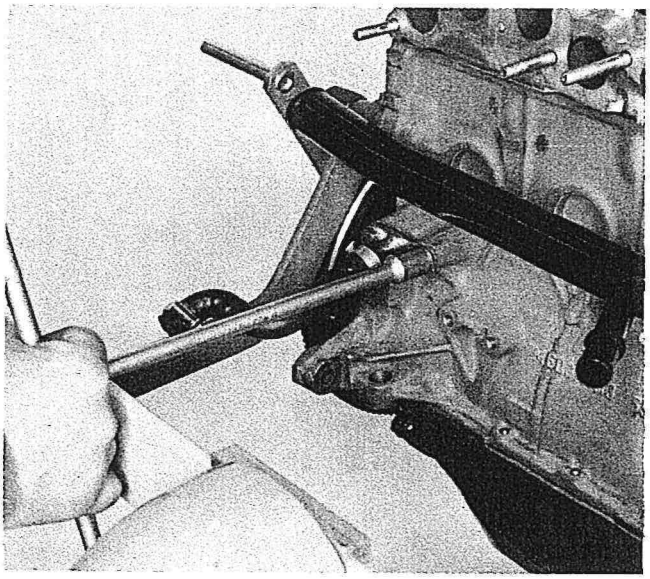


4,9 daNm

Fitting intermediate shaft support and tightening to torque

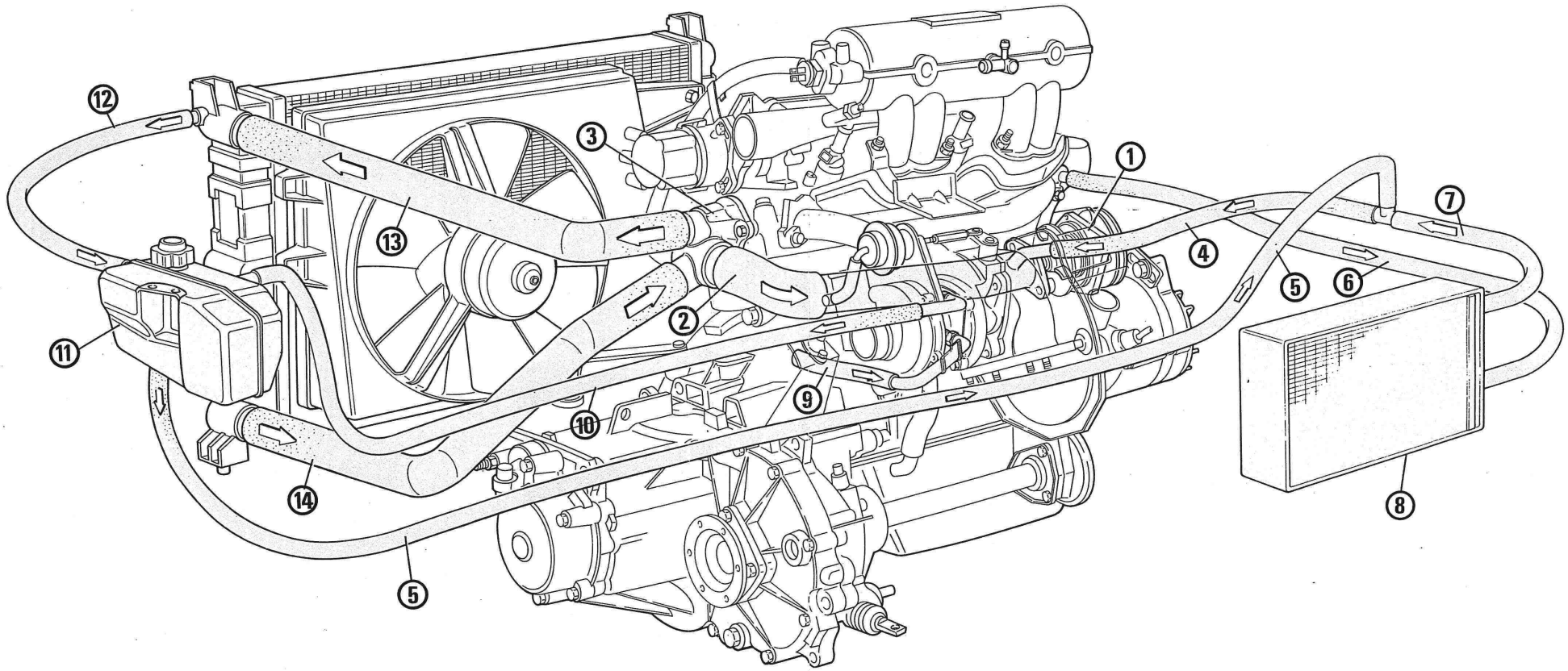


Fitting pipe between water pump and thermostat



Fitting pipe between crankcase and turbocharger

DIAGRAM SHOWING ENGINE COOLING SYSTEM



Thermostatic valve (3) in closed position

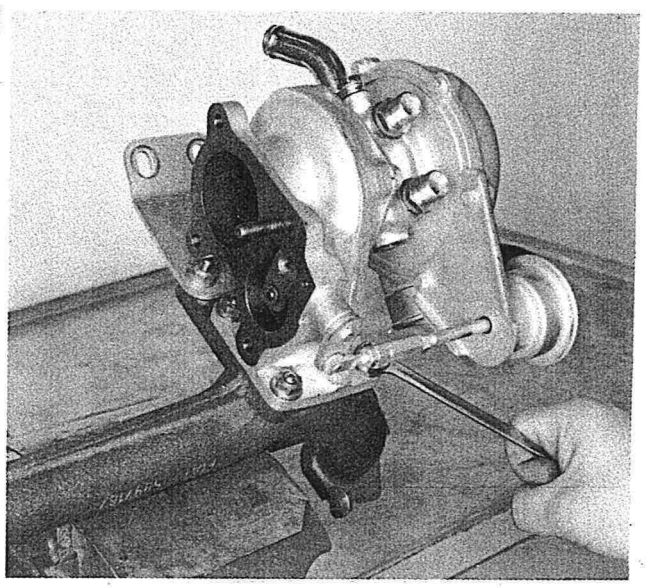
The water pump (1), controlled by the engine, sets the coolant in motion sending it directly to the cylinder block.
After coming into contact with the walls of the cylinder block, part of the coolant escapes from the thermostat casing (3) and is drawn by the pump via the duct (2) and recirculates in the cylinder block. Some of the coolant escapes from the cylinder head and supplies the heater radiator (8) via the pipe (6) and then returns to the inlet side of the pump through pipes (7) and (4).
A minimal amount of coolant can pass through the closed thermostat; it supplies the expansion tank (11) through the sleeve (13) and the pipe (12) and returns to the inlet side of the pump via pipes (5) and (4).

Thermostatic valve (3) in open position

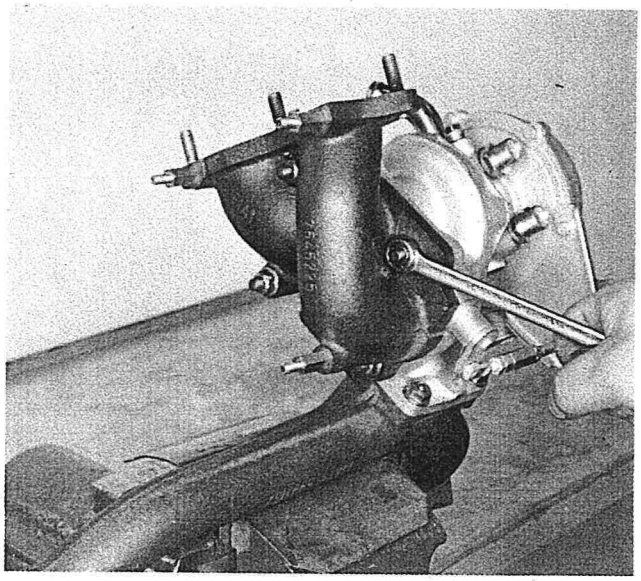
When the temperature of the coolant reaches 78° – 82° C, the thermostatic valve starts to open and the coolant comes from the cylinder block via the sleeve (13) to the radiator.
The water, cooled by the valve which comes into operation at a temperature of 90° – 94° C, travels downwards and is drawn in by the pump through the sleeve (14) and the duct (2).

The coolant from the cylinder block cools the turbocharger casing arriving via the pipe (9) and returns t the expansion tank (11) via the pipe (10) whatever position the thermostat (3) is in.
The coolant is always circulating in the heater-radiator (8).
There is a pressure valve in the radiator cap (2) which pressurizes the coolant circuit.

1. Coolant pump
2. Pump inlet sleeve and duct
3. Thermostat casing with by-pass valve
4. Coolant pump return pipe
5. Expansion tank return pipe
6. Heater-radiator delivery pipe
7. Heater-radiator return pipe
8. Car interior radiator
9. Turbocharger coolant delivery pipe
10. Turbocharger return pipe
11. Expansion tank with coolant level gaug (for check system)
12. Expansion tank supply pipe
13. Radiator delivery sleeve

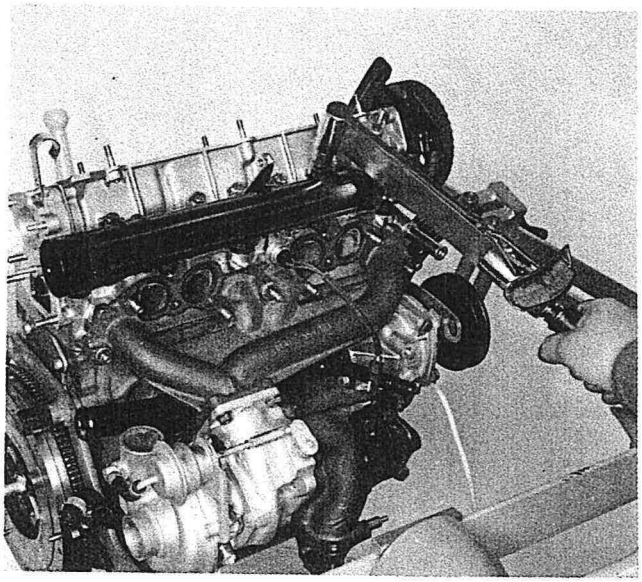


Fitting turbocharger to exhaust manifold



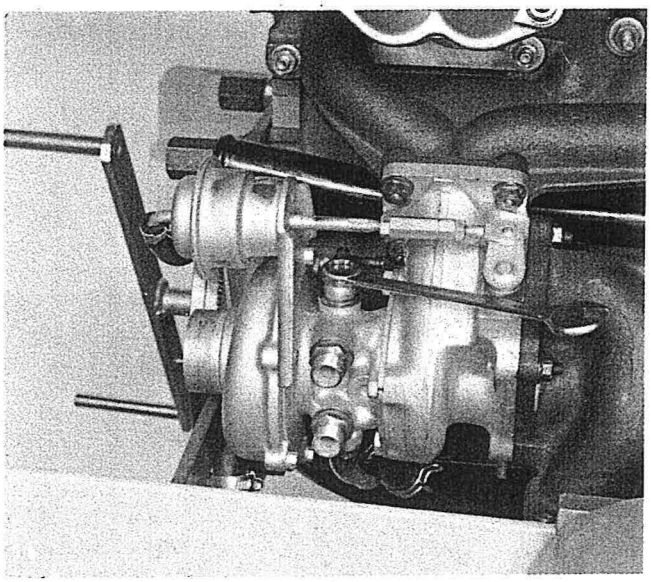
Fitting exhaust manifold with turbocharger to exhaust pipe

2 daNm

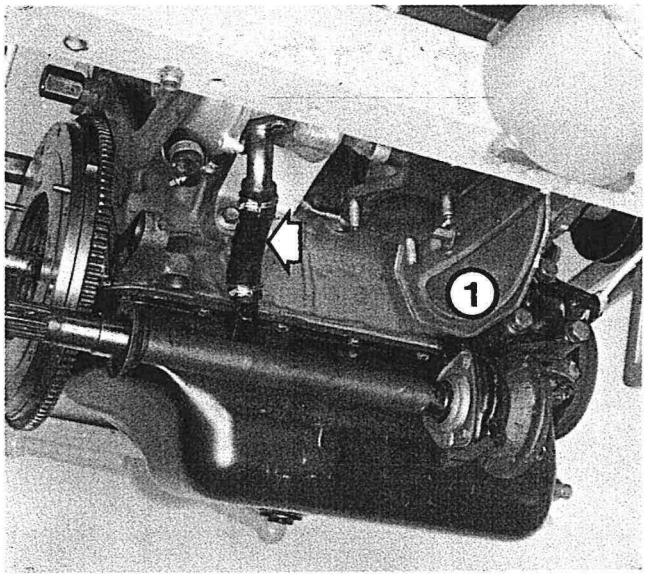


Fitting exhaust manifold complete with turbocharger in cylinder head and tightening camshaft housing to torque with injector coolant duct in place

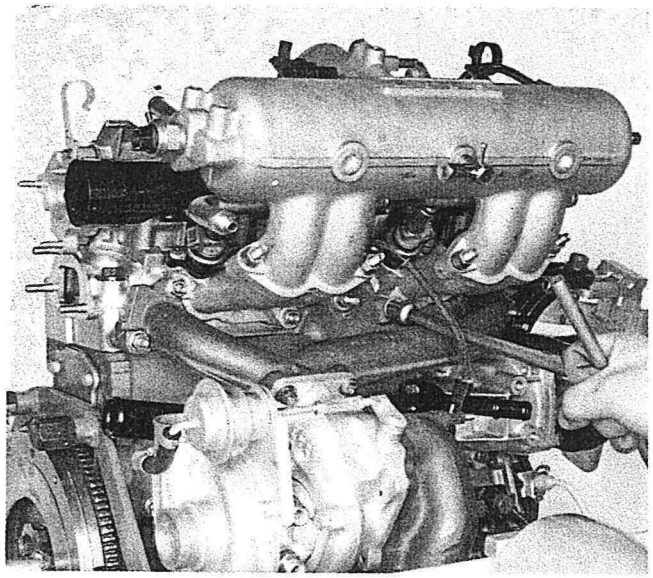
10.



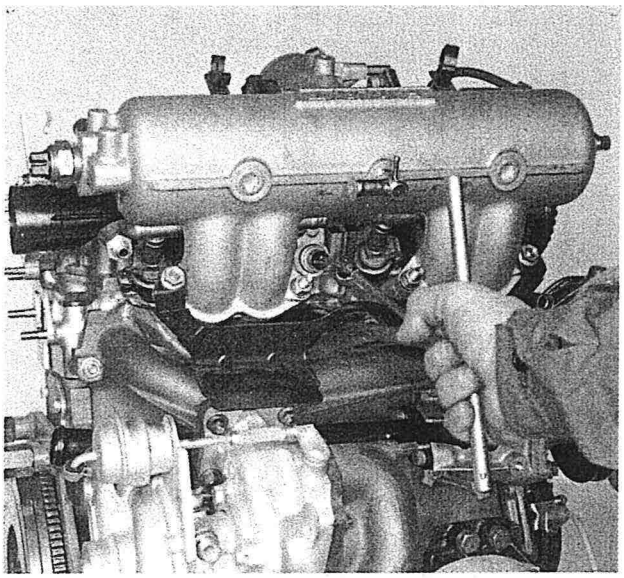
Fitting oil supply duct to turbocharger



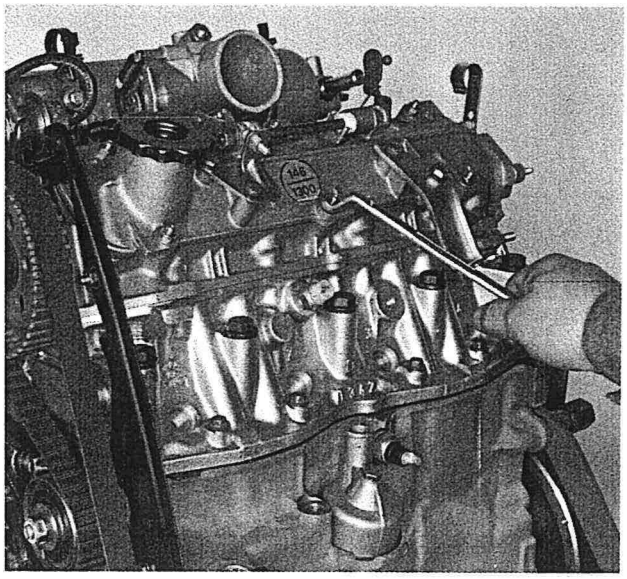
Connecting engine oil drain pipe (shown by arrow) from the turbocharger to the oil sump and alternator shield (1)



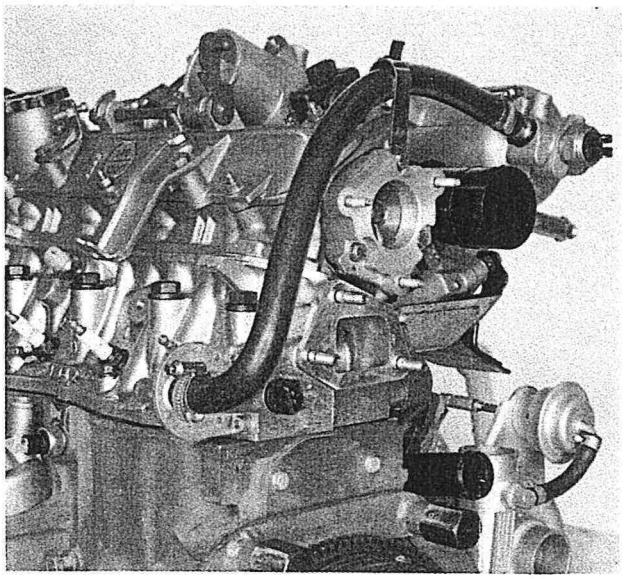
Fitting inlet manifold complete with injectors and maximum supercharging switch



Fitting heat shield

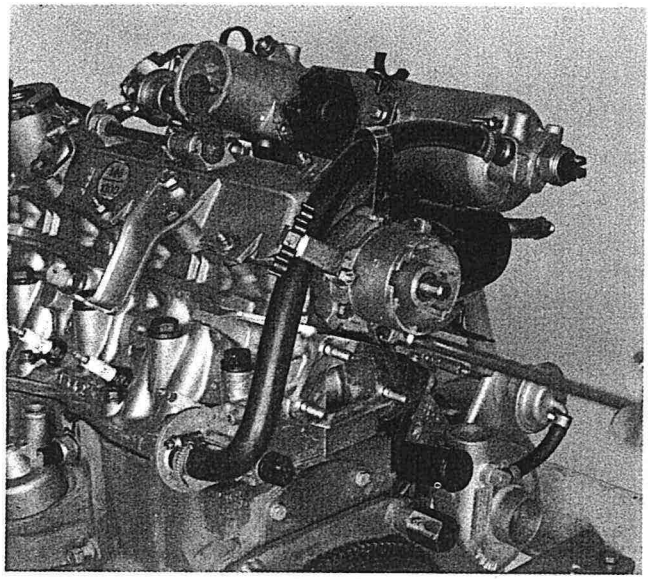


Fitting tappet cover

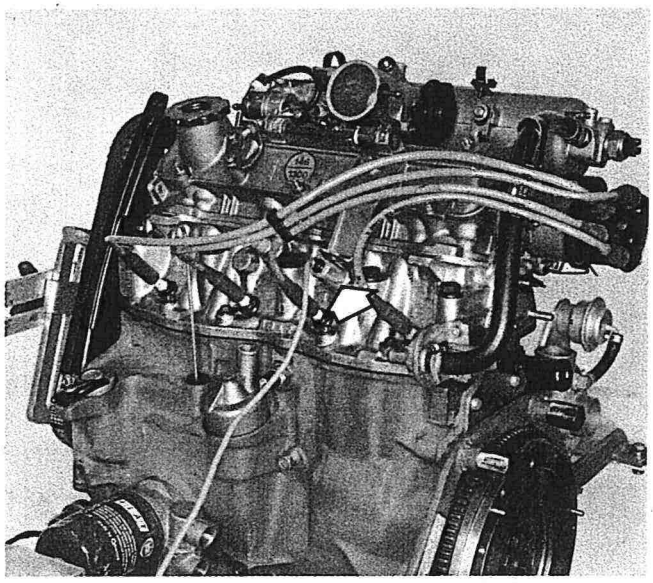


Fitting supplementary air valve and inlet manifold duct

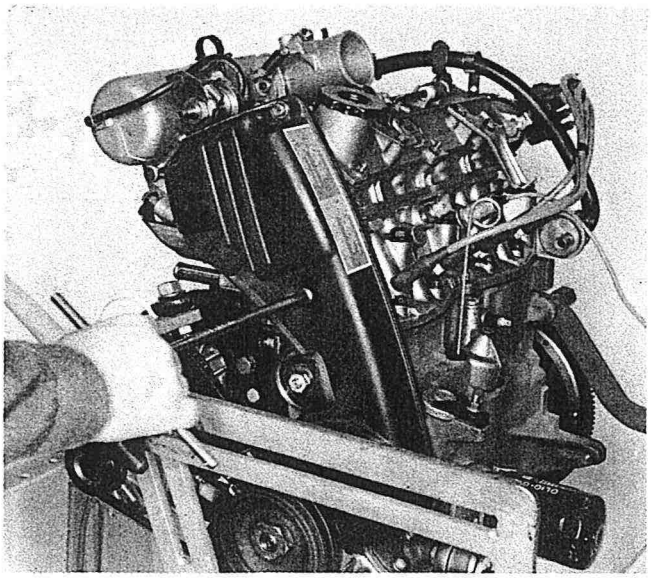
10.



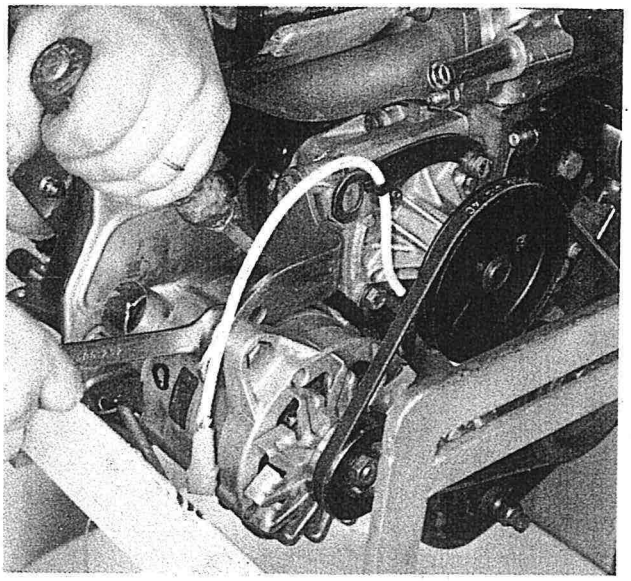
Fitting distributor
(see instructions on page 13, Section 55)



Fitting detonation sensor (shown by the arrow) on the cylinder head; distributor cap and spark plug supply cables



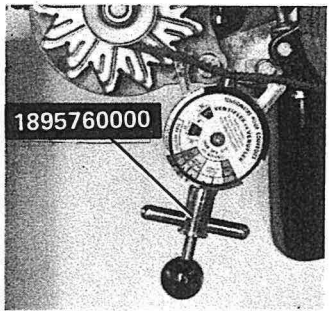
Fitting timing belt shield



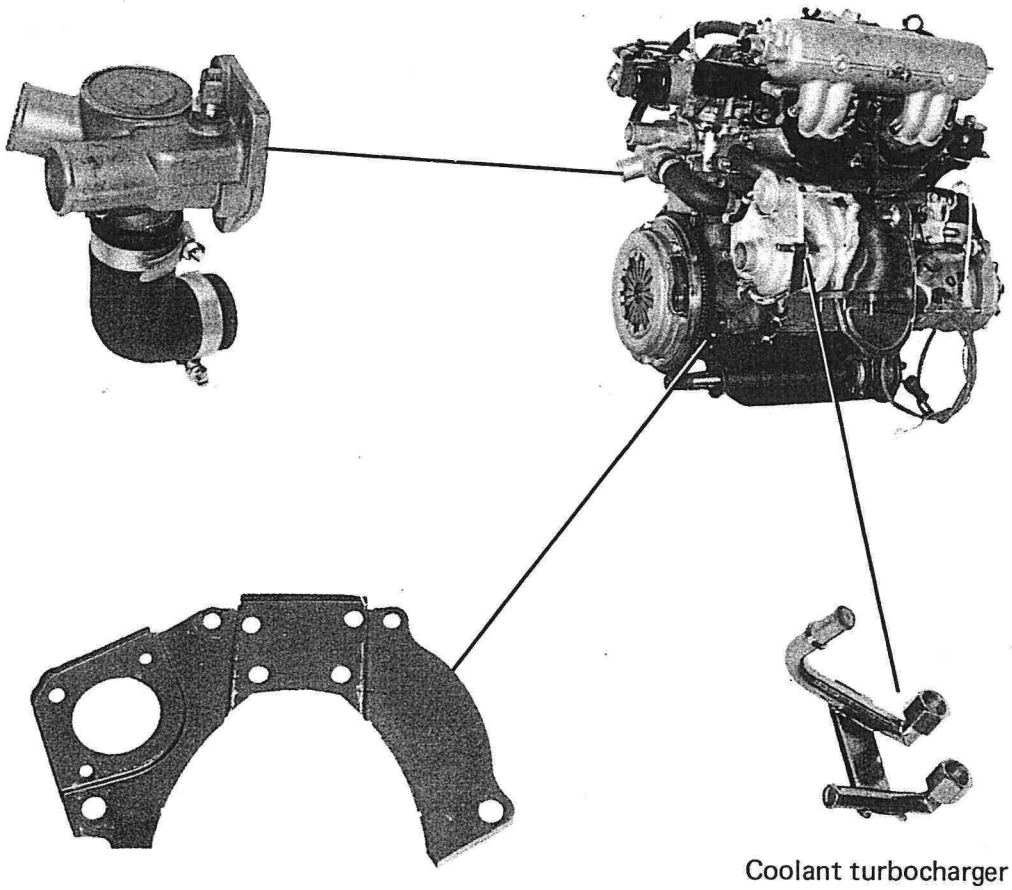
Fitting alternator and checking belt tension

Tensioning alternator belt

Tension the belt by carrying out the adjustment so that the load, measured using tool 1895760000, is 30 - 35 daN.



Fitting thermostat, flywheel shield and coolant circuit supply unions to the turbocharger



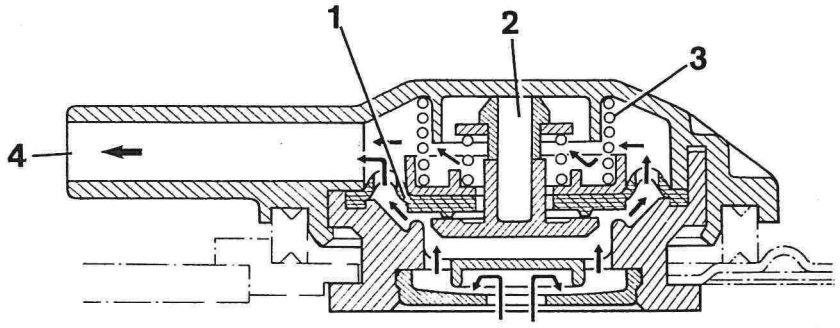
Coolant turbocharger nuts

FUEL TANK VENTILATION SYSTEM

The tank ventilation system is the type commonly known as "open".
This system comprises a sealed fuel filler cap, an overflow pipe directly connected to the top of the filler and a two way valve located on the fuel tank.
The adjustment of the internal pressure is carried out by the valve which discharges the excess pressure due to the excessive evaporation of the fuel and prevents the formation of a possible vacuum inside the tank which would be caused by the fuel and its low temperature.

Operation

When the pressure inside the fuel tank exceeds 0.045 – 0.075 bar, the valve diaphragm (1) and the piston (2) move and overcome the reaction of the spring (3) allowing the excess pressure to be discharged via the breather pipe (4).



However, if a vacuum starts to develop inside the fuel tank, the valve piston (2) moves, overcoming the reaction of the spring (3), allowing outside air to enter the tank via the breather pipe (4) which restores the internal pressure to the given figure.

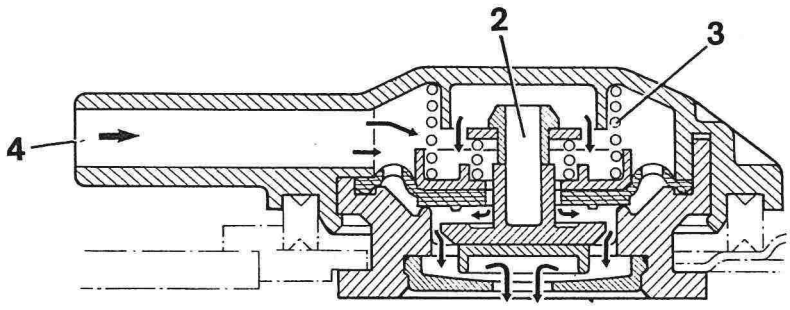
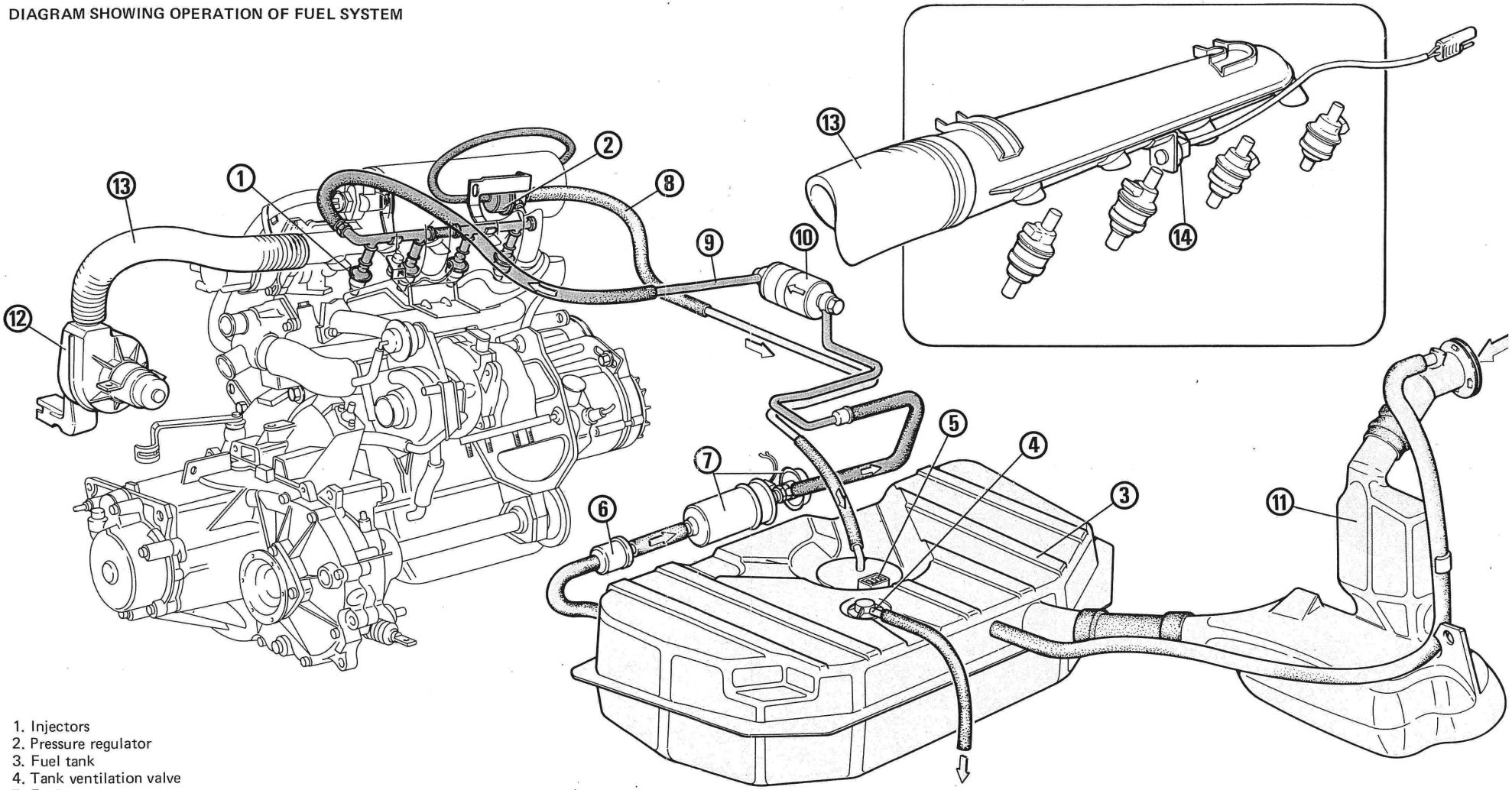


DIAGRAM SHOWING OPERATION OF FUEL SYSTEM



1. Injectors
2. Pressure regulator
3. Fuel tank
4. Tank ventilation valve
5. Fuel gauge
6. Secondary fuel filter
7. Electric fuel pump and fuel pressure peak damper
8. Return pipe
9. Delivery pipe
10. Main fuel filter
11. Expansion tank
12. Electric fan for cooling injectors
13. Injector cooling air duct
14. Electric fan (12) thermal control switch

Circuit under pressure

Circuit without return pressure

Fuel

Circuit at atmospheric pressure and fuel vapour breather

Circuit at supercharging pressure

BOSCH LE2–JETRONIC ELECTRONIC FUEL INJECTION

The Bosch LE2–Jetronic system belongs to the category of low pressure, intermittent multiple injection systems for 4 stroke Otto cycle engines.
Its function is to inject an exact quantity of petrol into the engine inlet manifold, upstream of each inlet valve, which will mix with the air introduced into the cylinder to give the correct mixture strength.
This system guarantees efficient operation, economic running, a reduction in harmful exhaust emissions and good driveability.

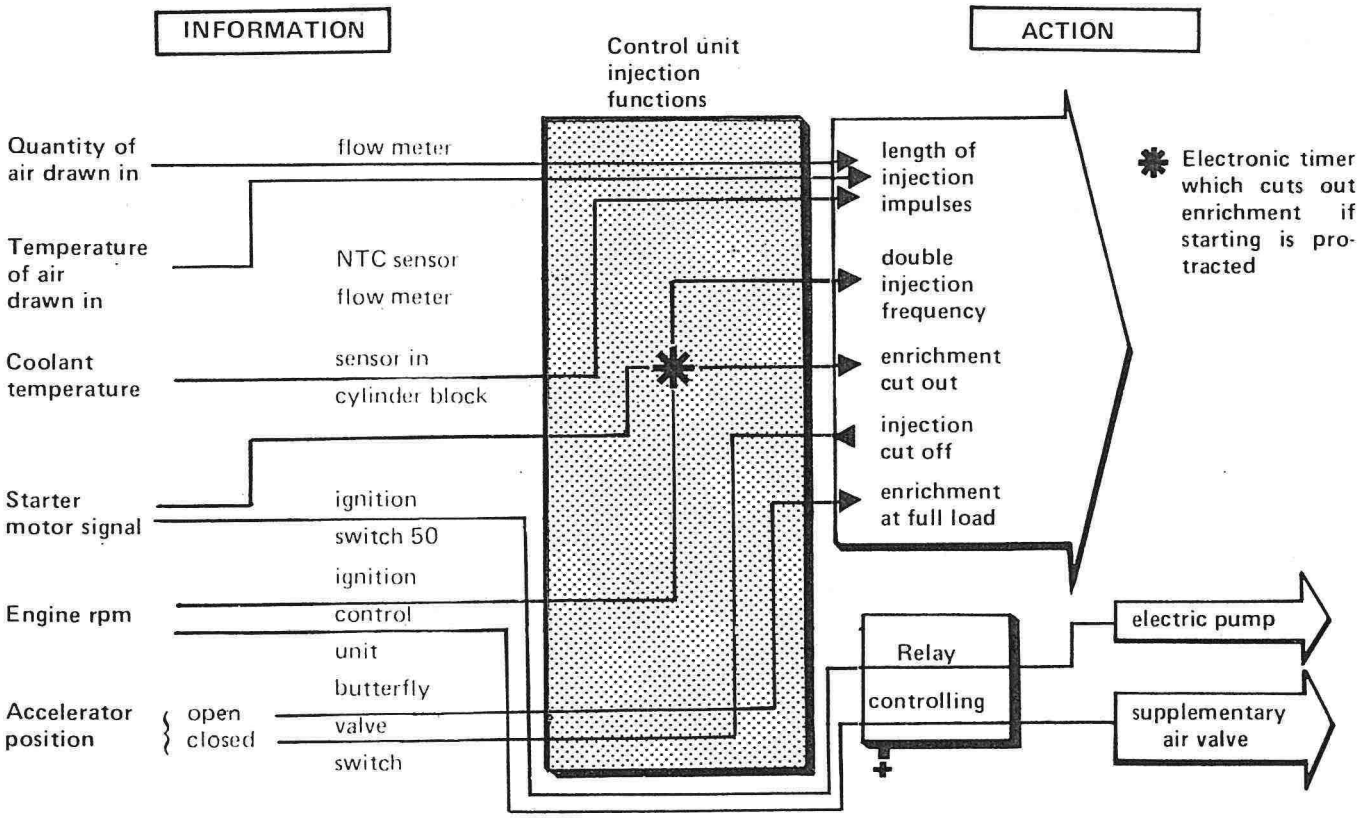
Operating principle (see wiring diagram on page 83)

The LE2–Jetronic system measures:
- The exact amount of air drawn in by the engine through a flow meter.
- The inlet temperature of the air drawn in through an NTC sensor housed in the flow meter.
- The temperature of the coolant via a sensor in the cylinder block.

By means of the above mentioned devices the LE2–Jetronic system can calculate the exact quantity of petrol to be injected into the engine to obtain the correct air/petrol (weight) ratio.
Since the air drawn in may be in various states of depression (or pressure when the engine is being supercharged) it is necessary to adjust the amount of fuel to be injected so as not to alter the air/fuel weight ratio. This ratio is kept constant by varying the value of the fuel supply pressure, by means of a regulator, according to the value of the depression of the air in the inlet manifold in such a way that the difference between the two pressures is constant for all engine operating conditions.

For certain engine operating conditions, such as:
- Cold starting at low external temperatures (ignition switch in "AVV" position).
- Accelerating (flow meter floating plate opens rapidly).
- Full power (switch contacts on butterfly valve).
- Release (switch contacts on butterfly valve).

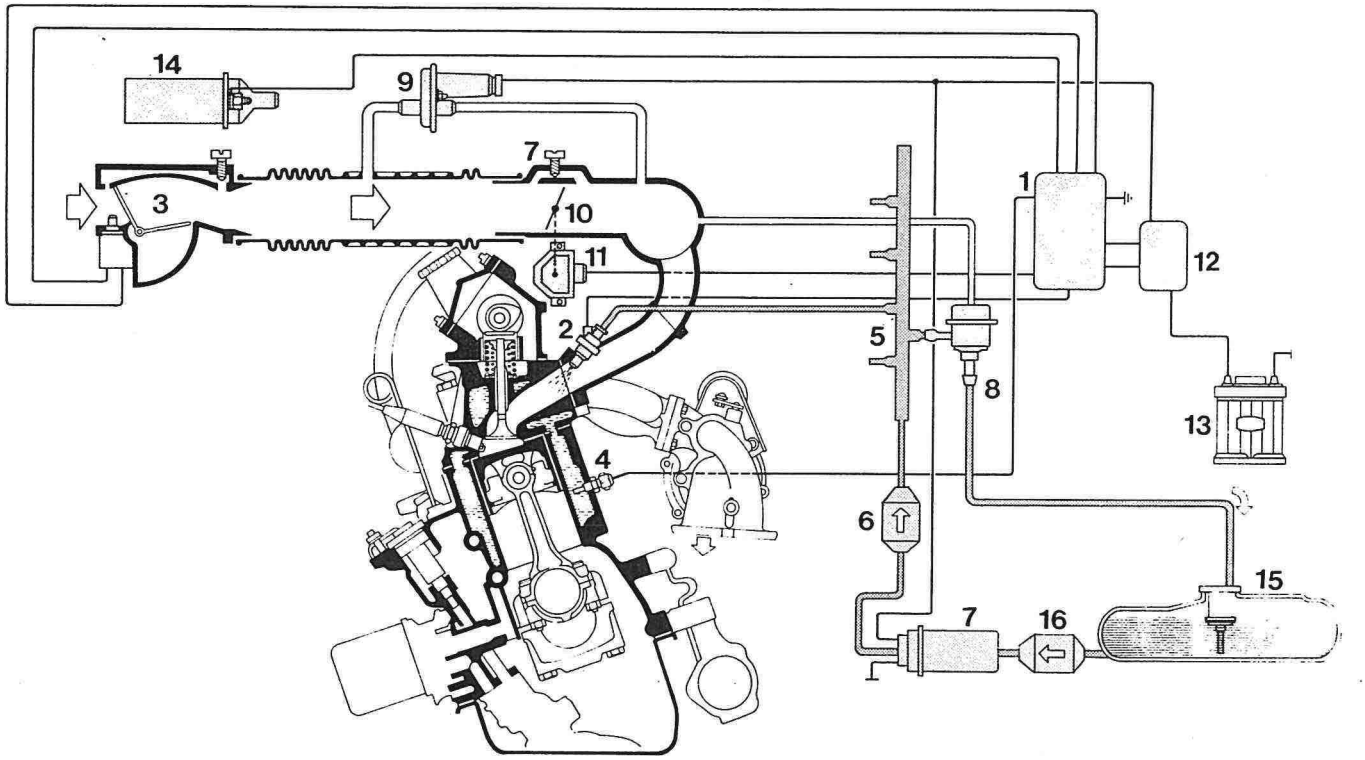
The control unit calculates the amount of fuel injected so that the mixture is richer or weaker as required.



10.

The LE2–Jetronic system comprises 3 integrated circuits:

1st circuit: fuel supply and injection.
2nd circuit: air intake into the engine.
3rd circuit: electrical control circuit for 1st circuit; it receives the necessary information from the 2nd circuit.



LE2–Jetronic injection system components

1. Electronic control unit
2. Injector (4 in number)
3. Air flow meter
4. Water temperature sensor
5. Injector fuel feed manifold
6. Fuel filter (with fitting direction)
7. Fuel pump
8. Fuel pressure regulator
9. Supplementary air valve for cold warm up
10. Butterfly valve
11. Accelerator position switch
12. Control or speedometer relay
13. Battery
14. Coil
15. Fuel tank
16. Fuel pre-filter

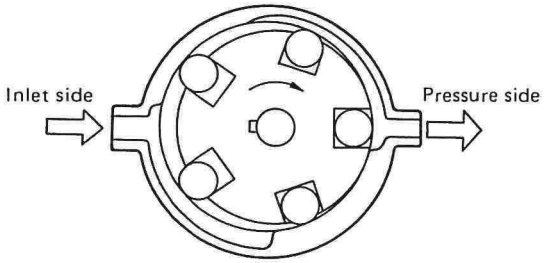
FUEL SUPPLY SYSTEM

The fuel supply system comprises an electric pump (7) which draws in petrol from the tank and sends it, through a filter (6) to the manifold (5) and the injectors (2) which are electro-magnetically activated at a voltage of 12 V.
The pressure of the fuel is kept constant and proportional to the depression (or pressure) value in the inlet manifold by a pressure regulator (8).
The excess fuel flows back into the tank (15) under no pressure.

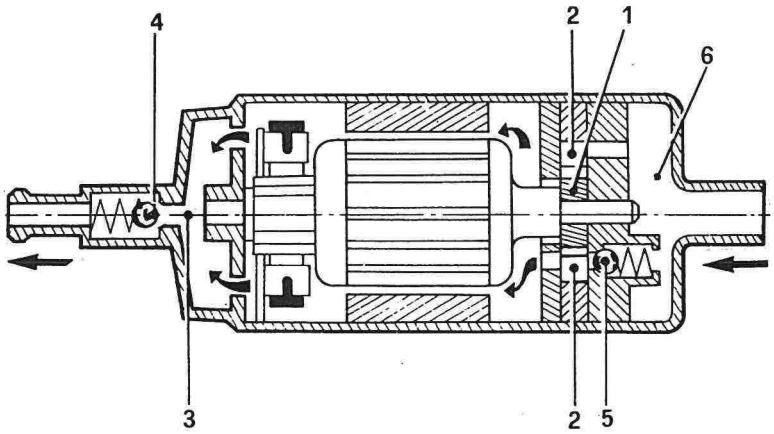
Electric fuel pump

The electric fuel pump is located under the bodyshell, near the tank after the first fuel filter. The pump is of the cell type with rollers activated by an electric motor immersed in the fuel and energized by permanent magnets.
A disc rotor (1), positioned eccentrically in the pump casing, contains metral rollers (2) in the cells along its circumference which are thrust be centrifugal force against the outer race with the effect of ensuring a water tight seal.

The fuel flows through the empty vanes and is compressed in the inlet manifold (3). A non-return valve (4) prevents the delivery pipe from being emptied when the engine is not running.
An excess pressure valve (5) short circuits the delivery to the inlet chamber (6) when the pressure is above 7 bar.
When the ignition switch is in the "starting" position, the electric pump starts to operate.
If the vehicle is not started up or if the engine stops for some reason, if the ignition switch remains in the ON position, the pump automatically stops working for safety reasons. When the starter motor is energized, for the length of the actual starting up, the pump operates supplying fuel under pressure to the injectors.
When the starting stage is over, the electric pump continues to work until the engine speed goes below 225 rpm or the ignition is switched off.



Cross section of electric fuel pump



Longitudinal section

Fuel filter

The fuel filter with a paper filter surface is located between the fuel pump and the pressure regulator. The correct position (fitting direction) for the filter is given by an arrow stamped on the container. It should be replaced every 40,000 km (25,000 miles) or when it has been incorrectly fitted.

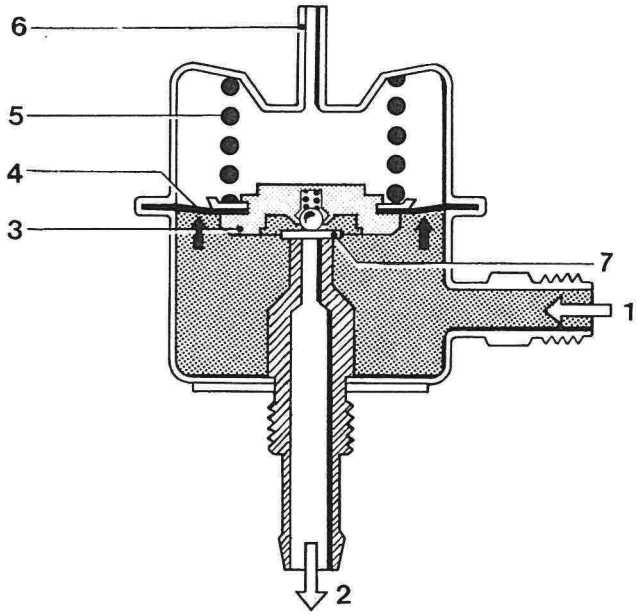
Pressure damper

A diaphragm type damper has been fitted on the pipe downstream from the electric pump in order to reduce the noise caused by the strong thrust of the electric fuel pump. The variable volume chamber in the damper reduces the fuel pressure peaks making the pump operate more quietly.

Pressure regulator

The mechanical, diaphragm type pressure regulator is fitted on the injector pipe and cannot be adjusted. It comprises a metal casing which contains a rotor made up of a metal casing (3) and a diaphragm (4) loaded by a spring (5). Overcoming the pre-established force made up by the pressure or vacuum in the opposite part of the diaphragm and the spring (5) loading, the fuel thrust by the pump causes a valve (7) to open which allows the excess fuel to flow back to the tank.
The chamber which houses the spring is in contact with the engine inlet manifold (6) (vacuum signal or pressure signal if the engine is being supercharged). The difference between the fuel pressure and the vacuum or pressure in the inlet manifold in all engine operating conditions is kept constant in this way.
Pressure regulator calibration: 3 ± 0.2 bar with engine idling (vacuum around 0.5 bar).

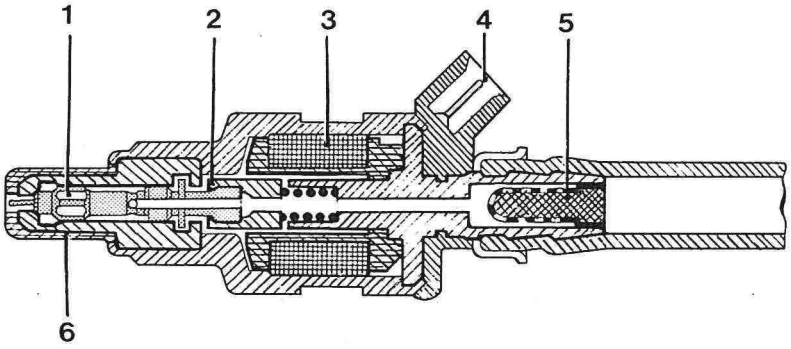
Longitudinal section of pressure regulator



1. Fuel manifold connecting union
2. Fuel return pipe connecting union
3. Metal casing
4. Diaphragm with downflow valve
5. Adjustment spring
6. Inlet manifold vacuum connecting pipe
7. Downflow valve

Injectors

The fuel is metered by means of 4 injectors each situated on the duct near the inlet valve and electrically connected in parallel. The injectors are composed of a casing which houses the electrical winding (3) which operates at 12 V and an integral core (2) with the needle (1) thrust against the seat by an opposing spring.
The voltage impulses coming from the electronic control unit create a magnetic field in the winding which attracts the core raising the needle from its seat by a few tenths of a millimetre.



1. Needle valve
2. Core
3. Magnetic winding
4. Terminal for electrical connection
5. Injector inlet fuel filter

Longitudinal section of injector

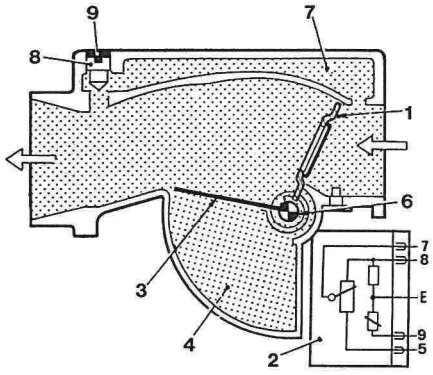
The amount of fuel injected therefore depends purely on the length of time the injector remains open which is established by the control unit. Since the four injectors are electrically connected in parallel, the injection of the fuel into the four inlet ducts takes place simultaneously which results in a sufficiently uniform and homogenous mixture being obtained. The fuel is supplied in two stages; half of the fuel required for a complete cycle (2 rpm) is injected for each revolution of the crankshaft. In effect, the injection is determined by the extra current generated at the moment when the current in the ignition coil primary winding is cut off.
Consequently, the operation of the injection system is closely linked with the ignition system.
In addition, during cold starting at low external temperatures, the injection frequency is automatically doubled by the control unit.

The injection takes place at the sparking ignition without any link to the engine stroke.
Even if the injection does not take place during the inlet stroke, this does not adversely affect the operation of the engine as the fuel sprayed into the inlet manifold waits to be drawn in as soon as the appropriate valve opens.

AIR INLET SYSTEM

Air flow meter

This device measures the amount of air drawn in by the engine and transforms this value into an electric signal which it supplies to the electronic control unit.
The quantity of air drawn in by the engine exerts a force on the floating plate (1) in the flow meter.
The plate is in a precise angular position according to air flow and the opposing force of a spring (6). The angular position is transfered to a potentiometer (2) rigidly connected to the plate shaft.
A compensating butterfly (3) linked to the floating plate and having the same effective surface area compensates for any oscillations in reflux pressure which may occur so that they do not affect the measurement of the amount of air.
The butterfly causes a reduction in the oscillations in the measuring system as it is subject to the braking effect of a damper chamber (4). A small amount of air which is not measured is sent into a by-pass channel (7) varying the cross section of this channel by means of an adjustment screw (8). In this way the ratio of the air/petrol mixture drawn in by the engine when idling is varied. This adjustment makes it possible to correct the mixture strength during idling if the CO exhaust emission legal limits are exceeded. The adjustment screw (8) can be compared with the carburettor mixture screw and consequently it requires an idle anti-tamper plug (9).
The air flow meter houses an NTC type temperature sensor whose resistance value decreases as the temperature of the air drawn in by the engine increases.
The mixture strength is corrected when the temperature of the air drawn in is between −30° and 40° C.



Flow meter with 5 terminals

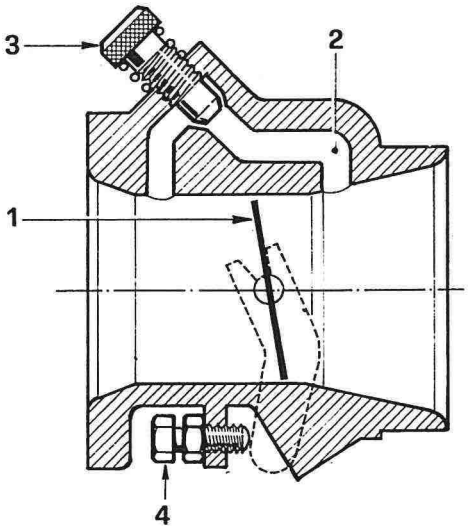
1. Floating plate
2. Potentiometer
3. Compensating butterfly
4. Damper chamber
6. Opposing spring
7. By-pass channel for air not measured
8. CO adjustment screw
9. Black anti-tamper plug

Terminals: 5, 7, 8 Potentiometric race
9 Air temperature NTC sensor
E Calibrated at the Factory not to be used under any circumstances

Accelerator butterfly casing

The amount of air drawn in is determined by the opening of the butterfly (1) located at the beginning of the inlet manifold. The butterfly is controlled by the accelerator pedal. The air required for the operation of the engine when idling passes through a by-pass channel (2) which has an adjustment screw (3); by turning this screw the quantity of air which is introduced into the manifold and consequently the idle speed can be varied (the mixture strength does not, however, vary).
A second screw (4) with a lock nut makes it possible to correctly adjust the butterfly closure to avoid contact with the surrounding duct; this screw is not used for idle adjustment.

1. Butterfly valve
2. Idle air by-pass duct
3. Engine idle adjustment screw
4. Butterfly closed position adjustment screw



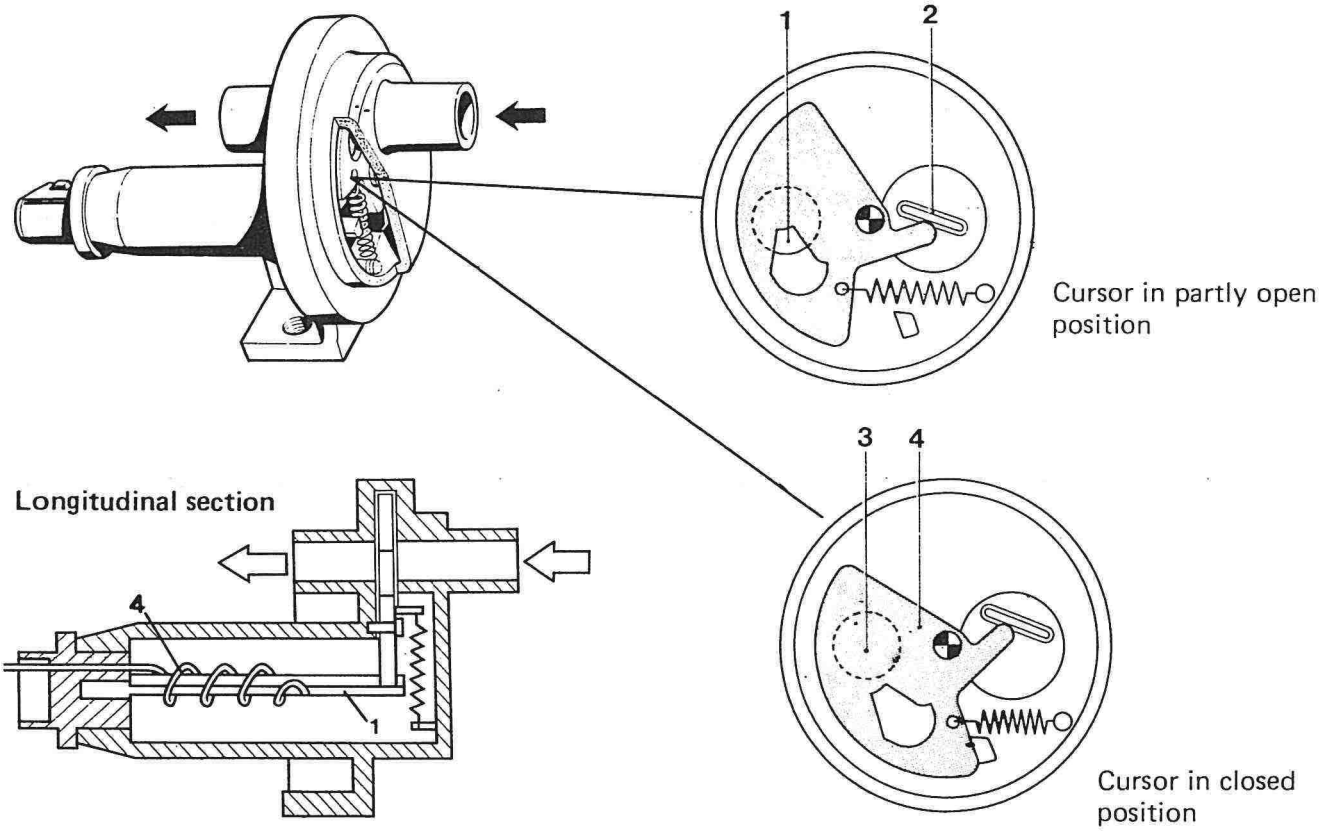
Longitudinal section of butterfly casing

10.

Supplementary air valve

The supplementary air valve provides the amount of air required by the engine during cold starting.
The cross section of the passage (3) is controlled by a rotating cursor (4) which contains a slit (1) for the air to pass through.
The cursor is activated by a bimetallic strip (2) heated by an electrical resistor, permanently supplied by the control (speedometer) relay.
As the temperature increases, the bimetallic strip makes the cursor rotate, overcoming the force of an opposing spring, thereby choking the passage of the extra air until it is completely shut off when the engine is warm.
During the warming up stage following a cold start, the engine needs a considerably richer mixture because some of the fuel injected condenses on the cylinder walls which are still cold. In addition, to compensate for the increased internal wear, the engine must produce a greater torque in order to run smoothly when idling. In these conditions the engine must be provided with a larger amount of mixture which must at the same time also be richer. The increase in the flow of air drawn in by the engine when idling is achieved by means of a valve known as a supplementary air valve (11) which bypasses the accelerator butterfly valve when the engine is cold. The enrichment of the mixture during the warming up stage, on the other hand, is taken care of by the injection control unit which, on the basis of the information received from the engine coolant temperature sensor, suitably increases the injection time and consequently the amount of fuel injected into the engine.

Part cross section of the supplementary air valve (11)

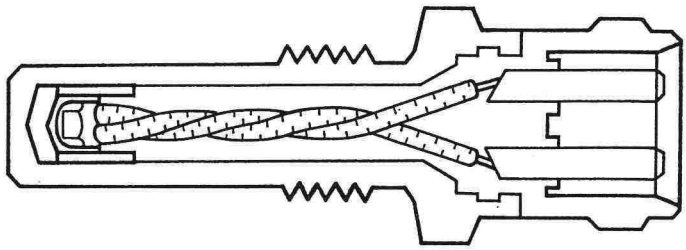


ELECTRICAL CONTROL CIRCUIT

This circuit supplies all the components in the flow meter circuit as far as the electric pump.
Two very important components in this system are the main control or speedometer relay and the electronic control unit. The latter receives all the information concerning rpm, engine load and air and coolant temperature in the form of variable voltages which it processes in order to be able to place the injectors to earth for a greater or lesser length of time to obtain the correct air/petrol mixture strength.
The operation of each individual component of the electrical circuit will be described overleaf.

Coolant temperature sensor

The sensor is fitted with the sensitive section in contact with the coolant.
It provides the control unit with a variable voltage according to the temperature of the engine so as to correct the air flow information for the air flow meter so that, on the basis of the signal received from the sensor, the control unit can increase the length of the fuel injection period providing the necessary enrichment to compensate for the fuel losses due to the condensation of the particles of petrol in the inlet manifolds when the engine is operating at lower temperatures than optimum.
This sensor therefore guarantees smooth engine operation during the stage following starting up as it continues to supply an enriched mixture and lengthens the injection period according to the temperature of the coolant measured. In addition, it enables the engine to run smoothly when accelerating when the engine is cold.



Longitudinal section of temperature sensor

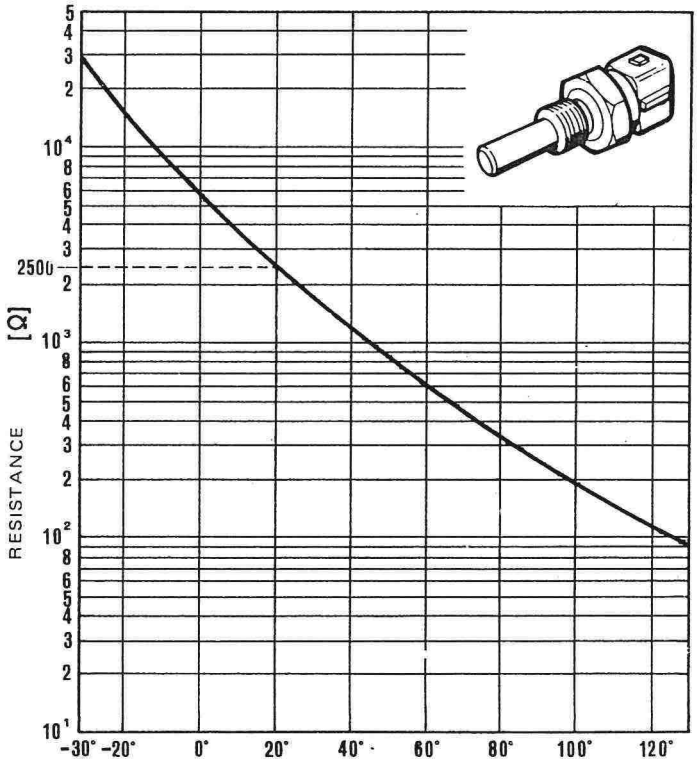
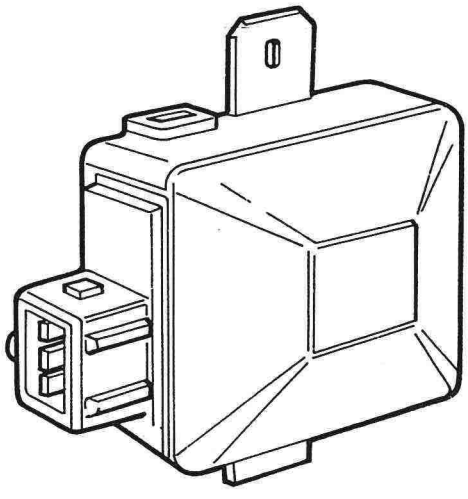


Diagram showing temperature sensor resistance - temperature

Switch on accelerator butterfly valve

The switch is controlled, by means of a rod, by the butterfly shaft which activates it. The switch sends a voltage signal to the control unit to inform it of the following conditions:
- butterfly valve in closed position, so that the control unit can operate the cut-off device (in other words stop injection) during deceleration above 1500 ÷ 2500 rpm approx
- butterfly valve in completely open position so that the control unit can increase the length of the injection period (in relation to normal values supplied by the flow meter and the temperature sensors) to enrich the mixture in a full power situation.



Butterfly valve switch

10.

Control or speedometer relay

The circuit for this relay is electronic and is energized by turning the ignition switch to the ON position. It allows the following functions:

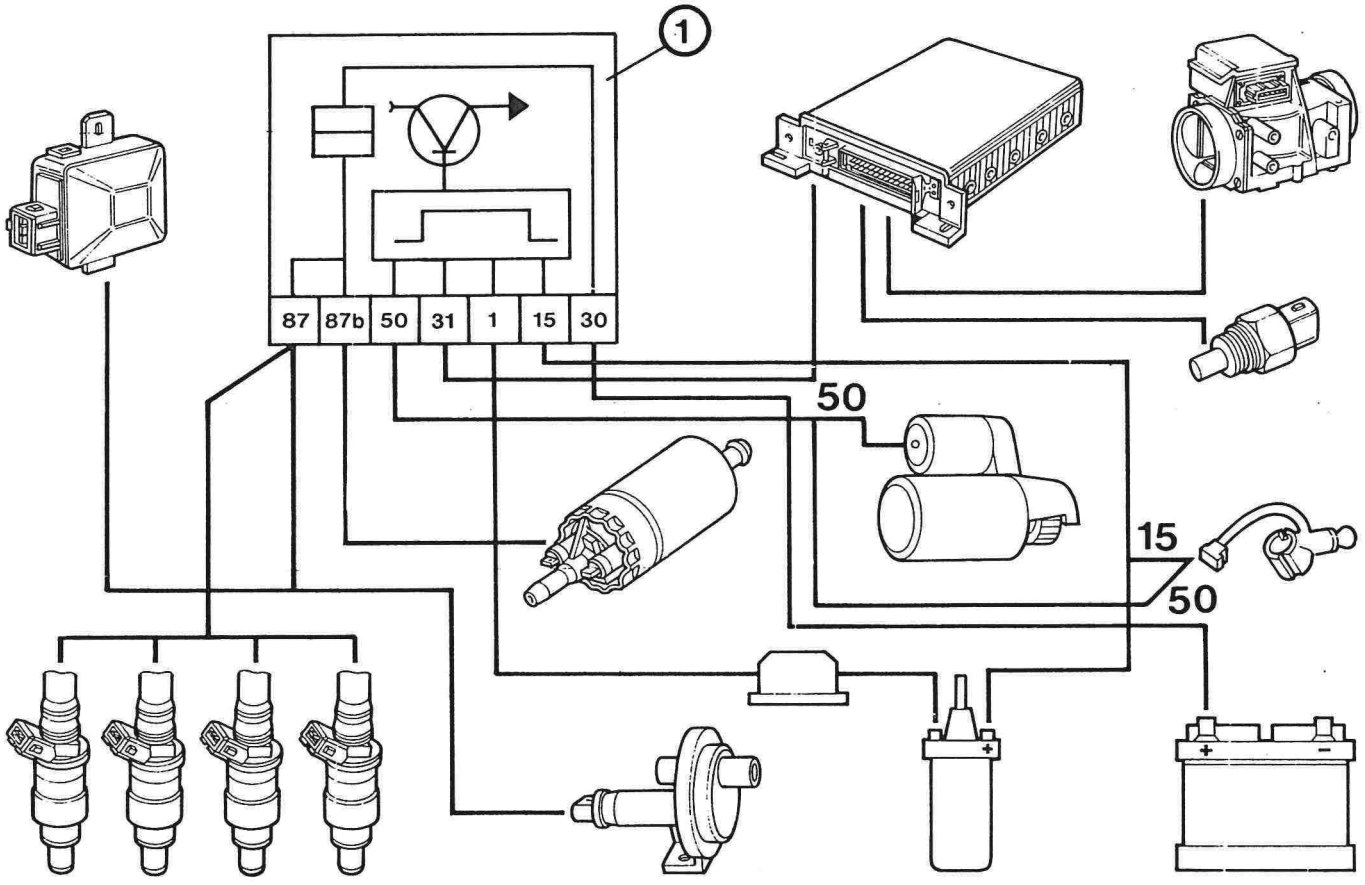
- supply of the electric fuel pump for the whole time the ignition switch remains in the "STARTING" position.

  This condition is achieved for the length of time the ignition switch contacts are closed (AVV) when the currect reaches the control relay feed.

- supply of the electric fuel pump when the igntion switch is in the ON position and the engine is running at above 225 rpm.

NOTE *The control relay has a safety device which cuts off the supply of fuel when there is an engine failure, the vehicle turns over, one of the fuel pipes is broken, etc, thereby avoiding fire risks.*

The control relay supply circuit transfers the current from the battery to the electric fuel pump, the injectors, the supplementary air valve resistor, the flow meter, and the butterfly valve switch, respectively. After passing through the flow meter, the butterfly valve switch, the current returns to the control unit providing the voltage signals required to determine the length of the injection period.



Components energized by the control relay (1)

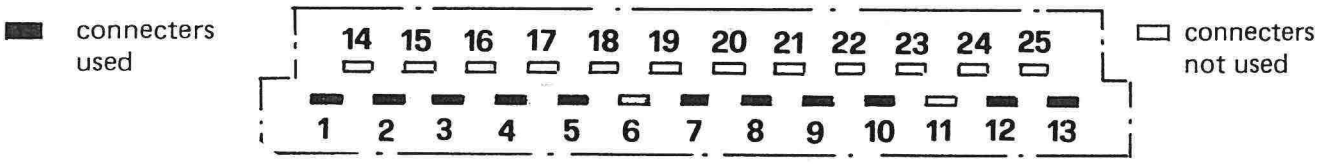
Electronic control unit

The control unit comprises thick film hybrid circuits and is connected to the electrical cables by means of a 25 pole multiple connecter.
In order to supply the correct amount of fuel for all engine operating conditions, the control unit processes the following information:

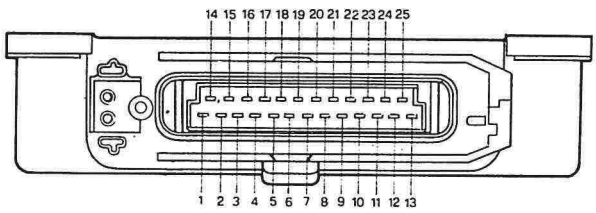
- amount of air
- air temperature
- engine temperature
- starting signal
- engine rpm
- accelerator pedal position (idle and full load)
- battery voltage

The control unit processes these data and sends electrical impulses to the injectors (electrically connected in parallel) which inject half the amount of fuel required by the engine for each revolution of the crankshaft. The impulse to begin injection comes from the ignition coil primary winding directly from the control unit which processes the signals to have two injections per cycle.
The control unit limits the minimum and maximum length of the impulses through continual adjustments, in actual time, to carry out the following functions:

- enrichment during starting
- enrichment when the engine is warming up
- enrichment during acceleration
- enrichment at full power
- anti-tear function
- fuel cut-off on overrun
- fuel adjustment during overrun



Front view of control unit terminals

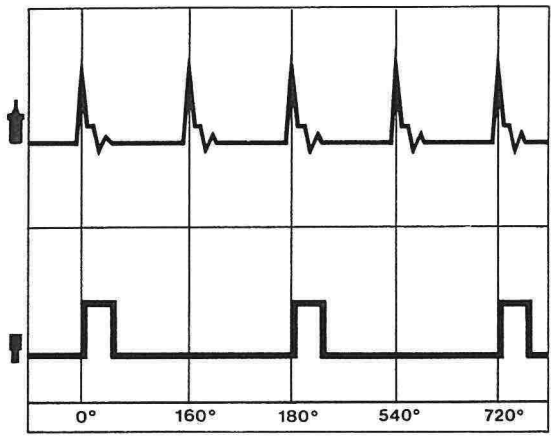


Front view of LE2-Jetronic injection system electronic control unit

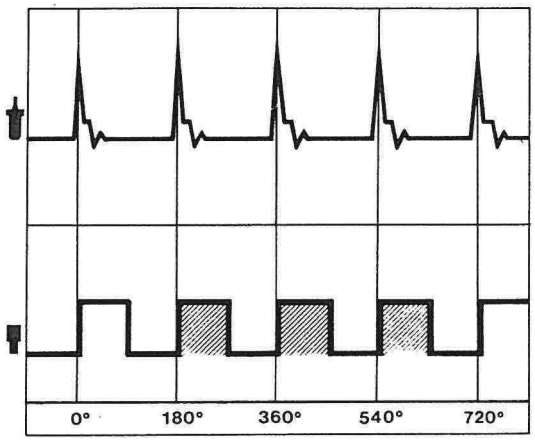
10.

Enrichment during cold starting

When the engine is operating normally, the electronic control unit provides two injection impulses for each engine cycle (720° of the crankshaft). During cold starting, on the other hand, it provides four injection impulses for each engine cycle.

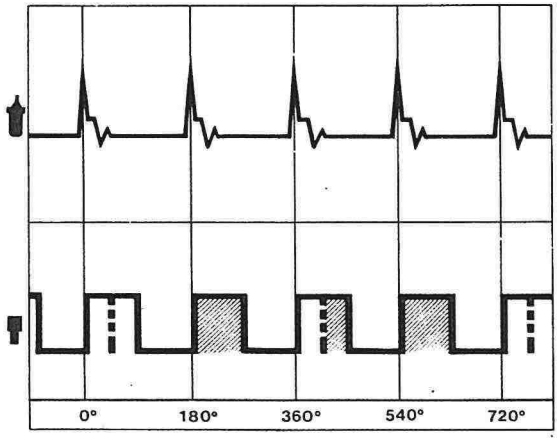


Normal engine operation

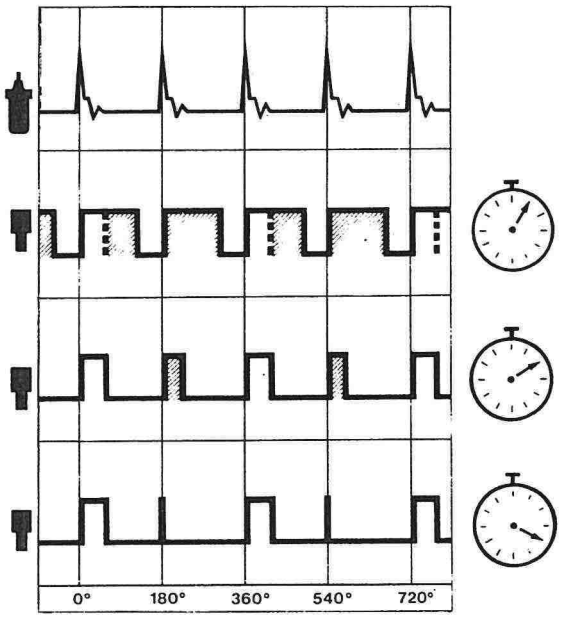


Actual operation during starting

What actually happens is that during the starting stage, in addition to the "normal" injection impulses, there are the impulses for the "cold starting" conditions which result in a final signal which is of the correct length and frequency to ensure the amount of fuel required for starting the engine.
If the starting stage becomes particularly long (for example when the battery is discharged) the enrichment impulse is continuously reduced.



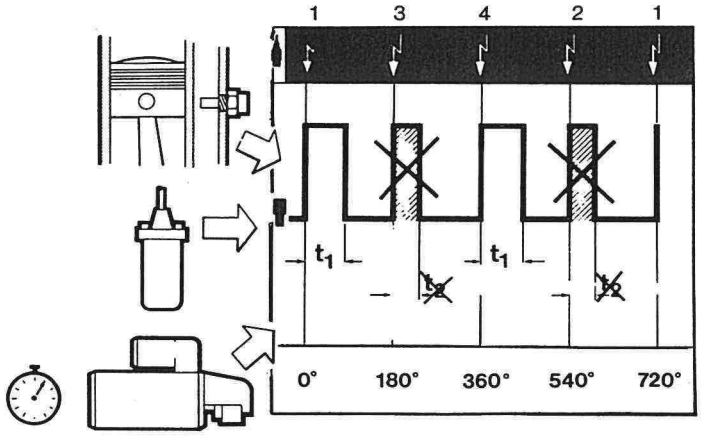
Operation during starting stage

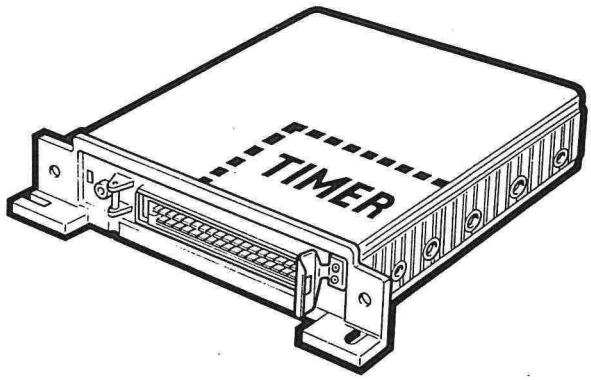


Operation during starting stage where there are difficulties

Starting engine at operating temperature with a high number of starting revs

The enrichment control impulse is cut off when the number of revs when starting exceeds a certain value.
No enrichment takes place in these circumstances; simply the normal amount of fuel actually needed for starting the engine is injected.





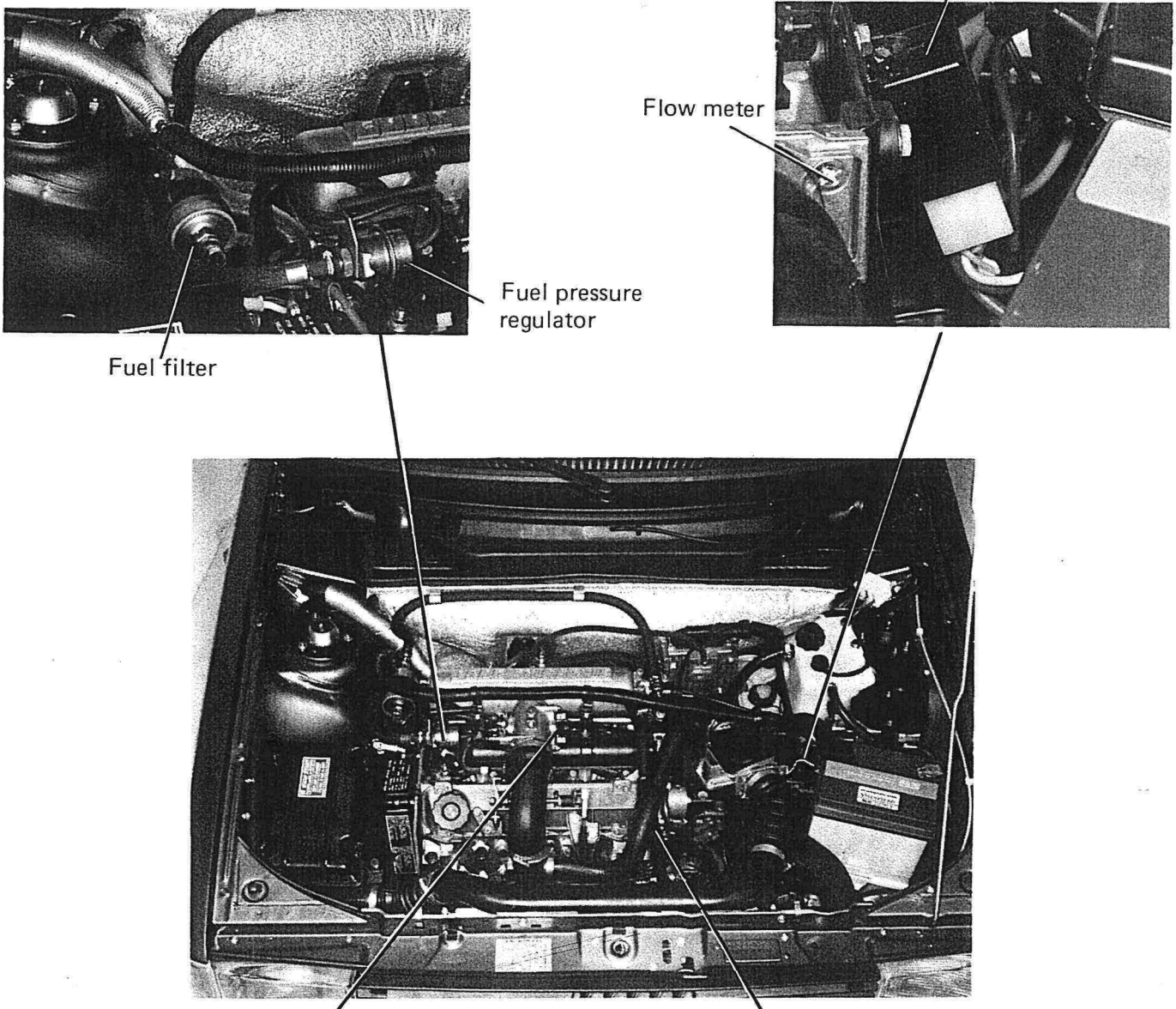
In order to prevent flooding the engine, a calibrated timer, inside the control unit, cuts off the enrichment if the pre-set limit for the length of the starting period is exceeded.
To sum up, if the revs during the starting stage or the engine coolant temperature or the actual length of the starting period exceeds the range of values memorized in the control unit it either decreases or cuts off the enrichment.

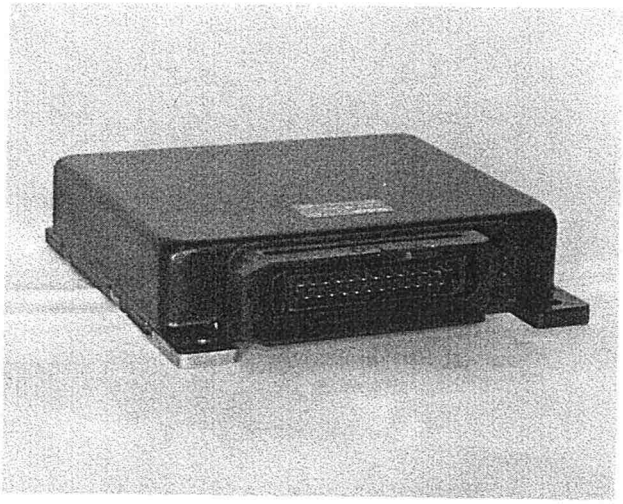
Fuel cut-off

As well as controlling the injectors during the starting stage and throughout normal operation, the control unit operates a cut-off function when the engine is decelerating following the closure of the butterfly valve. This device reduces fuel consumption and atmospheric pollution.
Injection is resumed at differing speeds according to the speed of the engine deceleration to avoid the engine cutting out. In addition, the lower the temperature of the coolant, the higher the speed at which injection recommences.

10.

Location of injection system components in engine compartment



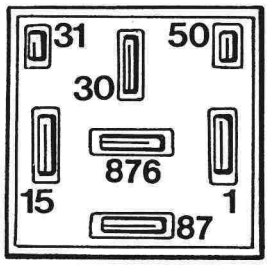


Injection system control unit located under the dashboard on the right hand side

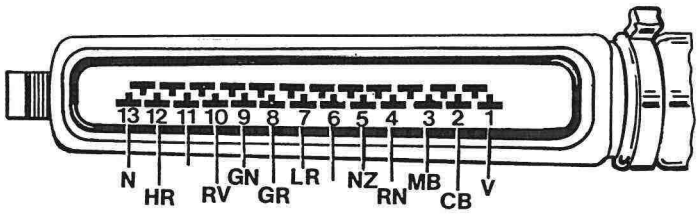
Multiple connecter connecting injection system to control unit

CHECKING INJECTION CABLES AND COMPONENTS

The continuity of the cables for the electronic fuel injection system can be checked using an ohmmeter with the probes inserted between the various terminals of the multiple connecter and the speedometer relay socket.



Speedometer relay socket



Electronic fuel injection control unit multiple connecter

Checking electronic fuel injection system cables

Disconnect the multiple connecter from the injection system control unit, then connect the probes of an ohmmeter to check the electrical continuity between:

Terminal	1	and terminal 1	of the ignition coil
Terminal	2	and terminal 2	of the butterfly valve switch
Terminal	3	and terminal 3	of the butterfly valve switch
Terminal	4	and terminal 50	of the ignition switch
Terminal	5	and an earth point	
Terminal	5	and terminal 5	of the flow meter
Terminal	5	and an earth point	
Terminal	7	and terminal 7	of the flow meter
Terminal	8	and terminal 8	of the flow meter
Terminal	9	and terminal 9	of the flow meter
Terminal	9	and terminal 9	of the butterfly valve switch
Terminal	9	and terminal 18	of the supplementary air valve
Terminal	9	and terminal 87	of the relay socket
Terminal	10	and terminal 10	of the coolant sensor
Terminal	12	and the connecters for the individual injectors	
Terminal	13	and an earth	

Always disconnect the terminal being checked from the electrical system before carrying out the continuity test.

10.

Disconnect the speedometer relay from the socket, then connect the probes of an ohmmeter to check the continuity between the following socket terminals:

87 and the individual injectors
87 and terminal 18 of the butterfly valve switch
87 and terminal 9 of the injection system multiple connecter
31 and an earth
1 and terminal 1 of the ignition coil
15 and terminal 15 of the ignition switch
50 and terminal 50 of the ignition switch
30 and the positive battery pole
87b and the electric fuel pump terminal (through a protective fuse, see page 24 Section 55).

If there are any breaks in continuity, renew the circuit.

Checking the resistance for the main components of the injection system

Carry out the checks directly on the components after having disconnected the connecters linked to the injection system cables.

Supplementary air valve: the resistance between the terminals should be 50 ± 10 Ω at 20° C.

Flow meter

1. Between terminals 5 and 8: the resistance of the potentiometer should be 350 ± 20 Ω at 20° C.
2. Between terminals 8 and 9: the resistance of the internal circuit should be 200 ± 10 Ω at 20° and 180 ± 10 Ω at 60° C.

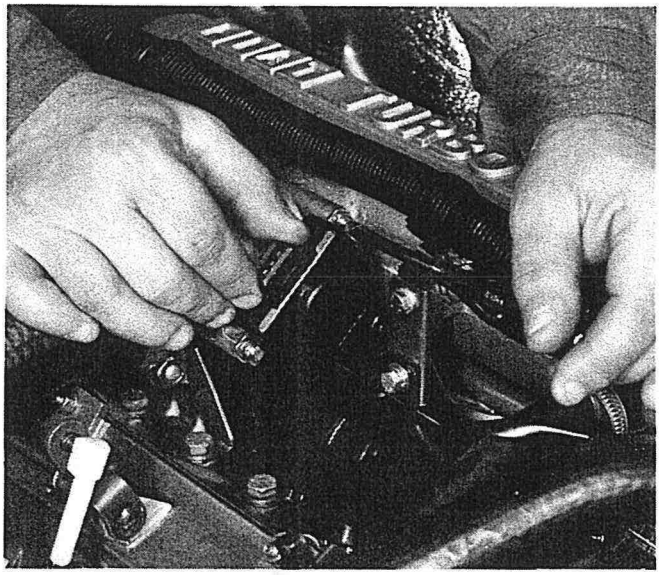
Engine coolant temperature sensor resistance

At 20° C it should be between 2 and 4 K Ω
At 50° C it should be between 600 and 900 Ω
At 90° C it should be between 100 and 300 Ω

Injector winding resistance: between 15 and 17 Ω at 20° C.

If the values measured are outside the figures given then the faulty components must be replaced.

FOR AN EASIER, QUICKER AND MORE ACCURATE WAY OF CHECKING THE LE2–JETRONIC SYSTEM COMPONENTS, USE THE PR01 ELECTRONIC ANALYZER EQUIPMENT WHICH CAN BE ORDERED FROM VOLVERA QUOTING PART NUMBER 1806034000



Checking butterfly valve switch contacts

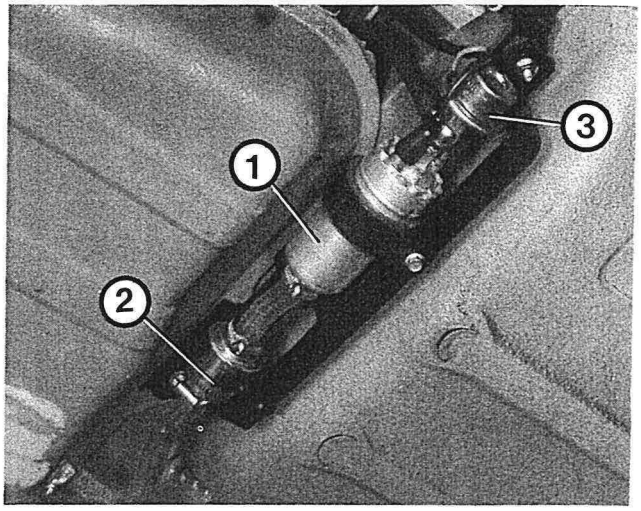
Check that with the butterfly closed there is continuity between terminals 18 and 2 and with the valve completely open that there is continuity between terminals 18 and 3.

Adjusting position of switch in butterfly casing

Rotate the switch in the direction of the arrows until the microswitch (18-2) clicks as soon as the butterfly opens, then fix the switch.

Never remove the switch unless it is absolutely necessary.

Since the injection system is dependent on the impulses sent by the ignition system, before carrying out any repairs to the injection system it is always necessary to firstly ensure that there is a spark between a spark plug HT terminal (which has been disconnected from the spark plug) and an engine earth point about 5 mm away.



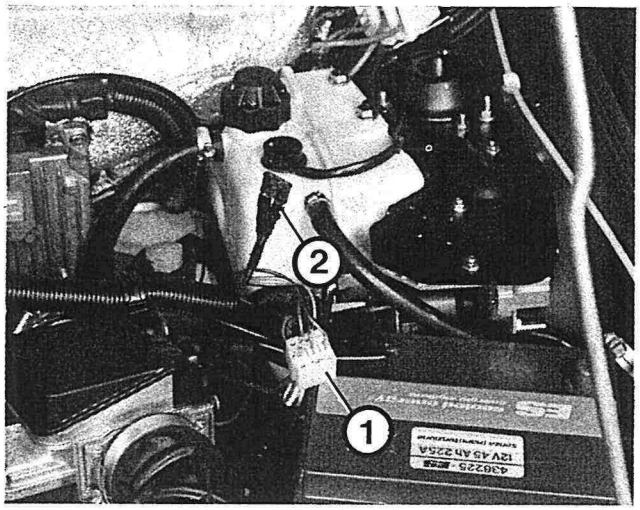
Location of electric fuel pump

1. Electric pump
2. Fuel pre-filter
3. Fuel pressure peak damper (diaphragm type)

CHECKING FUEL SUPPLY PRESSURE

To carry out this check, connect the special pressure gauge 1895890000 to the fuel delivery pipe.
Remove the control relay and insert a connecting cable (2) into the socket (1) between terminals 87b and 30.
Turn the ignition switch to the ON position.

In these circumstances the electric fuel pump should operate and the pressure of the fuel in the circuit should reach 3 ± 0.2 bar, whilst the pump absorption current should be between 6 and 7 A.



Insufficient fuel pressure

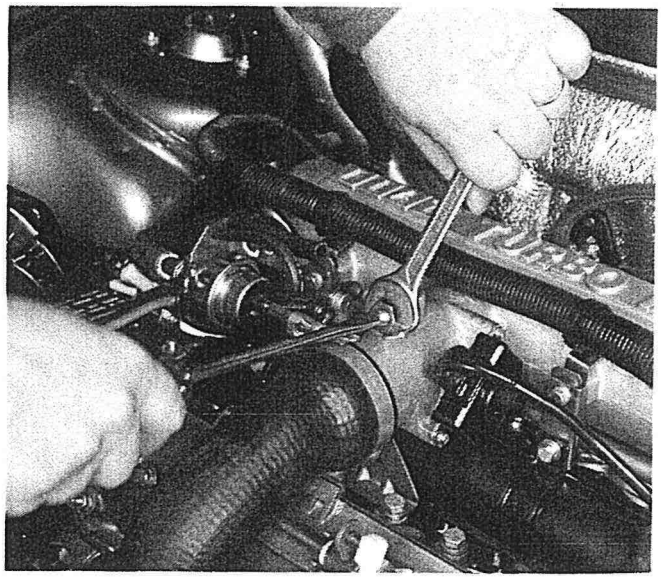
If the pressure measured is below 3 ± 0.2 bar, shut the pressure gauge tap: the pressure should be above 4 bar. If this is not the case, replace the pump as it is faulty. If the pressure remains lower than the normal value, with the tap open, pinch the return pipe: if the pressure increases, replace the pressure regulator as it is defective.

Excess fuel pressure

If the pressure measured is above 3 ± 0.2 bar with the pressure gauge tap open, check that the delivery pipe is not constricted; check that the fuel filter is not blocked; check that the return pipe is not constricted.
In addition, with the engine running, check that as the position of the accelerator pedal is altered there is a corresponding variation in the pressure of the fuel as follows: with the engine idling 3 ± 0.2 bar; with rapid acceleration the value should vary up to 3.5 ± 0.2 bar.

Checking supplementary air valve for leaks

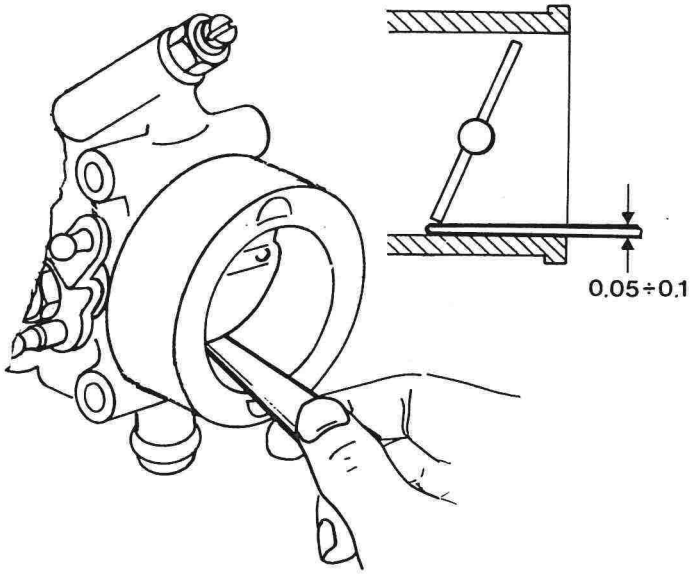
With the engine idling at the normal operating temperature, pinch the rubber supplementary air tube using pliers: the engine speed should not drop by more than 50 rpm; if this is not the case, replace the supplementary air valve as it is faulty.
Also, check that there are no air leaks which are not measured by the supplementary air valve rubber tube collars.



Adjusting engine idle speed

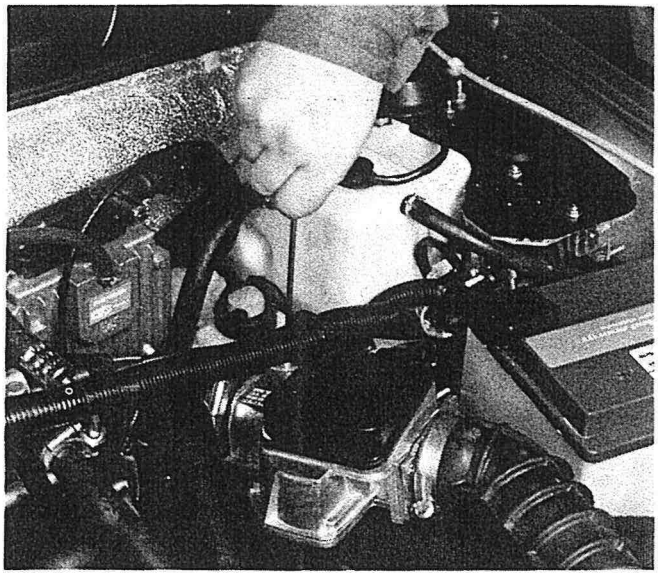
This adjustment is carried out with the engine warm, after the 2nd click of the radiator fan thermal switch.

It is possible to adjust the engine speed by means of the special screw (turning it clockwise to decrease the speed and anticlockwise to increase it). The idle speed should be 850 ± 50 rpm.



Adjusting butterfly valve base

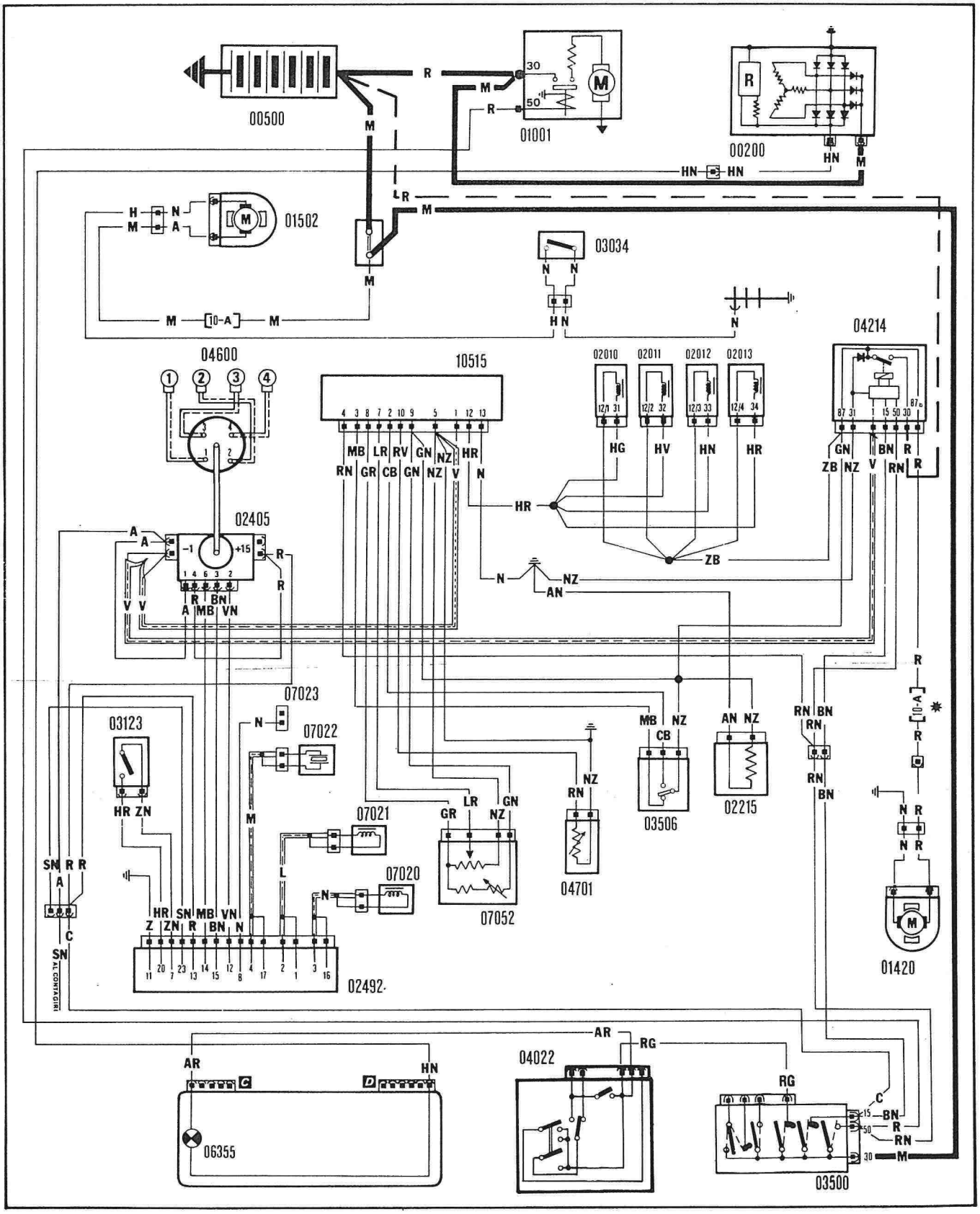
The adjustment of the butterfly valve base has been carried out at the Factory and can only be altered if the adjustment screw is worn or if the butterfly adjusting screw has been misadjusted.
First adjust the butterfly valve closing position using the adjustment screw up to get a play between butterfly and bore as in the picture.
Then start the engine (warm) and turn the idle adjusting screw completely clockwise up to stop the by-pass hole.
Slightly turn the butterfly closing position screw up to get 750 ± 50 rpm. Then fix the security nut.
Turn the idle adjusting screw up to get 850 ± 50 rpm.



Adjusting CO percentage

The percentage of CO in the exhaust gases is adjusted by means of a special screw in the air meter (D).
Firstly, remove the seal (E) and close off the Pulsair system (if fitted).
By turning the adjustment screw towards the right the CO percentage is increased and by turning it to the left it is decreased. The adjustment value for the percentage of CO is 1 ± 0.5%.
When the adjustment has been carried out, fit a new seal.
If the CO figure differs considerably, check the injectors for possible leaks.

Wiring diagram showing LE2–Jetronic injection system and Microplex static advance ignition system (see Section 55 page 39 for key)



* For the location of this fuse see page 24 of Section 55.

10.

Introduction

Supercharging an internal combustion engine means introducing a greater amount of mixture per cycle into the cylinders, with the aid of a compressor, than the engine is capable of drawing in through the pumping effect of the pistons.
With the increased charge to burn, obtained in this way, the output produced by the engine thanks to the raising of the brake mean pressure values of its operating cycle is increased.
This produces a corresponding increase in engine torque and power output.
This is the best system for increasing specific power, in other words the Power/Cylinder ratio and for improving the Power/Weight ratio of a given engine.

Supercharging pressures

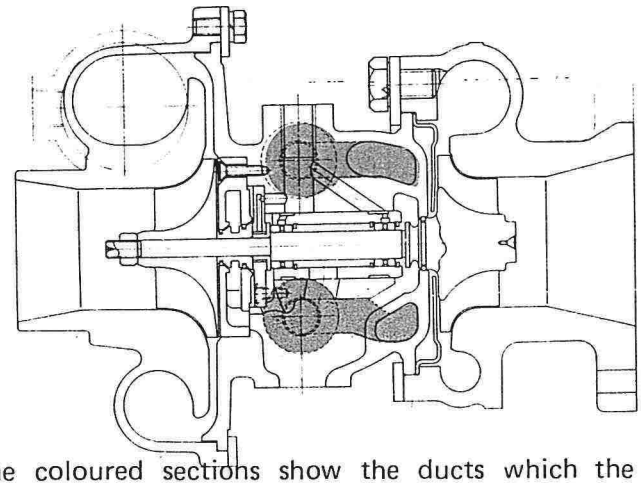
It is worth differentiating between the two levels of supercharging usually adopted:
— A thrust supercharger which reaches absolute supply pressures of between 0.70 and 1 bar.
— A light-medium supercharger which reaches absolute values between 0.40 and 0.55 bar.
In recent years, manufacturers have tended to favour the adoption of light-medium supercharging for achieving improvements in the important features of a class of motor vehicle.
These improvements have, in our case, been accomplished through parallel modifications carried out on the engine to be supercharged, such as:
1) Reducing the compression ratio to 7 : 1
2) Reducing the overlap angle in the engine timing diagram.

A reduction in the compression ratio causes a reduction in the maximum pressures and temperatures developed from combustion to within the prescribed tolerances for the engine without forgoing increased brake mean effective pressures and temperatures for the cycle.
In this way increases in power and torque are obtained whilst the maximum mechanical loads on the crankshaft and associated components are reduced.
The lowest compression ratio also reduces the danger of detonation.
The reduction in the valve overlap produces the shift of the maximum engine torque figures towards lower engine speeds and, at the same time, the amount of unburnt hydrocarbons emitted is reduced.
This factor is advantageous as far as atmospheric pollution is concerned and improves the smoothness of the engine rotation when idling.

TURBOCHARGER IHI – VL2

The turbocharger used for supercharging the engine is the IHI – RHB 52 which basically consists of 2 impellers on the same shaft.
One impeller, known as the turbine, is located on the exhaust manifold side and is propelled by the kinetic force and the pressure of the exhaust gases which are specially directed towards it by means of a duct.
The compressor is located on the inlet manifold.
The rotary action of the turbine caused by the gas sets the other impeller, known as the compressor, in motion at the same speed.
On account of its rotation speed and the special shape of its vanes, the compressor draws in outside air and compresses it in the inlet manifold and therefore in the cylinder bore.

Cross section of turbocharger IHI – VL2



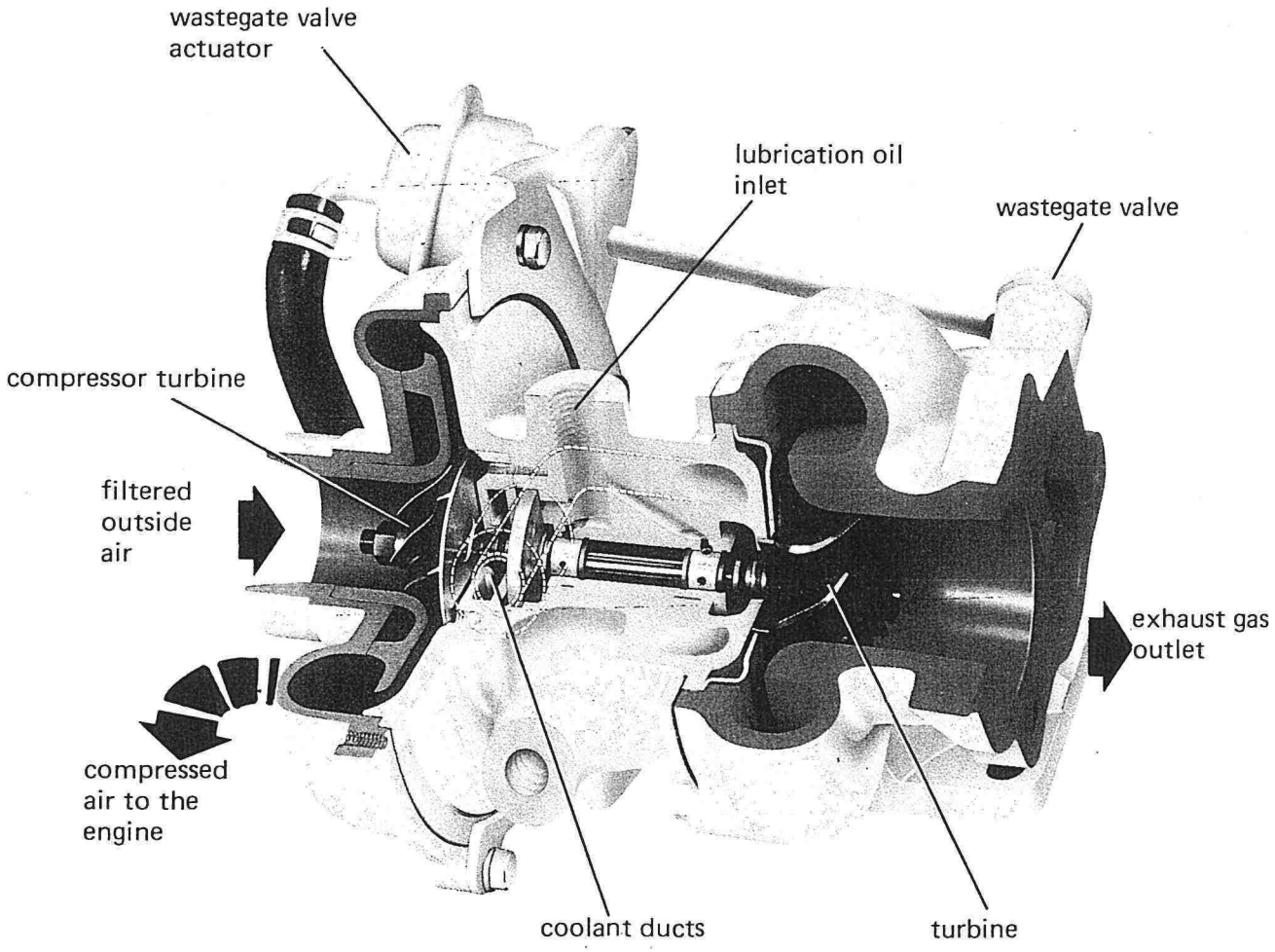
The coloured sections show the ducts which the coolant from the engine passes through

The rotation speed of the turbocharger depends both on the pressure and quantity of engine exhaust gases and also on the shape and size of the turbine. The turbocharger reaches a maximum speed of 180,000 rpm and supplies a maximum absolute supercharging pressure of 2.8 bar.
These pressures, however, are not available until the turbocharger gets above 60,000 rpm.
The compressor axis rotates on two anti-friction bearings which are well lubricated with engine oil. This oil also has the task of:

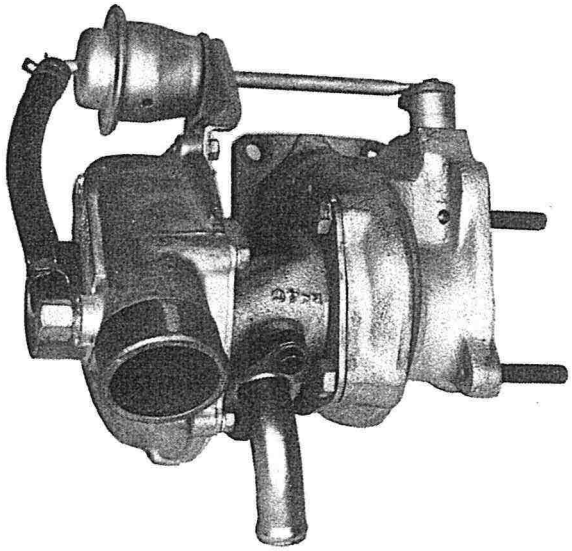
- creating a sealing film between the exhaust gases, the air drawn in and the internal components of the turbocharger;
- transferring part of the enormous amount of heat produced by the gases in the turbine.

In addition, the temperature of the exhaust gases which come into contact with the turbine approaches 900°C posing severe resistance problems for the materials used and if the mixture should temporarily weaken, the above mentioned temperature exceeds 950°C.
To avoid this a turbocharged engine operates at high speeds with somewhat rich mixtures.
The turbocharged engine also becomes particularly quiet as regard exhaust noise even compared with naturally aspirated engine. This is due to the considerable expansion which the burnt gases undergo, on account of the turbine, in the silencer which has a sound deadening effect on the noise produced in the silencer resonance chambers.

The turbocharger used uses the engine coolant for cooling its components which are subject to the most stress.
The coolant circulates in the turbocharger components highlighted.



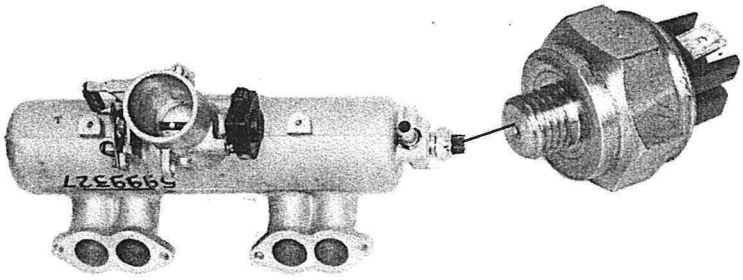
Cross section of IHI-RHB 52 turbocharger



Turbocharger unit

WASTEGATE VALVE

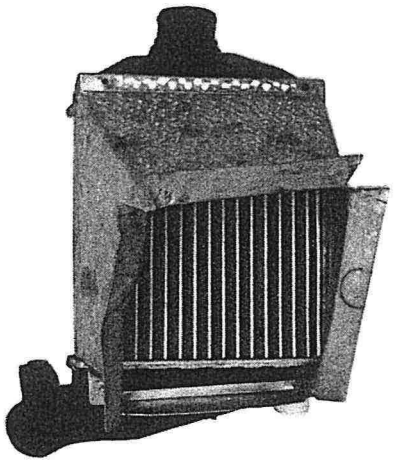
Supercharging systems with wastegate type regulator valves make it possible to fit a small turbocharger which is, however, capable of supplying high supercharging pressures even when there is not a large quantity of exhaust gases, in other words at low-medium engine speeds. This system enables the lag time characteristic (the time which elapses until the engine changes over from being naturally aspirated to supercharged) to be kept fairly short. The IHI turbocharger is fitted with a wastegate type regulator valve.
When the operating conditions create a supercharging pressure which exceeds the permissible figure, the spring opens the valve and only part of the exhaust gases pass through the turbine whilst the rest escape through the valve and are discharged directly through the exhaust pipe.
This valve is located upstream from the turbine and comprises a diaphragm and a spring which is calibrated at the maximum supercharging value.



MAXIMUM AIR PRESSURE SWITCH

The UNO turbo engine also has a safety device fitted known as a maximum air pressure switch which is located in the inlet manifold. This device cuts off the ignition circuit fuel supply when the supercharging pressure continues to increase beyond the maximum permitted value (0.86 bar) to avoid combustion temperatures and pressures which would damage the main engine components.

HEAT EXCHANGER (INTERCOOLER)



The heat exchanger positioned between the compressor and the inlet manifold has the task of cooling the charge taken into the cylinders in such a way that its weight increases so that the power developed by the engine during combustion is greater.

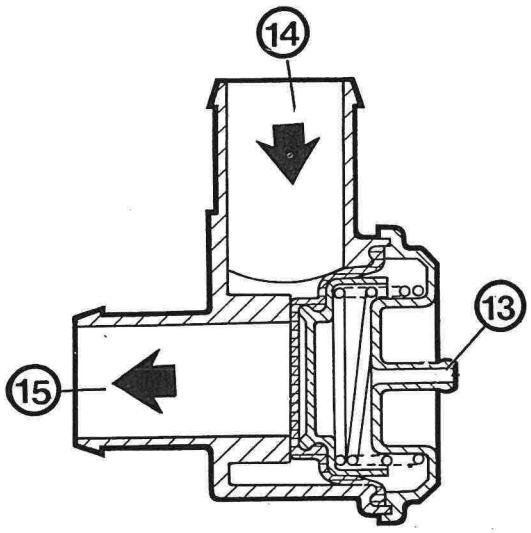
OPERATING PROBLEMS WITH TURBOCHARGER

Problem	Cause	Remedy
Noise or vibration from the turbocharger	Impeller shaft bearings not properly lubricated	Check engine oil pressure and turbo oil ducts
	Leaks or gaps in the inlet or exhaust manifold	Tighten the defective bolts a/o replace the seals
	Impeller shaft unbalanced	Replace the turbo
Supercharging pressure too low (shown on the display panel on the left of the dashboard) or engine power poor	Leaks between the turbocharger and the cylinder head	Tighten the fixing bolts a/o replace the faulty seals
	Regulator valve incorrectly adjusted	Replace the turbocharger
	Regulator valve does not close	Replace the turbocharger
	Exhaust pipe blocked	Clean or replace
	Air filter blocked	Replace the air filter
	Ignition delayed	Check the TDC sensor
Supercharging pressure too high (shown on the display panel on the left of the dashboard)	Regulator valve actuator incorrectly adjusted	Replace the turbocharger
	Wastegate valve stuck in closed position (shaft bent)	Replace the turbocharger
	Ice forming in exhaust pipe. Excess pressure 1–2 mins after a cold start at an ambient temperature below 0° C	Avoid overloading the engine immediately after a cold start
Engine pinking	Supercharging pressure too high due to fault in wastegate valve actuator	Replace the turbocharger
	Fuel with too low octane rating	Change fuel
	Excessive ignition advance	Check TDC sensor
Oil leaks from the impeller shaft seals (blue exhaust fumes)	Engine oil return defective	Check for blockages
	Oil spillage in turbine	Excess wear of impeller seals. Replace turbocharger
	Air filter blocked	Replace air filter
	Turbocharger seals worn	Replace turbocharger

10.

Operation

The air taken in through the air filter (1) is measured by the air flow meter (8) and drawn by the compressor turbine (3) and then sent, via the heat exchanger (intercooler) (6) to the inlet manifold to supply the engine.
The air compressed by the compressor can reach a maximum value of 0.7 bar when the butterfly valve is completely open with the engine operating at maximum torque.



MECHANICAL BY–PASS VALVE (2)

There is a by-pass valve (2) located between the low pressure pipe, downstream of the turbocharger and the high pressure pipe upstream of the turbocharger, which has the task of reducing the typical noise from the compressor when the accelerator is released.
The vacuum which is created downstream of the butterfly valve (9) acts on the by-pass valve diaphragm opening it.
The sypply system downstream of the turbine is thus placed in direct contact with the air filter, discharging the excess pressure in the section of the circuit supercharged outwards.
Consequently, there is a pressure peak, during this phase, caused by the sudden decrease in air flow required by the system.
The butterfly valve reopens during acceleration and the by-pass valve closes renewing the normal operation of the supply circuit.

13. Vacuum arrival pipe - 14. Supercharging pressure pipe - 15. Vacuum pipe.

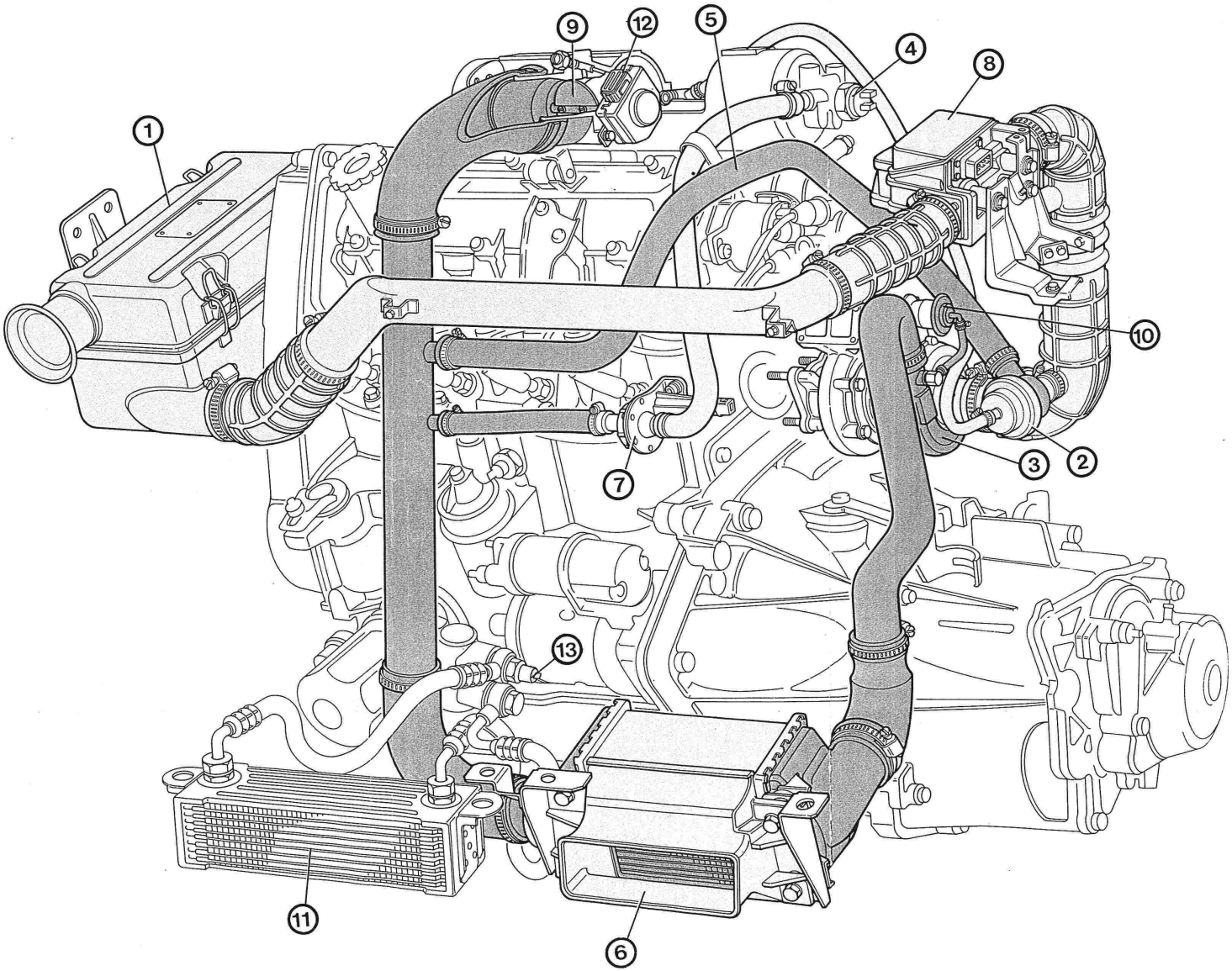
MAIN PRECAUTIONS TO BE TAKEN WHEN USING A TURBOCHARGED ENGINE

- *Never rotate a turbocharged engine unless an air filter is fitted. This could cause irreparable damage to the unit given the high energy which the smallest particle of grit drawn in would acquire.*
- *Never turn off the engine at average-high speeds before it goes down to idling. In effect, the engine would stop too soon before the turbine so that it would not be lubricated for a certain amount of time, causing damage. In addition, after the engine has been used for "sporty" driving, leave it to idle for a few minutes before switching it off to accelerate the cooling of the turbocharger and the exhaust manifold.*
- *Check, from time to time, that the electronic injection system is working properly because operating with lean mixtures the exhaust temperature and therefore that of the turbocharger reaches dangerously high levels and could cause the unit to seize.*

Supercharging system key

1. Cartridge air filter
2. Mechanical by-pass valve
3. Turbocharger
4. Maximum air pressure switch
5. Direct supply pipe
6. Intercooler
7. Supplementary air valve (i.e.)
8. Air flow meter (i.e.)
9. Butterfly valve
10. Fuel pressure regulator (i.e.)
11. Radiator for cooling engine lubrication oil
12. Butterfly valve switch (i.e.)
13. Engine oil temperature sender unit

SUPERCHARGING SYSTEM



1850088000	Spanner for manifold fixing nuts
1850113000	Spanner for engine oil drain plug
1850121000	Spanner for nut fixing pulley on crankshaft
1850132000	Spanner with 1/2" socket for camshaft housing fixing bolts
1850167000	Spanner for adjusting bolts fixing pipes to water pump
1850172000	Spanners with 1/2" socket for cylinder head nuts
1850184000	Spanner for ignition spark plugs
1860054000	Drift for removing-refitting small end bush
1860183000	Pliers for removing-refitting piston rings
1860313000	Tool for fitting oil seal on valve guide
1860372000	Drift for removing and refitting bush for oil pump auxiliary shaft
1860395000	Drift for removing valve guides
1860442000	Support for cylinder head whilst removing and refitting valves
1860443000	Lever for inserting tappet retaining tool
1860455000	Cylinder head support whilst replacing shim
1860459000	Crank to check timing
1860462000	Drift for fitting valve guides
1860470000	Tool for locking and positioning cylinder head whilst refacing valve seats
1860473000	Tool for locking camshaft pulley whilst adjusting
1860490000	Tool for retaining valve leakage test equipment 1895868000
1860592000	Hoist for removing, refitting and moving engine
1860605000	Tool for fitting pistons into cylinders
1860644000	Tool for removing and refitting valves
1860662000	Tool for removing cartridge oil filter
1860747000	Tool for retaining tappets whilst replacing shims during valve clearance adjustment
1861001032	Bracket for fixing engine, timing side, to rotating stand
1861001231	Bracket for fixing engine, flywheel side, to rotating stand
1867019000	Drift for removing and refitting bush for oil pump control gear
1867029000	Flywheel lock
1876036000	Cable with contacts to be connected to starter motor for rotating engine whilst adjusting tappets
1887001000	Pliers for removing tappets shims
1890310000	Reamer (Ø 8 mm) for valve guide openings
1890365000	Reamer for oil pump auxiliary shaft bush
1895113000	Gauge (0.05, 0.10 . . . 0.80) for checking tappet clearance
1895751000	Tool for measuring timing belt tension
1895868000	Valve leakage test equipment
1895876000	Tool for checking piston alignment when positioning sensor carrier plate (to be used with 1895882000)
1895882000	Dial gauge to be used with special tools
1895887000	Tool for positioning sensor carrier plate, timing side

10.A

1895890000	Tool for measuring fuel injection pressure
1895890020	Pipe with union for measuring fuel pump supply pressure (to be used with 1895890000)
1896219000	Gauge for checking valve stem height

DESCRIPTION	Thread size	Torque daNm
ENGINE		
Caps to crankcase, bolt	M 10 x 1,25	8
Breather to crankcase, bolt	M 8	2,3
Power unit mounting to crankcase, bolt	M 10 x 1,25	5,9
Cylinder head to crankcase, bolt	M 10 x 1,25	4 +90° +90°
Cylinder head to crankcase side, bolt	M 8	3
Camshaft housing to cylinder head, bolt	M 8	2
Inlet manifold to cylinder head lower and upper, nut	M 8	2,5
Camshaft housing to inlet manifold bracket, bolt	M 8	2,5
Exhaust manifold to cylinder head, nut	M 8	2,5
Exhaust manifold to crankcase bracket, nut	M 8	2,5
Big end, nut for bolt	M 9 x 1	5,1
Flywheel to crankshaft, bolt	M 10 x 1,25	8,3
Driven gear to camshaft, bolt	M 10 x 1,25	8,3
Bearing to belt tensioner mounting, nut	M 10 x 1,25	4,4
Auxiliary shaft driven gear, bolt	M 10 x 1,25	8,3
Crankshaft pulley, nut	M 20 x 1,5	13,7
Butterfly control shaft to cam on inlet manifold, nut	M 8	2
Fuel pressure regulator, nut	M 16 x 1,5	4,8
Accelerator relay mounting bracket, bolt	M 8	2,5
Accelerator control shaft, nut	M 8	2,5
Turbocharger to exhaust manifold and cylinder head, nut	M 8	2,9

10.

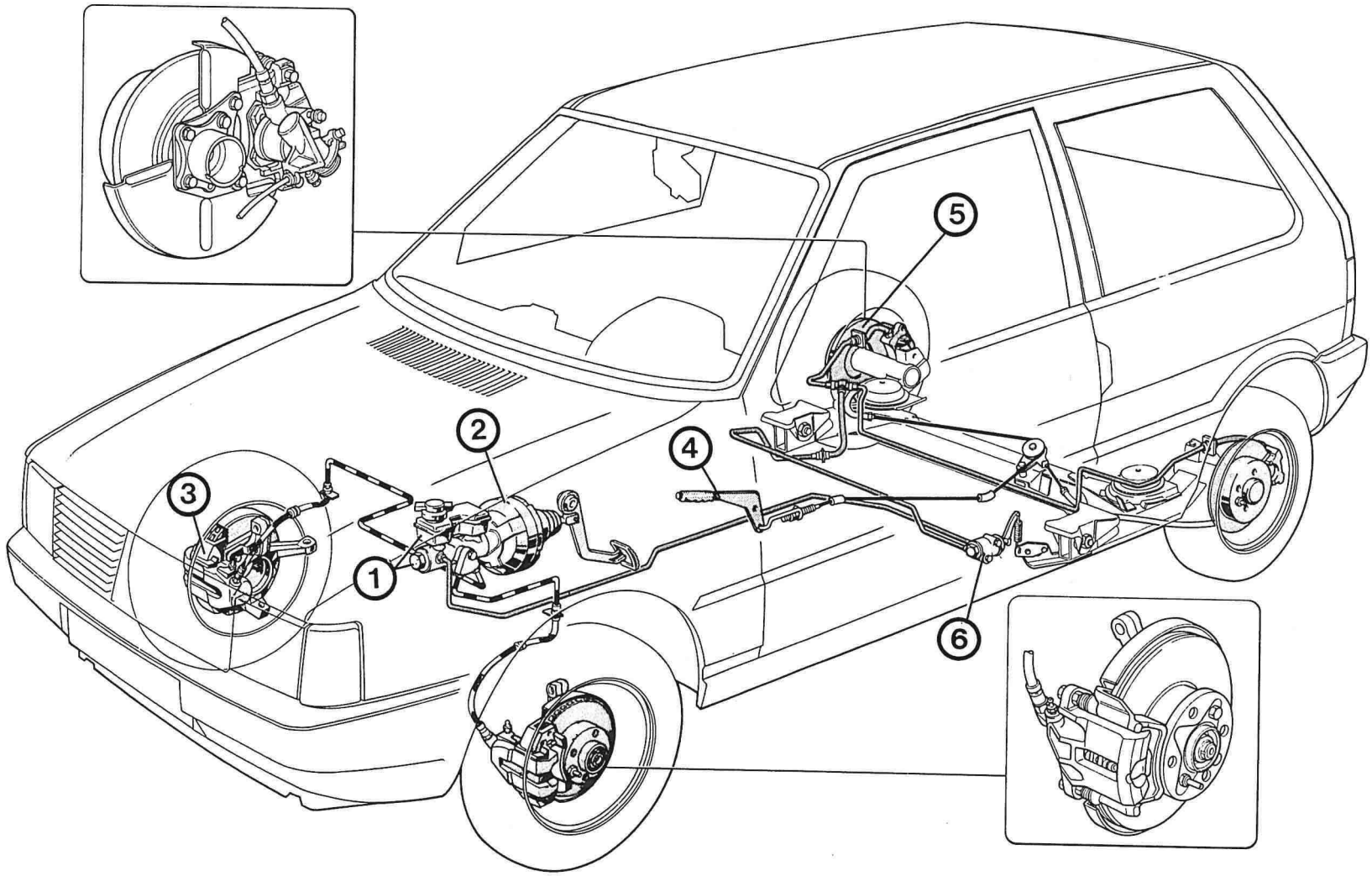
DESCRIPTION	Thread size	Torque daNm
Coolant pipe union to turbocharger, nut	M 16 x 1	4
Coolant pipe to turbocharger, bolt	M 8	2,5
Oil pump to crankcase, bolt	M 8	2,5
Ignition distributor cover to crankcase, bolt	M 8	2,5
Water pump to crankcase, bolt	M 8	2,5
Water pump cover, bolt	M 8	1,5
Alternator mounting to crankcase, bolt	M 10 x 1,5	4,9
Alternator adjustment bracket to water pump casing, bolt	M 8	2
Alternator to bracket, nut	M 10 x 1,25	4,9
Alternator to mounting, nut	M 10 x 1,25	4,9
Spark plugs	M 14 x 1,5	3,7
Oil temperature sender unit	M 16 x 1,5 tapered	4,9
Coolant temperature sender unit	M 14 x 1,5 tapered	2,7
Oil pressure switch	M 14 x 1,5	3,2
Oil pressure sender unit	M 14 x 1,5	3,7

ENGINE EXHAUST

Silencer bracket and rear exhaust pipe, nut	M 8	2,4
Meter joint, nut	M 8	1,5
Flange to exhaust manifold, nut	M 8	2,4

DESCRIPTION	Thread size	Torque daNm
POWER UNIT MOUNTING		
Bracket to gearbox, nut	M 12 x 1,25	8,8
Flexible mountings to brackets, bodyshell and cross member, bolt	M 8	2,4
Central flexible mounting to bracket (engine side), nut	M 12 x 1,25	8,8
Central flexible mounting to bracket (gearbox side), nut	M 8	2,4
Bracket to bodyshell (engine side), bolt	M 10 x 1,25	4,9
Bracket to differential, bolt	M 12 x 1,25	9,8
Central flexible mounting to bracket (differential side), bolt	M 8	2,4

DIAGRAM SHOWING HYDRAULIC BRAKING SYSTEM AND MECHANICAL HANDBRAKE

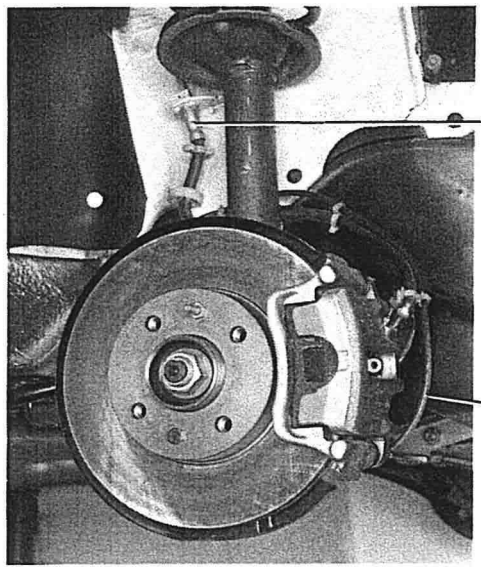


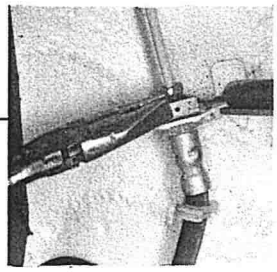
Hydraulic circuit for front brakes

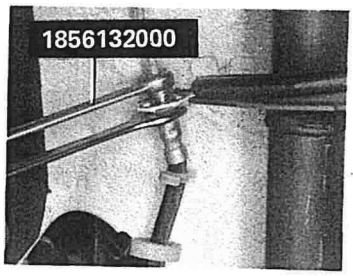
Hydraulic circuit for rear brakes

1. Brake fluid reservoir and master cylinder for independent front and rear circuits
2. Vacuum servo brake
3. Front disc brakes
4. Handbrake lever
5. Rear disc brakes
6. Load proportioning valve for rear hydraulic circuit

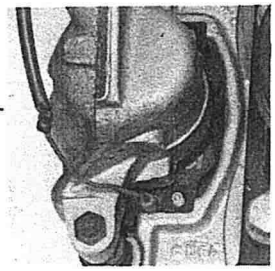
33.



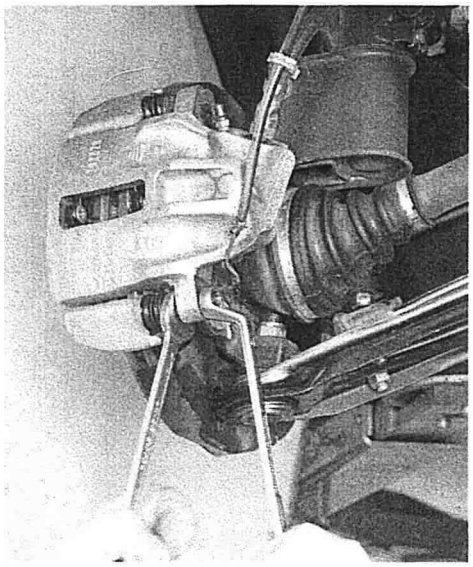


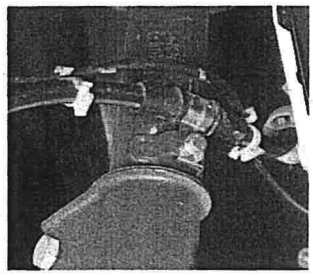


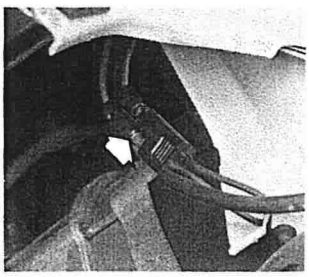
REMOVING – REFITTING



Removing - refitting flexible pipe and electrical connection from brake pad



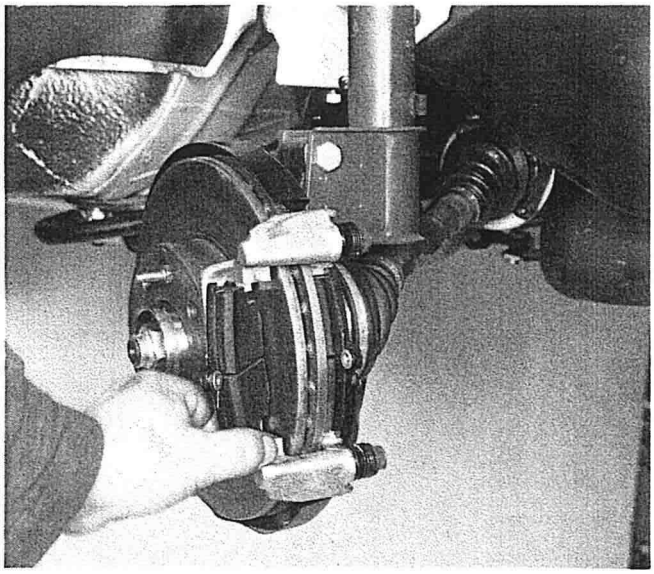




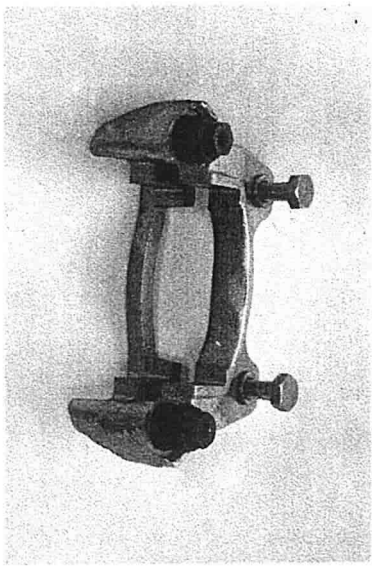
Removing - refitting brake caliper

Disconnect the flexible union from the shock absorber and the electrical connection for the brake pad wear sensor in the engine compartment, shown by the arrow.

The bolts fixing the caliper casing are self-locking and must always be replaced each time they are undone or loosened.

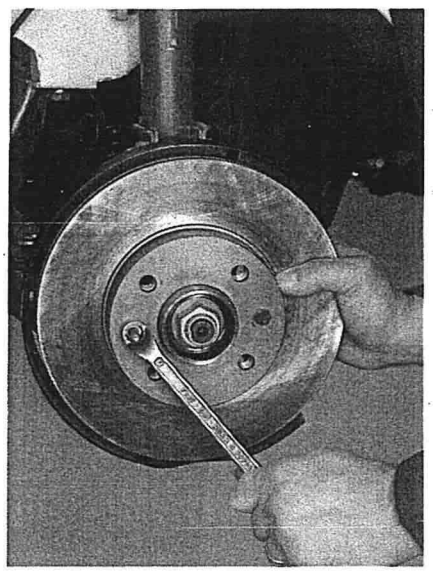


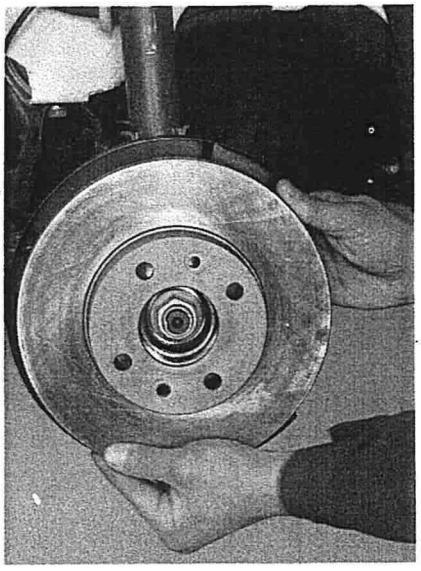
Removing - refitting brake pads



Removing - refitting caliper support

Before refitting the caliper support bracket, check that the rubber boots are intact. If this is not the case, they must be replaced.

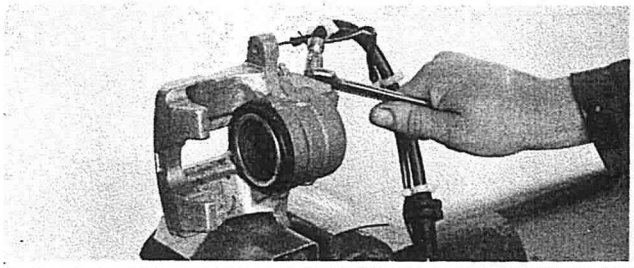


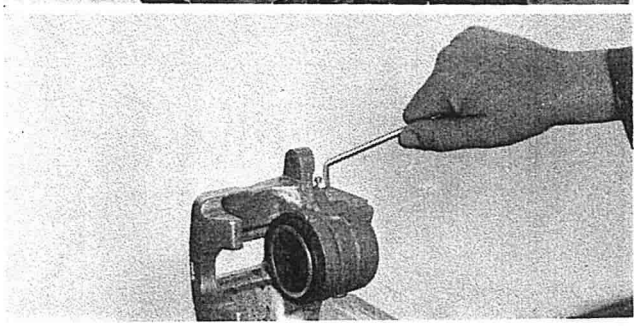


Removing - refitting brake disc

When refitting, remove any possible traces of rust to ensure that the disc is perfectly perpendicular in relation to the hub.

BRAKE CALIPER

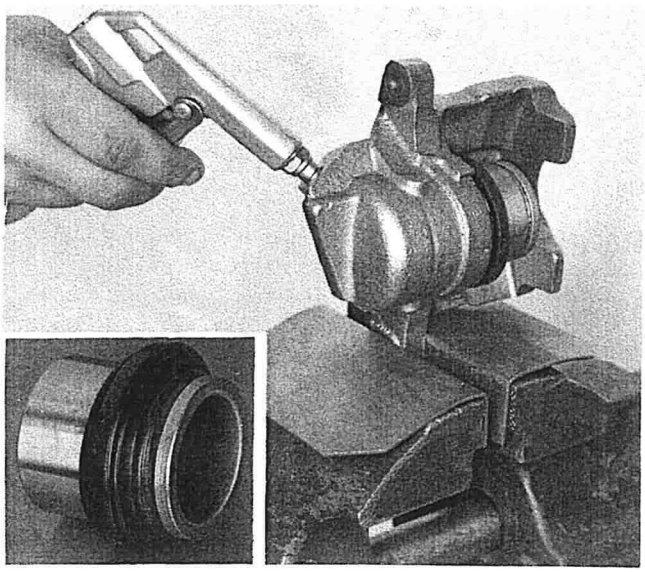




Removing - refitting flexible union and bleed screw

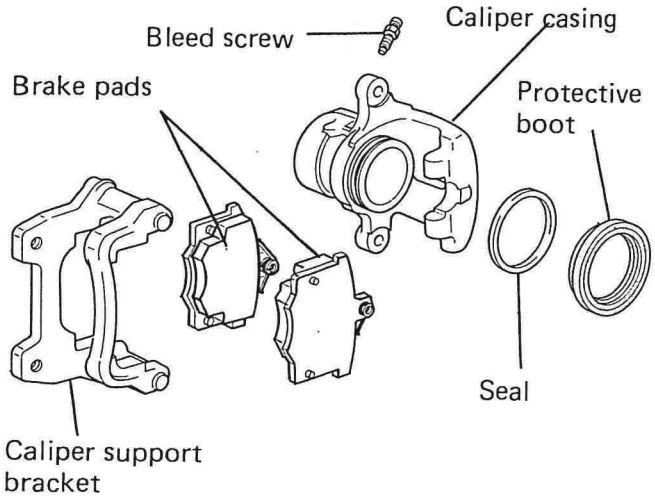
NOTE *There should not be any bulges or cracks in the pipe or it has to be replaced.*
It is advisable to replace both pipes.

33.



Removing piston and protective boot

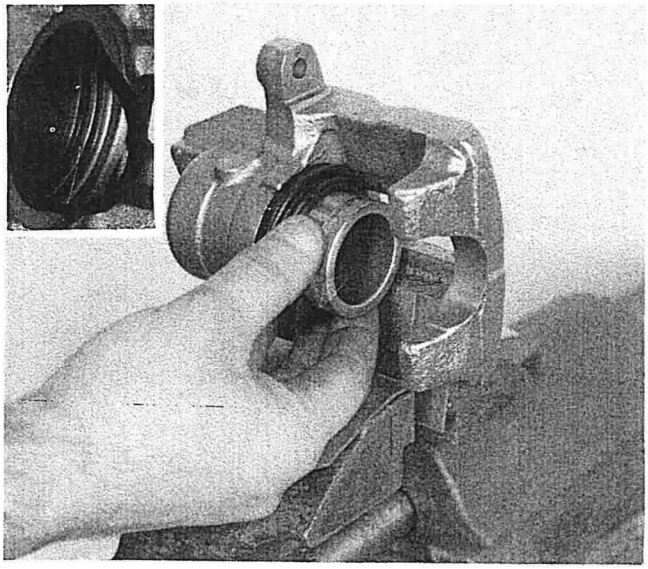
The piston is removed from the casing by directing a jet of compressed air into the brake fluid inlet hole.



Checking caliper unit components

The piston and the caliper casing should not have any traces of abrasion or seizing or else the caliper complete with piston has to be replaced.
In any case, the protective boot and the seal always have to be replaced. Ensure that the adjustment screw is not obstructed.

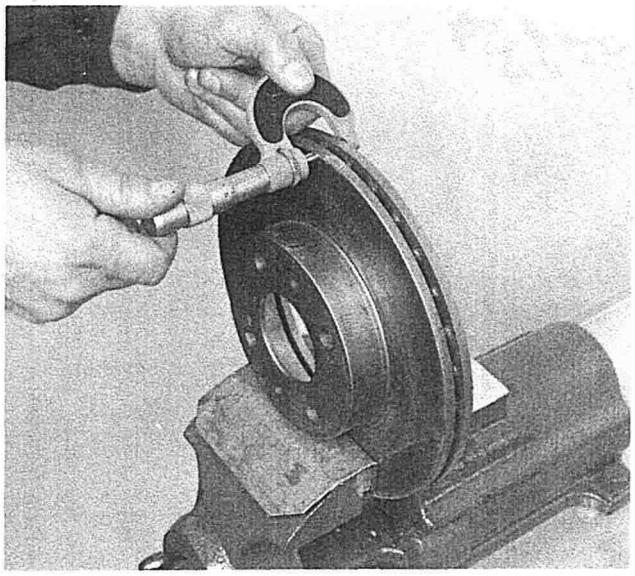
Carefully wash the metal components using a solution of FIAT LDC detergent in warm water.



Fitting seal and piston in caliper casing

Lubricate the parts concerned with brake fluid before fitting.

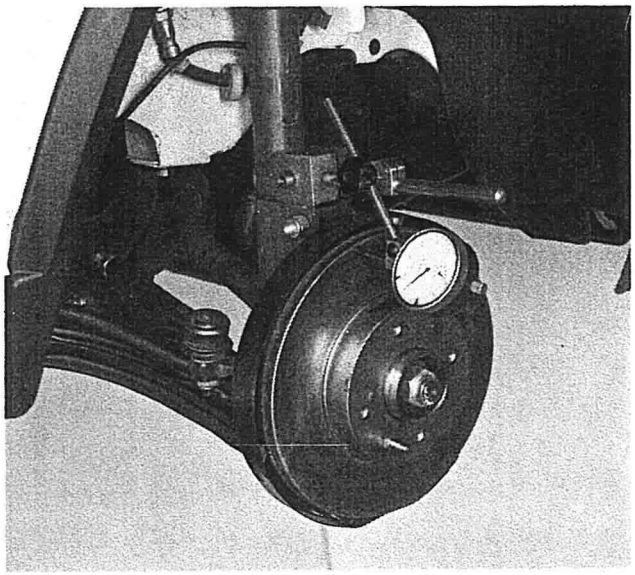
BRAKE DISCS



Checking and measuring

The minimum allowable thickness for brake discs is 18.2 mm; if it measures less than this, the disc must be replaced.
If the case of wear or deep grooves, the surfaces of the brake disc can be machined. After grinding the brake disc must not be less than 18.55 mm thick.

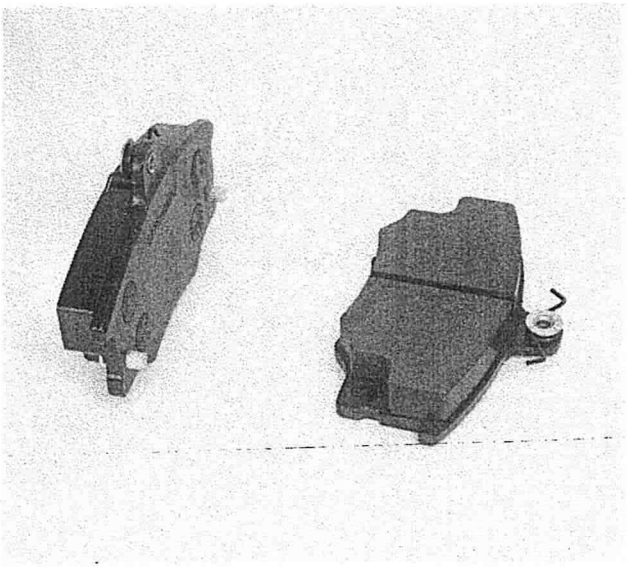
NOTE *The parallel tolerance for the disc surfaces should be ± 0.015 mm with slight vibration of the brake pedal when it is activated.*



Checking run out of brake disc

If the brake pads have to be replaced, it is advisable to check that the disc is no more than 0.15 mm off centre.
This is measured 2 mm from the external diameter of the disc.

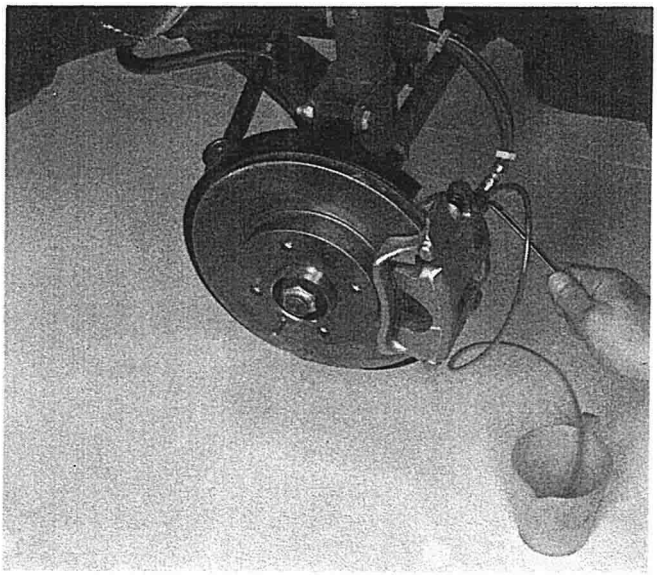
BRAKE PADS



Checking brake pads

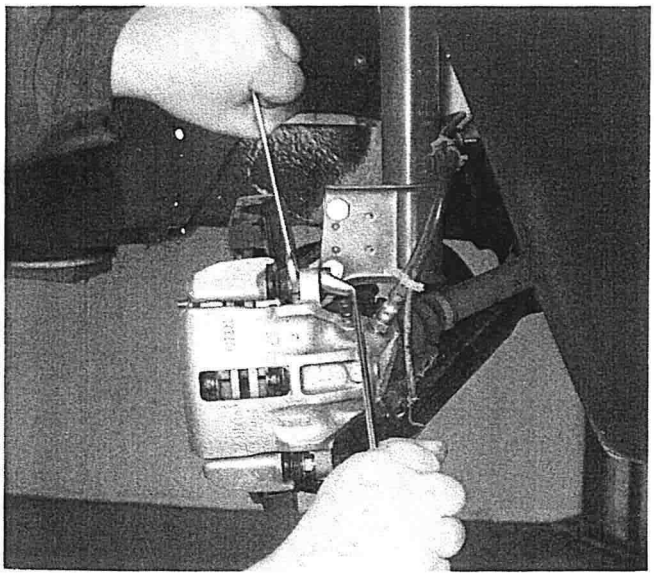
The brake pads must be replaced when the thickness of the lining is less than 1.5 mm. Check that the same type of pads are fitted on each pair of wheels.

33.



BLEEDING

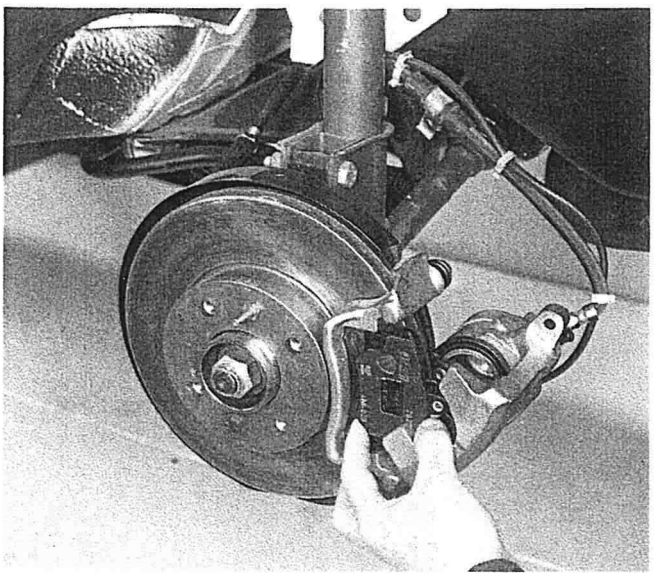
It is not advisable to reuse the brake fluid collected. The reservoir should be topped up with new brake fluid.



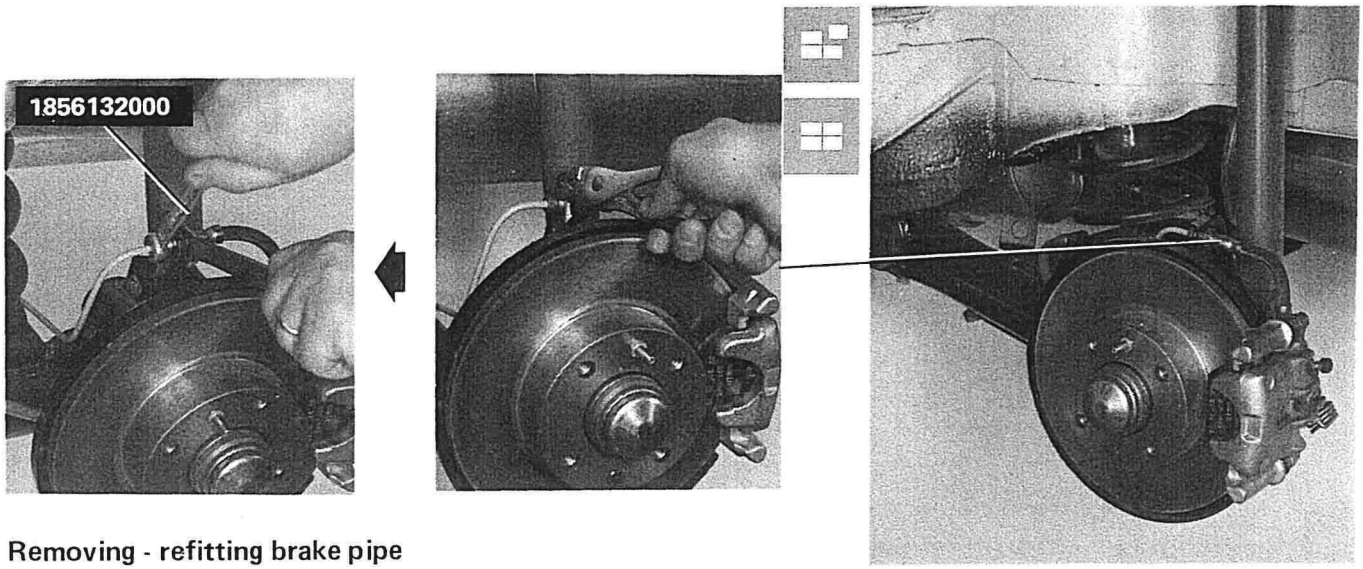
REPLACING BRAKE PADS

When replacing brake pads, proceed as follows:

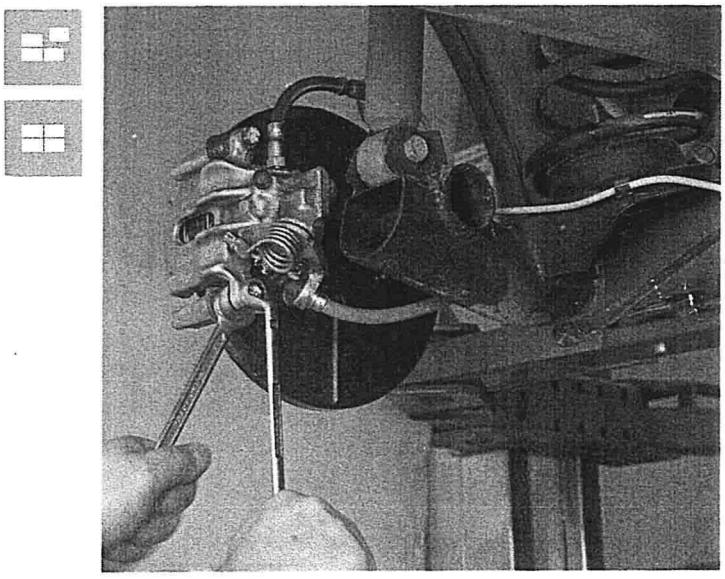
- undo the flexible pipe and the electrical connection form the brake pad;
- remove the upper bolt fixing the brake caliper to the support bracket;
- move the brake caliper as appropriate and remove the brake pads.



The bolts fixing the brake caliper are self-locking and must be replaced each time they are undone or loosened.



Removing - refitting brake pipe

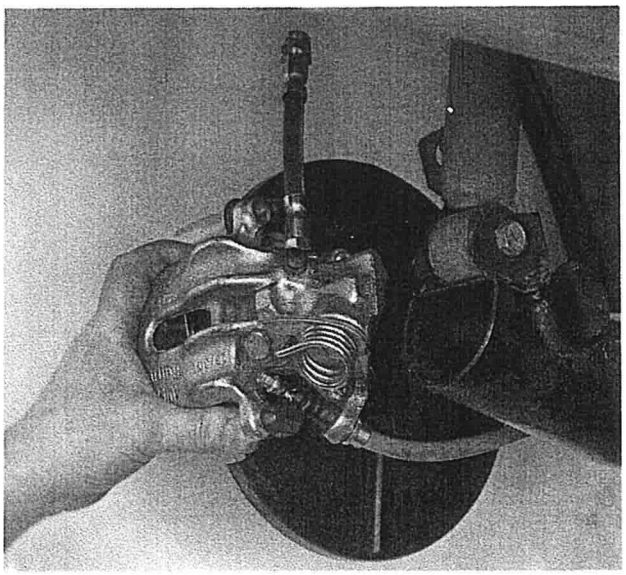


Removing - refitting brake caliper

The bolts fixing the caliper body are self-locking and must therefore always be replaced each time they are loosened or undone.

Bleed braking system

NOTE *After replacing the brake caliper, adjust the handbrake.*



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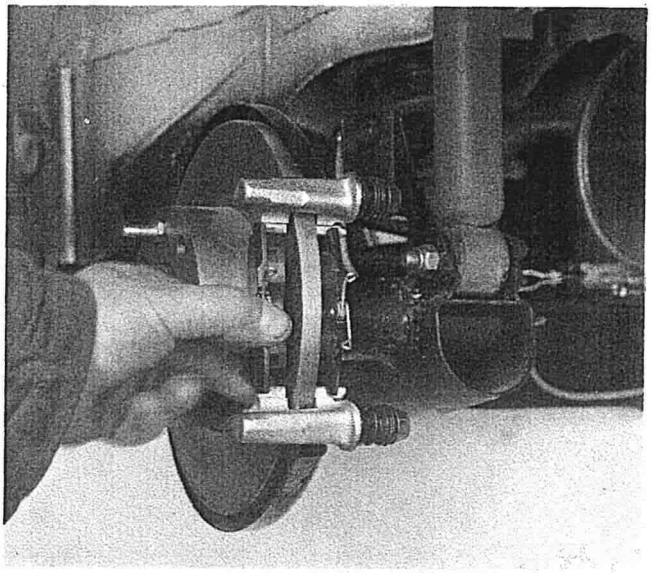
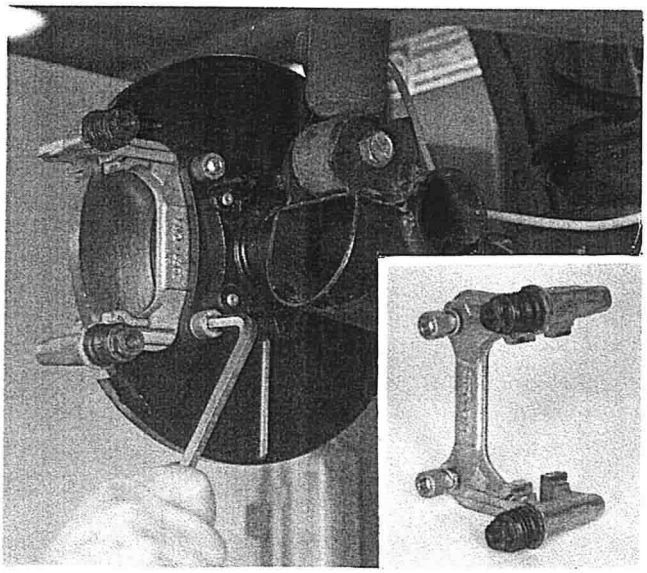


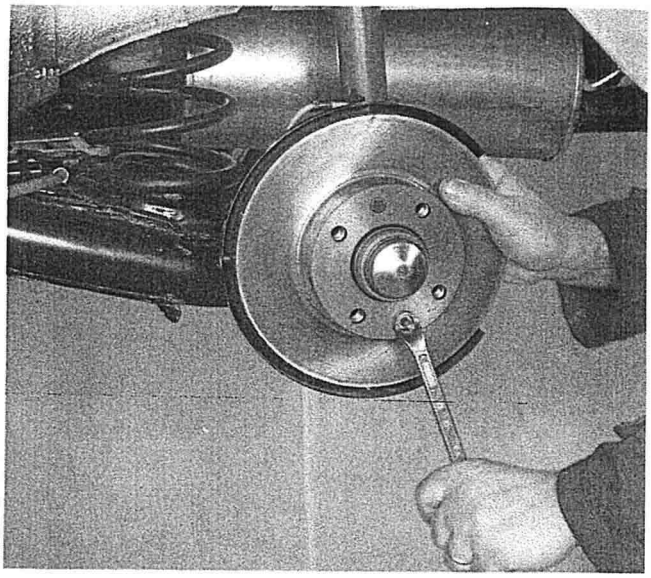
Removing - refitting brake pads

NOTE *Before placing the new brake pads in position, make sure that the caliper piston is completely back in place by turning it in a clockwise direction. Then start up the engine and depress the brake pedal, about 40 times, to reset the handbrake automatic clearance recovery and lastly, adjust the handbrake lever.*



Removing - refitting caliper support bracket

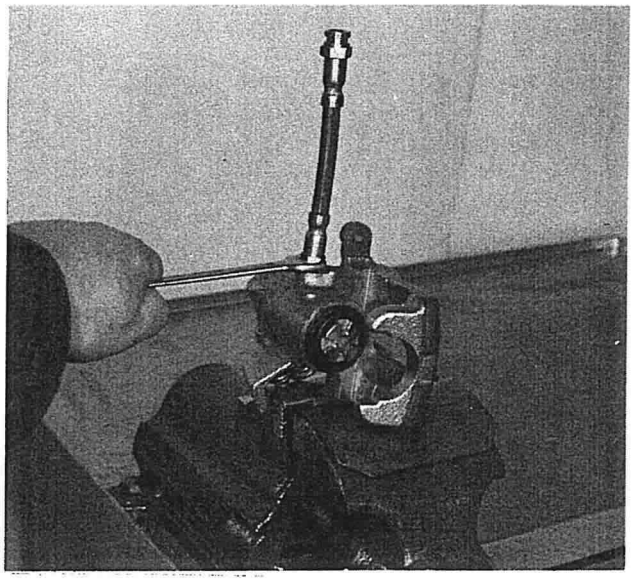
Before refitting the caliper support bracket, check that the rubber boots are intact or else they must be replaced.



Removing - refitting brake disc

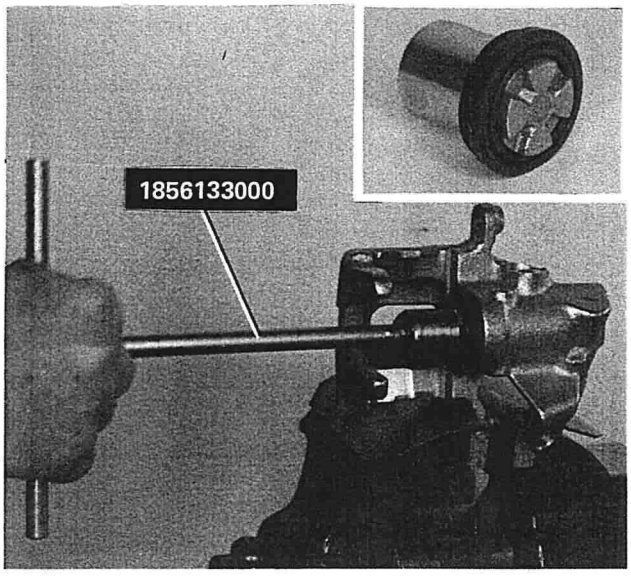
When refitting, remove any possible traces of rust to ensure that the disc is perfectly perpendicular to the hub.

BRAKE CALIPER



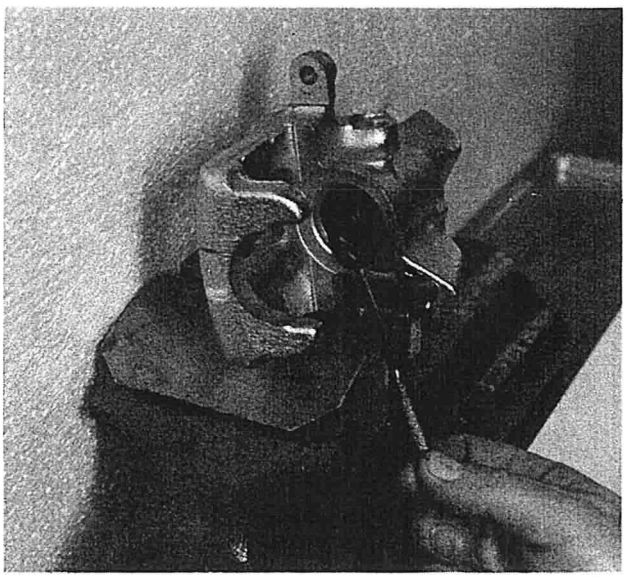
Removing - refitting flexible union

NOTE *There should not be any bulges or cracks in the pipe or it has be replaced. It is advisable to replace both pipes.*



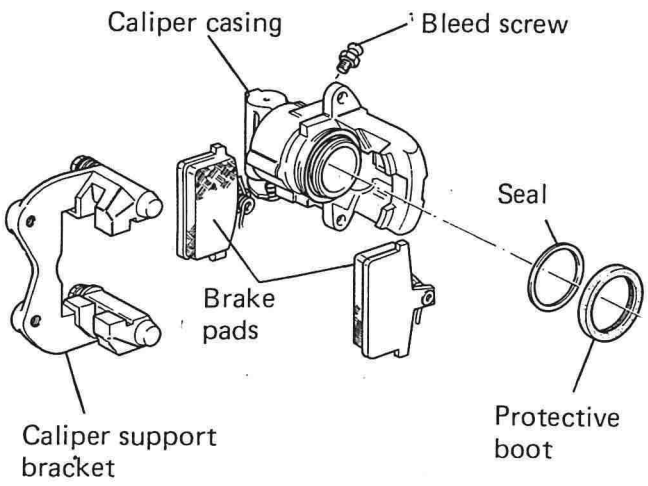
Removing piston and protective boot

NOTE *Inside the caliper piston there is a telescopic, self-adjusting device which automatically renews the handbrake clearance as the brake pad wear increases. As this device is immersed in brake fluid it is not subject to wear and therefore does not require repairing.*



Removing seal

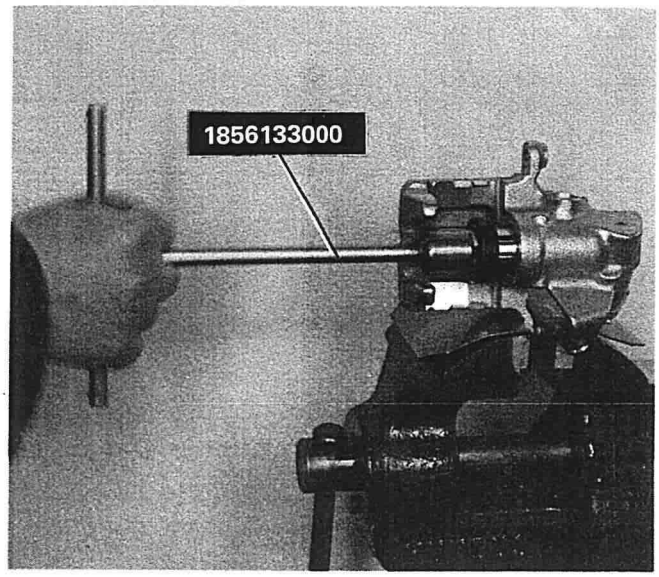
33.



Checking caliper unit components

There must not be any traces of abrasion or seizing on the piston or the caliper casing or else the entire unit must be replaced.
In any case, it is always necessary to replace the protective boot and the seal and to ensure that the air bleed screw is not obstructed.

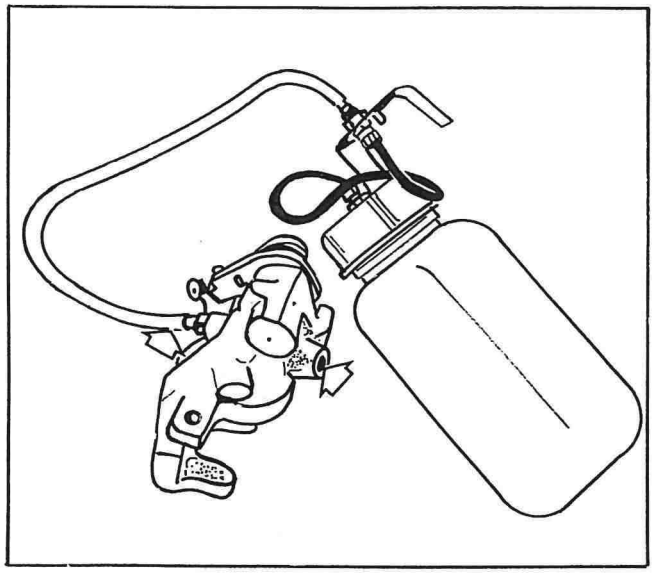
Use a solution of hot water and FIAT LDC detergent to clean the metal components.



Fitting piston in caliper casing

Before fitting the piston in the caliper casing, position the protective boot on the rear section.

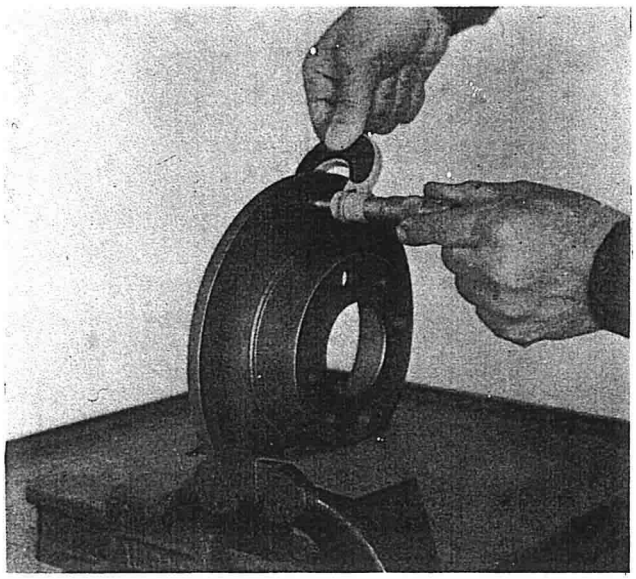
Lubricate the parts concerned with brake fluid before fitting.



Filling brake caliper

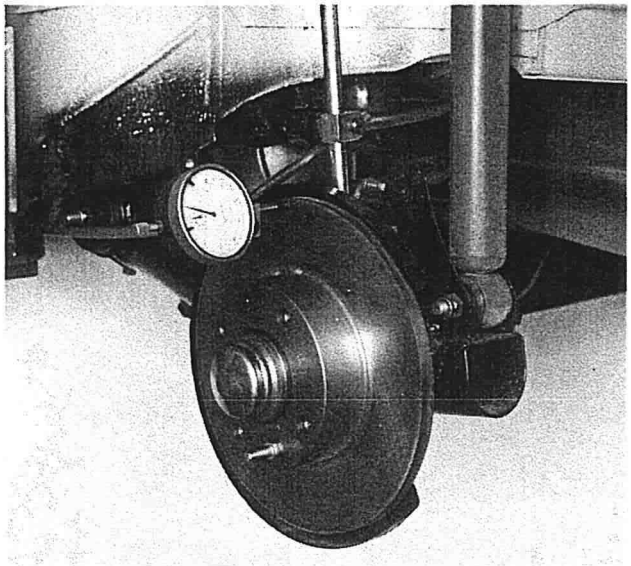
After overhauling the brake caliper and before refitting it in the vehicle, it must be refilled in the following way:
- loosen the bleed screw;
- insert the end of a transparent tube into the bleed screw opening;
- using a normal container with brake fluid, add the fluid to the caliper until air bubbles come out of the threaded hole where the flexible brake pipe is connected;
- tighten the bleed screw.

BRAKE DISCS



Checking and measuring

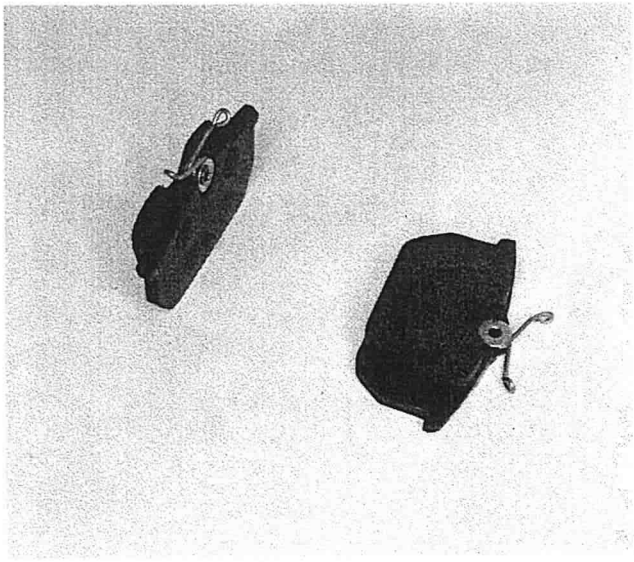
The minimum allowable thickness for brake discs is 9 mm. If it measures less than this, the disc must be replaced. In the case of wear or deep grooves, the surfaces of the brake disc can be machined. After grinding the brake disc must not be less than 9.70 mm thick.



Checking run out of brake disc

If the brake pads have to be replaced, it is advisable to check that the disc is no more than 0,15 mm off centre.
This is measured 2 mm from the external diameter of the disc.

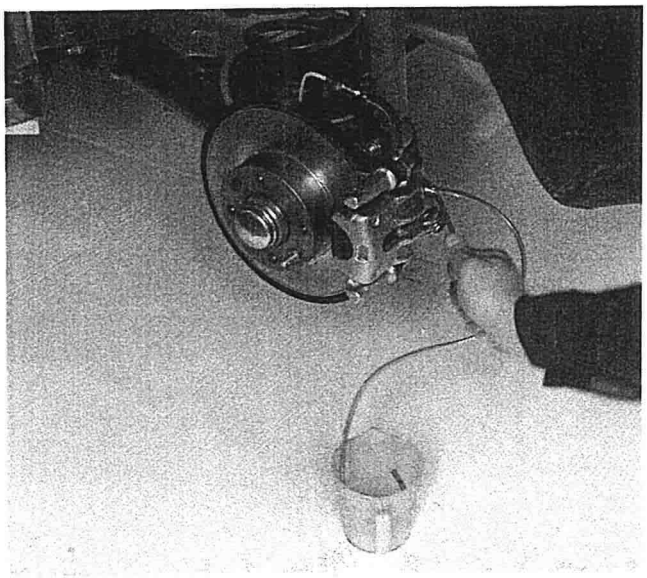
BRAKE PADS



Checking brake pads

The brake pads must be replaced when the thickness of the lining is less than 1.5 mm. Check that the same type of pads are fitted on each pair of wheels.

33.

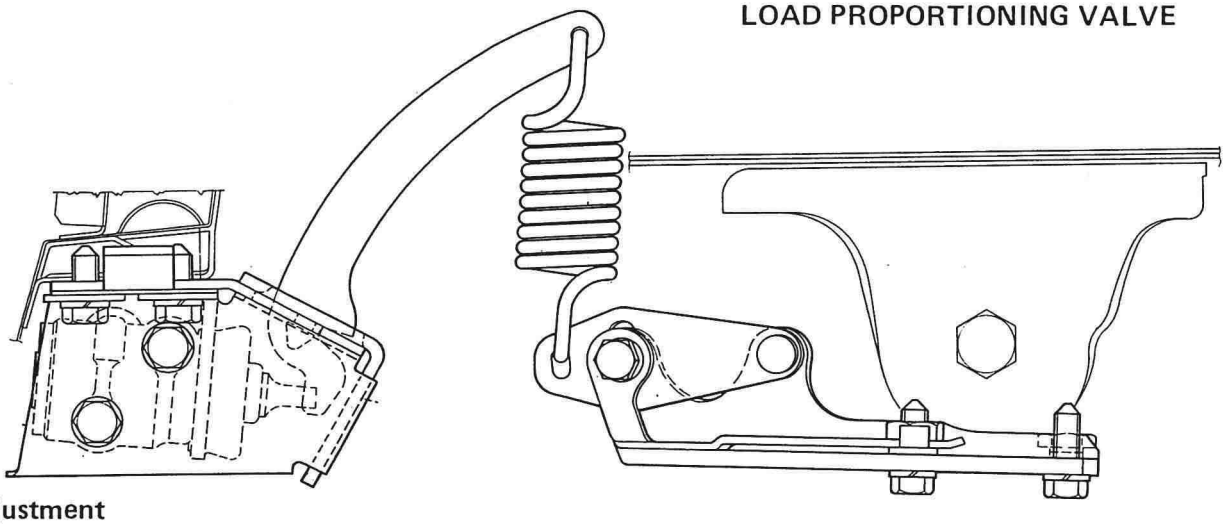


BLEEDING

It is not advisable to reuse the brake fluid collected.
The reservoir should be topped up with new brake fluid.

To bleed the system it is necessary to compress the suspension so that the load proportioning valve comes into operation.

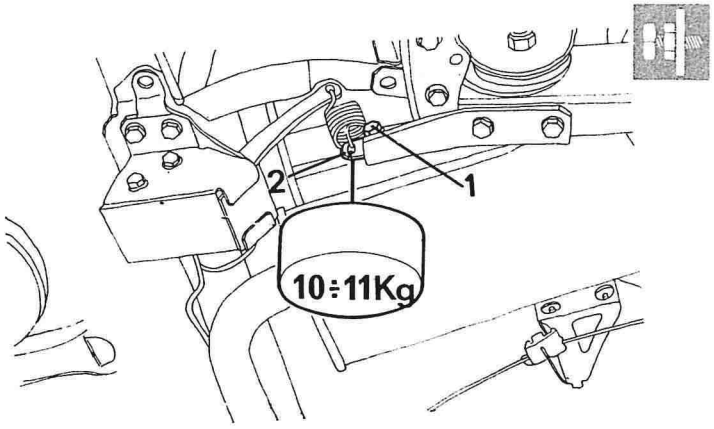
LOAD PROPORTIONING VALVE



Adjustment

Carry out the following operations:

- set the suspension;
- position the vehicle on a horizontal plane with the wheels on the ground (over an inspection pit or on a lift);
- ensure that the vehicle is in running order with supplies, spare wheel and tools;
- load the luggage compartment with a weight of 45 kg behind the backrest;



- loosen the bracket securing bolt (1);
- apply a load of 10 - 11 kg to the bracket eyelet;
- maintaining the bracket (2) in this position, tighten the fixing bolt.

NOTE *If the load proportioning valve is not operating correctly, the entire unit has to be replaced.*

Bleed braking system.

1847014000	Percussion extractor for rear wheel hub caps	**1856133000**	Spanner for adjusting rear brake caliper self-adjusting device
1856132000	Spanner for brake pipe unions	**1874088000**	Drift for fitting rear wheel hub caps

Tightening torques

33.

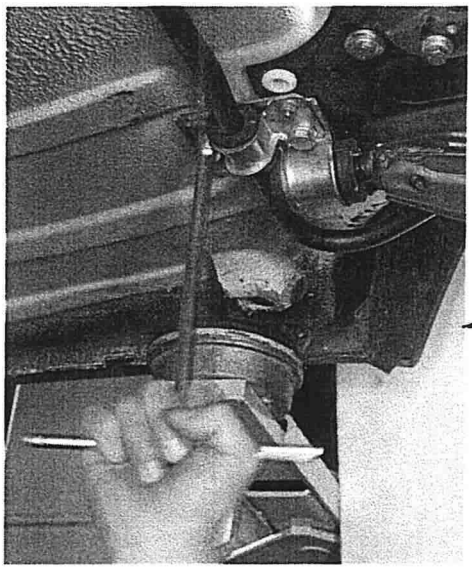
DESCRIPTION	Thread size	Torque daNm
BRAKING SYSTEM		
Lever to bodywork, bolt	M 8	1,5
Load proportioning valve to support bracket bolt	M 8	2,4
Load proportioning valve support bracket to rear cross member, bolt	M 8	2,4
Load proportioning valve bracket to bodywork, bolt	M 8	2
Load proportioning valve adjustment, screw	M 8	2,4
Brake pump to servo brake, nut	M 8	2
Servo brake to pedal mounting, nut	M 8	2,5
2 way union	M 10 x 1	1,1
Pipes to front brake caliper	M 10 x 1	1,8
2 way union on rear brake pipe	M 10 x 1	1,8
Caliper to front steering knuckle, bolt	M 10 x 1,25	5,3
Front wheel brake caliper bleed screw	M 8	0,64
Rear wheel brake caliper support plate, bolt	M 8	2,4
Rear brake caliper mounting, bolt	M 10 x 1,25	5,3
Rear wheel brake caliper bleed screw	M 8	0,64

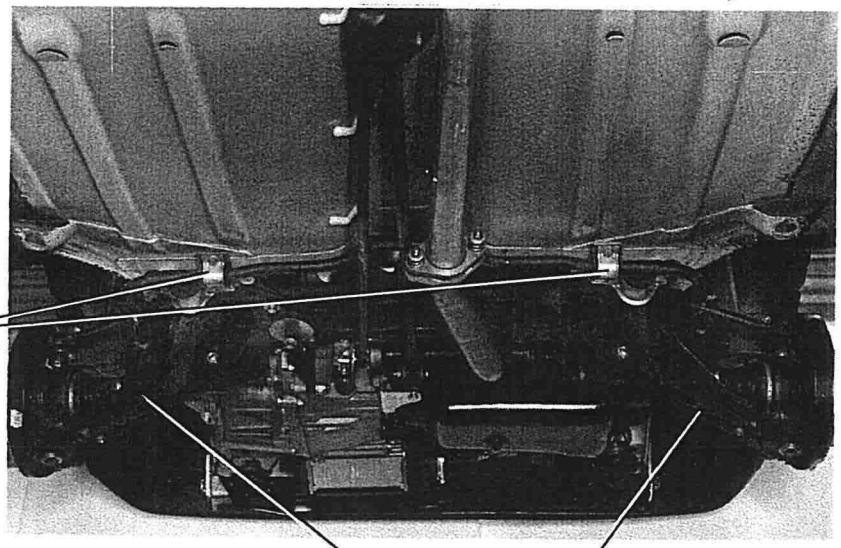
page

REMOVING–REFITTING STABILIZER BAR

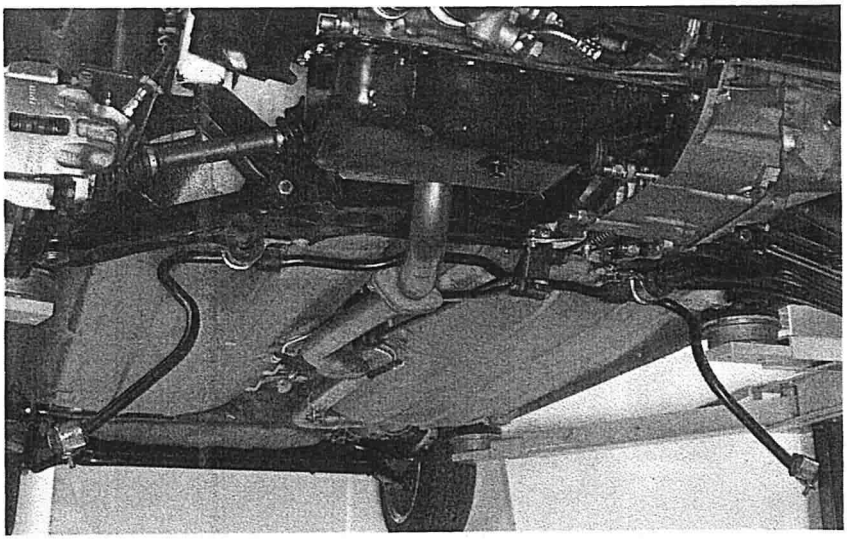
Proceed as follows:

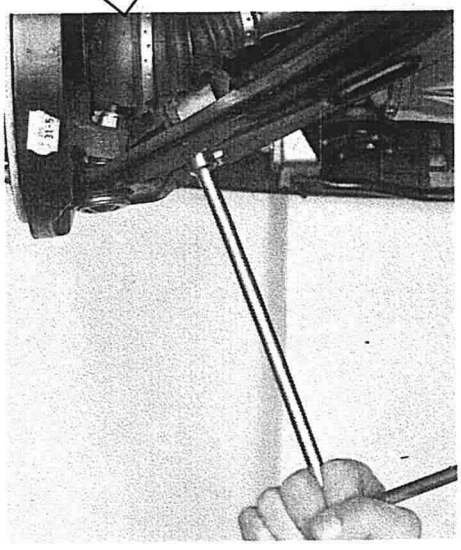
- Position the vehicle on a lift.
- Remove the wheels.
- Remove the items illustrated below:





NOTE *When removing-refitting the stabilizer bar it is vital to disconnect the gear selector and engagement rods from the gearbox.*

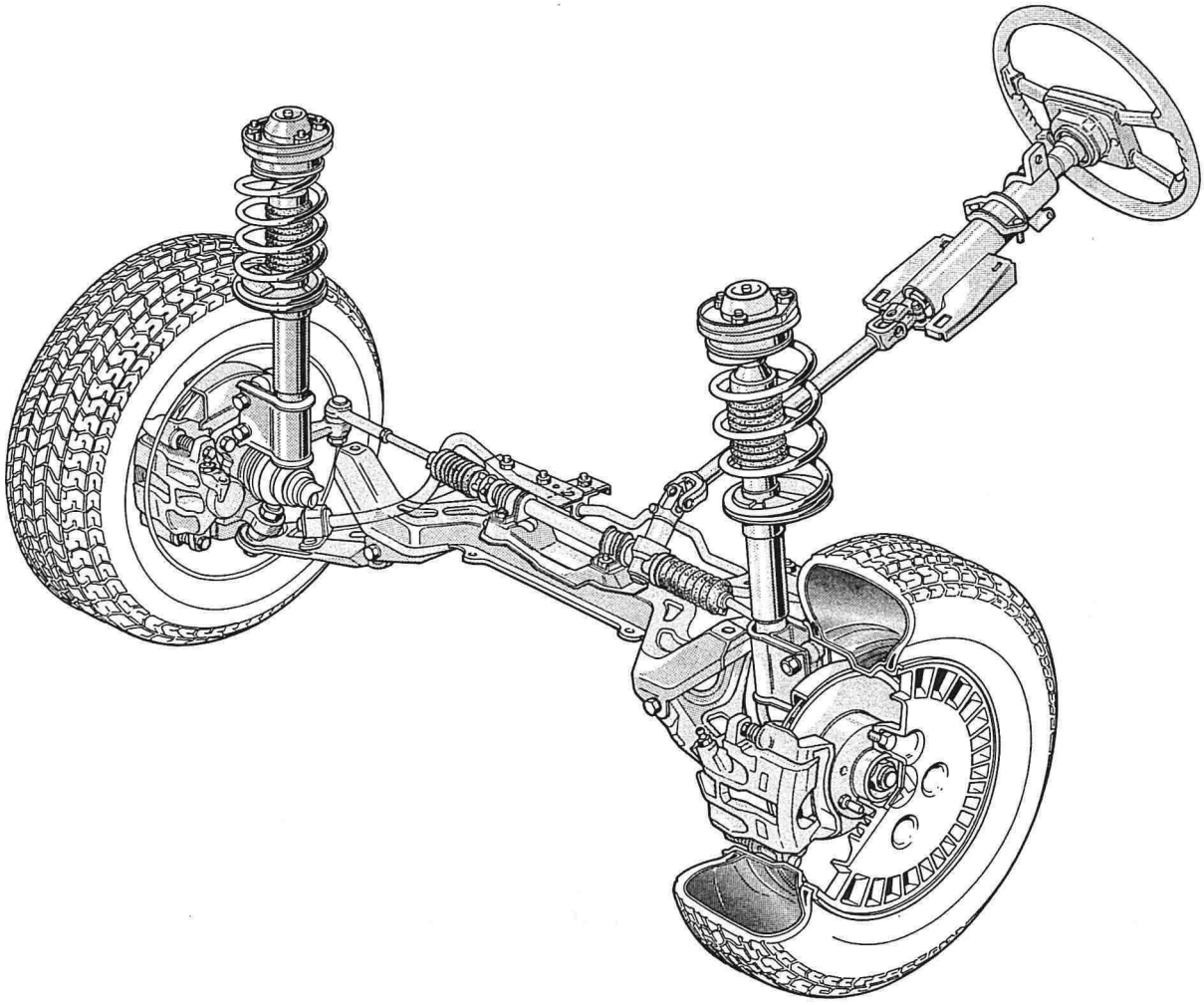




The nuts and bolts fixing the stabilizer bar are tightened with the vehicle horizontal with 4 passengers inside plus 40 kg of luggage (1 person = 70 kg).

44.

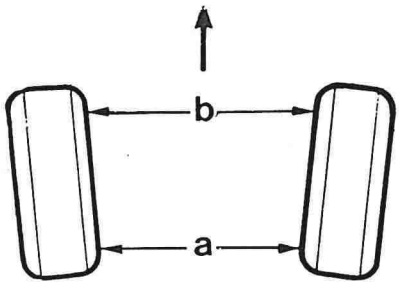
FRONT SUSPENSION ASSEMBLY



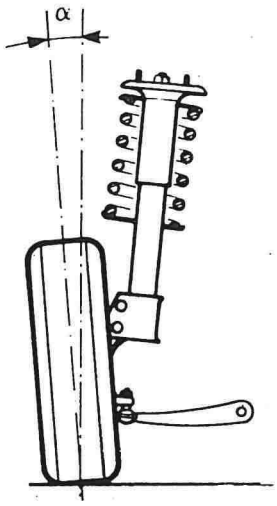
FRONT WHEEL GEOMETRY

The wheel geometry must be checked after having subjected the components involved to the following checks:

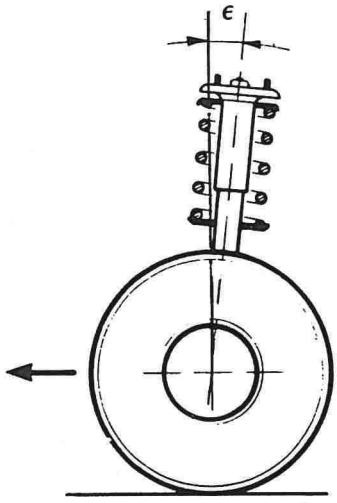
- Tyre inflation pressure.
- The eccentricity and squareness of the wheel rims must not be more than 3 mm.
- Wheel bearing end float.
- Clearance between steering knuckle and ball joint.
- Steering rod ball joint clearance.



toe in a - b = 0 ÷ 2 mm

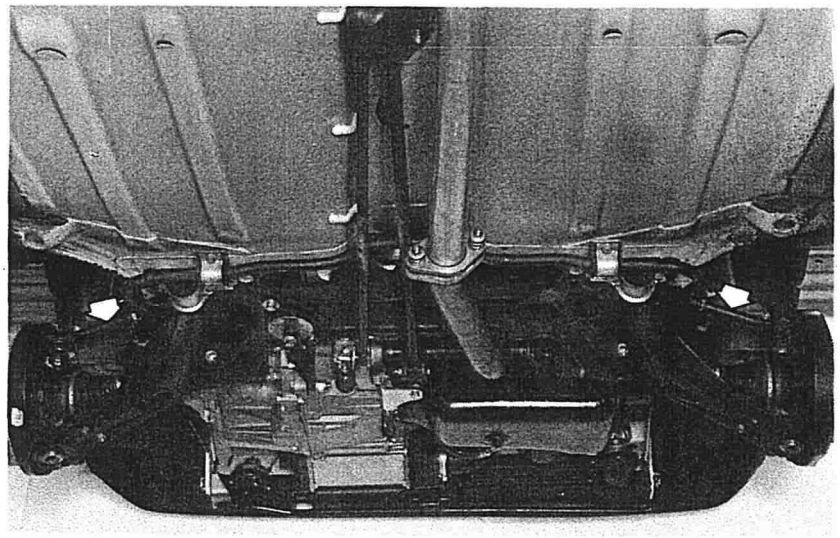


camber $\alpha = 25' \pm 30'$
(cannot be adjusted)



caster $\beta = 2° 15' \pm 20'$
(cannot be adjusted)

If the value measured when checking the toe in is different from the figure given, adjust the steering box rods after having loosened the fixing nuts.



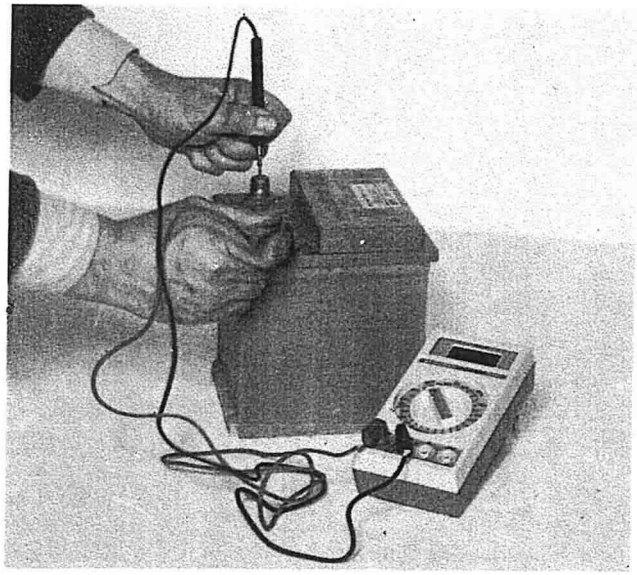
If the camber and caster angles measured are different from the figures given, the bodyshell and the front cross member must be checked.

44.A

1847014000	Rear wheel hub cap extractor
1847017001	Percussion extractor
1847017004	Tool for removing wheel hubs (to be used with 1847017001)
1847035000	Tool for removing front suspension track control arm ball joint
1854014000	Spanner for retaining front shock absorber stem
1870358000	Tool for removing constant velocity joint
1874088000	Drift for refitting wheel hub covers
1874140001	Pliers for staking nuts
1874140009	Tool (to be used with 1874140001)
1874544001	Tool for compressing suspension springs
1874544031	Tool (to be used with1874544001)

DESCRIPTION	Thread size	Torque daNm
FRONT SUSPENSION		
Wheel nuts	M 12 x 1,25	8,6
Front wheel hub, nut to be staked	M 20 x 1,5	29,4
Front track control arm to cross member, "Nyloc" nut	M 12 x 1,25	8,8
Ball joint to steering knuckle, "Nyloc" nut	M 10 x 1,25	4,9
Shock absorber to steering knuckle, "Nyloc" nut	M 10 x 1,25	4,9
Shock absorber upper flexible mounting to bodywork, nut	M 8	2,4
Upper shock absorber to mounting, nut	M 12 x 1,25	5,9
Suspension arm and cross member to bodywork rear, bolt	M 10 x 1,25	6
Cross member to bodywork front, bolt	M 10 x 1,25	6
Front suspension stabilizer bar central mounting, bolt	M 8	2,4
Stabilizer bar to front suspension track control arm, nut	M 8 x 1,25	1,5
REAR SUSPENSION		
Wheel nuts	M 12 x 1,25	8,6
Rear wheel bearing, nut to be staked	M 20 x 1,5	21,6
Axle to bodywork attachment bracket, bolt	M 8	2,4
Rear axle to bodywork attachment bracket, "Nyloc" nut for bolt	M 10 x 1,25	5,5
Shock absorber to rear axle, "Nyloc" nut	M 10 x 1,25	3,1
Upper shock absorber to flexible mounting, "Nyloc" nut	M 10 x 1,25	3,1
Upper shock absorber flexible mounting to bodywork, nut	M 8	1,5

BATTERY



The battery is of the ES, sealed energy, maintenance free type.

The advantages of this type of battery are:

- It uses very little water because of the new type of alloy used for the grilles and the plates.
- It will maintain its starting potential for a period of up to 7 months thanks to the very much reduced tendency to self discharge and therefore it lends itself to prolonged storage (at temperatures below 28°C).
- It ensures no corrosion or bad contacts at the terminals due to the reduction in the volume of gas produced during charging.

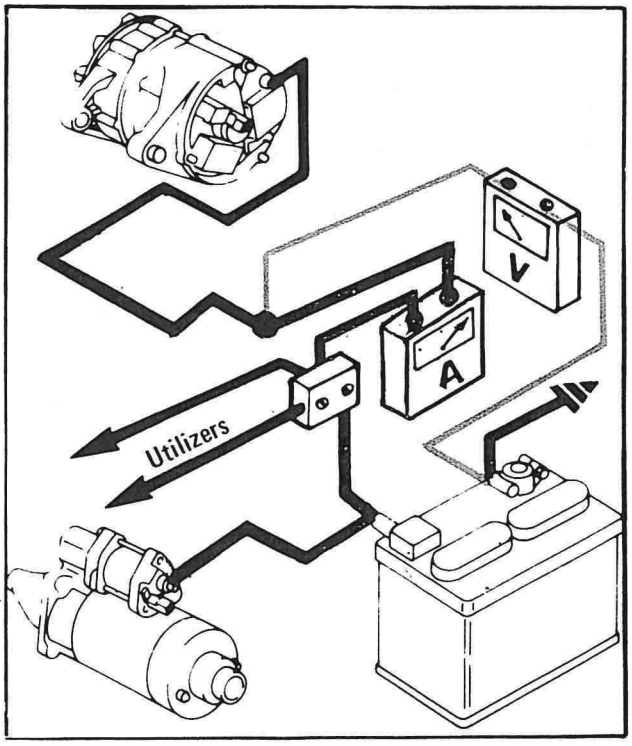
If the battery appears to be discharged, measure the no-load voltage at the terminals using a digital voltmeter; if it is less than 12.30 V it is 50% discharged; if it reaches 12.48 V it is 25% discharged; if it reaches 12.66 V it is 100% charged.

NOTE *Carry out this check after leaving the battery with an open circuit for at least 2 hours.*

If the electrolyte level is below the minimum level on the plastic container, open the cover on the plugs and top up with distilled, de-ionized water (as used in ordinary batteries).

NOTE *Never use a rapid battery charger at voltages above 15.5 V and at high currents.*

ALTERNATOR

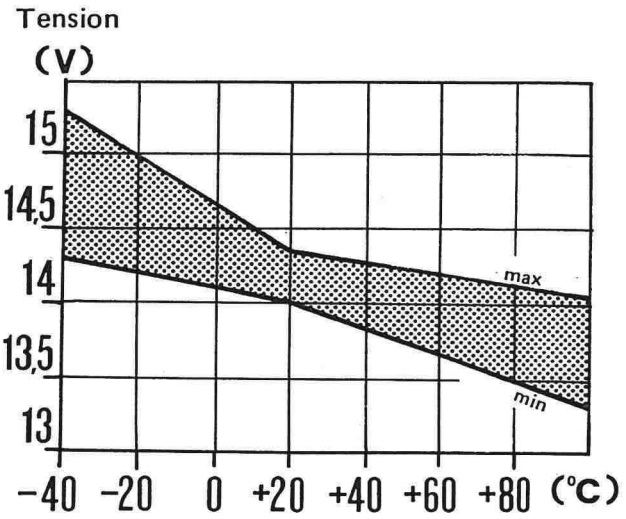


Checking maximum charge rate on car of alternator with built in electronic regulator

- Disconnect the cable coming from the alternator and the connecter block (*) in the engine compartment and insert an ammeter in series.
- Connect a voltmeter in parallel to the battery.
- Start up the engine and bring it to a speed of 3000 - 4000 rpm.
- Connect all the available connecters in order.
- Measure the maximum charge rate when the voltmeter goes below 13.5 V.
  If the current is more than 5A below the value given, it is necessary to overhaul the alternator.

(*) Red cable of average size coming from the alternator.

55.



Regulator ambient temperature

Checking voltage regulator in car

Maintaining the previous connections and engine speed, disconnect some connecters until an absorption of about **half maximum load** (20 - 25 A) is reached.
In these conditions the voltage should be between the min and max values in the diagram shown according to the ambient temperature of the electronic regulator (alternator).

NOTE *For alternator temperatures of 80°C the voltage regulator should reach a value of 13.5 - 14.2 V.*

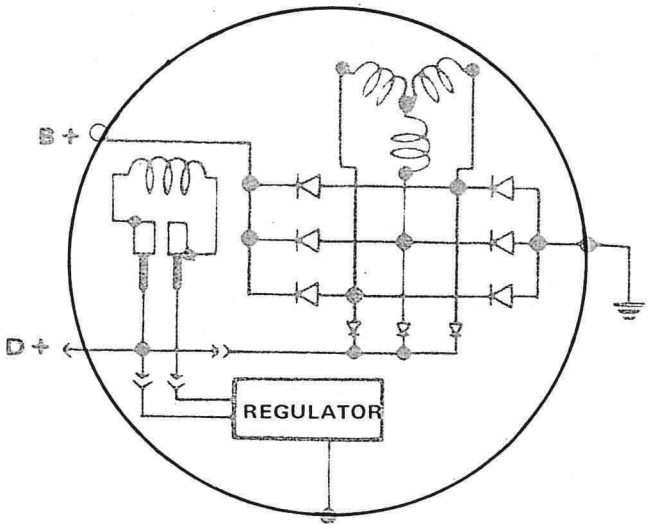
Checking regulation stability of electronic regulator

Maintaining the same electrical connections and engine speed, insert some connecters until the current load is equal to 2/3 of the alternator rating current. In these conditions the voltage should not decrease by more than 0.4 V.
Then disconnect some connecters until the current absorption is around 5 A. The voltage should not vary by ± 0.2 V compared with the regulation voltage value.
If it is not within the prescribed tolerances, the voltage regulator should be replaced as it is faulty.

Tensioning alternator belt

Loosen the nut fixing the lower alternator support. Loosen the nut fixing the upper bracket. Introduce a lever between the alternator and the engine in order to suitably tension the belt.
Then tighten the 2 alternator fixing nuts.

NOTE *Ensure that the belt yields 10 - 15 mm under a load of 10 kg at the centre.*

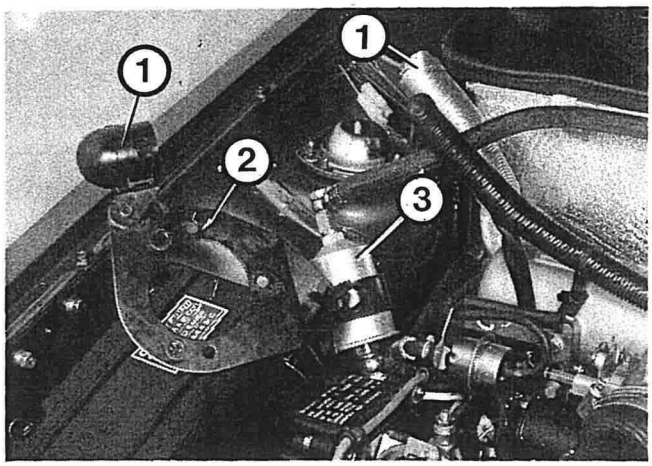


ALTERNATOR

Wiring diagram

Never operate the engine with the electrical connections of the recharging circuit temporary or slack. This could damage the alternator diodes. Never carry out diagnostic checks on the electronic regulator using test lamps as this could damage it.

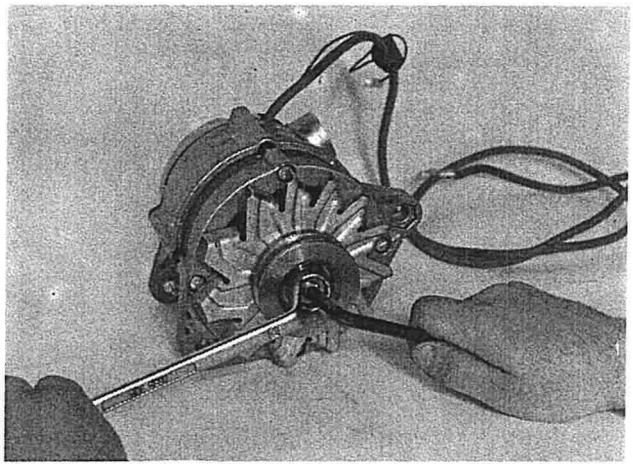
BOSCH ALTERNATOR



Removing - refitting

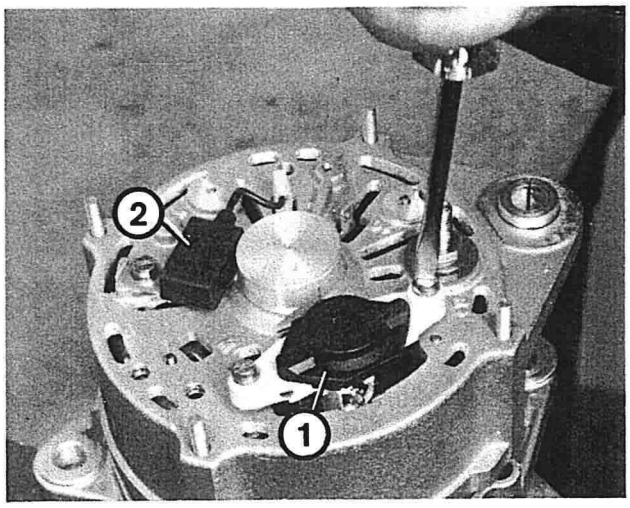
The alternator is removed from the engine compartment after having removed the fuel filter support bracket from the right shock absorber mounting in order to make room.

1. Alternator cooling pipe and anchorage
2. Support
3. Fuel filter



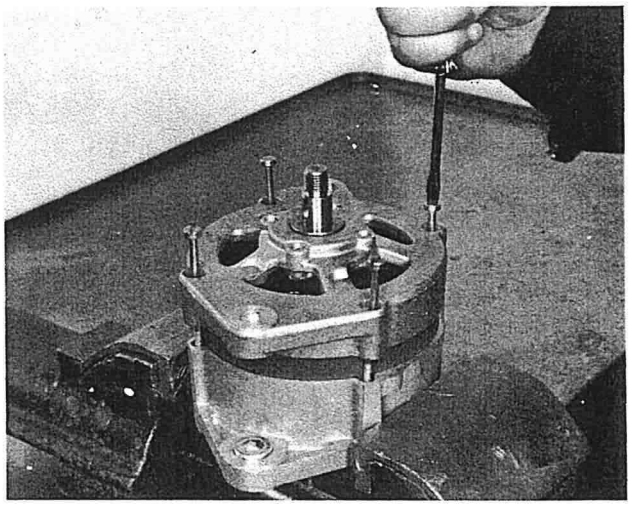
Removing alternator control pulley

Use a spanner to keep the alternator shaft still.
Tightening torque: 3.5 daNm.



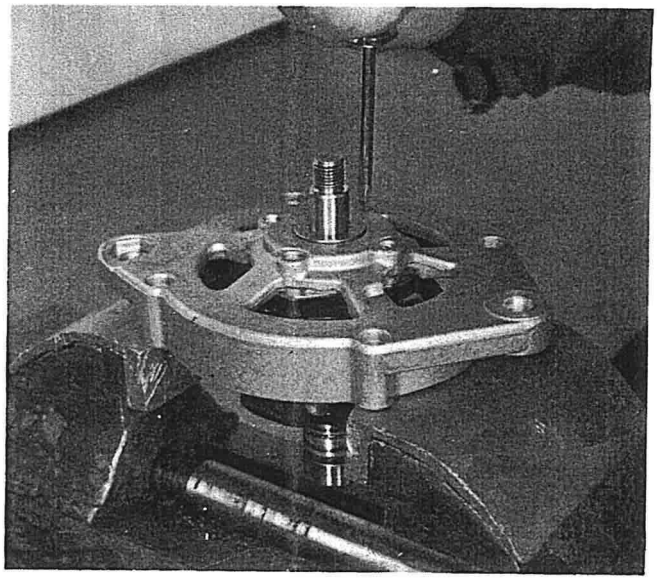
Removing electronic regulator (1) complete with brushes and brush carrier

Loosen the condenser (2).

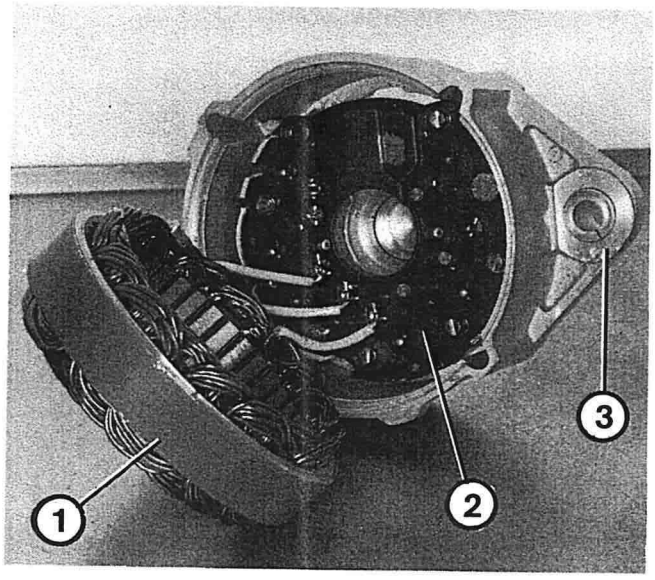


Dismantling alternator to remove rotor and mounting

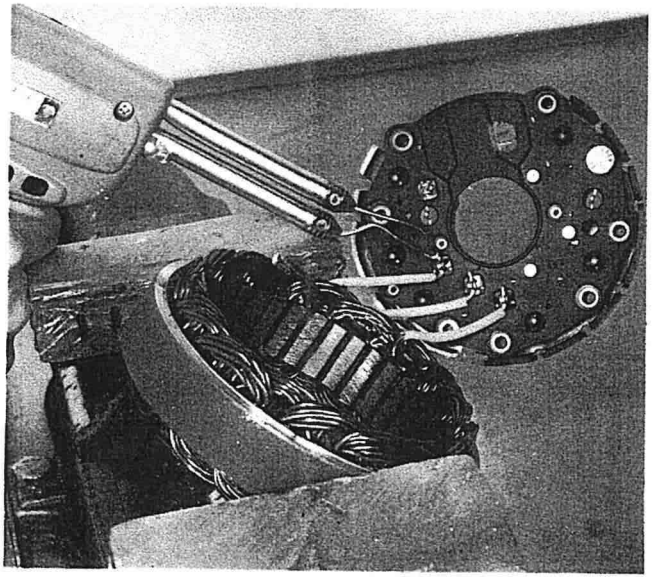
55.



Removing rotor from pulley side mounting.

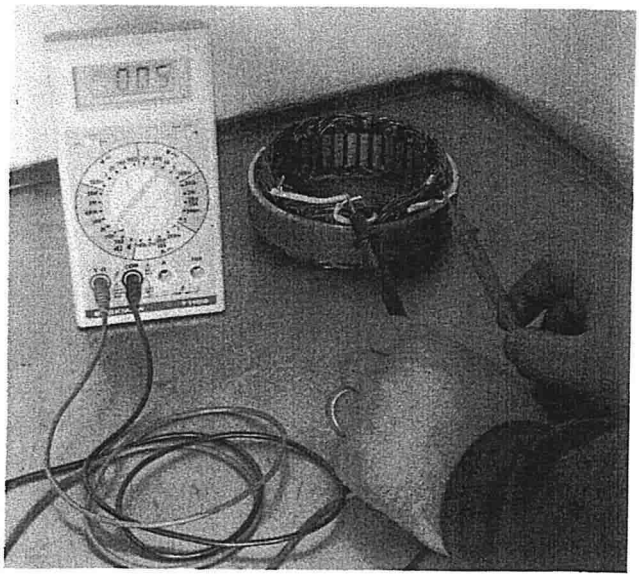


1. Stator
2. Diode carrier plate
3. Diode carrrier plate side mounting



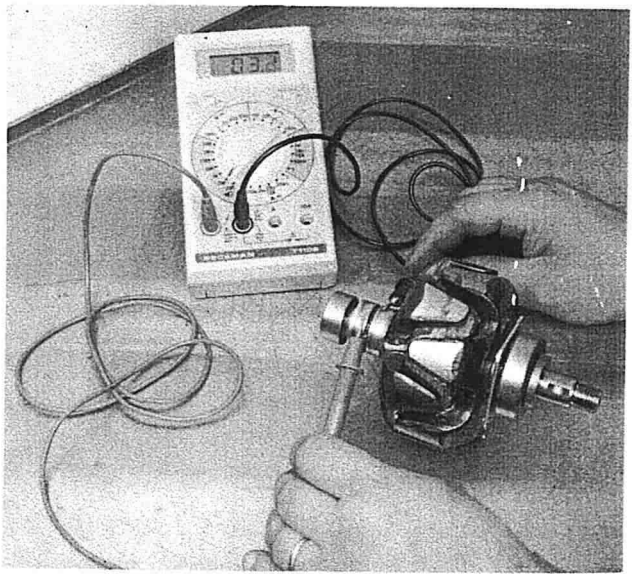
Unsoldering ends of stator windings

NOTE *This operation is necessary to carry out the check on the continuity of the stator windings and the efficiency tests for the diodes.*

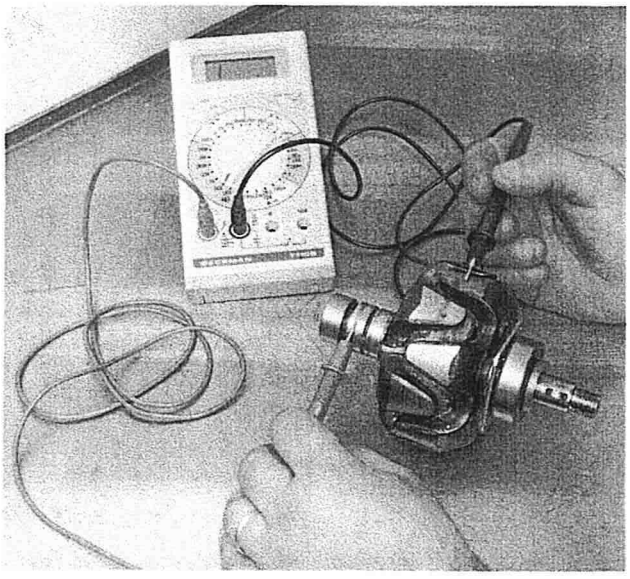


Checking resistance (and/or continuity) for one stator winding

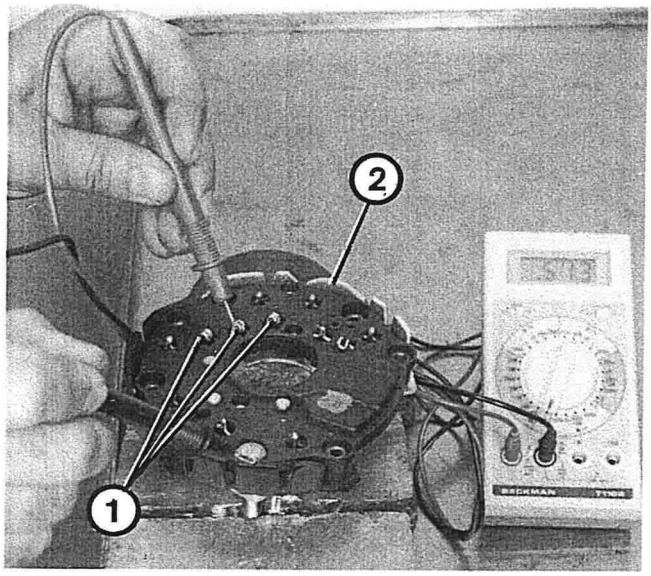
Measure the resistance for the 3 stator windings and the insulation between the windings and the casing.



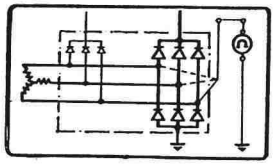
Checking winding resistance at the slip rings



Checking winding insulation



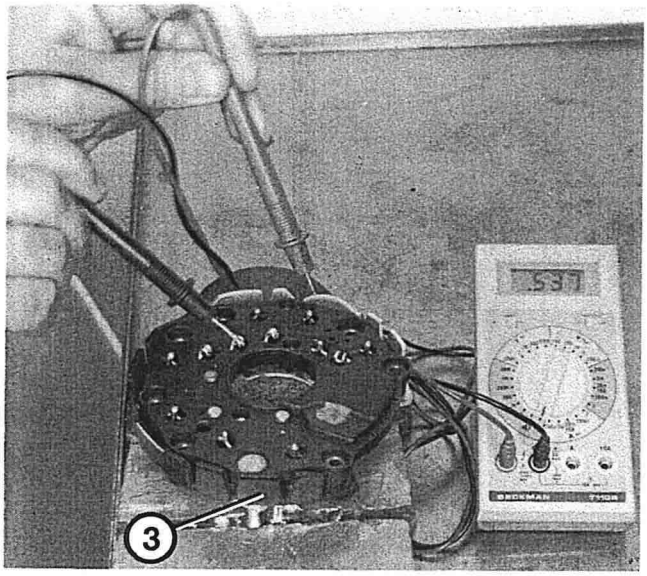
CHECKING DIODES

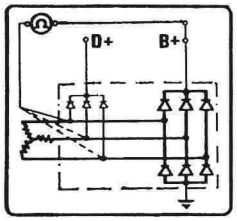


Checking negative diodes

This is carried out between each terminal of the stator windings (1) and the diode carrier plate (2).

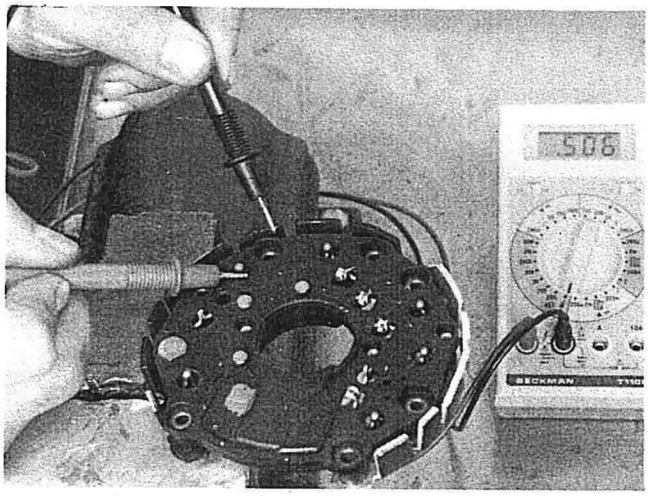
The diode is working properly if the drop in voltage is between 0.5 and 0.9 V and the reverse current is zero.



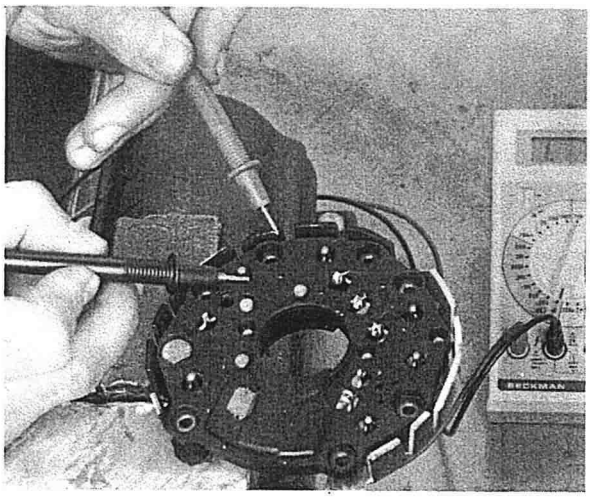


Checking positive diodes

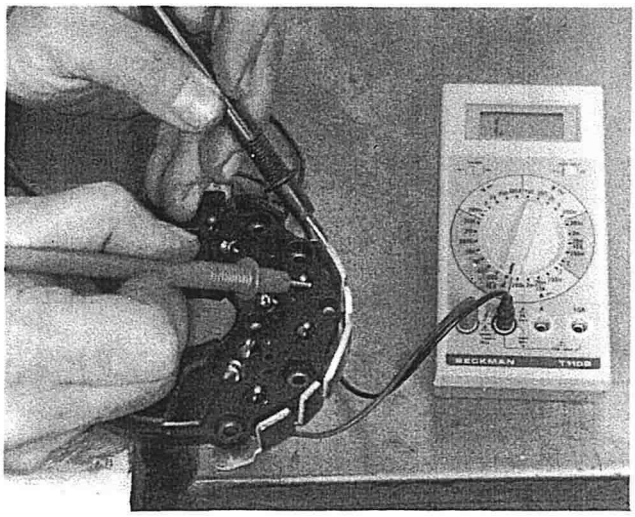
This is carried out in the same way as described above, between the stator terminals and the positive diode carrier plate (3).



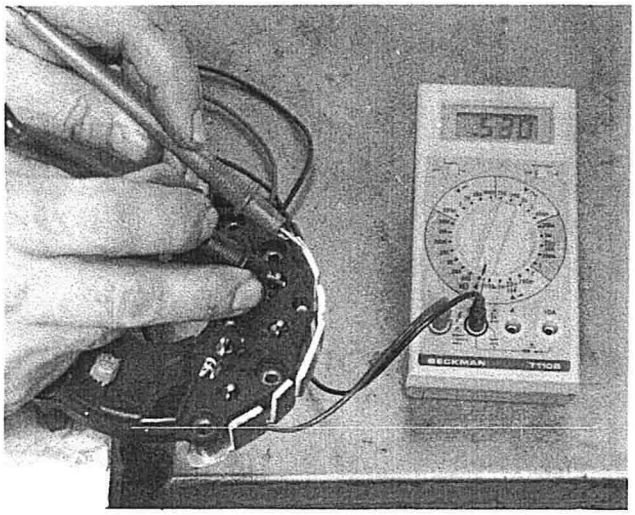
Positive diode discharge voltage test



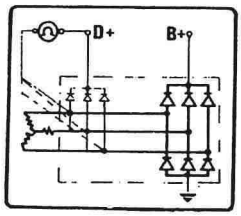
Positive diode reverse current test

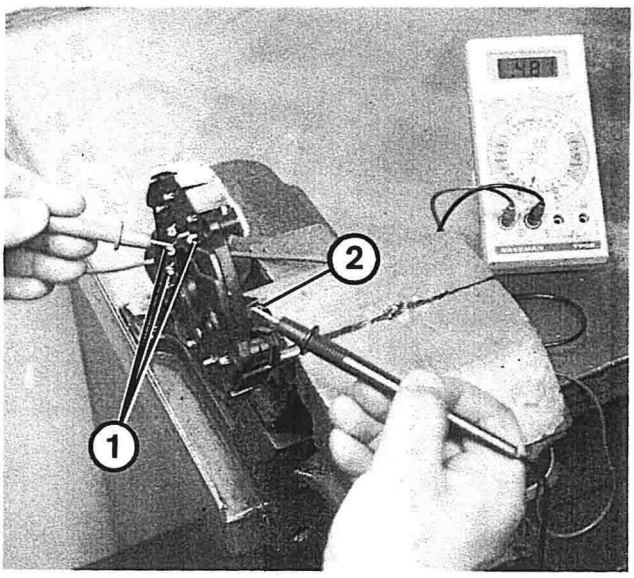


Negative diode reverse current test



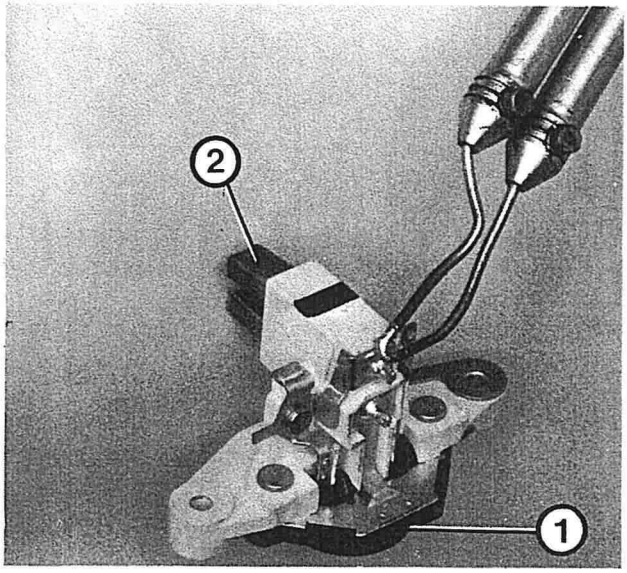
Negative diode discharge voltage test





Checking diodes: reverse current and discharge voltage tests

Connect the probes of the diode tester between each stator winding (1) terminal and the positive brush support blade (2) or terminal + D. Then reverse the diode tester probes.



Replacing brushes

Unsolder the 2 brush terminals from the regulator, fit the new brushes and the resolder the two terminals.

NOTE *Rest the regulator on a metal plate whilst carrying out the welding to prevent an excessive increase in temperature from damaging it.*
If the voltage regulator is not working properly then the entire unit has to be replaced: brushes, brush carrier and regulator.

1. Electronic voltage regulator
2. Brushes

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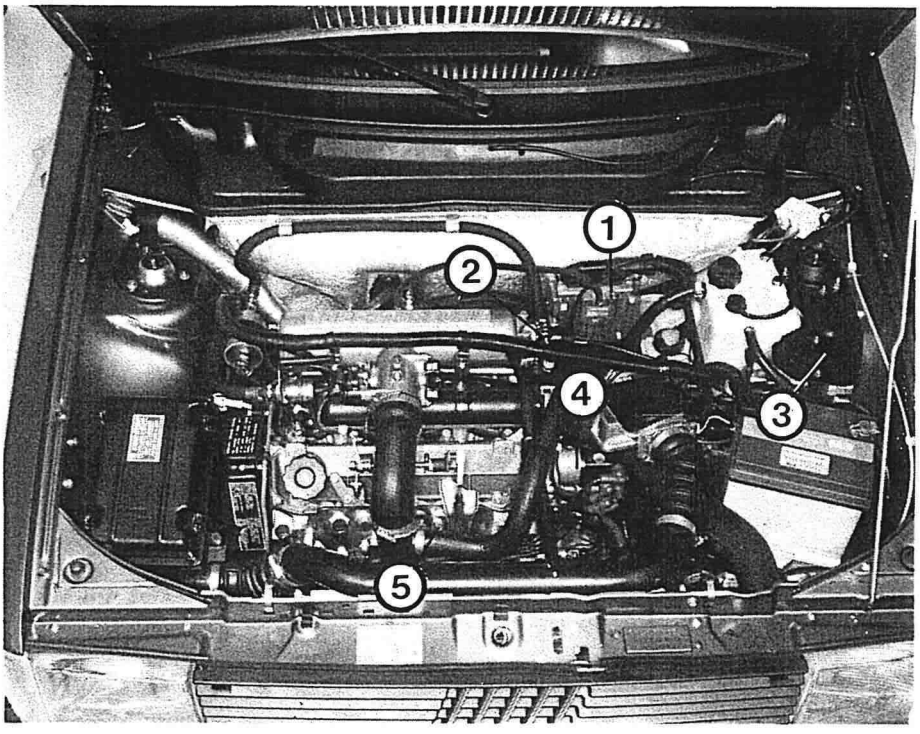
M. MARELLI MICROPLEX STATIC ADVANCE ELECTRONIC IGNITION SYSTEM

Introduction

The Microplex static advance ignition system **eliminates** the conventional distributor and centrifugal and automatic advance system **replacing** them with a digital type electronic control unit with a computer and a memory for controlling the inductive discharge equipment supplying the current to the spark plugs.
Unlike conventional systems or even breakerless electronic systems in which the advance is mechanically obtained by means of centrifugal masses according to linear laws, the MICROPLEX system is capable of providing advance values calculated with experimental data taking into account the various possible operating conditions of the engine enabling it to supply the maximum power compatible with reduced fuel consumption and less pollutant exhaust gases. Another feature of this new ignition system is that it is also possible to **automatically correct the advance curves in operating conditions close to detonation (*). The MICROPLEX device can choose the optimum value, from the thousands of advance values stored in its memory, to suit any engine operating condition (load and revs).**
The electronic control unit is constantly informed of the load conditions, engine speed and type of operation - naturally aspirated or supercharged - by means of two electro-magnetic sensors and a pressure and vacuum sensor.
In addition, if the phenomenon of detonation (*) occurs in the engine, the ignition control unit is informed of it by a special **detonation sensor (5).**
The operating range for this sensor does not extend to vacuum values below 0.13 bar.

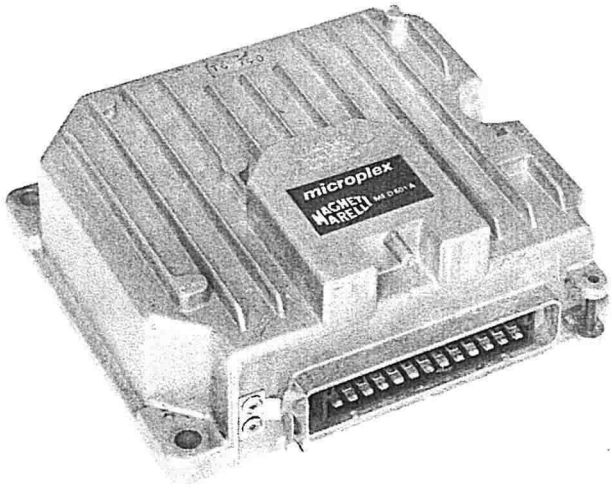


1. Electronic control unit – 2. Safety pressure switch – 3. Ignition unit – 4. Distributor – 5. Anti-detonation sensor

(*) Detonation is the irregular combustion of the last portion of unburnt charge. It develops extremely quickly compared with the normal speed of combustion. It causes extremely high frequency vibrations inside the combustion chamber which are perceived in the form of "engine knock" which can, if prolonged, cause damage to the pistons and the piston rings.

This system comprises:

- **two electro-magnetic sensors** (S1 and S2) which pick up information concerning rpm and TDC directly on the crankshaft, respectively, thereby eliminating any inaccuracies of a mechanical nature (shaft - gear clearances) due to the transmission of power between the distributor and the crankshaft.
- **a pressure and vacuum sensor** comprising a resistive bridge ceramic diaphragm for measuring the relative pressure in the engine inlet manifold.
  This sensor is located in the electronic control unit (1) and connected by means of a tube to the engine to transform the inlet manifold pressure or vacuum values (depending on whether the engine is naturally aspirated or supercharged) into an electric voltage signal.



Microplex static advance electronic ignition system control unit

- **a detonation sensor** (5) which transforms the vibrations which may occur inside the combustion chamber if the engine is operating irregularly into an electric signal.
  This takes place more often when the engine is being supercharged. For this reason the operation of the sensor (5) is restricted to vacuum values below 0.13 bar.
- **an electronic control unit** (1) which selects the optimum advance angle on the basis of actual input parameters and controls the conduction and cut out of the **ignition unit** by means of a clipped, logic signal.
- **an ignition unit** (3) composed of:
  - an **electronic power module** which receives the ignition advance command and controls the conduction angle of the primary current and the energy stored in the coil;
  - a **dissipator plate** for the heat produced by the large quantities of current passing through;
  - a closed magnetic circuit **ignition coil** with low primary resistance capable of guaranteeing an extremely high level of spark energy;
  - a **rotary distributor** (4) fitted directly on the camshaft to distribute the high tension to the spark plugs.

Lastly, the system is equipped with a **safety pressure switch** (2), located in the inlet manifold, with the function of cutting out the ignition if the supercharging pressure exceeds the maximum safety value of 0.84 ÷ 0.93 bar above atmospheric pressure.

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Operation

The electro-magnetic sensor S2 provides a signal corresponding to 2 reference marks or teeth on the crankshaft pulley thus indicating TDC.
The electro-magnetic sensor S1, which is facing the flywheel teeth, supplies information on the rpm and later on the angular position which is used to advance the spark as required.
The pressure and vacuum sensor provides an electric voltage signal proportional to the absolute pressure in the inlet manifold.
The control unit processes the signals received from the sensors and, on the basis of the information it has received, it selects the most appropriate advance value.
The **ignition unit** receives a logic signal from the control unit and therefore allows the current to pass through the ignition coil primary winding, controlling the exact conduction angle for the current and the constancy of the energy in the primary winding.
The system identifies and divides the engine speed range into 16 sections, not necessarily equally spaced, which are linked with 16 equally spaced advance values, corresponding to 8 vacuum conditions selected in the "aspirated" operating range of the engine and 8 pressure conditions selected in the "supercharging" operating range of the engine.

To sum up, the ignition advance is obtained by processing the information supplied by the sensors concerning engine speed, vacuum and pressure (and the conditions which may give rise to detonation) in a digital form and with the help of a computer and reading off the corresponding advance angles stored in the memory.
Since the information is obtained directly from the crankshaft by means of electro-magnetic sensors, the advantages compared with conventional and breakerless systems are listed below:

- pre-set advance values which do not change for the entire life of the device since there is no longer any wear of the mechanical components.
- the imprecision caused by vibrations and the mechanical coupling between the crankshaft and the camshaft.

The MICROPLEX ignition system guarantees a high spark energy thanks to the low primary resistance of the coil and maintains the primary winding charge energy constant on account of an internal feed back circuit contained in the power module capable of varying the primary circuit closure period. This feature makes it possible to obtain sparks with **high tension** even at high engine speeds or when the battery voltage is rather low (e.g. when starting).
In addition, as soon as the phenomenon of "engine knocking" might appear, following detonation during combustion, a special sensor informs the control unit which is then able to quickly reduce the ignition advance. The reduction of the advance angle takes place when the system recognizes the onset of "knocking" due to detonation which it distinguishes from regular combustion.
The advance curve as a function of a given engine charge is therefore reduced by around 3°.
If detonation should persist the curve memorized is reduced by a further 3° up to a maximum of 15°. After a certain number of operating cycles without "knocking", the advance is progressively restored to the original setting.
The advance curve based on a given charge, supply pressure and engine speed cannot be reduced by more than 15°.

Safety pressure switch

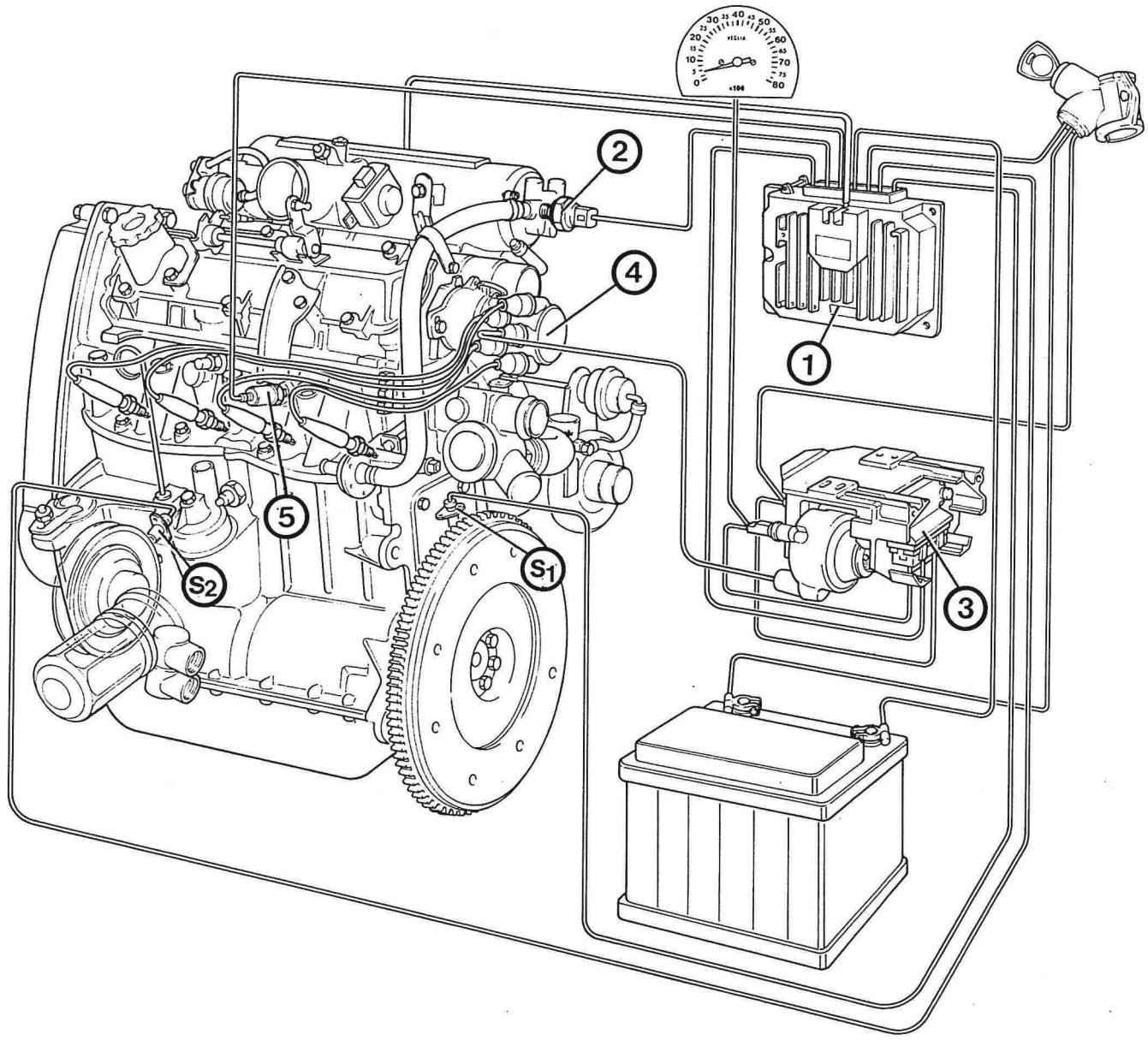
When the supercharging pressure exceeds atmospheric pressure by 0.84 ÷ 0.93 bar, a safety switch in the pressure switch located in the lower section of the engine inlet manifold, puts contact 20 of the electronic control unit to earth, interrupting the spark sent to the spark plugs.

Advantages

The advantages of the MICROPLEX ignition system compared with conventional ignition systems or the most recent innovations (breakerless ignition) can be summed up in:

- best engine performance in all operating conditions;
- minimum pollution;

- minimum fuel consumption compatible with the use of a turbocharger;
- no maintenance required;
- constant performance throughout the life of the vehicle;
- safeguarding the mechanical components of the engine from mechanical damage caused by operating under detonation conditions or excess supercharging.



Microplex static advance electronic ignition system components

1. Microplex electronic control unit - 2. Safety pressure switch - 3. Ignition unit with coil - 4. High tension distributor - 5. Detonation sensor - S1. TDC sensor - S2. Rpm sensor.

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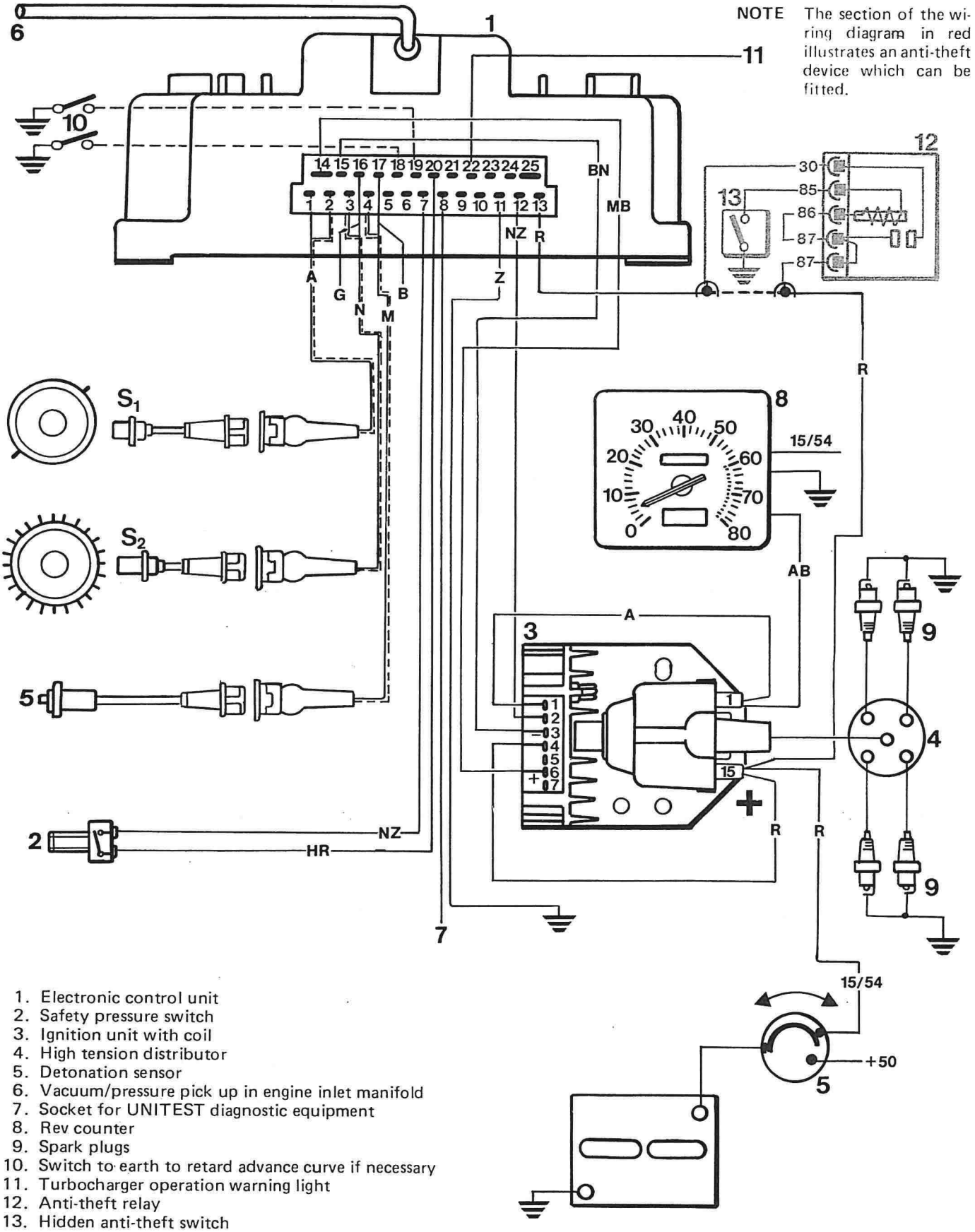
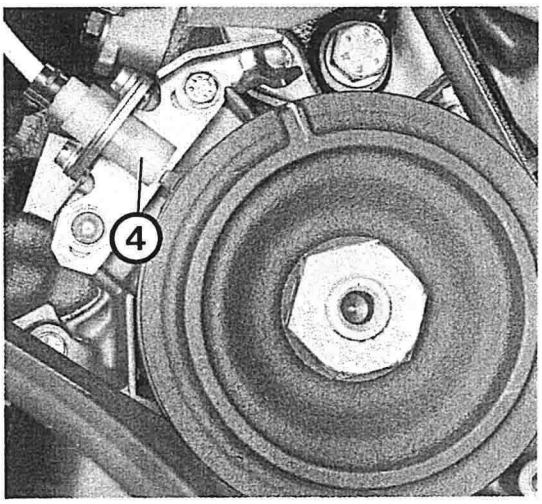
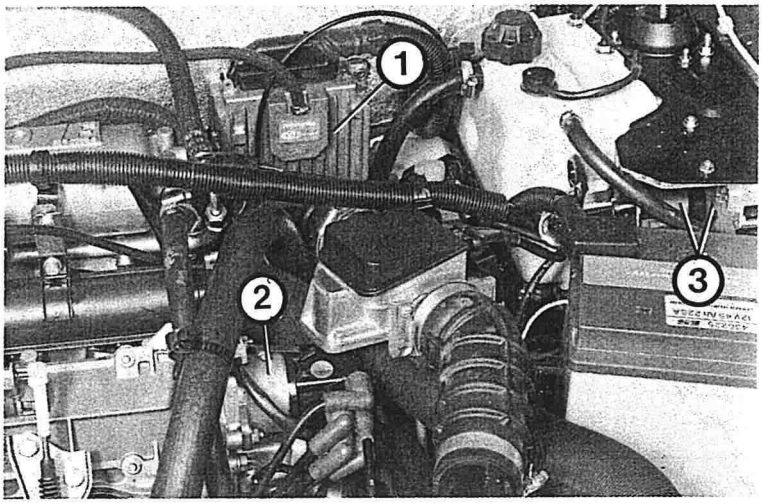
WIRING DIAGRAM FOR MICROPLEX IGNITION SYSTEM



NOTE The section of the wiring diagram in red illustrates an anti-theft device which can be fitted.

1. Electronic control unit
2. Safety pressure switch
3. Ignition unit with coil
4. High tension distributor
5. Detonation sensor
6. Vacuum/pressure pick up in engine inlet manifold
7. Socket for UNITEST diagnostic equipment
8. Rev counter
9. Spark plugs
10. Switch to earth to retard advance curve if necessary
11. Turbocharger operation warning light
12. Anti-theft relay
13. Hidden anti-theft switch



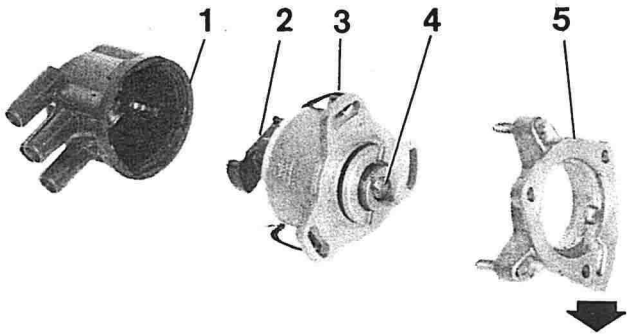


Location of static advance electronic ignition components

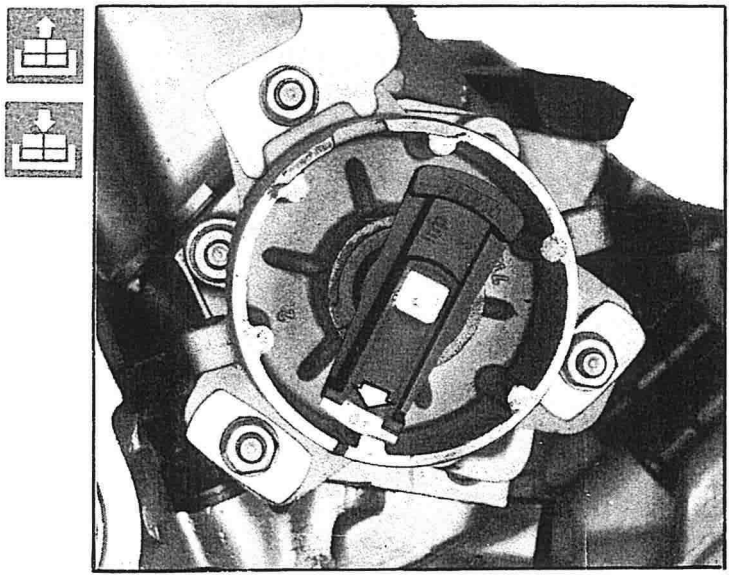
1. Static advance ignition electronic control unit with absolute pressure pick up in inlet manifold
2. High tension distributor
3. Ignition unit with coil
4. TDC sensor (hidden by wheel arch lining)

High tension distributor

1. Distributor cap
2. High tension rotary distributor
3. High tension distributor casing
4. Offset flange
5. Spacer for fixing distributor to cylinder head. Turn the oil drain notch (shown by the arrow) downwards.



NOTE *The distributor centering slots* **are not for altering the ignition advance** *but simply for centering the distributor in relation to the cap H.T. terminals.*

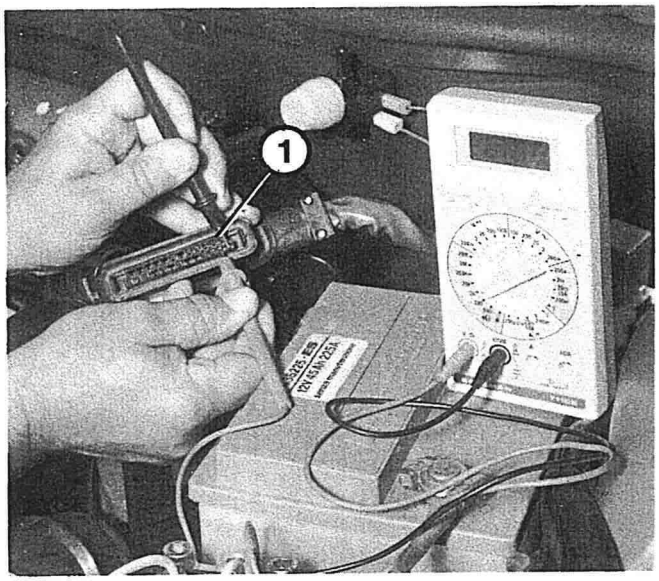


Removing - refitting distributor from head

In order to correctly refit the distributor on the engine it is necessary to:

- rotate the crankshaft until all the timing reference marks coincide (cylinder no. 4 in explosion stroke);
- fit the distributor with the rotor arm positioned as shown in the diagram.

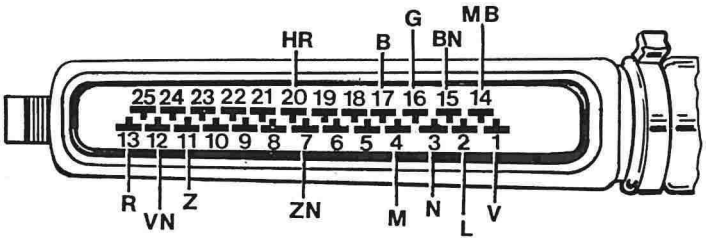
NOTE *The rotor arm and the cap should be replaced as necessary, as with a conventional ignition system.*



CHECKING COMPONENTS

The checks given below can be carried out using an ohmmeter:
- electrical continuity of Microplex ignition cables;
- resistance values for rpm and TDC sensors;
- electrical continuity and resistance of the ignition coil primary and secondary windings (using a digital instrument).

The cables and the sensors are checked by removing the multiple socket from the control unit and connecting the probes of an ohmmeter to the following terminals:



Ignition control unit multiple connecter (cable colour code - page 39)

Checking rpm sensor on flywheel on gearbox casing support

Insert the probes of the ohmmeter between terminals 3 and 16 of the multiple connecter.
The reading should be between 618 and 748 Ω at 20°C. If this is not the case, disconnect the connecter linking the sensor to the control unit and then carry out the sensor resistance test directly.
If the result is still negative, replace the sensor.

Checking value of gap between rpm sensor and flywheel teeth

As this check is identical to the one described for the UNO ES on page 50 of Section 55 follow the instructions given there.

Checking TDC sensor on bracket near crankshaft pulley

Insert the probes of the ohmmeter between terminals 1 and 2 of the multiple connecter. The resistance value in Ohms should be the same as for the rpm sensor. If this is not the case, disconnect the sensor-control unit connecter.
Then, carry out the check of the sensor directly.
If the result is still negative, replace the sensor as it is faulty.

Checking value of gap between TDC sensor and crankshaft pulley

As this check is identical to the one described for the UNO ES on page 49 of Section 55 follow the instructions given there.

Checking position of TDC sensor carrier plate

For this check, follow the instructions given for the UNO ES on page 51 of Section 55, using the same tools.

Checking control unit supply

With the ignition switch in the ON position, insert the probes of a voltmeter between terminals 13 and 11 of the multiple connecter.
If the instrument does not show the battery voltage, check that the earth connection for the battery or the ignition switch or the intermediate connecter (see wiring diagram) is working properly.

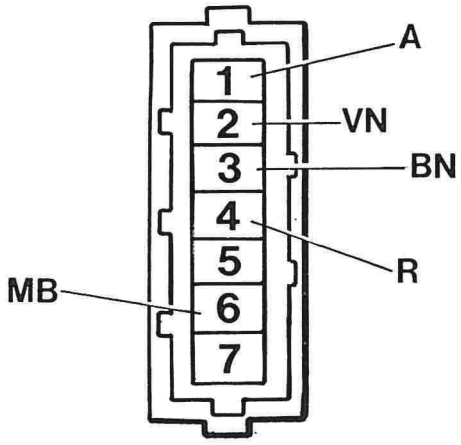
CHECKING IGNITION UNIT

Checking cables between control unit and ignition

Disconnect the connecter from the ignition unit and connect the probes of a voltmeter between terminal 4 of the connecter and an earth point.
If the voltage is lower than the battery voltage, check the connections starting from the ignition switch and ending at terminal + 15 of the ignition coil.
Renew any connections found to be faulty.
Disconnect the connecter from the unit, then turn the ignition switch to the ON position.

The checks which follow should be carried out with the Microplex control unit multiple connecter connected.

Insert the probes of a voltmeter between terminals 4 and 2 of the ignition unit connecter. If the voltage is lower than the battery voltage, check the connections starting from the ignition switch up to terminal + 15 of the ignition coil and the battery earth.
Renew any connections found to be defective.
If this is not the case, replace the control unit as there is a break internally between terminals 11 and 12.



Ignition system power module multiple connecter (see page 39 for cable colour code)

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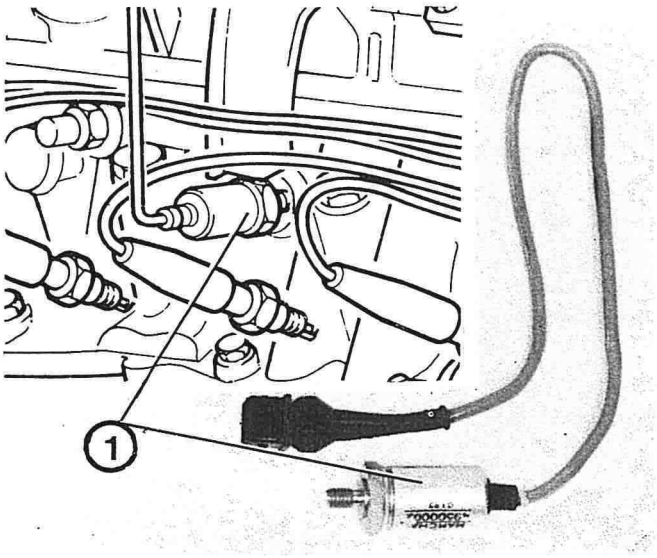


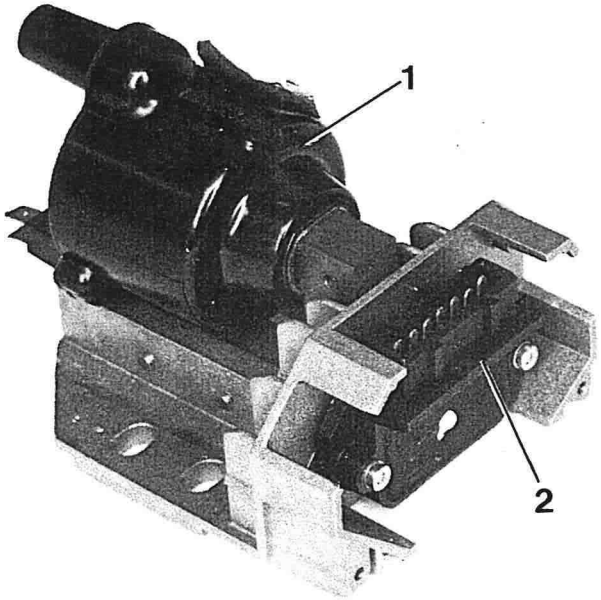
DETONATION SENSOR (1)

If the sensor is broken it may encourage the onset of detonation or a loss of power due to excess ignition delay.
If a fault in the sensor is suspected due to "knocking" heard during the road test of the vehicle or poor performance, carry out a check using another sensor and if this cures the fault, replace the defective sensor.

NOTE *Detonation can also arise as a result of excess facing of the cylinder head support surface or fitting the wrong spark plugs or incorrect positioning of the TDC sensor.*

CHECKING IGNITION COIL AND HIGH TENSION DISTRIBUTOR

Before checking the ignition coil, disconnect the cables connected to terminals 1 and 15.



Ignition unit

1. Ignition coil
2. Power module

Checking ignition coil primary winding resistance

The resistance value for the primary winding should be between 0.31 and 0.37 Ω at 20°C.

Checking ignition coil secondary winding resistance using a digital ohmmeter

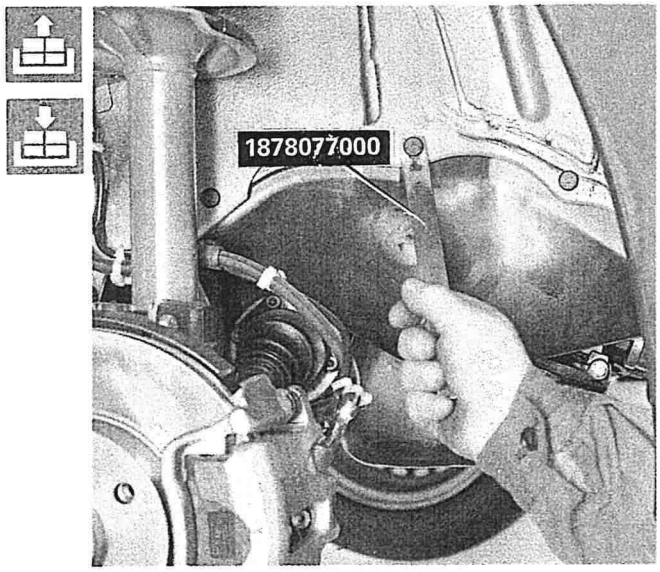
The resistance for the secondary winding should be between 3330 and 4070 Ω at 20°C.
Using the tester, also check the continuity of the high tension leads:
- between the distributor and the coil
- between the distributor and the spark plugs.

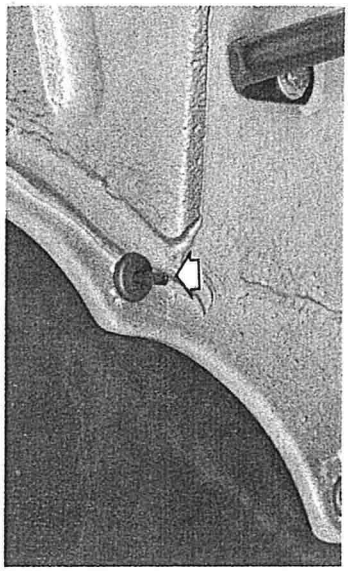
Check the condition of the high tension distributor cap (oxidation and cracks).
Check the continuity of the rotor arm resistance which should be between 800 and 1200 Ω.

If any anomalies are discovered during the above mentioned checks, replace the defective component. **If no anomalies are discovered during the checks described above, replace the Microplex control unit.**

Warnings for replacing the ignition unit and the control unit

Since it is not possible with the diagnostic system used to know whether the fault lies in the control unit or the ignition system power module, the ignition system power module should be replaced first and then see if the fault disappears.
If this is not the case, then the control unit also has to be replaced.



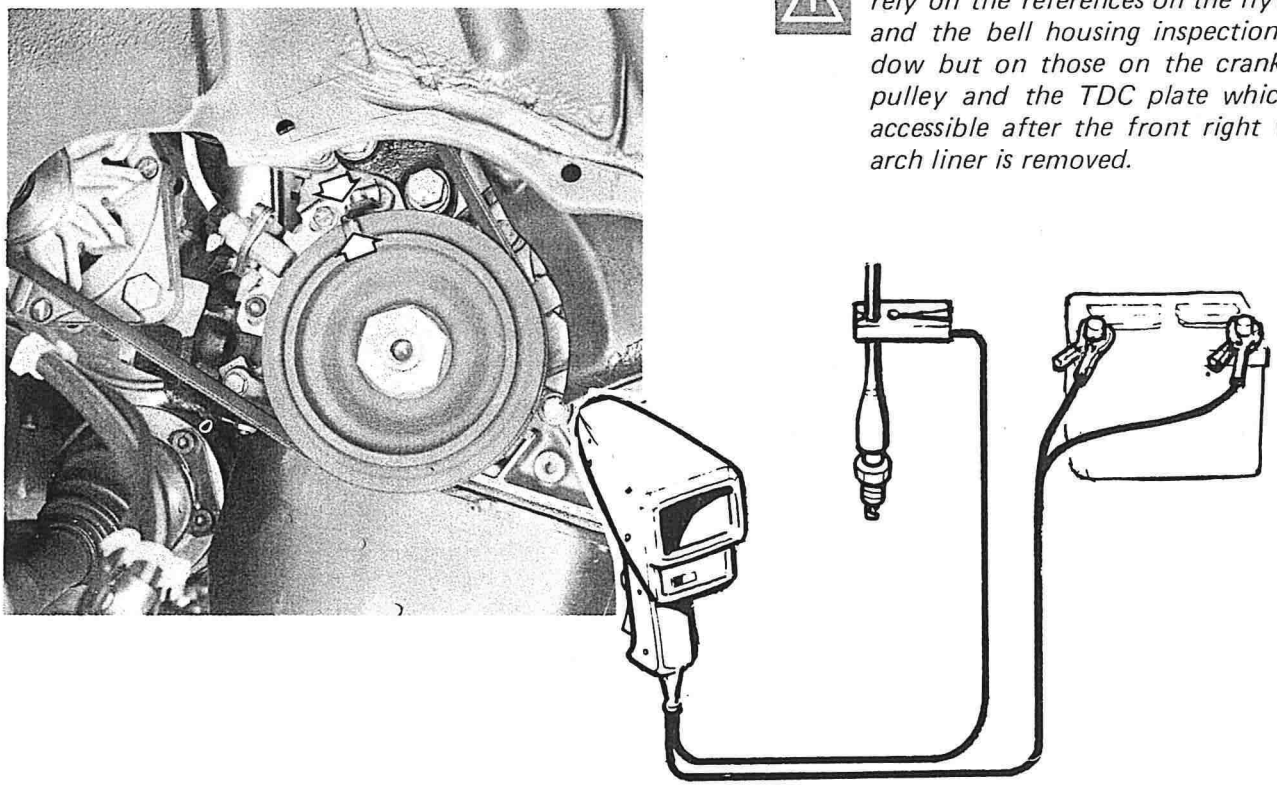


Removing - refitting wheel arch lining to gain access to the TDC reference marks

Rough check of ignition advance angles at different engine speeds using normal equipment

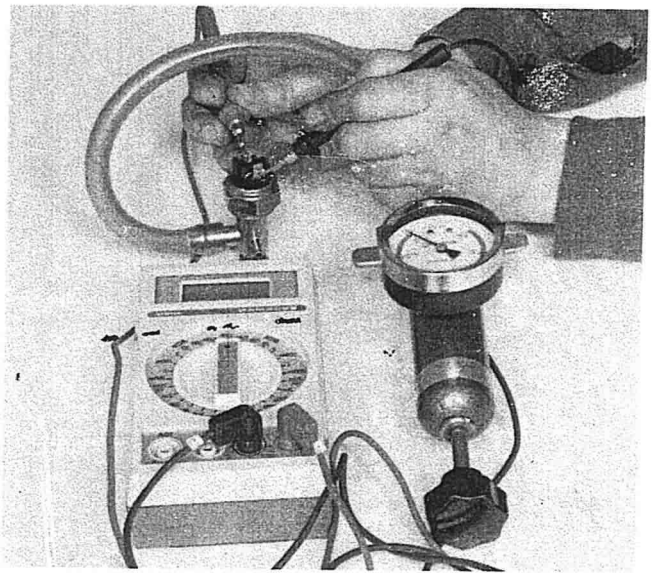
Connect a stroboscopic light of the inductive probe type with a built in graduated scale to the engine. Connect a rev counter and a vacuum gauge to the inlet manifold.

When carrying out the check, do not rely on the references on the flywheel and the bell housing inspection window but on those on the crankshaft pulley and the TDC plate which are accessible after the front right wheel arch liner is removed.



If the advance values are incorrect, check that the vacuum tube which connects the control unit with the inlet manifold is not obstructed or broken and that none of the flywheel teeth are broken. If this is not the case, replace the control unit.

To check the advance curves supplied by the Microplex control unit, use the advance diagrams given on page 36 of Section 00 and the corresponding vacuum values measured using a vacuum gauge at the inlet manifold.



CHECKING MAXIMUM PRESSURE SWITCH

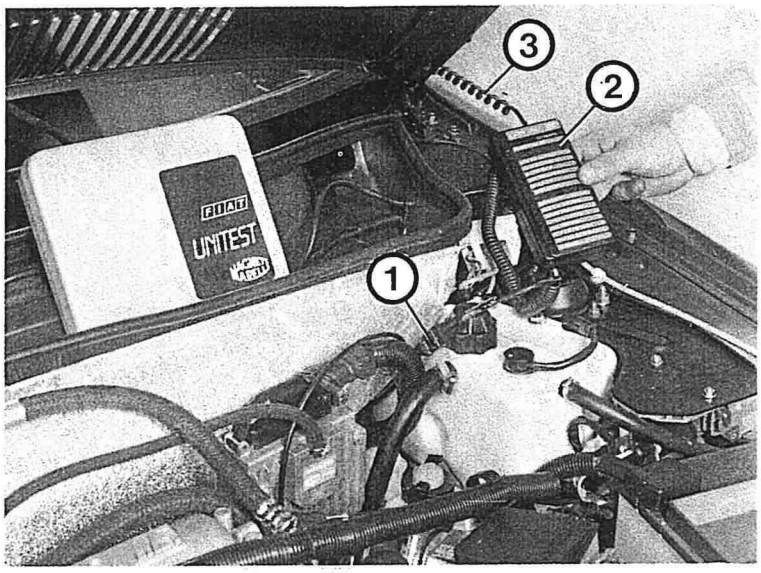
This device protects the engine from excessive supercharging pressure by placing the ignition control unit to earth.

Connect pump 1895362000 to the pressure switch through a plastic tube. Close the pressure switch openings, either with plugs or by hand, then connect an ohmmeter between the two terminals.
Pump slowly and read off the contact closing pressure. If it is higher or lower than 0.84 ÷ 0.93 bar, replace the pressure switch as it is faulty.

M. MARELLI MICROPLEX IGNITION SYSTEM FAULT DIAGNOSIS

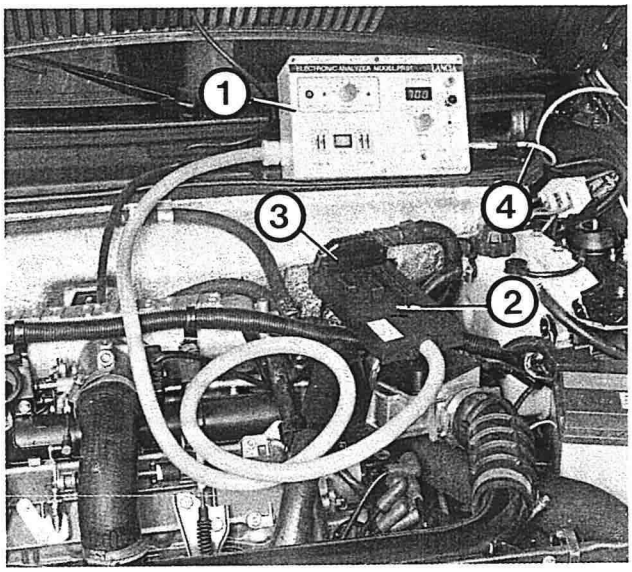
Problem	Causes	Remedies
Starter motor turns, engine won't start	Excessive gap on TDC sensor	Reset the gap
	TDC or rpm sensor short-circuited to earth or open	Check the sensor connecting cables and/or replace them
	Static advance ignition control unit defective	Replace the control unit
	Contacts connecting multiple connecter with control unit oxidized or open	Clean or renew the faulty contacts
	Coil defective with windings open, short circuited or to earth	Replace the coil
	Ignition switch or control unit terminal 8 supply cable connecter defective or open	Replace the switch and/or renew the connecter
Engine fires on three cylinders	Defective spark plug	Replace spark plug
	High tension cable open	Replace high tension lead
	HT distributor cap cracked	Replace HT cap
Engine lacks power, poor performance and excessive fuel consumption	Incorrect ignition advance	Flywheel teeth broken or TDC sensor fixing plate badly positioned or distorted
	TDC sensor incorrectly positioned	Re-position the sensor

UNITEST TMF 5000 DIAGNOSTIC EQUIPMENT for Microplex ignition



1. Vehicle's electrical system diagnostic socket for connecting UNITEST equipment
2. UNITEST equipment
3. UNITEST supply cable which fits in the vehicle cigar lighter socket

PR01 ELECTRONIC ANALYZER DIAGNOSTIC EQUIPMENT



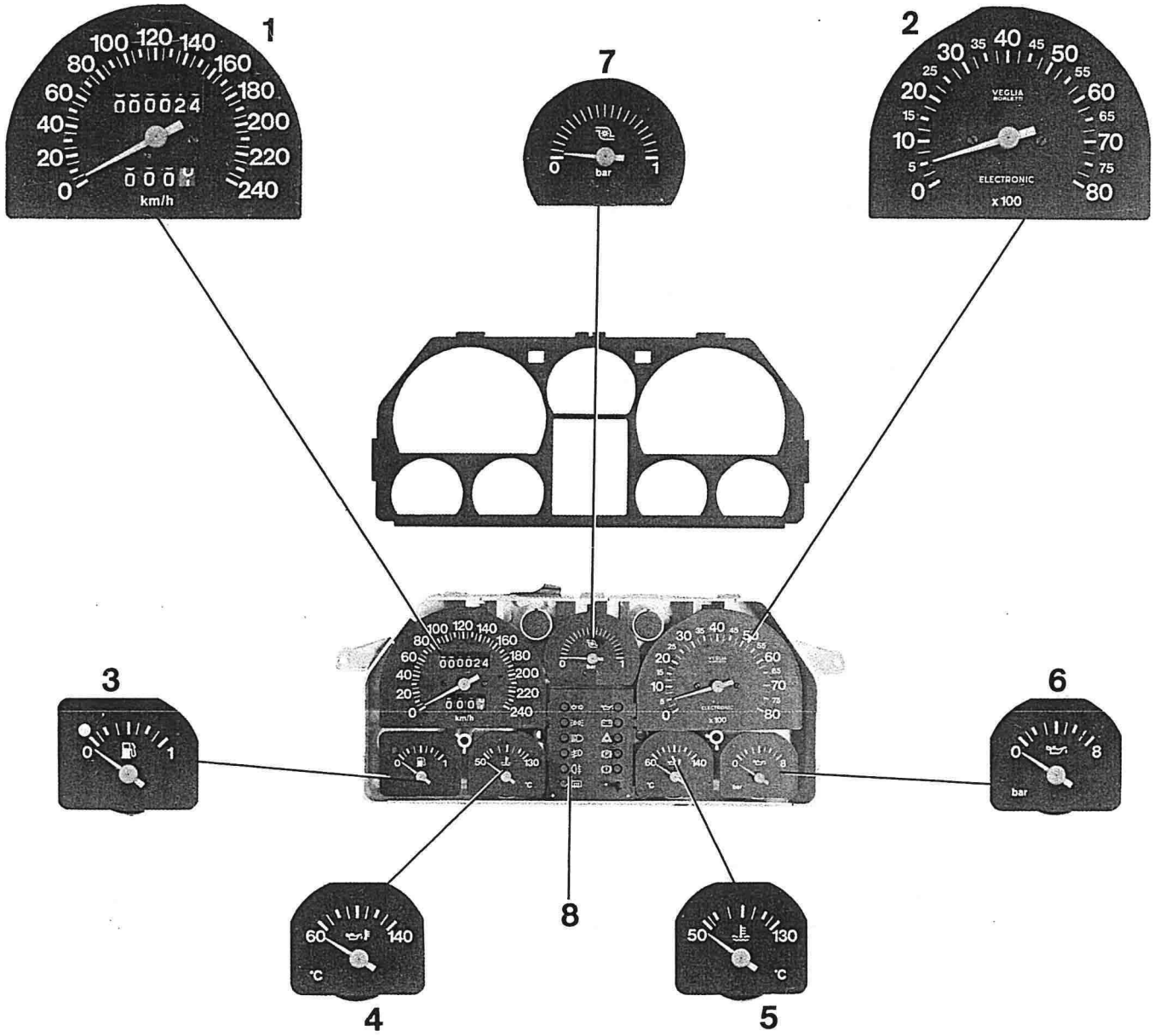
1. Diagnostic equipment
2. Socket for attaching vehicle system relevant control unit connecter
3. Ignition control unit multiple connecter
4. Analyzer supply cable which fits in the vehicle cigar lighter socket

THE ELECTRONIC ANALYZER IS USED FOR A QUICKER AND MORE ACCURATE METHOD FOR CHECKING STATIC ADVANCE IGNITION SYSTEMS AND LE2–JETRONIC FUEL INJECTION SYSTEMS
IT CAN BE ORDERED FROM VOLVERA BY QUOTING PART NUMBER 1806134000

55.

INSTRUMENT PANEL

For removing-refitting the instrument panel follow the instructions given for the UNO on page 16 of Section 55.



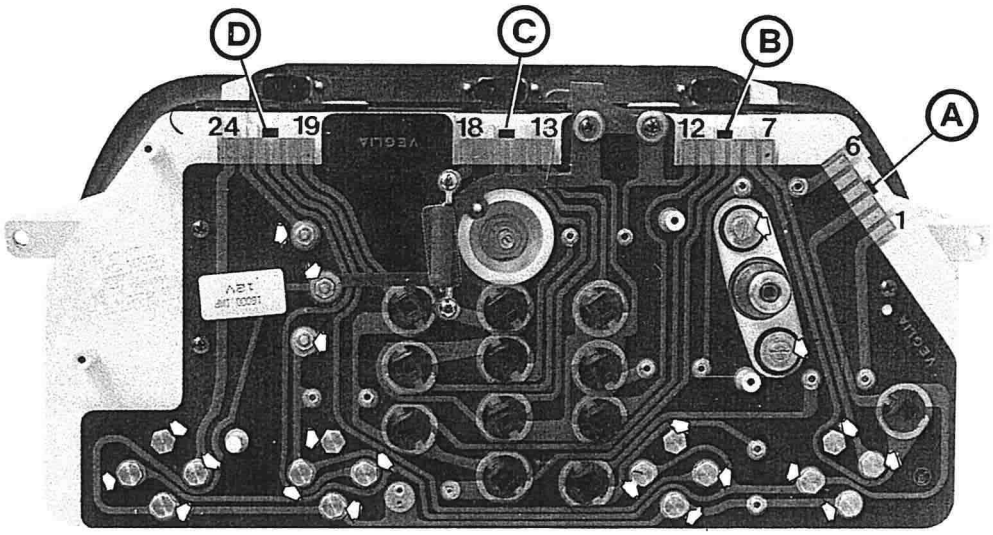
1. Speedometer with push button zeroing device for trip meter
2. Electronic rev counter
3. Fuel gauge with reserve warning light
4. Coolant temperature gauge
5. Engine oil temperature gauge
6. Engine oil pressure gauge
7.* Turbo charging pressure gauge
8. Warning lights (from the left, from top to bottom): direction indicators, side lights, main beam headlamps, fog lamps, rear fog lamps, heated rear windscreen
8. Warning lights (from the right, from top to bottom): insufficient engine oil pressure, alternator recharging, hazard warning lights, handbrake warning light, insufficient brake fluid, spare, and lower down, push button for checking efficiency of warning light bulbs.

* connected by means of a rubber tube to the engine inlet manifold

Removing instruments

Loosen all the bolts and nuts fixing the instruments shown in the photo, then extract the instruments from the front part of the panel.

Rear view of instrument panel showing terminals connected to the vehicle's electrical system cables



Electrical system connecters and cables with colour code **(see page 39)**

NOTE *The control box has been abbreviated in the tables to "CD" (centralina di derivazione).*

CONNECTER A		
GR	1	Heated rear windscreen warning light: from terminal 9, connecter 1 of the CD protected by fuse 1
–	2	Spare
GL	3	Instrument supply: from terminal 11 of connecter 1 of the CD protected by fuse 1
–	4	Spare
–	5	Spare
–	6	Main beam headlamps warning light: to the actual lights via the CD terminal 7 connecter 1

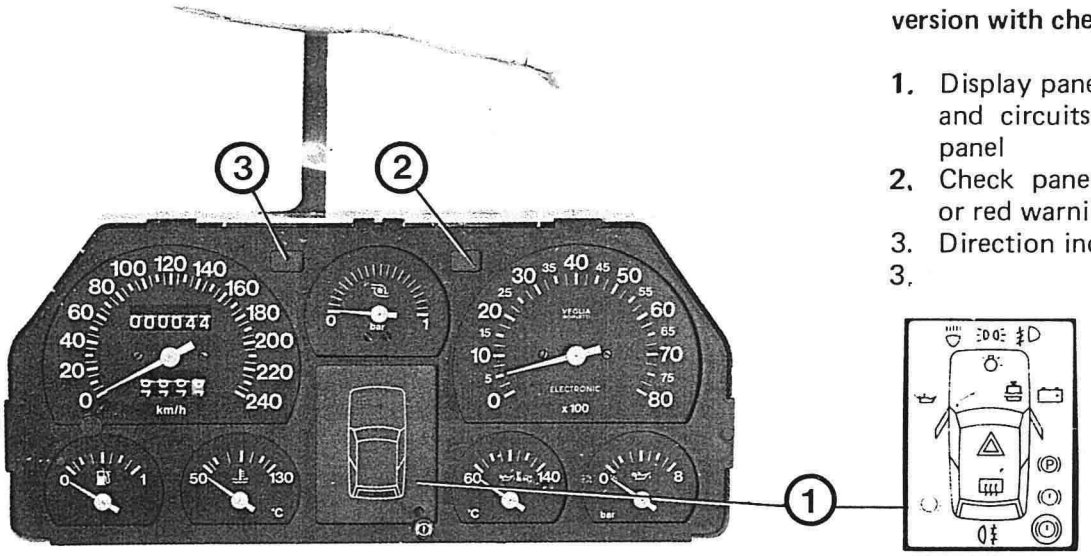
CONNECTER B		
BL	7	Fuel gauge from the device through the CD (2, I; 2, L)
BV	8	Fuel reserve warning light: from the device through the CD (3, I; 3, L)
BR	9	Insufficient brake fluid warning light via the CD (5, I; 4, F)
GN	10	Handbrake warning light: from the handbrake lever switch via the CD (10, I; 3, H)
BC	11	Rear fog lamps warning light: from the actual lights via the CD (1, I; 1, C) and the control switch
BG	12	Instrument panel light and side lights: through the CD (6, I) protected by fuse 4

CONNECTER C		
N	13	To earth
AN	14	To terminal P of the direction indicators flasher unit
MG	15	Fog lamps warning light: from terminal 87 of the fog lamps relay feed
AB	16	Hazard warning lights warning light: from the hazard warning lights control
–	17	Spare
AR	18	Alternator recharging warning light: from the INT of the ignition switch through the steering column switch unit control

CONNECTER D		
HN	19	Recharging warning light: from terminal + D of the alternator
HG	20	Insufficient engine oil pressure warning light: from the insufficient pressure switch on the engine
HB	21	Coolant temperature gauge: from the temperature sender unit on the engine
HL	22	Engine oil temperature gauge: from the relative sender unit on the engine
SN	23	Rev counter: from terminal 23 of the Microplex control unit
HR	24	Engine oil pressure gauge: from the pressure sender unit on the engine

55.

INSTRUMENT PANEL VARIANTS FOR VERSION WITH CHECK PANEL



Front view of instrument panel in version with check panel

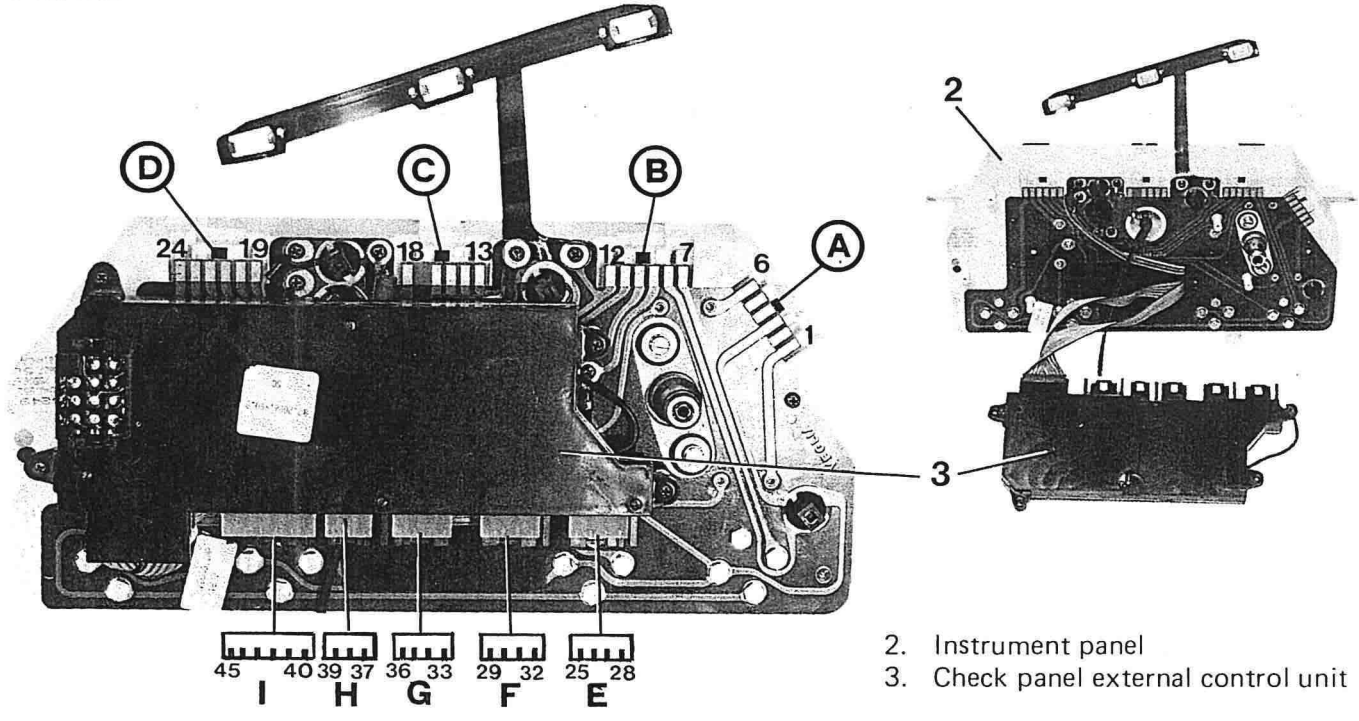
1. Display panel for electrical circuits and circuits controlled by check panel
2. Check panel general green signal or red warning light
3. Direction indicators warning light
3.

Warning lights display panel

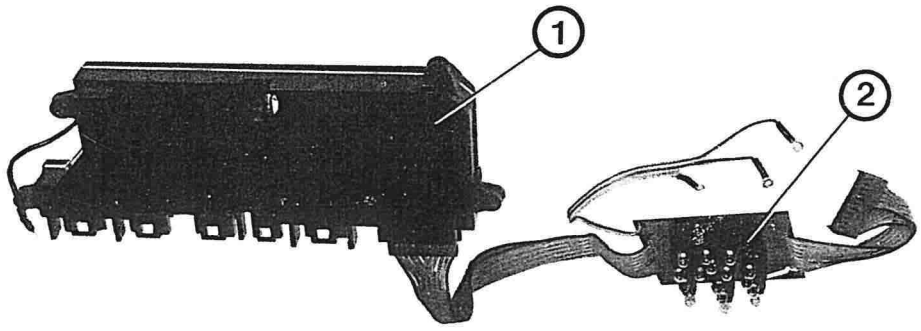
NOTE *The check panel test device is the same as the one used on the UNO S model which is illustrated on page 35 of Section 55 with the exception of the diagrams.*

The Uno Turbo i.e. display panel includes **all the conventional electrical circuit warning lights** as well as the services controlled by the check panel which are shown by an asterisk in the list which follows (from left to right, top to bottom): main beam headlamps on, side lights on, fog lamps on, side lights failure*, rear fog lamps failure* and brake lights failure*, insufficient engine oil pressure, insufficient engine oil level*, insufficient coolant level*, alternator not charging, doors open*, hazard warning lights on, handbrake applied, heated rear windscreen on, excess front brake pad wear*, insufficient brake fluid level*, rear fog lamps on, insufficient brake fluid level warning light test push button.

Rear view of instrument panel with electrical system connecting terminals



2. Instrument panel
3. Check panel external control unit



Check panel external module (1) and internal module (2) with display panel (rear side)

Check panel control unit connecters

CONNECTER F		
B	29	To the right rear side light
GR	30	To the left front side light
GN	31	To the left rear side light
GL	32	To the right front side light

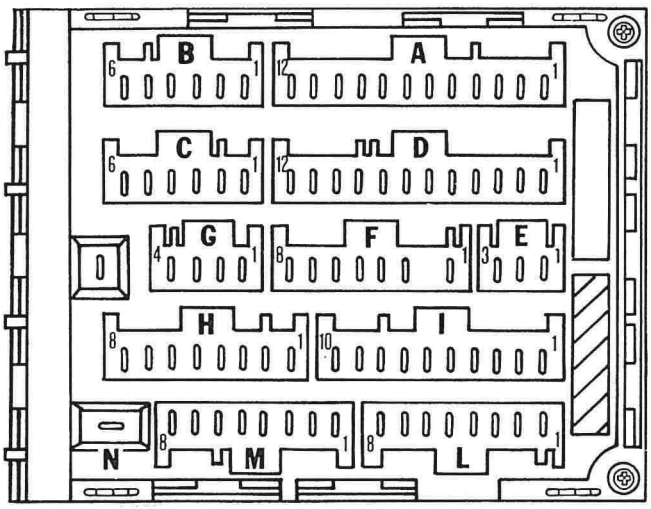
CONNECTER E		
G	25	Brake lights supply from the brake pedal switch
GV	26	Rear fog lamps supply from the control switch
RN	27	To the right front and left rear side lights
R	28	To the left front and right rear side lights

CONNECTER G		
RV	33	To the right rear fog lamp
RV	34	To the left rear fog lamp
RG	35	To the left brake light
RG	36	To the right brake light

CONNECTER H		
R	37	To the brake pedal switch
N	38	To the door closure sensors
M	39	Positive from the ignition switch

CONNECTER I		
N	40	Earth
VG	41	Front brake pad wear sensor entry
VB	42	To the insufficient engine oil level sensor
VG	43	Front brake pad wear sensor exit
VN	44	To the insufficient oil level sensor
V	45	To the insufficient coolant level sensor

55.



CONTROL BOX

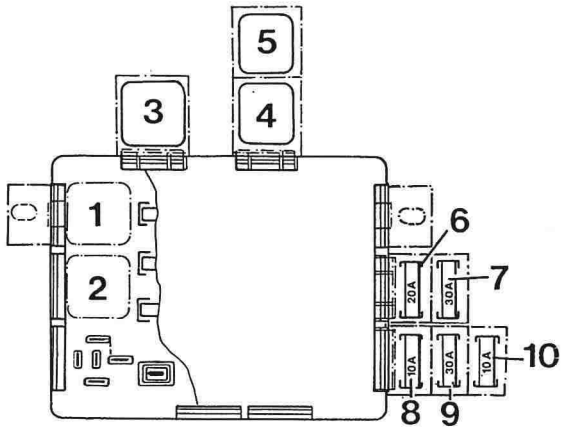
Rear view of control box showing the arrangement of the connections with the car's electrical system

The control box contains all the protective fuses for the electrical system with an ideogram for the main service protected.
It is also equipped with connections for some of the relays.
Inside it comprises a flexible mounting connected with the various conductors.

It is impossible to mix up the connecters by mistake as they are each a different shape.
The identification letters for the connecters are the same as those used in the wiring diagrams.

Classification of connecters with colours of respective cables (see page 39 for colour code)

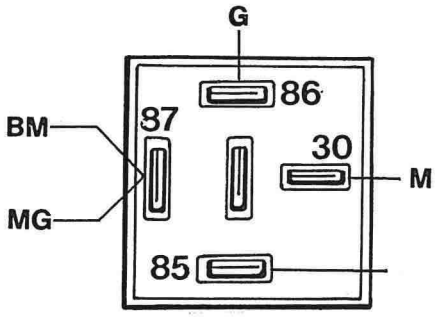
	1	2	3	4	5	6	7	8	9	10	11	12
A	–	HG	BN	GR fus. 4	R	AN	A	R	GN fus.3	B	H	--
B	H fus. 6	A fus. 9	Z fus. 9	–	–	V fus. 8						
C	LV	LG fus. 5	LN	L	LR fus. 3	LB						
D	RV	RV	G	BG	GL	GN	RG	RG	RN	GV	G	R
E	BV	G fus. 4	BV fus. 1									
F	GN fus. 3	–	AN	N	HN fus. 5	– fus. 1	SN	VN fus. 7				
G	CL	CN fus. 2	CB f. 7-8	C f. 5-6								
H	HR	HV f. 12	HR f. 1	–	HN fus. 2	Hm	RG fus.1	HL fus.10				
I	BC	BL	BV	GN	BR	BG fus. 4	GV fus. 7	– fus. 12	GR fus.11	GL fus.1		
L	–	S	HR	BN	BG fus. 4	– fus. 1	BR f.12	MB fus.11				
M	–	– fus. 4	AG fus. 1	– fus. 1	– f. 9-12	AB f.3-4	AR f.13	A				
N	RM f. 12											



LOCATION OF AUXILIARY RELAYS AND FUSES

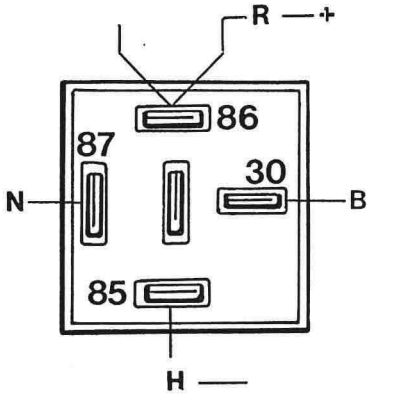
1. Horn relay feed
2. Heated rear windscreen relay feed
3. Fog lamps relay feed
4. Engine radiator cooling fan relay feed
5. Electric windows relay feed (optional)
6. Fog lamps protective fuse
7. Engine cooling fan 2nd speed fuse
8. Injector cooling fan protective fuse
9. Electric windows fuse (optional)
10. Electric fuel pump fuse

Fog-lamps relay socket connecting cables		
M	30	Supply from connecter block via the fog lamps (6) protective fuse
MG	87	To the fog lamps warning light in the instrument panel (terminal 15, connecter C)
BM		To the fog lamps
G	86	+ from the fog lamps control switch
N	85	To earth



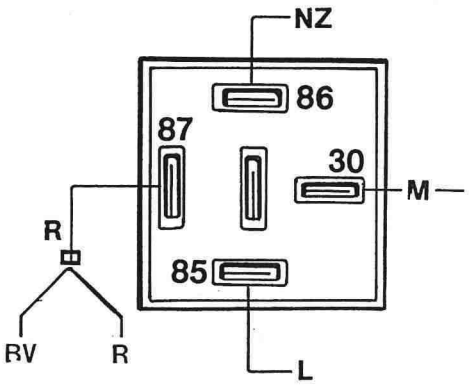
Fog lights (3) relay carrier socket (relay side)

Injector cooling fan relay connecting cables		
N	30	To earth
N	87	From the engine radiator cooling fan
R	86	Supply from the connecter block (Q)
R		To the radiator cooling fan through protective fuse (7)
H	85	+ from the radiator cooling fan via the 2nd speed thermal switch



Injector (4) relay carrier socket (relay side)

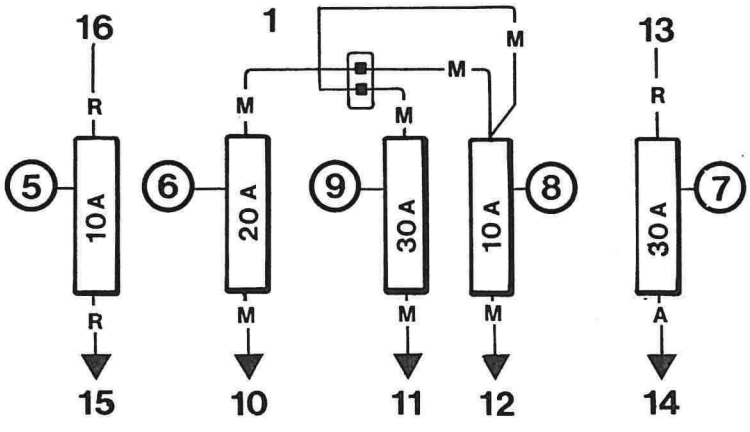
Electric windows relay socket connecting cables		
M	30	Supply from the connecter block via the electric windows protective fuse (9)
R	87	To the electric windows control
NZ	86	To earth
L	85	From terminal 15 of the ignition switch



Electric windows (5) relay carrier socket

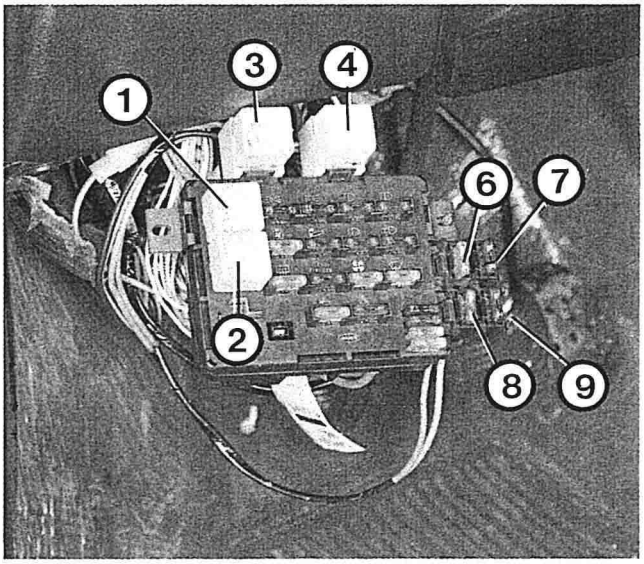
Supplementary fuses

5	Electric fuel pump protective fuse
6	Fog lamps circuit protective fuse
7	Engine radiator cooling fan protective fuse
8	Injector cooling fan protective fuse
9	Electric windows protective fuse
10	To terminal 30 of the fog lamps (3) socket
11	To the electric windows control
12	To the injector cooling fan
13	From terminal 86 of the radiator (4) socket
14	To the engine radiator cooling fan
+1	From the connecter block via terminal N of the control box
15	To the electric pump
16	From terminal 30 of the speedometer relay socket



Supplementary fuses

55.

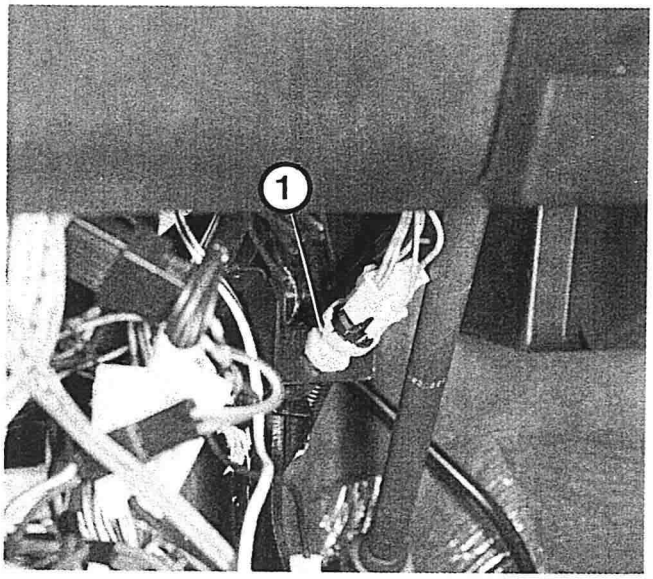


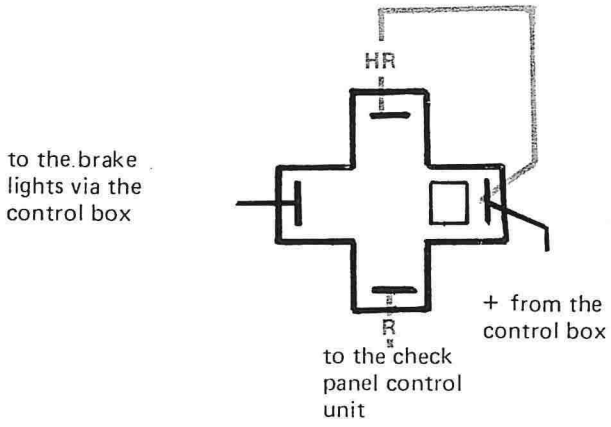
1. Horn relay feed
2. Heated rear windscreen relay feed
3. Fog lamps relay feed
4. Engine radiator cooling fan relay feed
6. Fog lamps protective fuse
7. Engine cooling fan 2nd speed fuse
8. Injector cooling fan protective fuse
9. Electric windows fuse (optional)

NOTE *The electric fuel pump protective fuse if missing and is dealt with on page 24.*

Control box, lowered, with auxiliary relays and fuses

for vehicles with check panel only



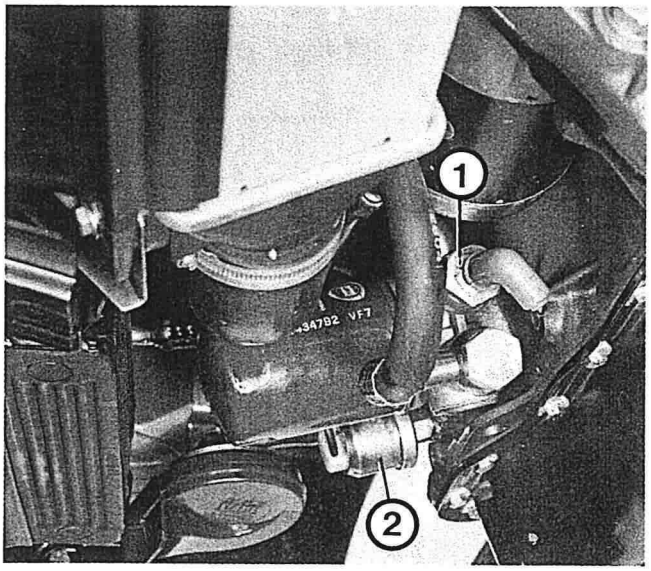


to the brake lights via the control box

\+ from the control box

to the check panel control unit

Brake lights control switch (1)

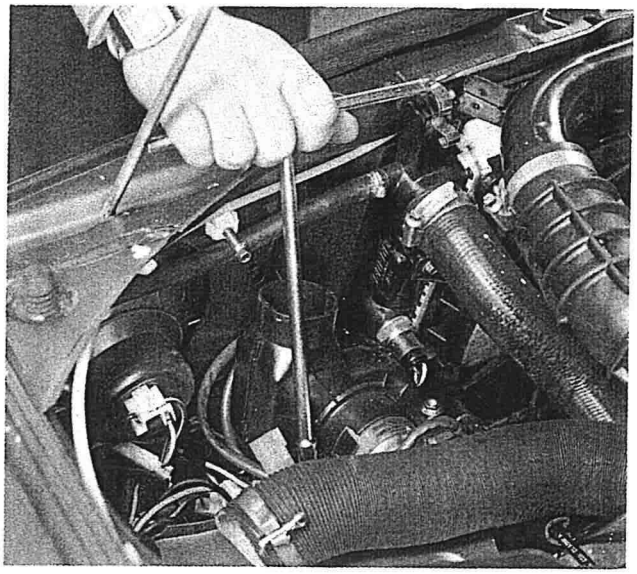


Insufficient engine oil pressure sender unit cut in pressure 0.2 - 0.4 bar

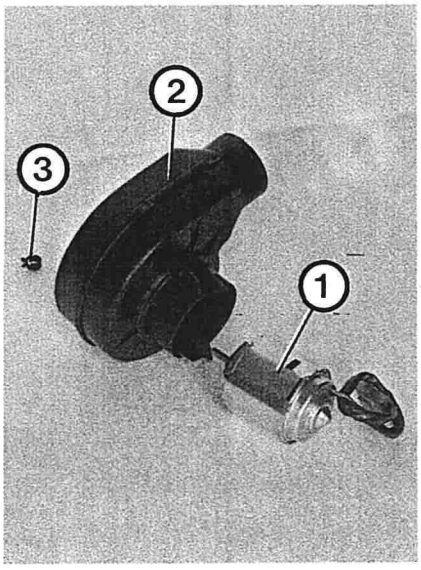
Fitting and tightening to torque of:

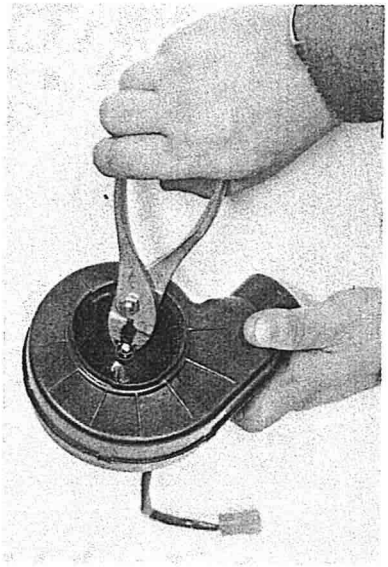
1. Insufficient oil pressure switch (3.2 daNm)
2. Oil pressure gauge sender unit (3.7 daNm)

ENGINE COOLING FAN



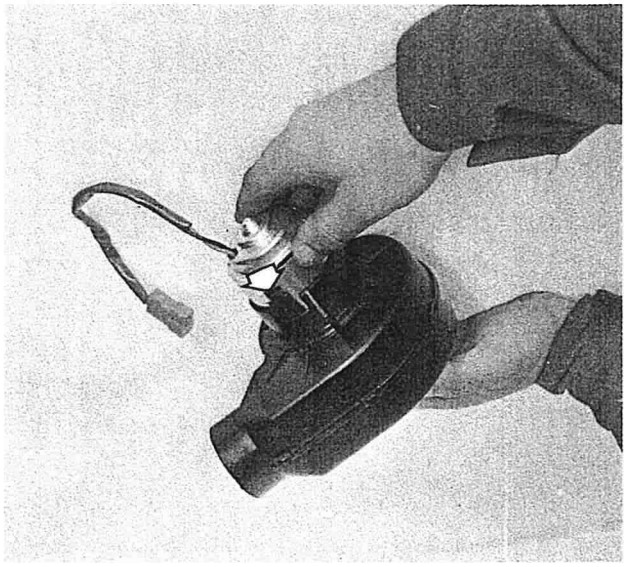
Removing-refitting injector cooling fan





Removing device fixing engine fan

1. Electric motor
2. External casing and fan (internal)
3. Device fixing fan to motor control shaft



Removing motor from fan casing

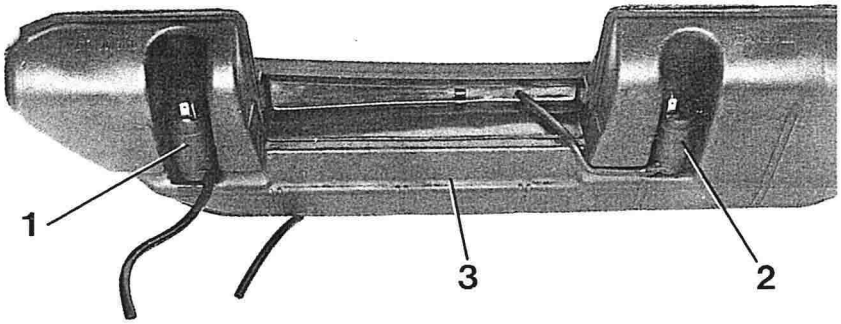
Open the two fixing blades (shown by the arrow) by exerting pressure by hand.

Motor operating test at the bench

Supply 12 V with the fan fitted in the fan casing:
speed 4400 ± 150 rpm
absorption about 4.5 A

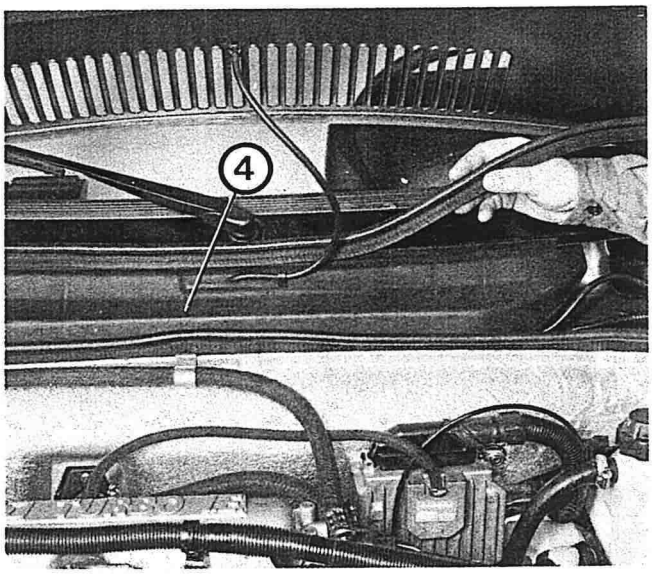
55.

WINDSCREEN WASH/WIPE MOTOR



Windscreen washer fluid reservoir

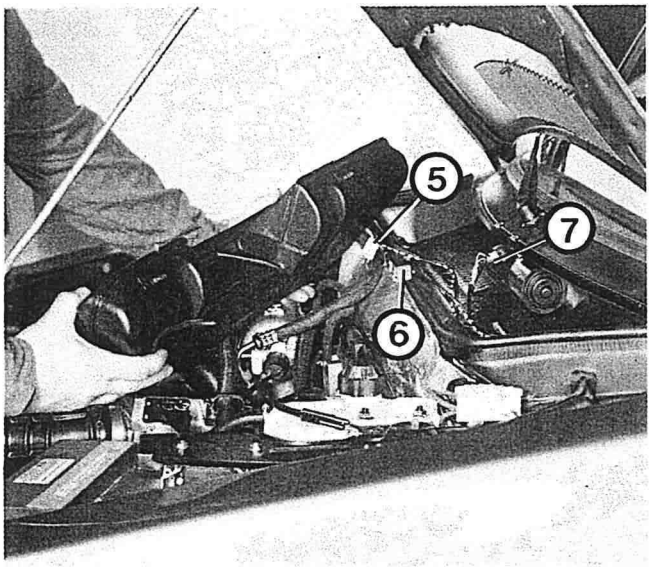
1. Rearscreen washer electric pump
2. Windscreen washer electric pump
3. Windscreen washer fluid reservoir



Electric pump operating test at the bench

Supply 12 V at no load; the absorption should be more than 4 A.

Removing seal fixing windscreen washer fluid reservoir

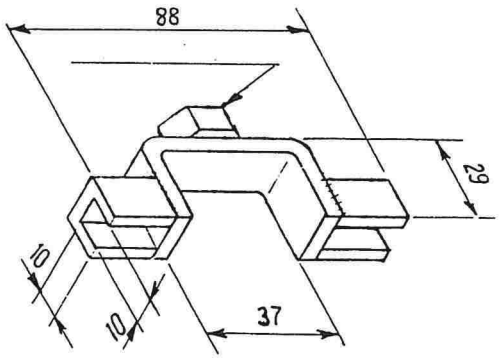


Removing windscreen washer fluid reservoir

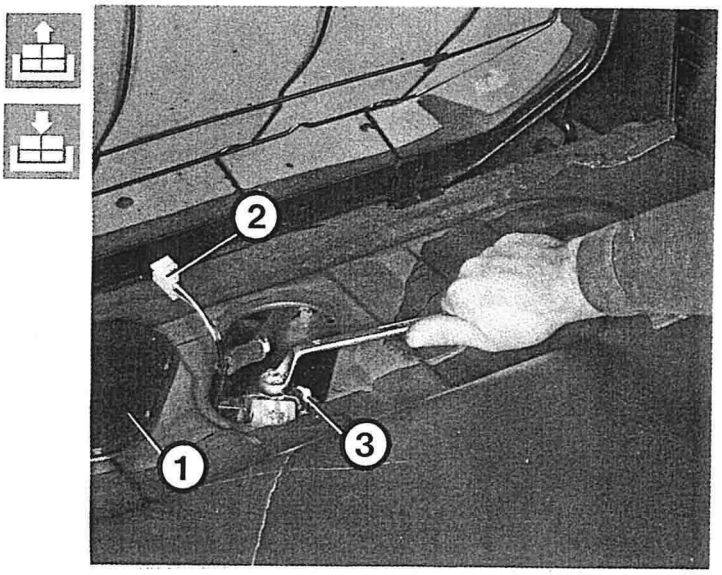
NOTE *To gain access to the windscreen wiper motor, it is necessary to remove-refit the windscreen washer fluid reservoir.*

5. Windscreen washer pump connecter
6. Rearscreen washer pump connecter
7. Windscreen wiper connecter

FUEL GAUGE

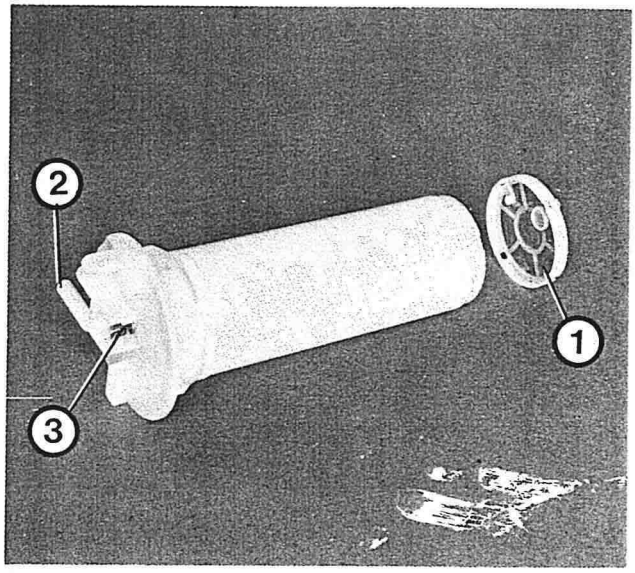


Design for constructing tool (3) for removing gauge, if necessary



Removing-refitting

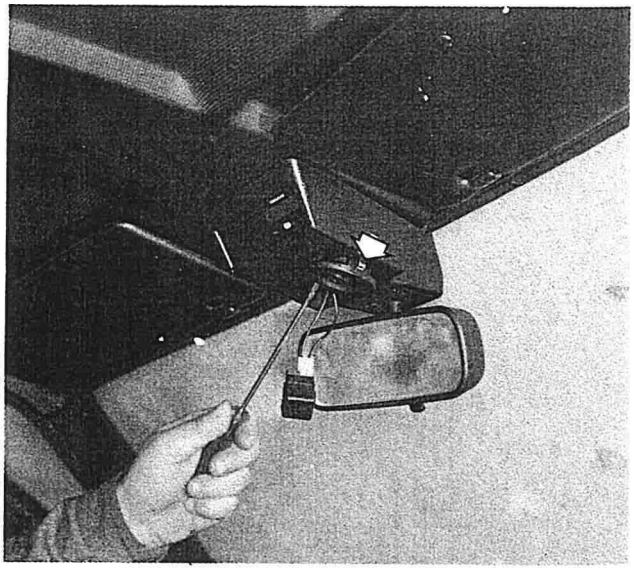
Gain access to the gauge protective cover and remove the gauge (1).
Disconnect the electrical connecter (2) and remove the fuel pipe band.



Co-axial type fuel level gauge

1. Gauze fuel filter
2. Fuel inlet pipe
3. Connecter block

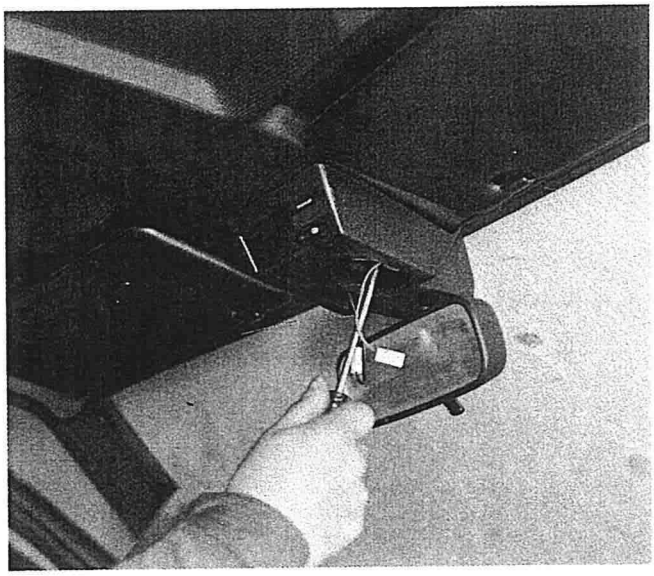
COURTESY LIGHTS WITH ADJUSTABLE MAP READING LIGHT AND DIGITAL CLOCK



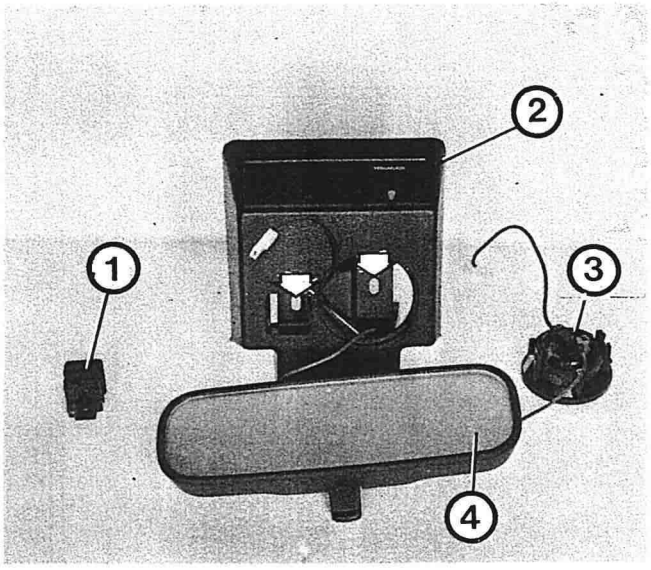
Removing-refitting adjustable light and control button

The light is held in place by two flexible tabs (shown by the arrow) which are compressed to remove it.

55.

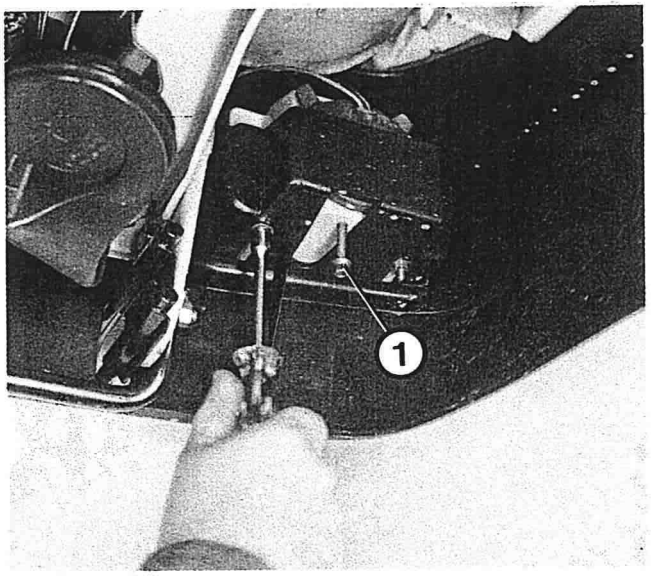


Loosen the internal bolts fixing the unit to the roof



1. Light control button
2. Digital clock fixed to the unit
3. Adjustable map reading light
4. Rear view mirror

➧ Slots for bolts fixing unit to roof



Removing-refitting right fog lamp

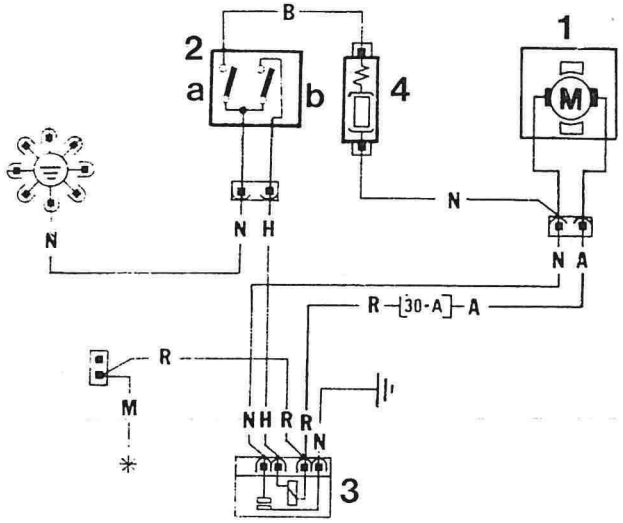
1. Adjustment screw

Fog lamp alignment

On a screen placed 5 metres away, the demarcation line between the dark area and the one lit up by the beam from the fog lamps should be lower than the distance between the centre of the fog lamps and the ground (measured with the tyres inflated to the correct pressure) by 5 cm + 1/3 of the value of the distance between the centre of the fog lamps and the ground.

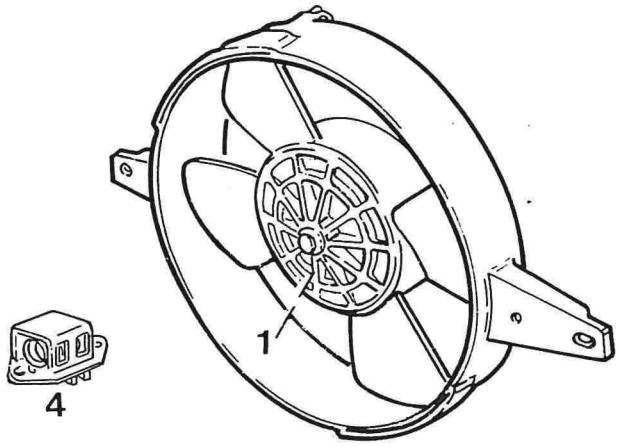
RADIATOR COOLING FAN

The electric fan (1) is controlled by the two stage thermal switch (2) which, when the switch (a) closes when the temperature of the coolant reaches 86° ÷ 90°C, allows the current to pass from the battery (*) to the fan (1) via the resistor (4) setting the 1st speed into operation.
The above mentioned switch (a) opens as the temperature drops to 81° ÷ 85°C causing the fan to cut out.
When the temperature of the coolant reaches 90° ÷ 94°C, the thermal switch (2) contact (b) also closes putting the control relay (3) or energizing circuit to earth which puts the fan (1) circuit to earth cutting out the resistor and putting the 2nd speed into operation.
When the temperature of the coolant goes below 85° ÷ 89°C, the opening of contact (b) causes the cut out of the relay (3) and the 1st operating speed of the fan.



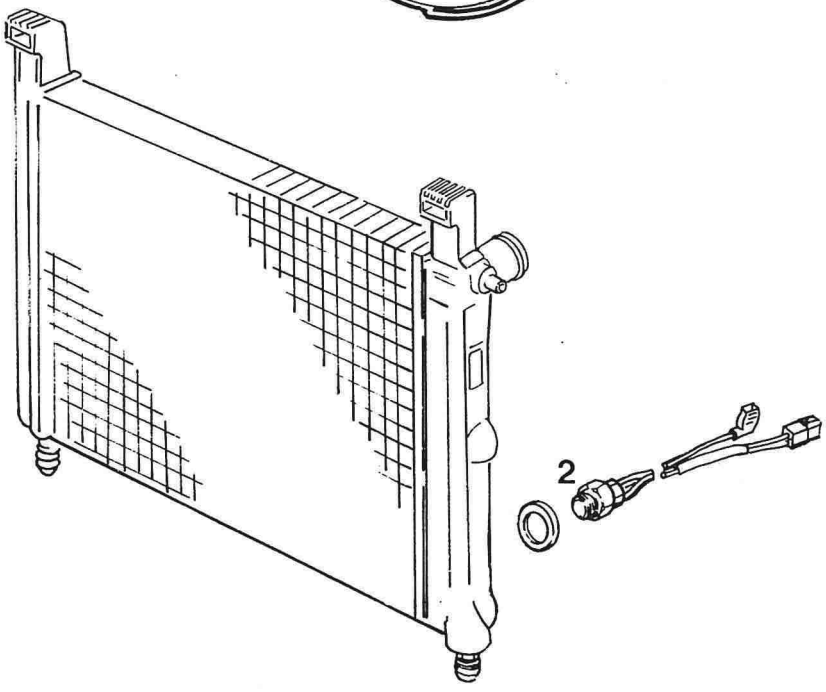
Fan operating test at the bench

With a supply voltage of 12 V it should operate at 2700 ± 100 rpm and should not absorb more than 26 A. The resistance value of the resistor (4) should be: 0.23 ± 0.2 Ω.



Car ventilation fan operating test at the bench

Operating in the open air with the fan fitted and a supply of 12 V:
- at 2600 ± 100 rpm it should not absorb more than 3.5 A
- at 1500 ± 100 rpm it should not absorb more than 2 A.

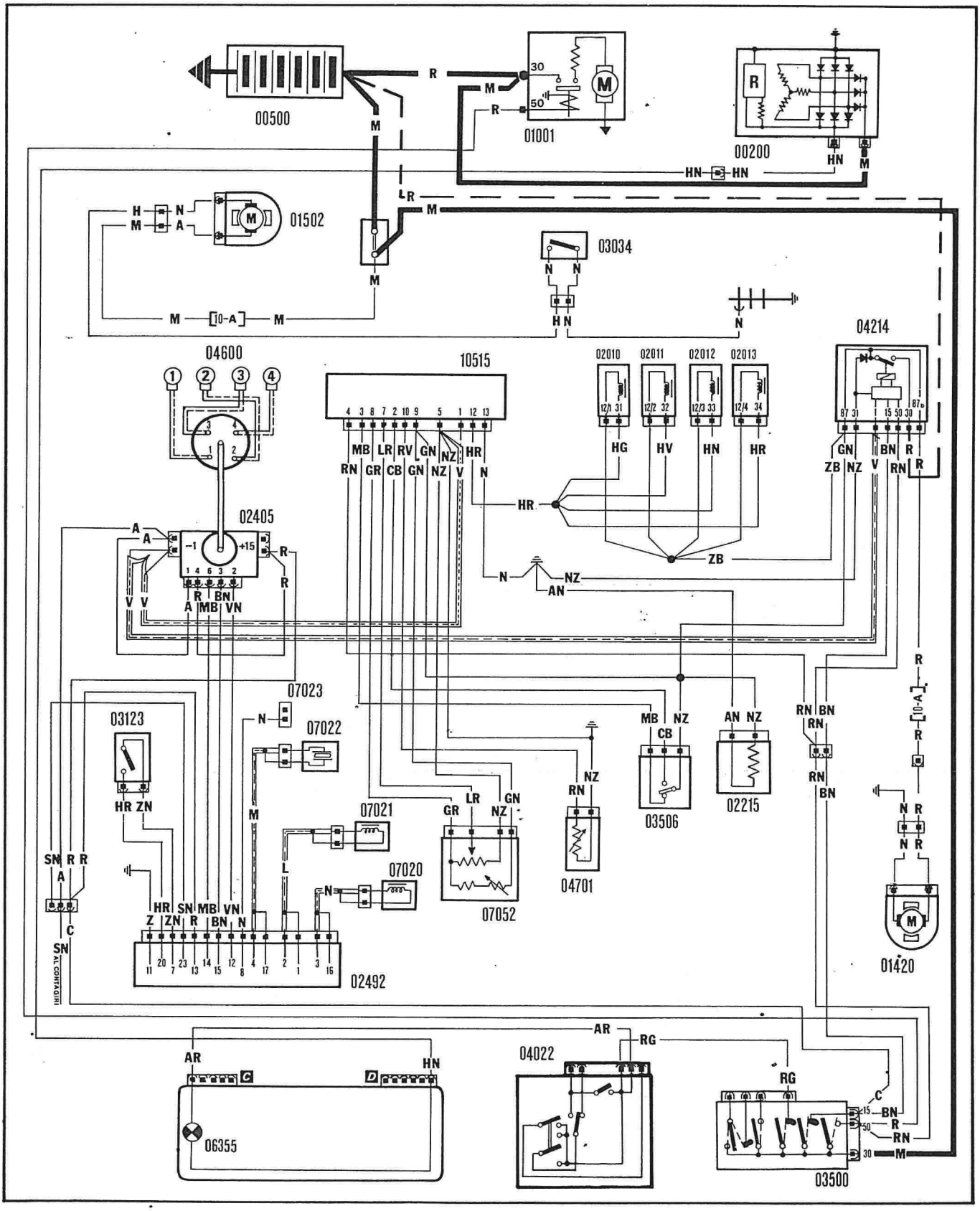


1. Radiator fan
2. Thermal switch
3. 2nd speed relay
4. Additional resistor

* Battery

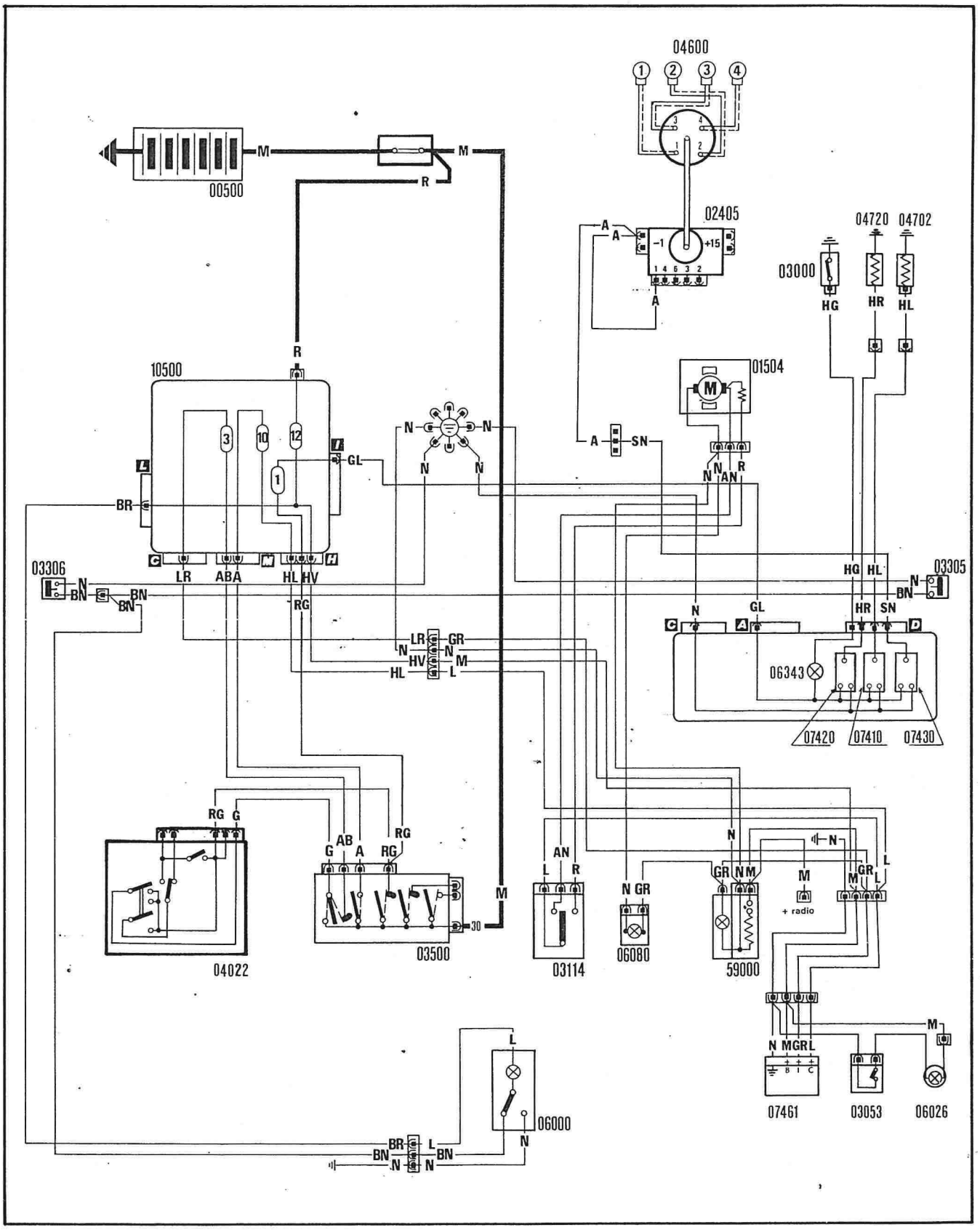
55.

Starting – Microplex electronic ignition – Recharging – LE2-Jetronic electronic ignition – Electric fuel pump – Injector cooling fan (for key see page 39)



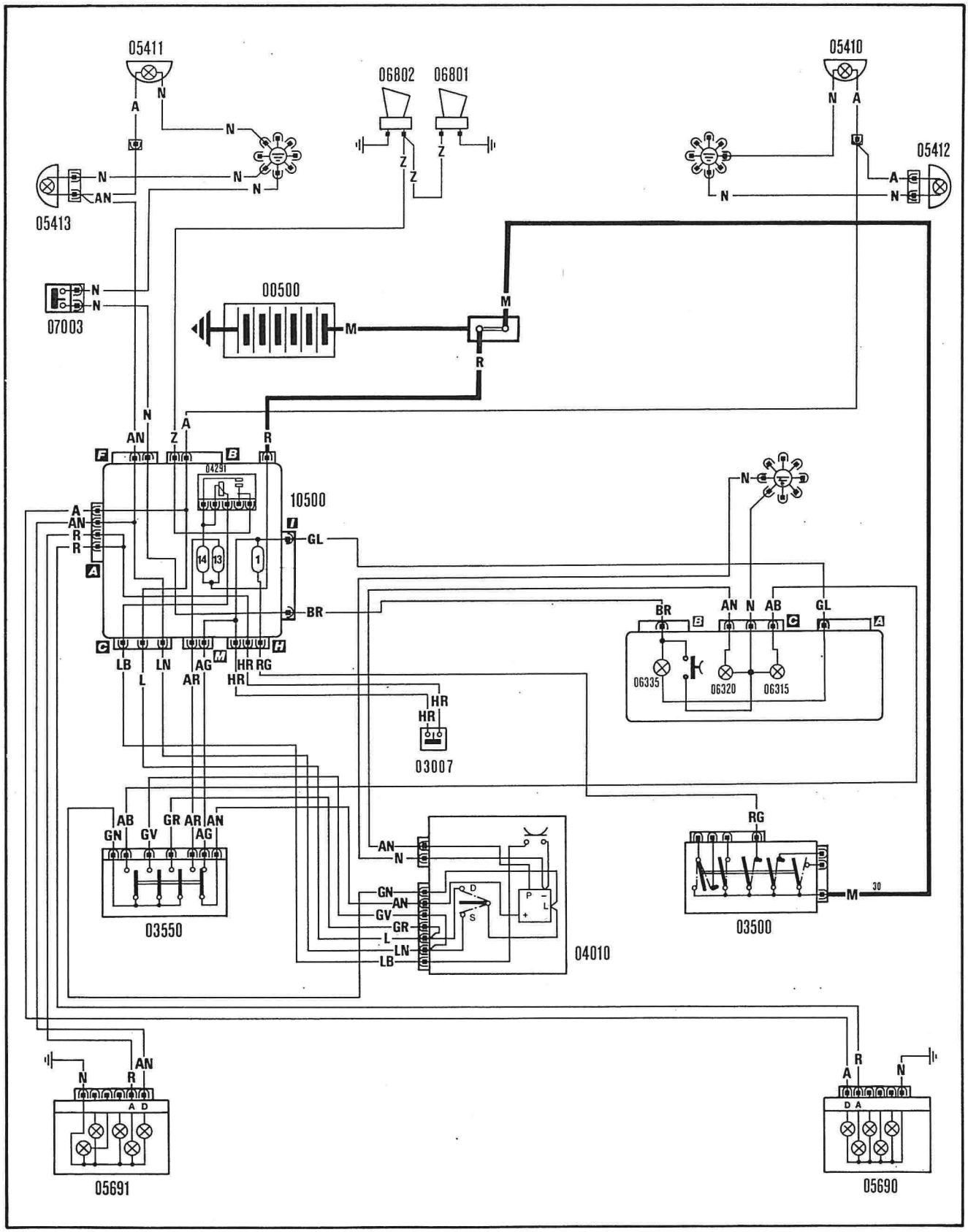
55.

Courtesy lights – Car interior ventilation – Heater controls illumination – Cigar lighter – Digital clock – Radio wiring – Insufficient engine oil pressure – Engine oil pressure – Oil temperature gauge – Rev counter (for key see page 39)

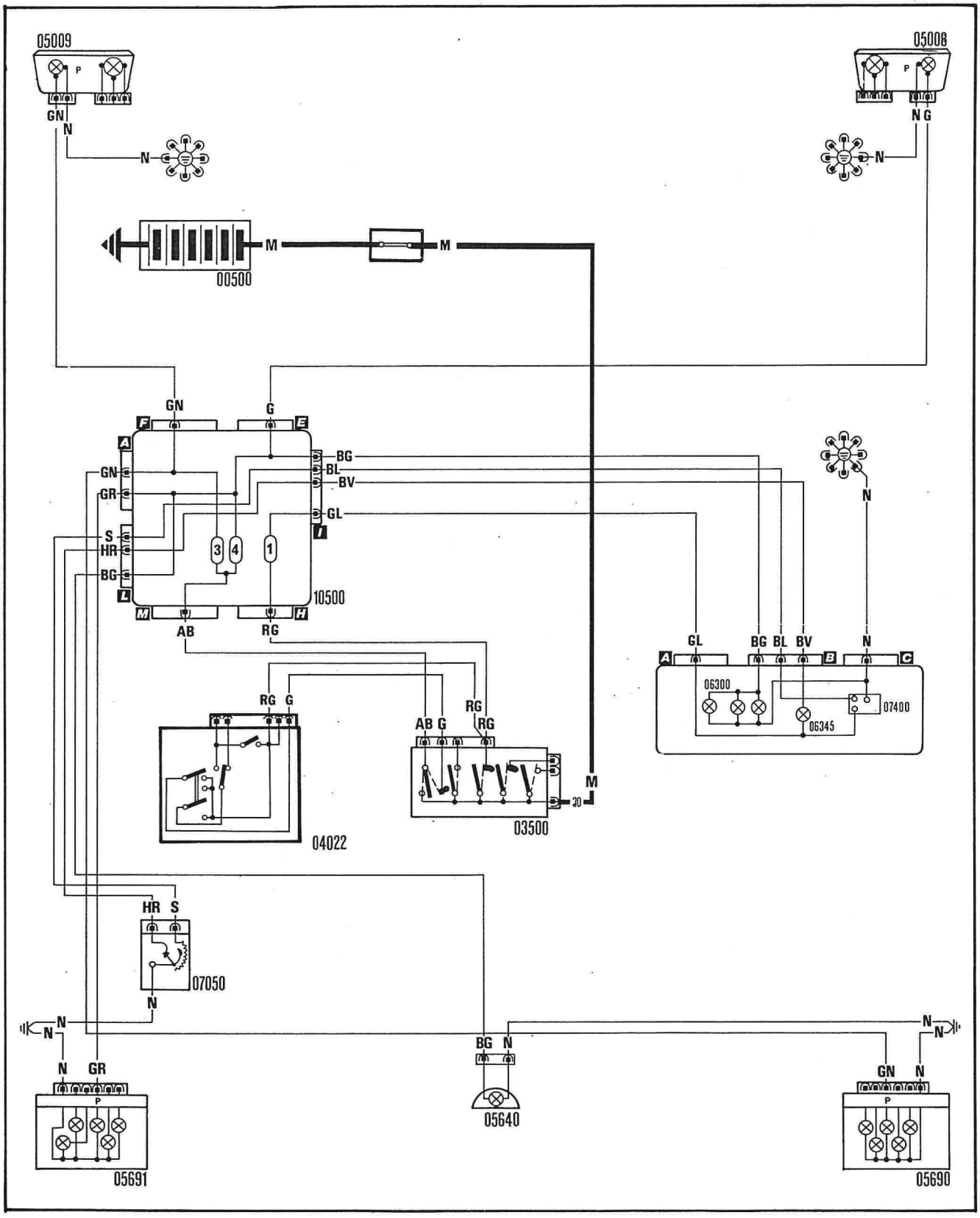


55.

Direction indicators – Hazard warning lights – Brake lights – Horn – Insufficient brake fluid level (for key see page 39)

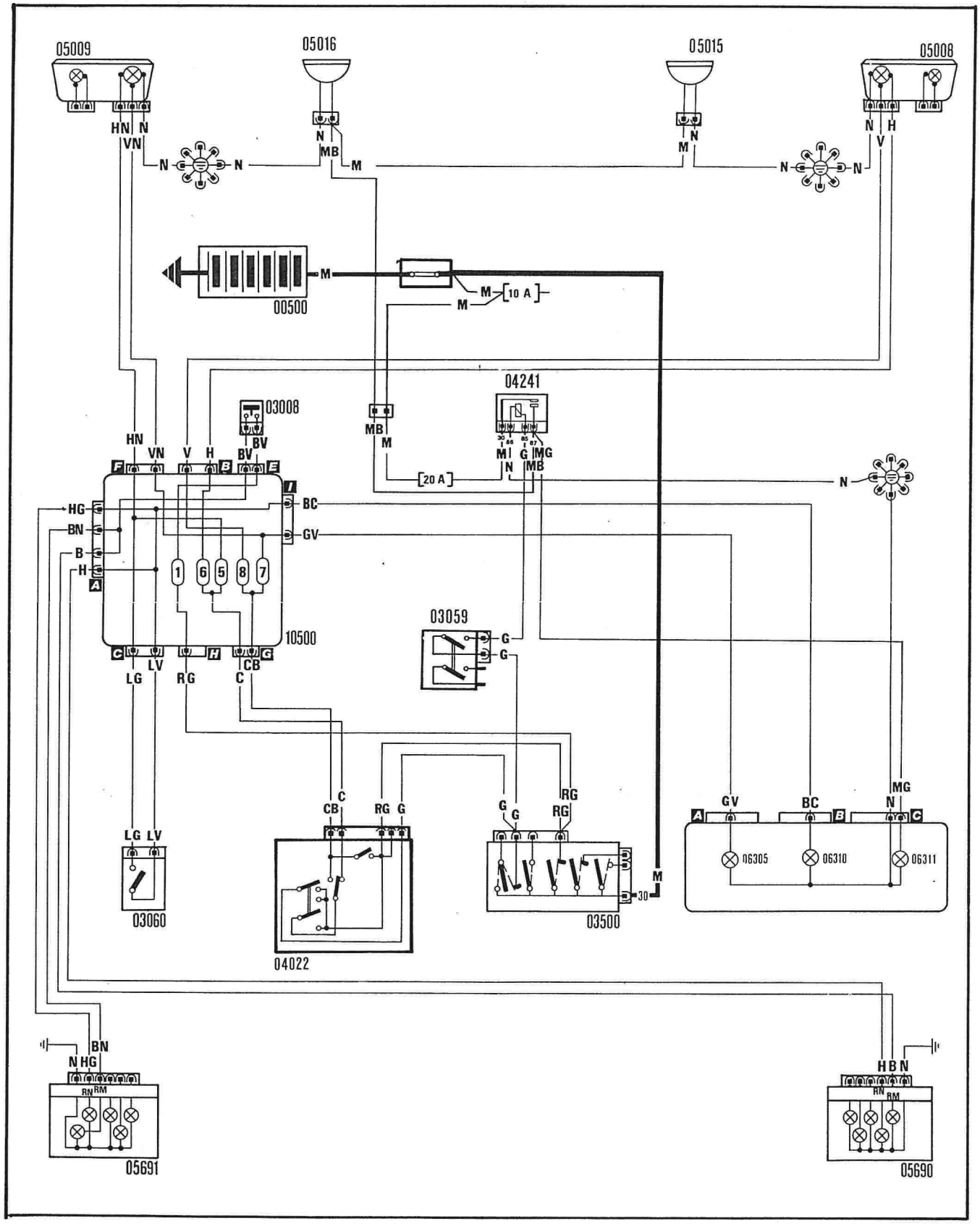


Side lights – No. plate light – Fuel gauge and reserve warning light – Instrument panel light (for key see page 39)



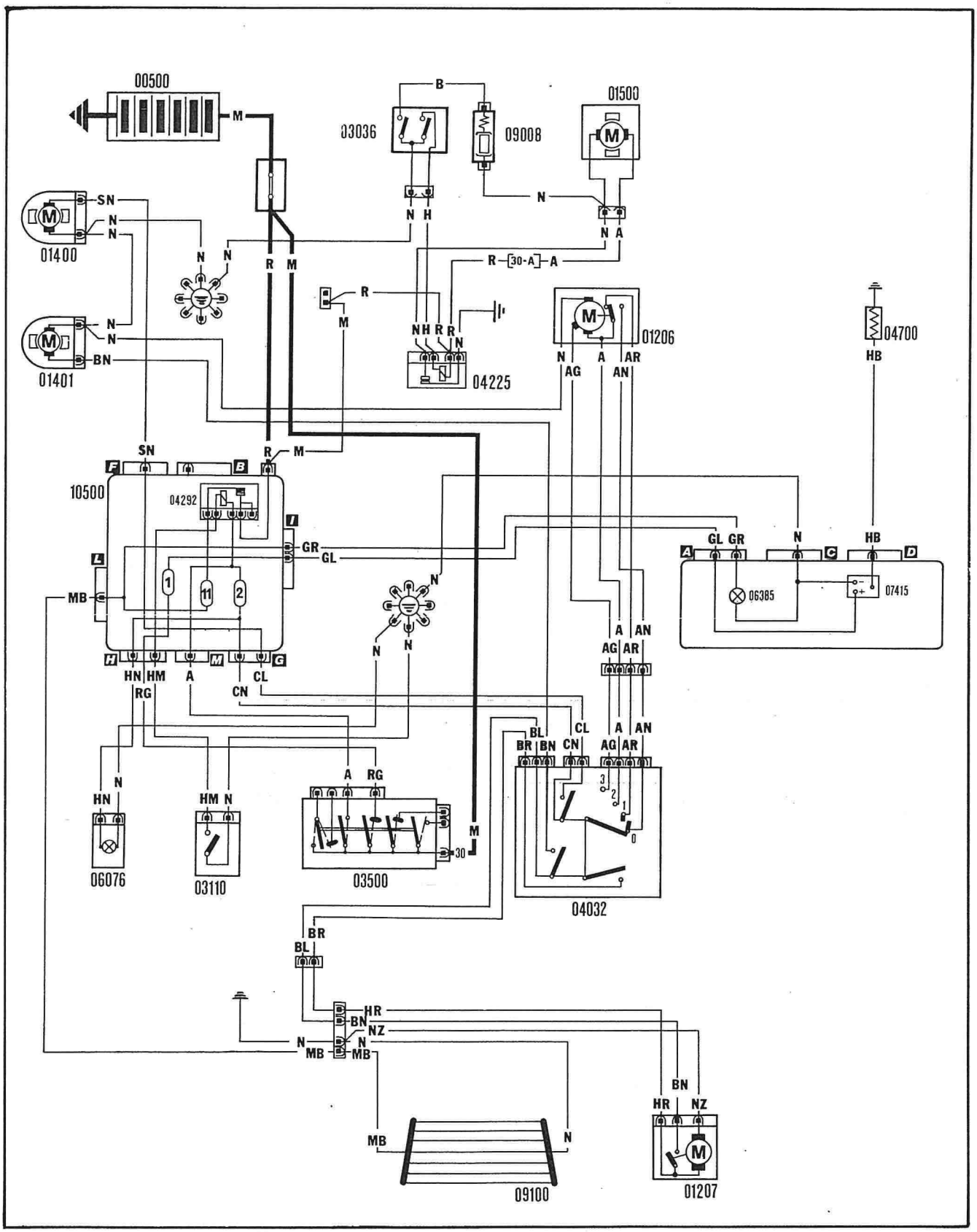
55.

Dipped headlamps – Main beam headlamps – Fog lamps – Reversing lights – Rear fog lamps (for key see page 39)



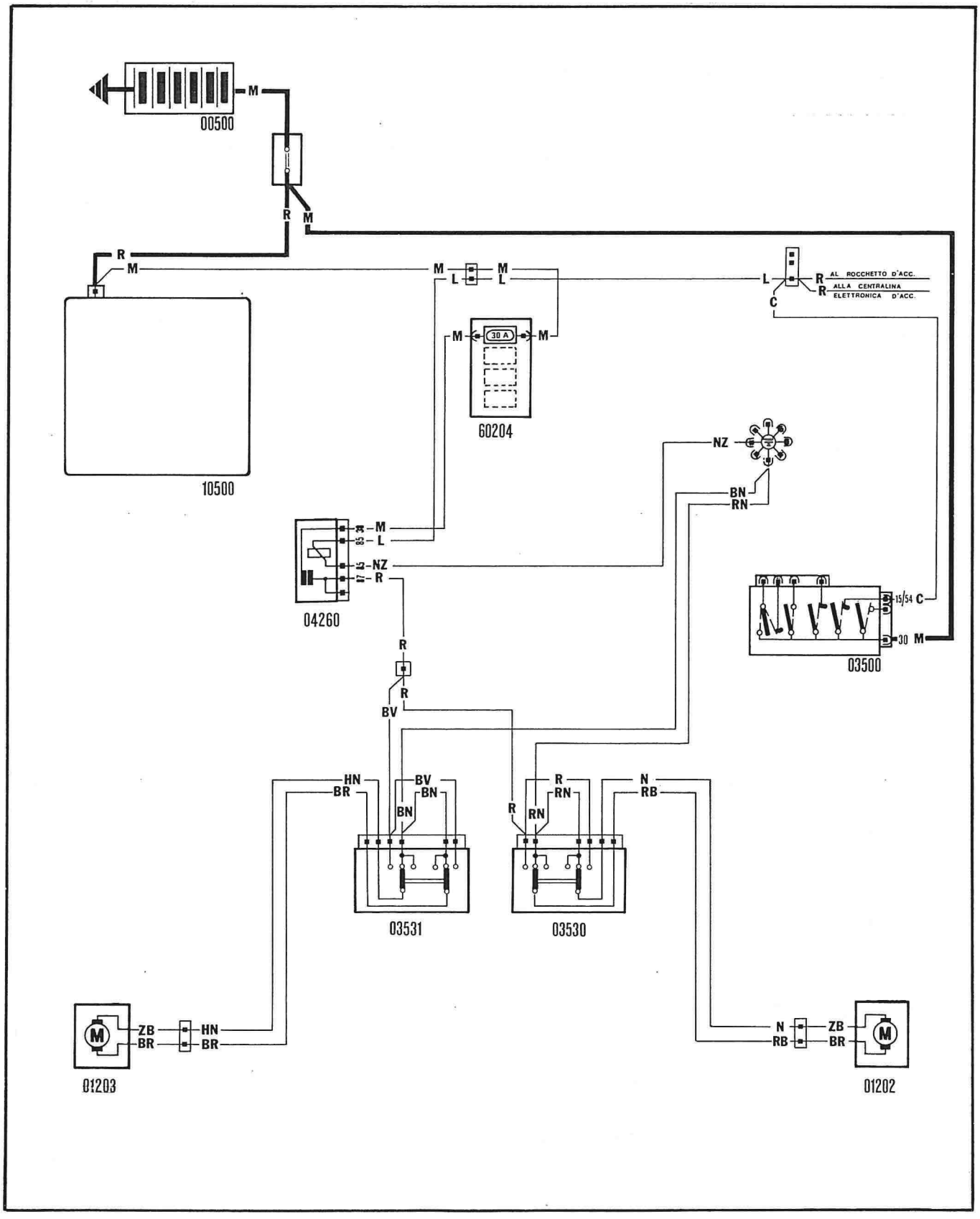
55.

Windscreen wiper – Windscreen washer electric pump – Radiator cooling fan – Heated rear windscreen – Ideogram fibre optic light – Coolant temperature gauge – Rearscreen washer electric pump (for key see page 39)

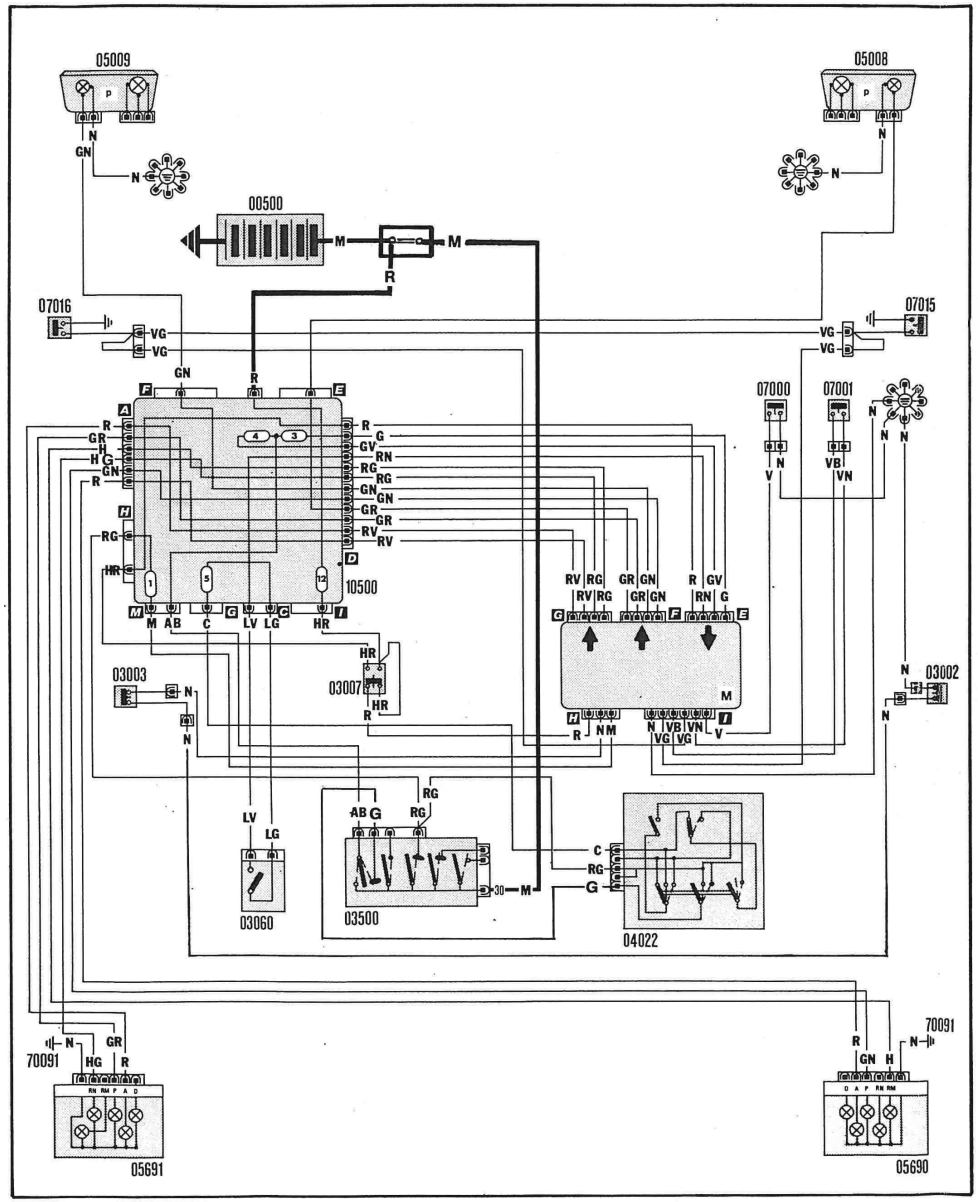


55.

Electric windows (for key see page 39)



Check panel



Wiring diagram key

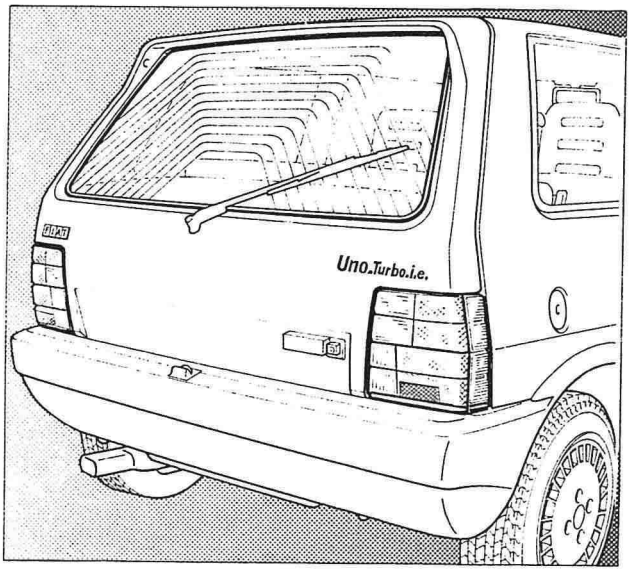
00200	Alternator with built in regulator
00500	Battery
01001	Starter motor
01202	Right front electric window motor
01203	Left front electric window motor
01206	Windscreen wiper motor
01207	Rearscreen wiper motor
01252	Right front door locking motor
01253	Left front door locking motor
01254	Rear right door locking motor
01255	Left rear door locking motor
01400	Electric windscreen washer pump
01401	Electric rearscreen washer pump
01420	Electric fuel pump
01500	Engine cooling fan
01502	Injector cooling fan
01504	Ventilation fan
02001	Solenoid on injection pump for cutting out engine
02010 **02011** **02012** **02013**	Fuel injectors
02215	Supplementary air valve
02400	Ignition coil
02405	Ignition coil with control unit
02490	Static advance ignition control unit
02492	Microplex electronic ignition control unit
03000	Insufficient engine oil pressure switch
03002	Right front door not properly shut switch
03003	Left front door not properly shut switch
03004	Right rear door not properly shut switch
03005	Left rear door not properly shut switch
03006	Handbrake applied switch
03007	Brake lights switch
03008	Reversing lights switch
03028	Radiator thermal switch
03029	Coolant overheating thermal switch
03034	Injector cooling fan thermal switch
03036	Radiator thermal switch with two operating ranges
03053	Map reading light switch
03059	Fog lamps switch
03060	Rear fog lamps switch
03110	Heated rear windscreen switch
03114	Ventilation fan switch
03123	Air pressure switch
03142	Choke warning light switch
03305	Right front door open warning light push button
03306	Left front door open warning light push button
03319	Horn push button
03500	Ignition switch
03505	Butterfly valve cut-off switch
03506	Butterfly valve switch
03530	Right front electric window switch
03531	Left front electric window switch
03546	Rearscreen wash/wipe switch
03550	Hazard warning lights switch
04010	Steering column switch unit, direction indicators switch
04022	Steering column switch unit, main beam and dipped headlamps and side lights
04032	Steering column switch unit, windscreen wash/wipe
04214	Speedometer relay
04225	Radiator cooling fan 2nd speed engagement relay
04241	Fog lamps relay
04260	Electric windows motor relay
04291	Horn relay feed

04292	Heated rear windscreen relay feed
04600	Ignition distributor
04700	Coolant temperature sender unit
04701	Coolant temperature for electronic injection sender unit
04720	Engine oil pressure sender unit
05008	Main beam and dipped headlamp with right side light
05009	Main beam and dipped headlamp with left side light
05013	Abnormal fuel consumption sensor
05015	Right fog lamp
05016	Left fog lamp
05410	Right front direction indicator
05411	Left front direction indicator
05412	Right front side direction indicator
05413	Left front side direction indicator
05640	No. plate light
05690	Right rear light cluster: side light, direction indicator, brake light, reversing light
05691	Left rear light cluster: side light, direction indicator, brake light, rear fog lamp
06000	Centre courtesy light
06026	Map reading light
06076	Ideogram fibre optic light
06080	Heater controls light
06084	Instrument panel light
06300	Side lights warning light
06305	Main beam headlamps warning light
06310	Rear fog lamp warning light
06311	Fog lamps warning light
06315	Hazard warning lights warning light
06320	Direction indicators warning light
06335	Insufficient brake fluid warning light
06336	Handbrake warning light
06343	Insufficient engine oil pressure warning light
06344	Insufficient brake fluid warning light
06345	Fuel reserve warning light
06350	Coolant overheating warning light
06355	Battery charging warning light
06365	Choke warning light
06385	Heated rear windscreen warning light
06800	Horn
06801	Right horn
06802	Left horn
07000	Insufficient coolant level sensor
07001	Insufficient engine oil level sensor
07003	Insufficient brake fluid level sensor
07015	Right front brake pad wear sensor
07016	Left front brake pad wear sensor
07020	Speed electro-magnetic sensor
07021	TDC electro-magnetic sensor
07022	Detonation sensor
07023	Diagnostic pick up
07050	Fuel level gauge
07051	Instant fuel consumption gauge (econometer)
07052	Air flow meter
07060	Idle cut out device
07400	Fuel gauge
07410	Engine oil temperature gauge
07415	Coolant temperature gauge
07420	Engine oil pressure gauge
07430	Rev counter
07460	Clock
07461	Digital clock
08051	Ignition coil condenser
09008	Resistor for radiator cooling fan 1st speed
09100	Heated rear windscreen
10022	Cut-off device electronic control unit
10500	Control box
10515	Electronic injection control unit
10571	Central locking control unit
59000	Cigar lighter
60204	Four place fuse box
60000	Instrument
70090	General earth
70091	General earth
M	Electronic control unit

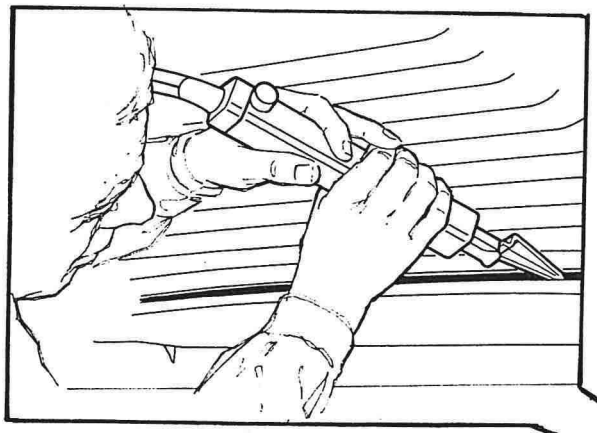
Cable colour code

A	Light blue
B	White
C	Orange
G	Yellow
H	Grey
L	Blue
M	Brown
N	Black
R	Red
S	Pink
V	Green
Z	Violet
AB	Light blue/White
AG	Light blue/Yellow
AN	Light blue/Black
AR	Light blue/Red
AV	Light blue/Green
BG	White/Yellow
BL	White/Blue
BN	White/Black
BR	White/Red
BV	White/Green
BZ	White/Violet
CA	Orange/Light blue
CB	Orange/White
CN	Orange/Black
GN	Yellow/Black
GL	Yellow/Blue
GR	Yellow/Red
GV	Yellow/Green
HG	Grey/Yellow
HN	Grey/Black
HR	Grey/Red
LB	Blue/White
LG	Blue/Yellow
LN	Blue/Black
LR	Blue/Red
LV	Blue/Green
MB	Brown/White
NZ	Black/Violet
RB	Red/White
RG	Red/Yellow
RN	Red/Black
RV	Red/Green
SN	Pink/Black
VB	Green/White
VN	Green/Black
VR	Green/Red

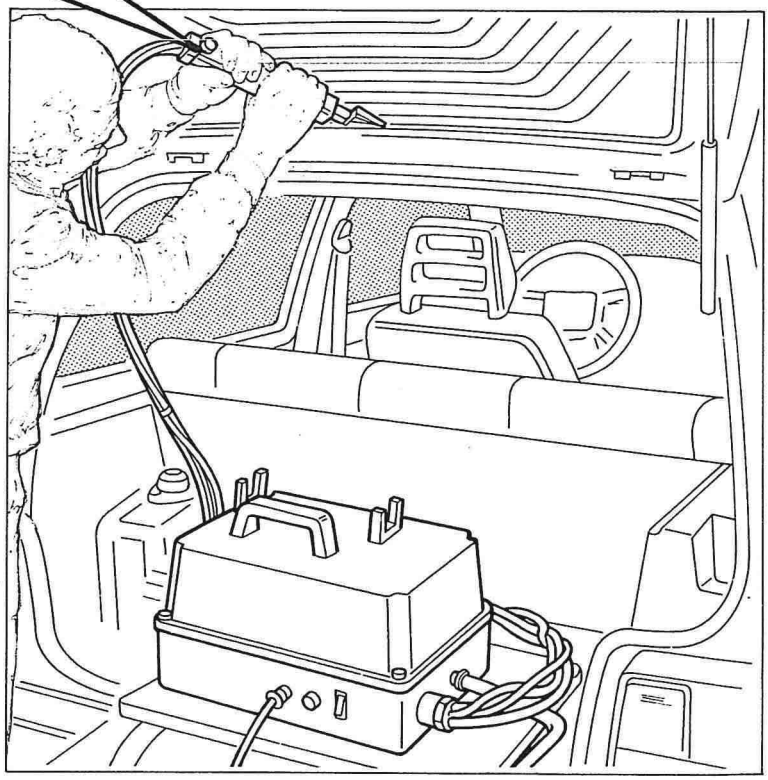
REPLACING REAR WINDOW GLASS (REARSCREEN)



Remove the rearscreen wiper lever

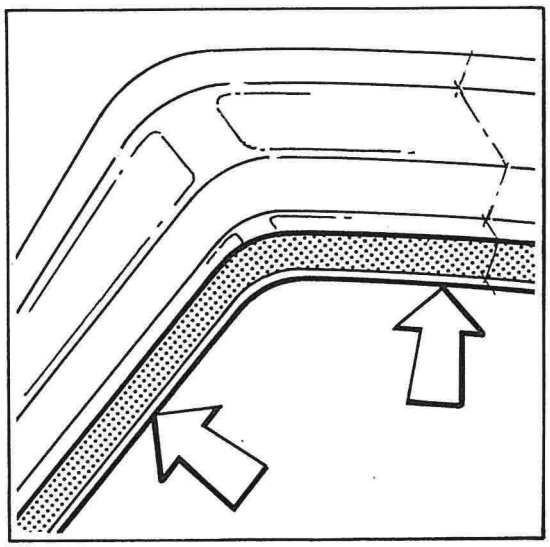


Cut the adhesive, using a special tool, working from the inside of the tailgate and making the thermal blade pass between the glass and the tab.

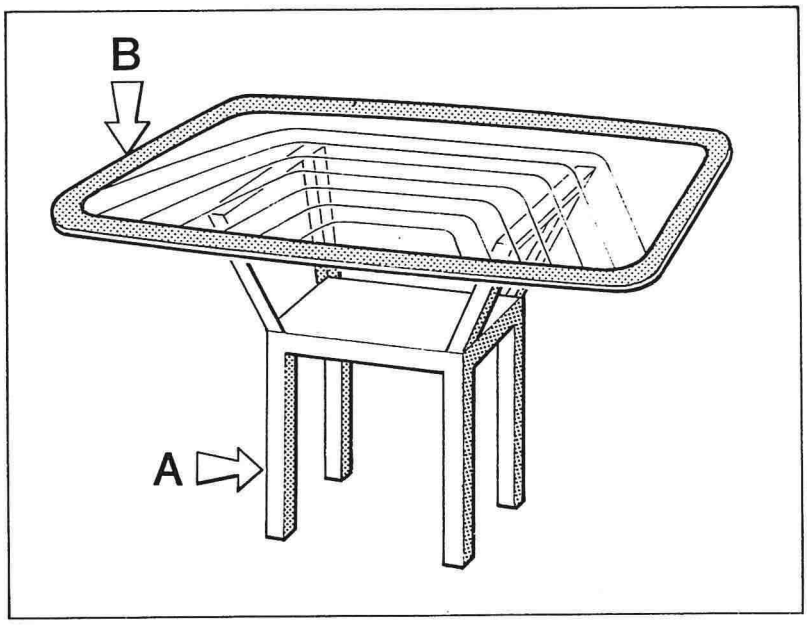


When the cutting operation is completed, remove the rearscreen from its housing.

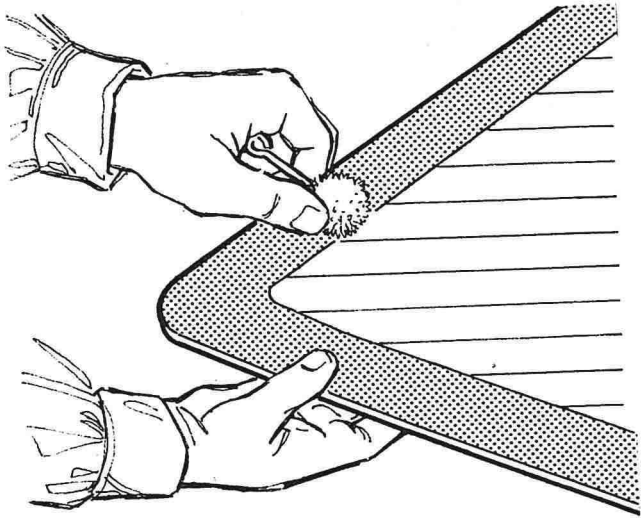
70.



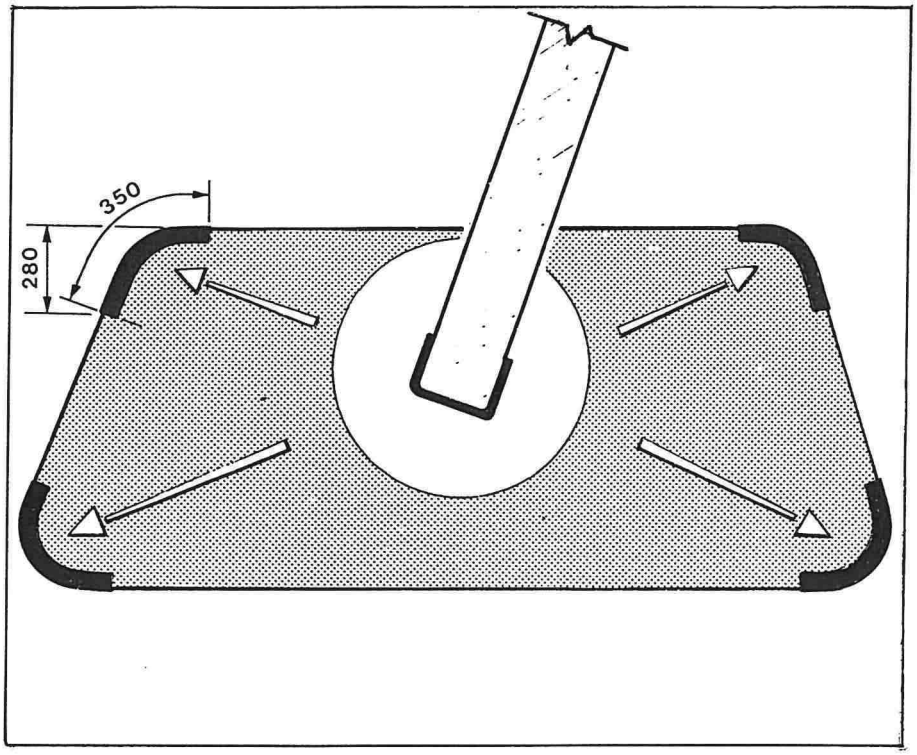
Ensure that the sealant remaining on the tab is of a virtually even thickness.
With this thickness of adhesive (which can remain in place) the risk of scratching the paint is avoided.
On the other hand, traces of adhesive do not adversely affect the subsequent adhesion.
Lastly, clean the entire window glass housing with compressed air and then with alcohol, taking care not to touch the rearscreen housing with bare hands.



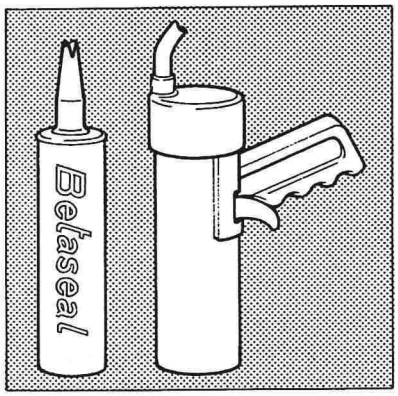
Position the rearscreen on the special support (A).
Using distilled water, clean the entire area along the edges of the glass (B) making a perimeter of around 10 cm wide.
Dry the area which has previously been cleaned with distilled water using absorbent paper.
Apply degreasing adhesion promoter (type 4) on the area which has just been cleaned in a stream at least 3 cm wide.
Wait 15 to 20 seconds and dry the area which has been treated with absorbent paper until it is completely dry.



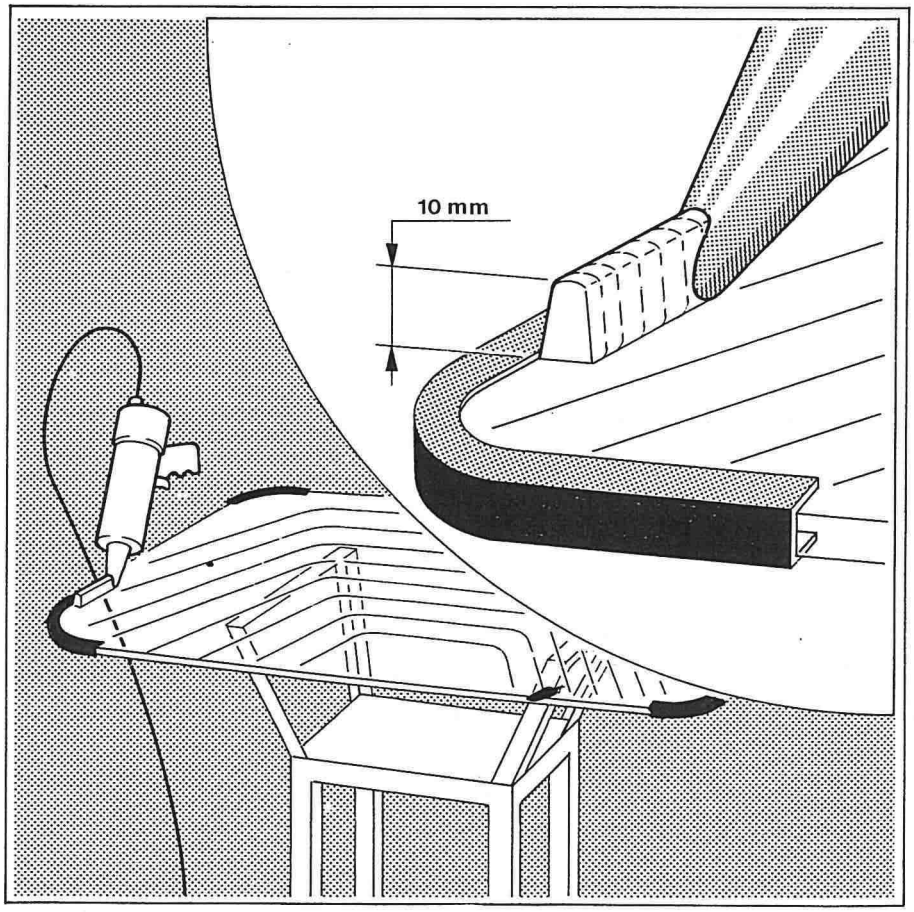
Using a cotton pad, apply the adhesion promoter (type 84132-11) to the prepared area and leave it to dry at room temperature for at least 15 minutes; do not, however, leave it for longer than 24 hours.



Apply adhesive tape (3 M. – Pressure sensitive Topey 471) 10 mm wide at the corners of the window glass.
Fit the window glass surround trim, taking care not to scratch or affect the surface which has been treated earlier. With this in mind, it is advisable to wear gloves when carrying out the operation.

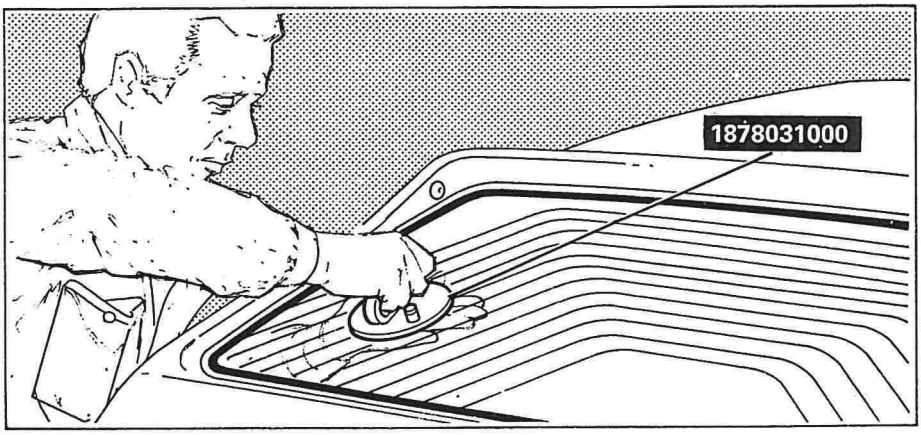


Then, using a spray gun, apply a seam of polyurethane adhesive (BETASEAL 71904 HV) which is supplied in a container with a tapered, plastic nozzle already cut in the shape of triangle.

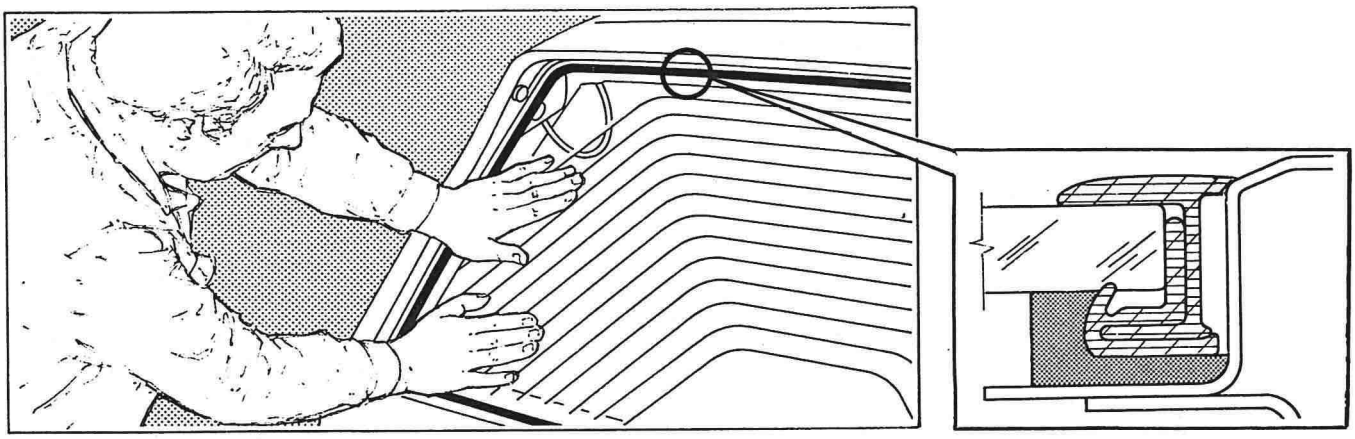


Special care should be taken during this operation to make sure that the correct amount of adhesive is applied, not too much and not too little, that the stream of adhesive is even and also that the end of the stream joins up with the beginning forming a continuous seam.

70.



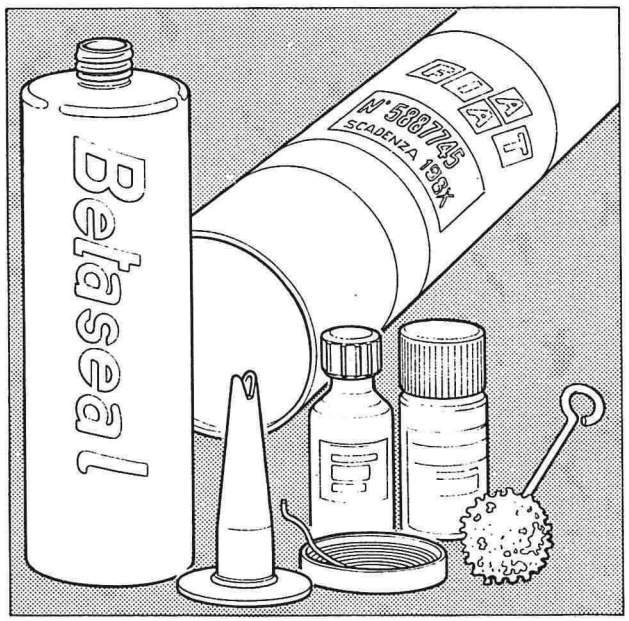
In order to move the window glass, clamps must be fitted to the convex side and the glass positioned in its housing in the tailgate.



Compress the glass until it reaches the correct position, when the outer side section of the joint cover seal is in line with the tailgate wire.

The window glass must be in place, at all costs, within 15 minutes from the application of the BETASEAL adhesive.

When this operation has been carried out, the clamps should be removed and all the bodywork components which have been removed should be refitted.



NOTE *It is advisable to wait at least 3 hours before moving the vehicle in the workshop as normal.*
The vehicle should not be collected by the customer for 24 hours since the use of the vehicle in certain conditions such as on uneven roads, cobblestones, tram lines, etc could damage the adhesion.

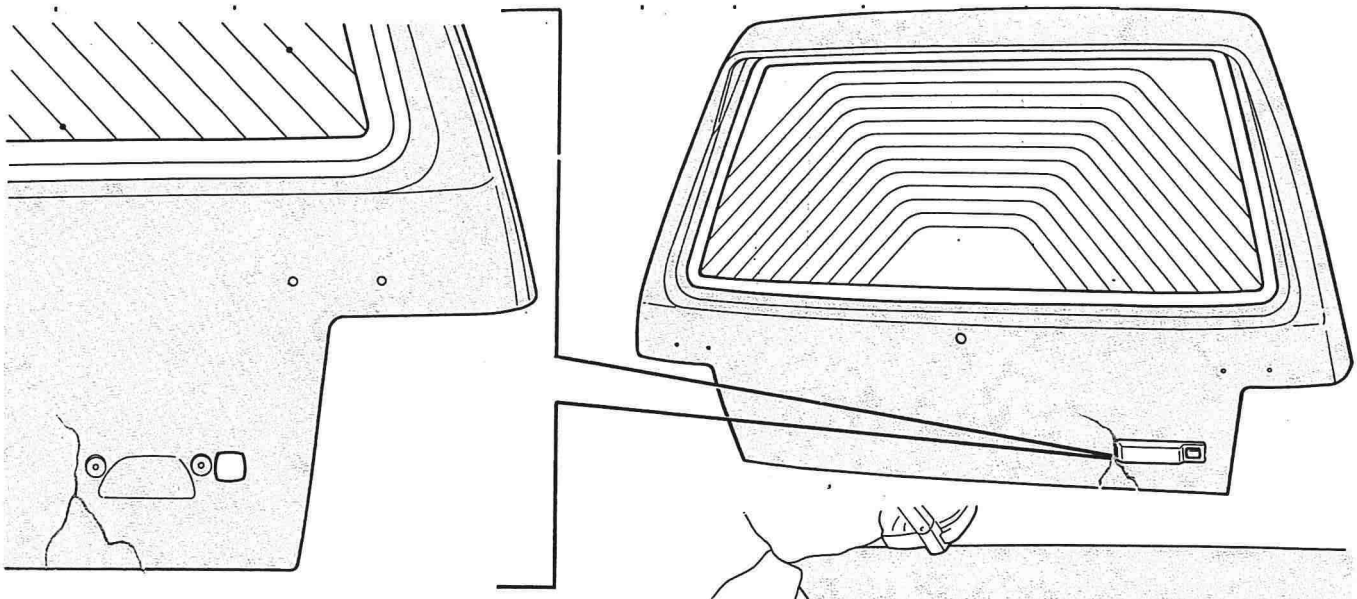
Components available as spares

The spares kit supplied under part no. 5887745 comprises:

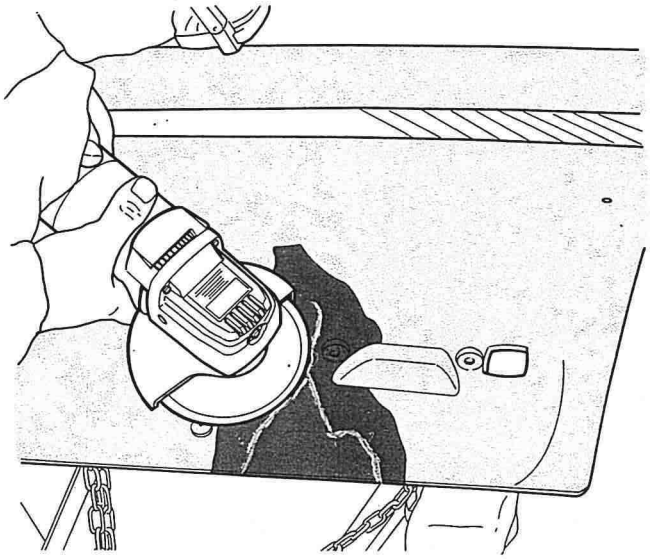
- BETASEAL adhesive container
- Degreasing primer in glass bottle
- Adhesive primer in aluminium bottle
- Wad of cotton
- Wire
- Plastic nozzle for container

REPAIRING BMC (Bulk Moulding Compound) TAILGATE

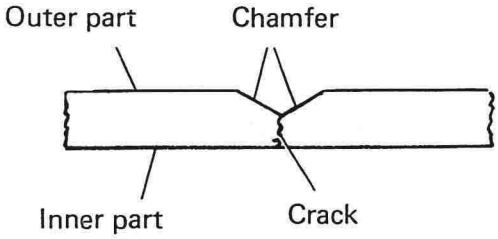
The fibreglass reinforced plastic tailgate is obtained by means of a new hot injection process.
This makes it possible to produce individual pieces with particularly complicated shapes (which cannot be made from steel). This material allows the absorption of slight impacts and is lighter.
Below are instructions for repairing and then repainting the tailgate.

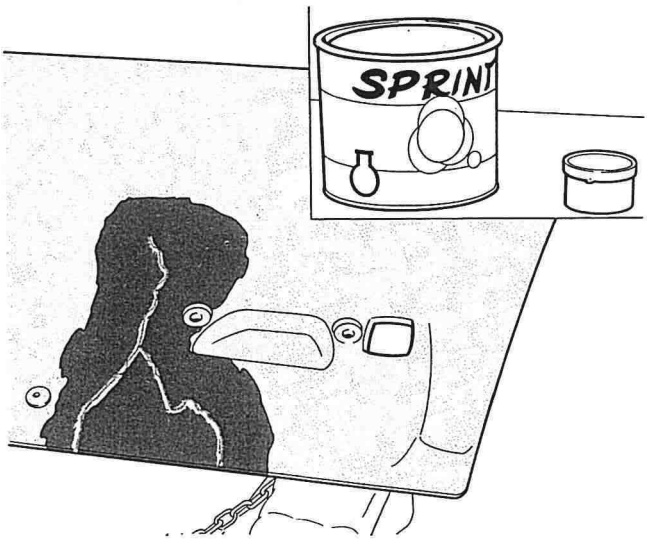


Remove the tailgate from the car.
Position it on the special workbench, as shown in the diagram.
Remove the handle and the lock.



Chamfer the crack (of the damaged part) using a disc grinder.





Prepare the polyester resin material required for the repair with 2% of catalyst (benzoyl peroxide).

Material required: Stuccatex Sprint from Reggiana Chemical Industries or an equivalent product.

Mix with care and use the catalyst resin fairly quickly.

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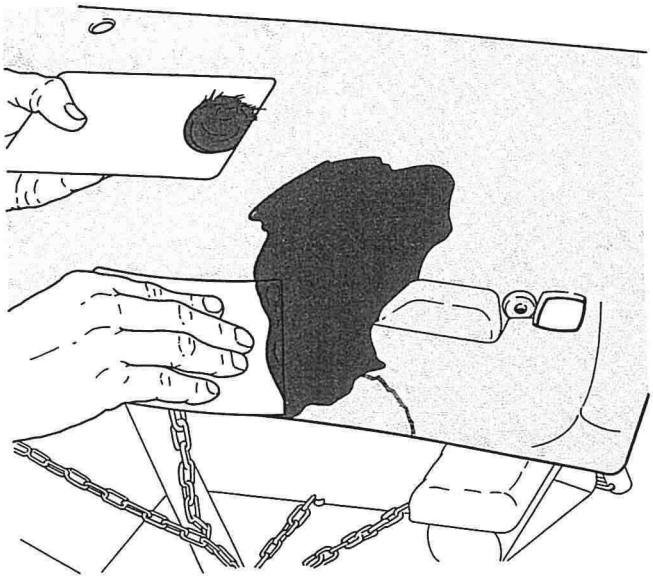
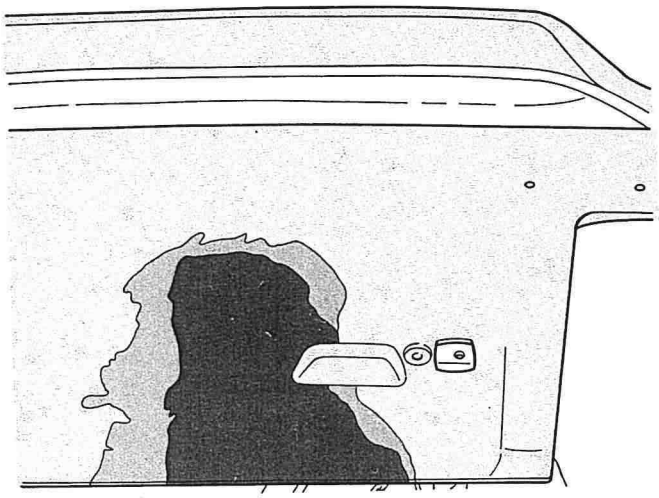
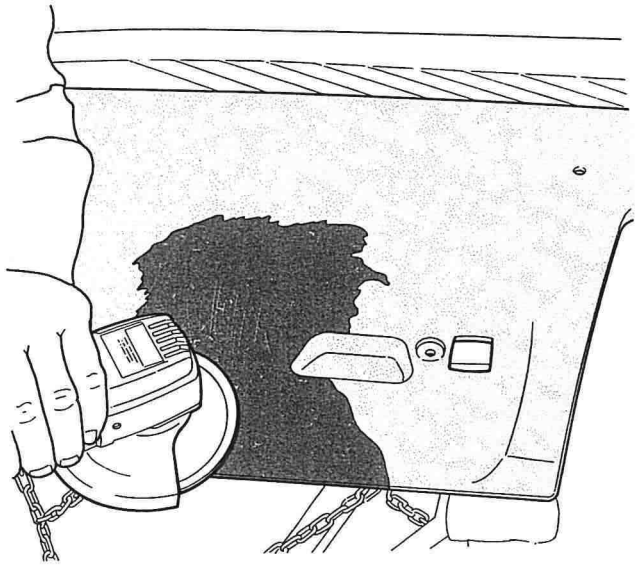


NOTE *The resin should be prepared and applied at a temperature of at least 15 – 20° C.*

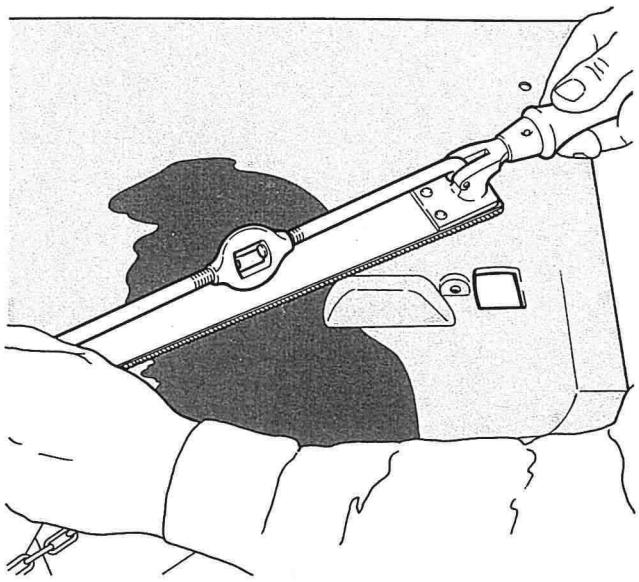
Apply the compound as illustrated in the diagram, entirely covering the chamfer.
Leave to harden for at least 30 minutes.



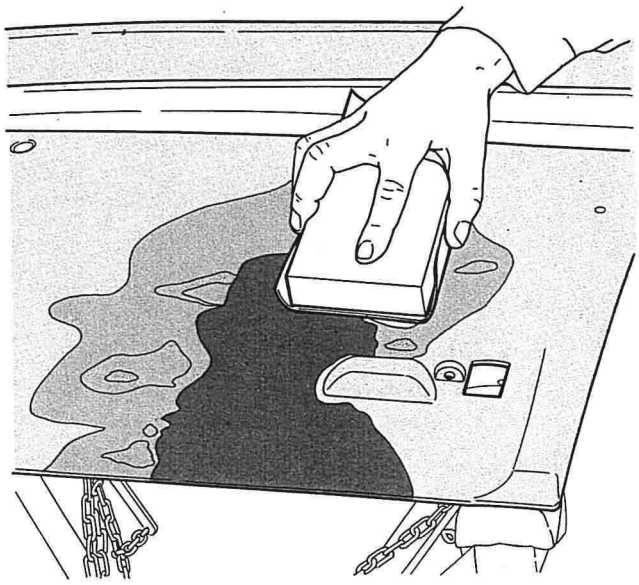
In order to accelerate the hardening process, it is possible to subject the area concerned to a moderate heat.



Remove the excess material using a disc grinder.



Finishing area repaired using a body file



Lastly, sand the area repaired and the adjacent areas using medium grade (320) abrasive paper.

For large areas which affect the functionality and the aesthetics of the tailgate, it is advisable to replace the entire section.

Then, prepare the surface to be painted and follow the painting cycle described below:

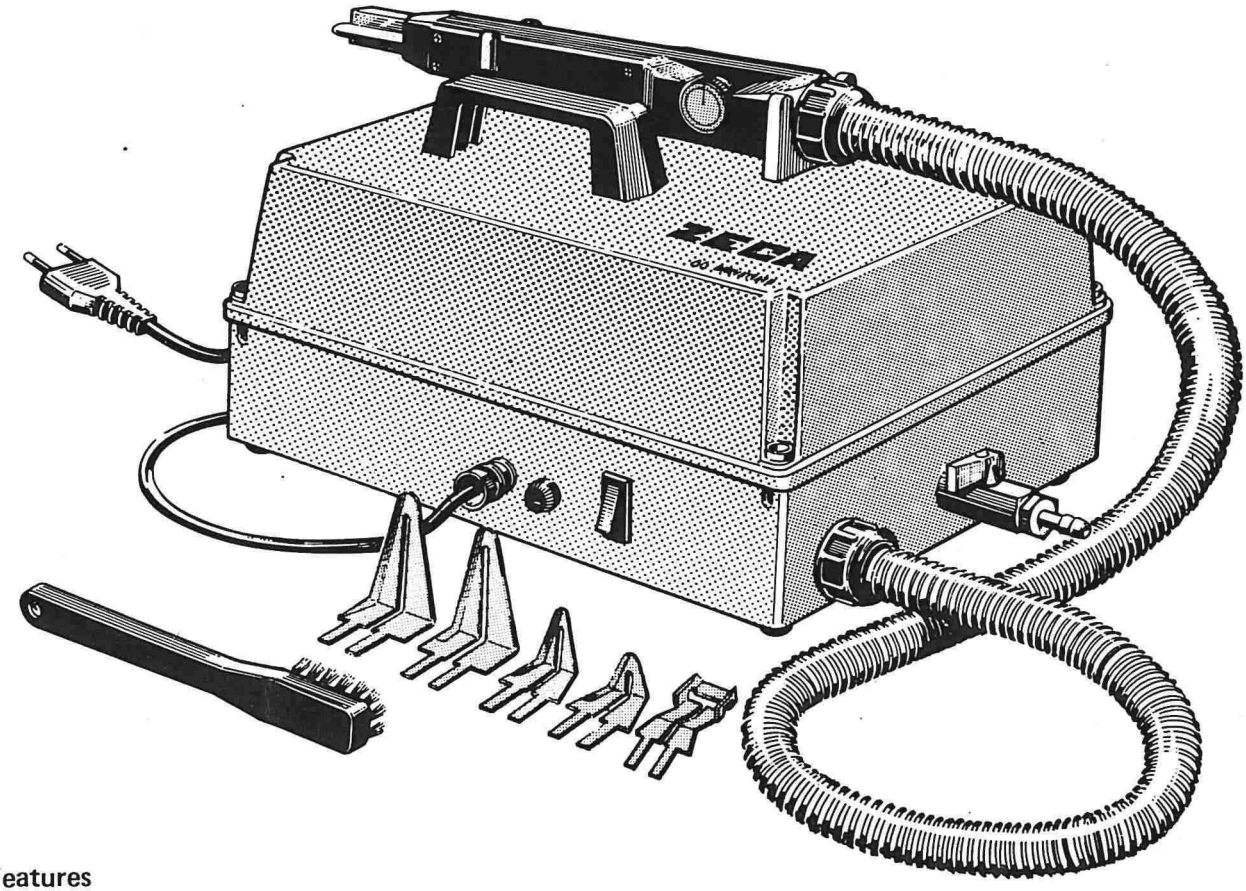
- If necessary, apply polyester filler (IVI PLAST 77 or an equivalent product) to the area which has been repaired.
- Sand the area previously filled using fine grade (800) abrasive paper and water.
- Dry with compressed air.
- Using a spray gun, apply the polyester filler IVI PLAST SP 498011 or an equivalent product.
- Leave to dry at 40° C for at least 15 - 20 minutes.
- Sand the entire external surface of the tailgate using wet fine grade (600) abrasive paper.
- Using a spray gun, apply the IVI bodywork insulator (or equivalent product).
- Dry with compressed air and degrease the entire surface of the tailgate with solvent.
- Apply the enamel paint using a spray gun (LACRIT or LACRIT DS or an equivalent product).
- Dry the tailgate with lamps or in the oven at 50° C for at least 40 mins.

70.A

1876044000	Pliers for extracting cigar lighter housing
1878017000	Pliers for closing seat cushion hooks
1878031000	Clamps for lifting windscreen and rearscreen window glasses
1878034000	Tool for removing inside door handles
1878076000	Tool for cutting car interior plastic lining
1878077000	Tool for removing plastic buttons and door panels
1889515000	Spanner for bolts fixing front door hinges

Working methods

THERMAL KNIFE



Features

Used for removing front and rear window glasses which are thermoplastically sealed.

It comprises:

- A container for the electrical equipment and the fume aspiration equipment.
- Handle for adjusting blade temperature, an aspirator for eliminating the fumes produced whilst cutting the adhesive and an ignition button.
- A series of interchangeable blades for each type of operation which can be carried out suitable for removing the various types of window glasses.

Supply	220 V - 50 Hz	Dimensions	330 x 240 x 230 mm
Power	300 W	Weight	15 kg

Produced and distributed by: ZECA — Str. della Chiara, 25 — 10080 Feletto Canavese (TO)