

WORK SHOP MANUAL

8LD600-2
8LD665-2
8LD665-2/L
8LD740-2



This manual contains the most important information for the repair of LOMBARDINI air-cooled, direct injection Diesel engines type 8LD600-2, 8LD665-2, 8LD665-2/L and 8LD740-2. This information is current upto November 1, 1988.

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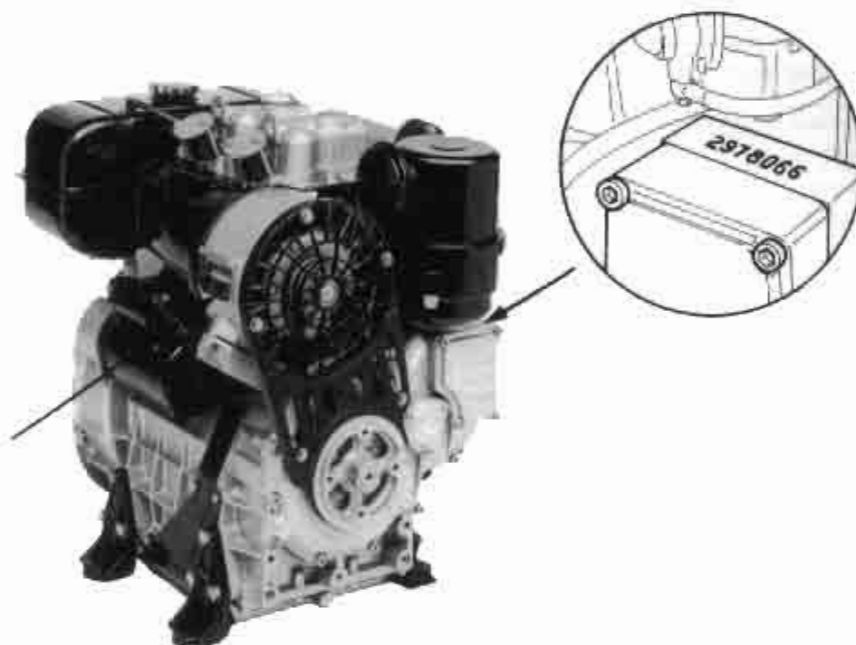
MODEL NUMBER AND IDENTIFICATION

I

MODEL NUMBER AND ENGINE IDENTIFICATION



Once the model number has been correctly interpreted, identify the engine through the serial number indicated both on the nameplate fitted to the blower housing and on the crankcase.



CHARACTERISTICS OF MODELS 8LD600-2, 8LD665-2, 8LD665-2/L, 8LD740-2


ENGINE TYPE		8LD600-2	8LD665-2	8LD665-2/L	8LD740-2
Number of cylinders	N	2	2	2	2
Bore	mm	90	95	95	100
Stroke	mm	94	94	94	94
Displacement	cm ³	1196	1332	1332	1476
Compression ratio		17.8:1	17.8:1	17.8:1	17.8:1
R.P.M.		3000	3000	2200	2600
Power kW/HP	N D/N 70020	18.8/25.6	21.0/28.6	—	21.0/28.6
	NB D/N 6270	16.9/23.0	19.1/26.0	16.3/22.0	18.9/25.7
	NA D/N 6270	15.4/21.0	17.6/24.0	14.7/20.0	17.5/23.8
Max. torque	Kgm	6.50	7.80	6.50	8.25
		@ 2200	@ 1800	@ 2000	@ 1800
Max. torque at 3rd p.l.o.	Kgm	4	4	4	4
		@ 2540	@ 2540	@ 1860	@ 2170
Specific fuel consumption *	g/CV h	196	200	178	190
Tank capacity	L	10	10	15	10
Oil consumption	Kg/h	0.045	0.052	0.045	0.052
Oil sump capacity	L	2.50	2.50	2.50	2.50
Dry weight	Kg	128	130	132	132
Combustion air volume at 3000 r.p.m.	l/min	1470	1640	1250 **	1600 ***
Cooling air volume at 3000 r.p.m.	l/min	25800	25800	18900 **	24300 ***
Max. permissible driving shaft axial load in both directions	Kg.	300	300	300	300
	momentary	α	35°	35°	35°
Max. inclination	lasting up to 1 h.	α	25°	25°	25°
	permanent	α	****	****	****

* Referred to max. NB power

** At 2200 r.p.m.

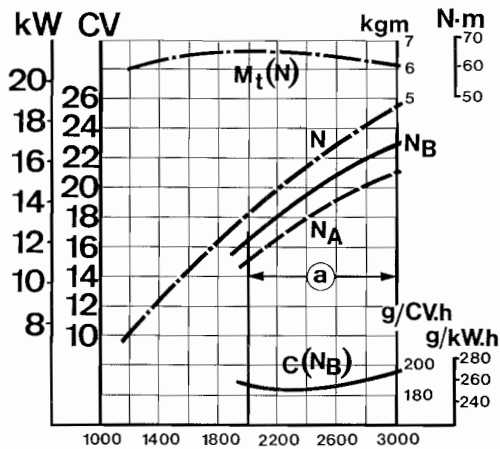
*** At 2600 r.p.m.

**** Depending on the application

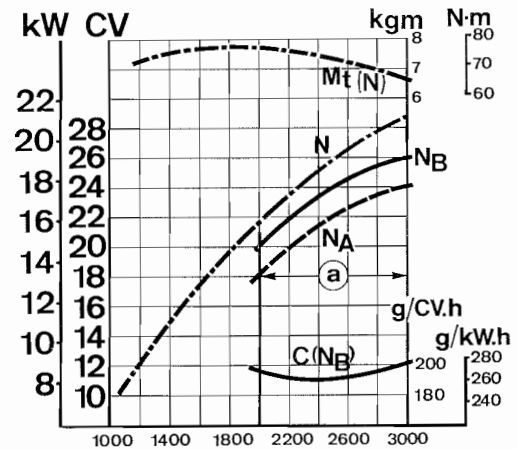


CHARACTERISTIC POWER, TORQUE AND SPECIFIC CONSUMPTION CURVES

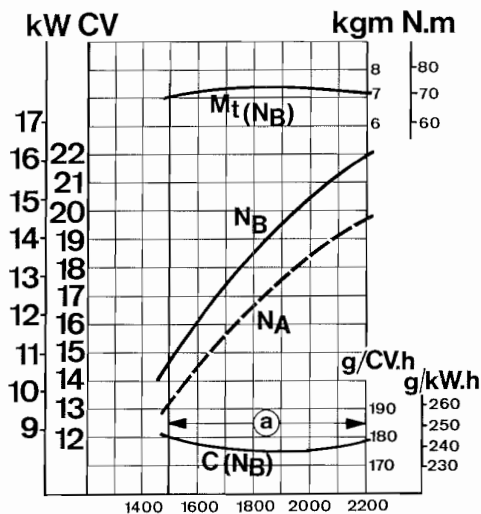
8LD600-2



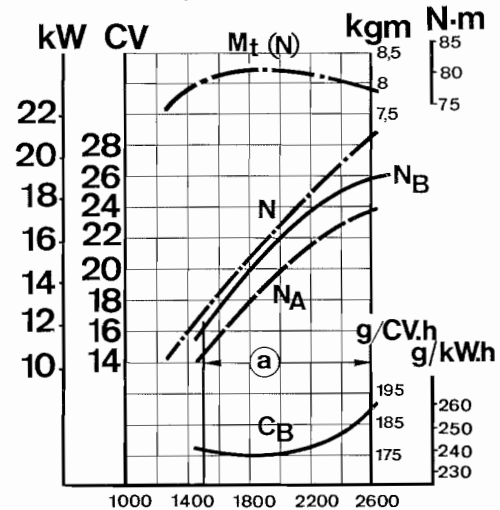
8LD665-2



8LD665-2/L



8LD740-2



N (DIN 70020), Automotive rating, intermittent operation with variable speed and variable load.

N_B (DIN 6270), Rating with no overload capability, continuous light duty operation with constant speed and variable load.

N_A (DIN 6270), Continuous rating with overload capability, continuous heavy duty with constant speed and constant load.

The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar.

Max. power tolerance is 5%. Power decreases by approximately 1% every 100m altitude and by 2% every 5°C above 20°C.

C (N_B): Specific fuel consumption at N_B power

M_t : Torque at N

Ⓐ : Range of application for continuous operation. In case of application outside this range please contact LOMBARDINI.

III**MAINTENANCE - RECOMMENDED OIL TYPE - REFILLING****MAINTENANCE**

OPERATION	COMPONENT	INTERVAL (HOURS)								
			10	50	125	250	500	1000	2500	5000
CLEANING	AIR CLEANER (*)		•							
	FEED PUMP FILTER					•				
	HEAD AND CYLINDER FINS (*)					•				
	FUEL TANK							•		
	INJECTORS						•			
	INTERNAL OIL FILTER								•	
CHECK	AIR CLEANER OIL		•							
	LEVEL CRANKCASE OIL		•							
	BATTERY FLUID			•						
	DELIVERY VALVE TIGHTNESS						•			
	FAN BELT TENSION				•					
	VALVE AND ROCKER ARM CLEARANCE						•			
	INJECTOR SPRAY PATTERN						•			
REPLACEMENT	AIR CLEANER (**) (***)		•							
	OIL CRANKCASE (***)					•				
	OIL FILTER CARTRIDGE					•				
	FUEL FILTER CARTRIDGE					•				
	FAN BELT						•			
OVERHAUL INSPECTION	PARTIAL (****)								•	
	COMPLETE									•

(*) Under severe working conditions, clean daily.

(**) Under extremely dusty conditions, change every 4-5 hours.

(***) See recommended oil type.

(****) Includes checking cylinders, piston rings, guides, springs grinding valve seats, de-carboning heads and cylinders as well as checking injection pump and injectors.

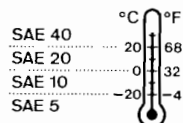
RECOMMENDED OIL TYPE

AGIP DIESEL SIGMA S SAE 30-40 specification MIL-L-2104 C

ESSO LUBE D3, specification

MIL-L-2104 D and UNIFARM specification MIL-L-2104 C

In countries where AGIP and ESSO products are not available use diesel engine oil API SERVICE CD or a similar type complying with the military specification MIL-L-2104 C and MIL-L-2104 D.

Suggested oil grades**CAPACITIES (LITERS)**

Standard fuel tank 10.0

Standard oil sump 2.5

Air cleaner oil tank 0.3

As for filters, tanks and special crankcases please refer to LOMBARDINI instructions.

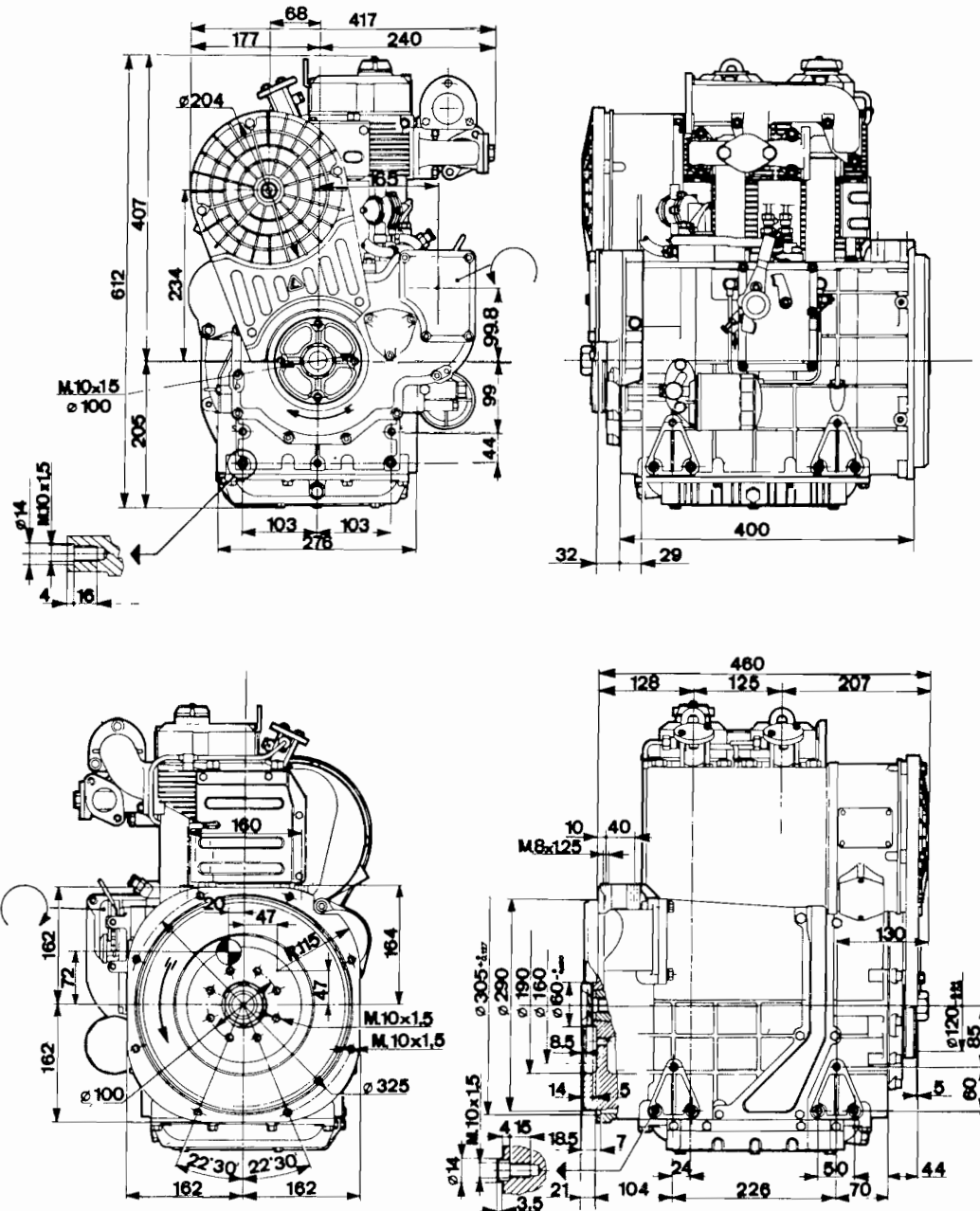


POSSIBLE CAUSES AND TROUBLE SHOOTING

The following table contains the possible cause of some failures which may occur during operation. Always perform the simplest checks before removing or replacing any part.

POSSIBLE CAUSE		TROUBLE						
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Too low oil pressure
FUEL CIRCUIT	Clogged pipings	•						
	Clogged fuel filter	•	•	•				
	Air inside fuel circuit	•	•	•				
	Clogged tank breather	•	•	•				
	Faulty feed pump	•	•					
	Stuck injector	•						
	Stuck injection pump valve	•						
	Wrong injector setting					•		
	Sticking injection pump rack	•		•	•			
	Wrong injection pump setting			•		•		
LUBRICATION	Too high oil level				•		•	
	Stuck pressure relief valve							•
	Incorrect relief valve setting							•
	Worn-oil pump							•
	Air inside oil suction pipe							•
	Faulty pressure gauge or switch							•
	Clogged oil suction pipe							•
ELECTRIC SYSTEM	Battery dis-charged	•						
	Wrong or inefficient cable connection	•						
	Defective starter switch	•						
	Defective starter	•						
MAINTENANCE	Clogged air filter	•		•		•		
	Excessive idle operation						•	
	Incomplete running-in						•	
	Engine overloaded			•		•		
SETTINGS/REPAIRS	Advanced injection timing	•						
	Retarded injection timing					•		
	Incorrect governor linkage adjustment	•			•			
	Broken or loose governor spring			•				
	Too low idle-speed setting		•					
	Worn-out or stuck piston rings						•	
	Worn-out cylinders						•	
	Sticking valves	•						
	Worn-out bearings							•
	Governor linkage not freely operating	•	•		•			
	Crankshaft not turning freely					•		

OVERALL DIMENSIONS 8LD600-2, 8LD665-2, 8LD665-2/L, 8LD740-2



VI

TORQUE SPECIFICATIONS

MAIN TORQUE SPECIFICATIONS		
COMPONENT	Diameter and pitch mm	Torque Kgm
Connecting rod	10x1.50	5.0
Injection pump delivery valve union	18x1.50	4.0
Rocker arm cover	8x1.25	2.0
Center main bearing support	8x1.25	2.5
Intake manifold	8x1.25	2.5
Exhaust manifold	8x1.25	2.5
Gear cover plate	8x1.25	2.5
External oil filter	8x1.25	2.5
Camshaft gear	20x1.50	15.0
Oil pump gear	12x1.50	4.0
Starting motor	10x1.50	4.0
Rocker arm shaft	8x1.25	2.5
Camshaft thrust plate	8x1.25	2.5
Engine mounting foot	10x1.50	3.5
Fuel feeding pump	8x1.25	1.5
Nozzle holder	6x1.00	1.0
Oil pan	8x1.25	2.5
Oil pressure switch	12x1.50	3.5
Starting pulley	10x1.50	4.0
Crankshaft pulley	27x2.00	30.0
Blower pulley	12x1.50	4.0
Crankshaft center support	10x1.50	4.0
Head	10x1.50	5.0
Flywheel	20x1.50	30.0

USE OF SEALANTS	
POSITION	Type of sealant
Tank bracket vibration dampers	Loctite 270
Camshaft cover, flywheel side	Gasket cement Arexon
Tank bracket (Rubber sheet)	Loctite IS 495
Crankshaft thread, to fix pulley	Loctite 270
Air shroud gasket	Loctite IS 495
Cylinder head stud, to crankcase	Loctite 270
Oil pump flange support	Gasket cement Arexon
Rocker arm shaft plug	Loctite 270

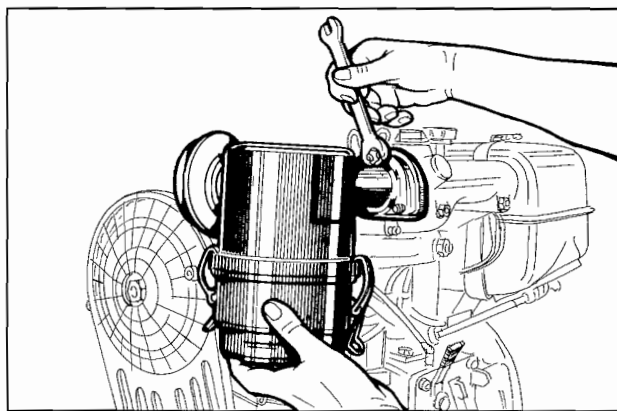


STANDARD BOLT TORQUE SPECIFICATIONS

DESCRIPTION	 8.8	 10.9 = R10	 12.9 = R12
	High-carbon steel	Alloy steel	Special alloy steel
Diameter per Pitch (mm)	Kgm	Kgm	Kgm
4x0.70	0.37	0.52	0.62
5x0.80	0.72	1.01	1.22
6x1.00	1.23	1.73	2.08
7x1.00	2.02	2.84	3.40
8x1.25	3.02	4.25	5.10
9x1.25	3.88	5.45	6.55
10x1.50	5.36	7.54	9.05
12x1.75	9.09	12.80	15.30
14x2.00	13.80	19.40	23.30
16x2.00	21.00	29.50	35.40
18x2.50	26.30	37.00	44.40
20x2.50	36.60	51.50	61.80
22x2.50	44.40	62.40	74.90
24x3.00	56.90	80.00	96.00

DISASSEMBLY AND REASSEMBLY

Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions. Always use original LOMBARDINI spare parts for proper repair operations.



Air cleaner

Oil-bath air cleaner with two filtering elements.

The lower filtering element is made of metal while the upper one is made of polyurethane.

Check gaskets and replace as necessary.

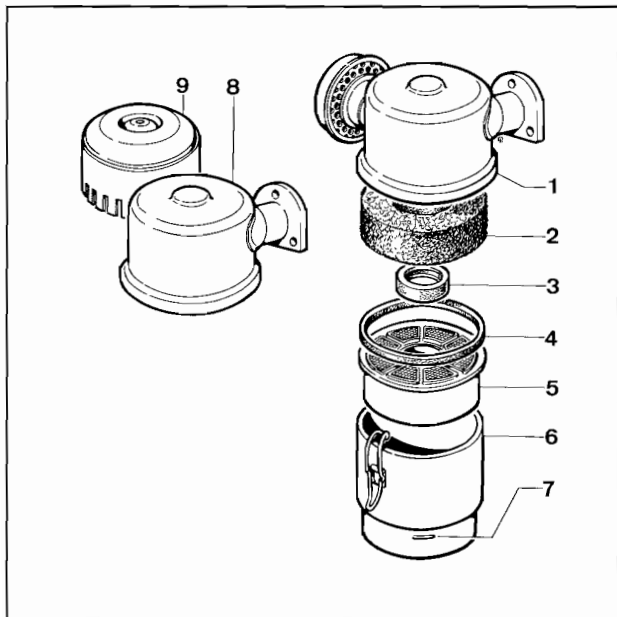
Check that welds are free of defective spots.

Carefully clean bowl and filtering elements with Diesel fuel. Blow through the lower filtering element with compressed air and dry the upper filtering element with a rag.

To up with engine oil to the mark.

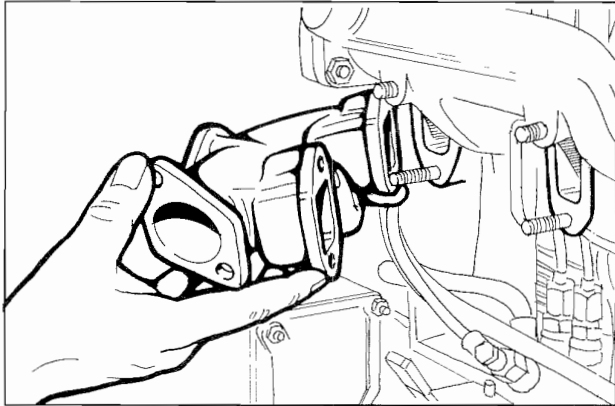
When refitting tighten nuts at 3 Kgm.

See Page 8 for periodic maintenance details.



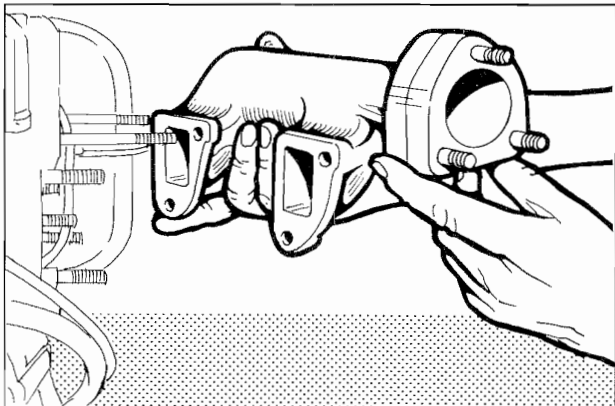
Air cleaner components

- 1 Cover
- 2 Polyurethane upper filtering element
- 3 Internal seal ring
- 4 External seal ring
- 5 Metal lower filtering element
- 6 Bowl
- 7 Oil level mark
- 8 Centrifugal prefilter cover
- 9 Centrifugal prefilter



Exhaust manifold

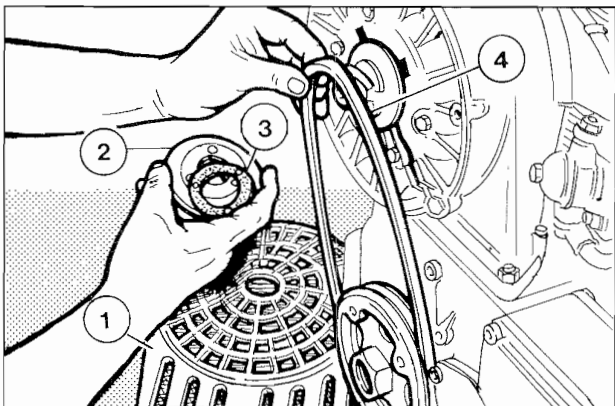
Check that the inside is free of carbon deposits.
To avoid manifold breakage and to insure a good exhaust gas seal-check exhaust flange alignment on each cylinder head relative to the other.



Intake manifold

Check flange surface for warpage and correct if necessary.
Before refitting check that heads are in line.
Replace self-locking nuts and tighten them at 1.8 Kgm. Replace gaskets.

Note: In case of low temperature starting we can supply a manifold with provision for an air preheating glow plug.

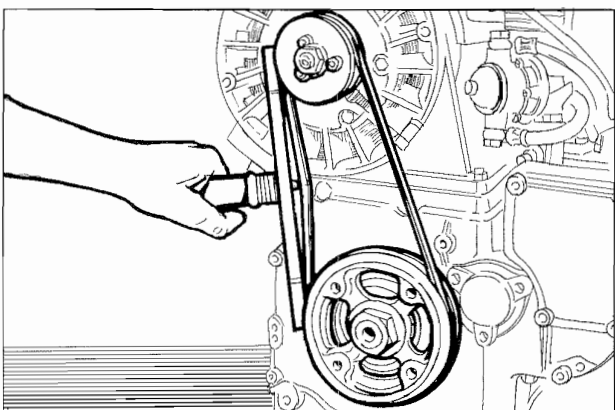


Axial blower belt

Components:

- 1 Guard
- 2 Pulley
- 3 Spacers
- 4 "V"-belt

Loosen the belt guard bolts and the nuts retaining the pulley.
Remove "V"-belt and check for wear.
See Page 8 for periodic maintenance details.

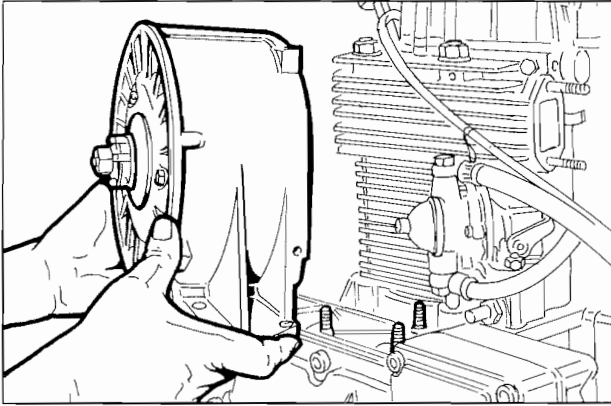


Belt tension adjustment

Belt tension can be adjusted by adding or removing the spacers located between the pulley halves. Spacers are 0.5, 1.0 and 2.0 mm thick.

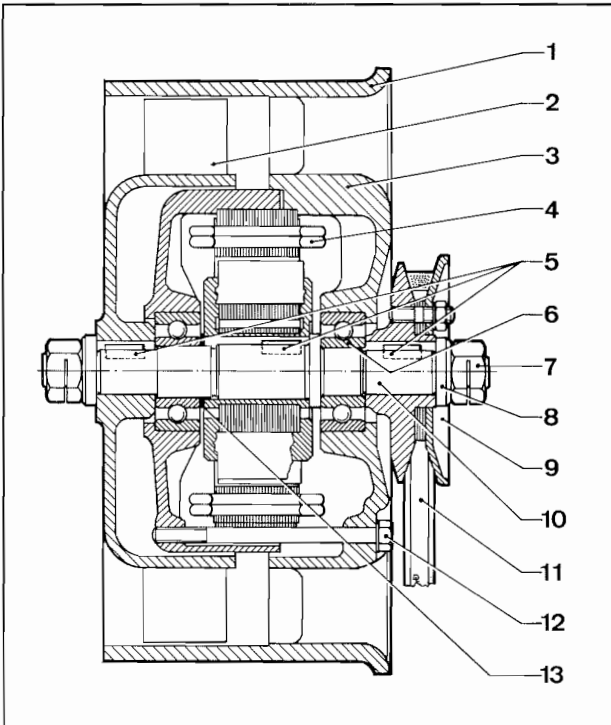
Tension check

A 4 Kg. load located halfway between the pulleys should cause the belt to deflect 5 ÷ 15 mm.



Blower assembly

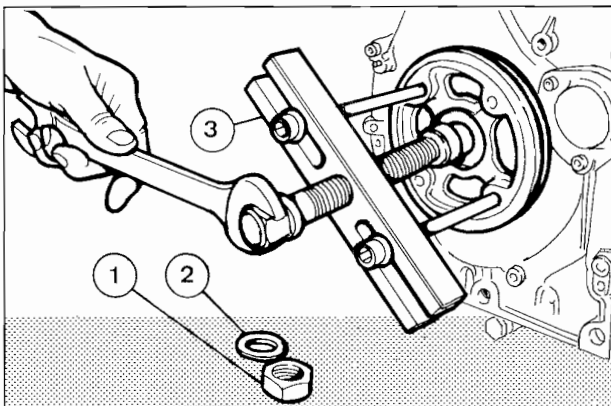
Data plate and voltage regulator are fixed outside the blower housing. A 14A or 21A alternator is housed inside the blower housing. See Page 50 and 51 for the alternator technical data. See Page 6 for the cooling air volume.



Blower assembly components

- 1 Blower housing
- 2 Fan
- 3 21A alternator bell
- 4 21A alternator
- 5 Key
- 6 Ball bearing
- 7 Nut
- 8 Washer
- 9 Pulley
- 10 Shaft
- 11 Belt
- 12 Bolt
- 13 Shim

Note: The 14A alternator thickness is smaller compared to the 21A alternator; furthermore, the 14A alternator is housed inside a different type of bell and features a spacer in place of shim. 13.



Crankshaft pulley

Components:

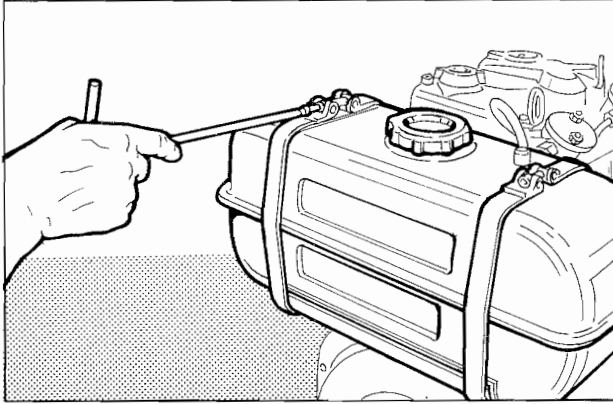
- 1 Nut
- 2 Washer
- 3 Puller, Part No. 7271-3595-048

Loosen the nut and remove the pulley using the puller. The pulley has reference marks for the top dead center and the injection timing (See Page 48). Check pulley hub surface close to the oil seal ring, and if necessary, polish with a fine grain emery cloth. When reassembling apply a few drops of Loctite 270 on the crankshaft thread and tighten nut at 30 Kgm.

Note: The crankshaft end play can be checked only after tightening the pulley.

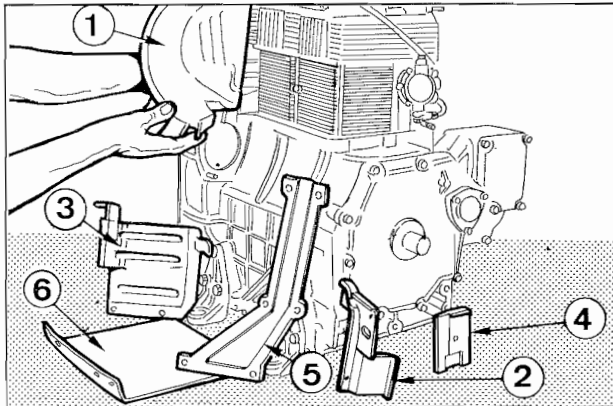
VII

DISASSEMBLY AND REASSEMBLY



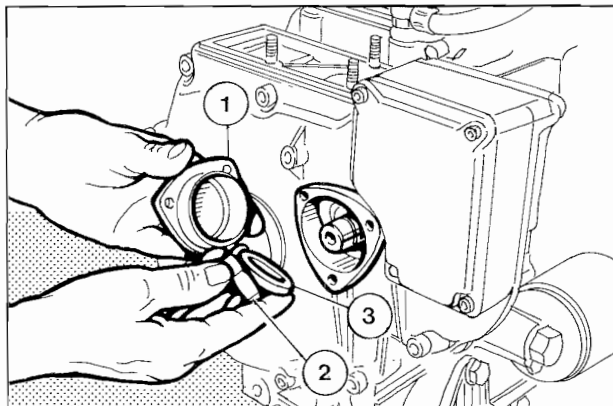
Tank

Remove fuel filter and loosen clamp screws. Completely empty the tank and check that no impurities are found inside. Check that cap breather is not clogged. When refitting fix gasket to the tank bracket by using Loctite IS 495. See Page 43 for refitting fuel filter.



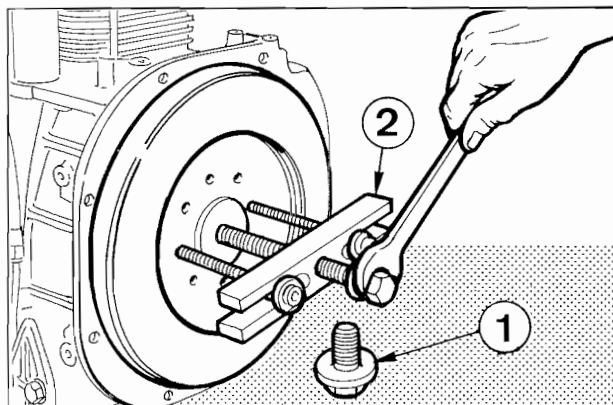
Air shroud and plates

By means of plates 2, 3 and 4 the air shroud 1 sends air to the cylinders for cooling purposes; by means of plates 5 and 6 it also conveys air to the crankcase and the oil pan for cooling oil.



Gear cover timing side

Before removing the gear cover remove cover 1, nut 2 and washer 3. Check crankshaft oil seal and replace if warped, hardened or worn. When refitting replace gear cover gasket and tighten screws at 2.5 Kgm. Tighten the camshaft gear nut 2 at 15 Kgm.

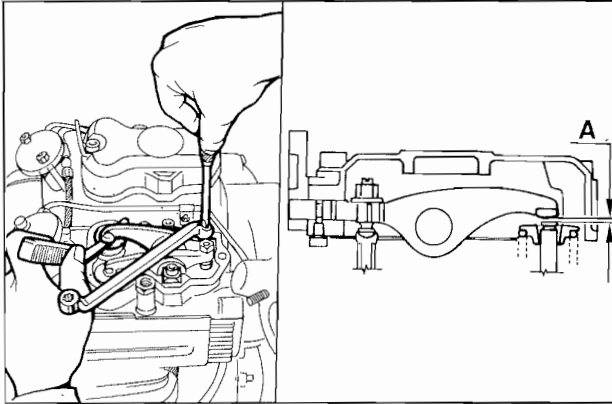


Flywheel

Loosen bolt 1 and remove flywheel with puller 2 (Part. No. 7271-3595-048). Check starter ring gear and tapered crankshaft mating surfaces. When refitting tighten bolt at 30 Kgm.

Note: To replace starter ring gear heat it up to 300°C for 15 minutes. Drive it onto the flywheel carefully checking that it perfectly fits into its seat. Let it cool down slowly.

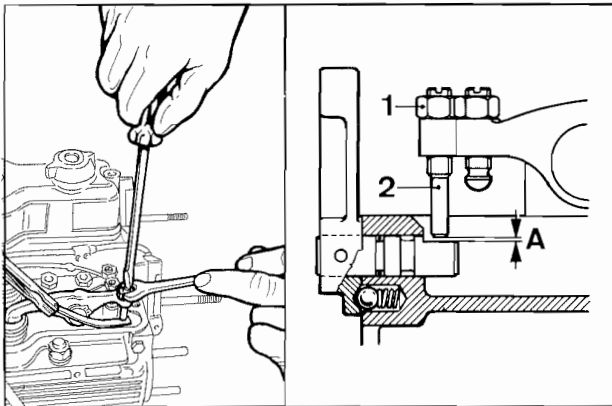




Valve / rocker arm clearance

Remove rocker arm cover and check gaskets for breakage. Setting should be performed when the engine is cold: bringing each cylinder piston to the top dead center on the compression stroke and setting clearance at $0.15 \div 0.20$ mm.

When refitting tighten cover screws to 2 Kgm.

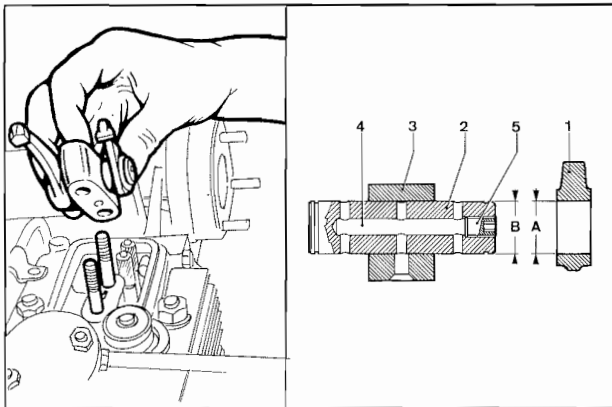


Compression release

Bring piston to top dead center on the compression stroke.

Measure clearance **A** with a thickness gauge.

For setting purposes unscrew nut **1** and set clearance **A** at $0.30 \div 0.40$ mm. by turning screw **2**; finally lock nut **1**.



Rocker arm assembly

Components:

- | | |
|--------------|--------------------------|
| 1 Rocker arm | 2 Shaft |
| 3 Support | 4 Lubrication shaft bore |
| 5 Plug | |

Dimensions:

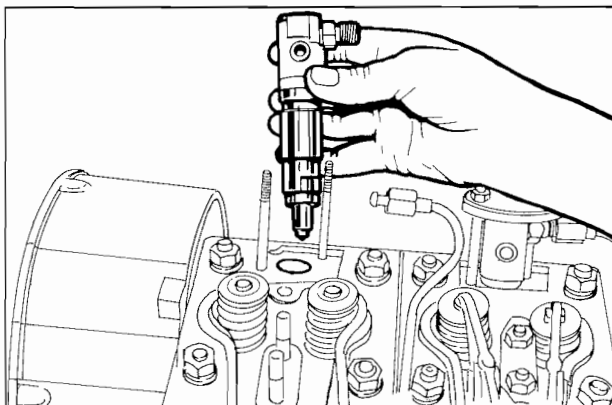
A = $15.032 \div 15.050$

B = $14.989 \div 15.000$

Clearance (mm):

(A-B) = $0.032 \div 0.061$ **(A-B) Limit Value** = 0.120

Note: To clean the lubrication shaft bore unscrew plug **5**. When refitting apply a drop of Loctite 270 on the cap threads before screwing.



Injectors

Disconnect injection lines and remove injectors.

Clean and check calibrated pressure (See Page 49).

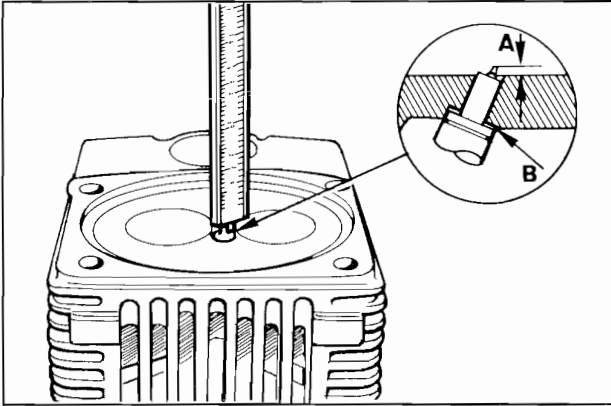
When refitting tighten the fixing nuts at 1 Kgm.

Note: Extreme care should be taken not to loose injector sealing gaskets/shims.

New shims of the same thickness should be installed.

VII

DISASSEMBLY AND REASSEMBLY

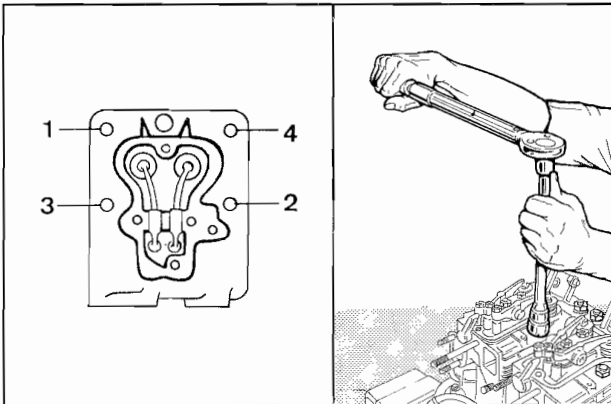


Injector protrusion

Check injector protrusion after removing the cylinder head.

The end of nozzle **A** should protrude 4.0 ÷ 4.5 mm from the cylinder head plane.

Adjust injector projection by means of copper shims **B** measuring 0.5 and 1.00 mm. in thickness.



CYLINDER HEAD

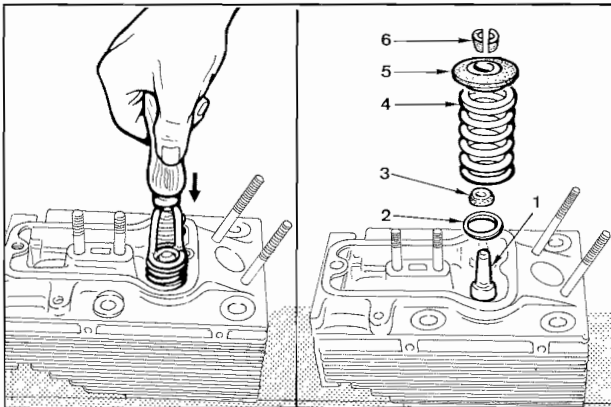
Do not remove when hot to avoid deformation.

If cylinder head is warped level it off by removing a maximum of 0.3 mm of material.

When refitting, tighten only if sure that both heads are in line.

Always replace copper head gasket; see Page 25 for choosing the right thickness.

Progressively tighten nuts in the **1, 2, 3, 4**, sequence at 5 Kgm.



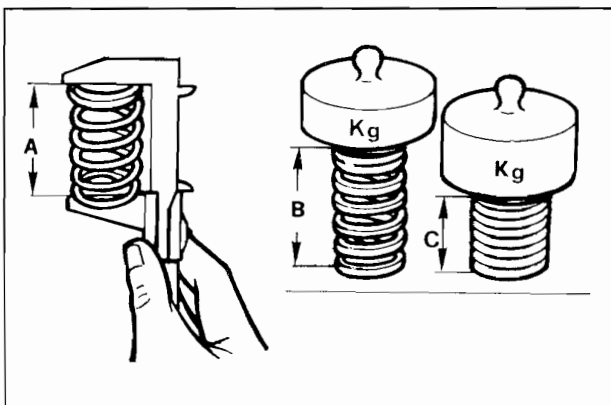
Valves

Components:

- 1** Intake valve
- 2** Spring seat
- 3** Valve stem oil seal
- 4** Spring
- 5** Retainer
- 6** Half collets

To remove half collets firmly press down as shown in the figure.

Note: Valve stem oil seal, **3** must be fitted to the intake valve only.



Valve springs

Measure free length with a gauge.

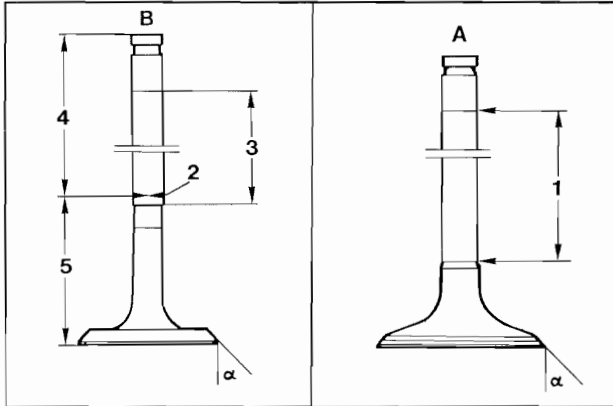
Using a spring tester check that the spring length under two different loads corresponds to the values below.

Free length **A** = 52 mm

Length **B** compressed by a 21 Kg weight = 34.8 mm

Length **C** compressed by a 32 Kg weight = 25.8 mm





Valve material

Intake valves A

Material: X 45 Cr Si 8 UNI 3992

1 Chromium-plated portion

α $45^{\circ}15' \div 45^{\circ}25'$

Exhaust valve B

Shaft and head are made of 2 different materials.

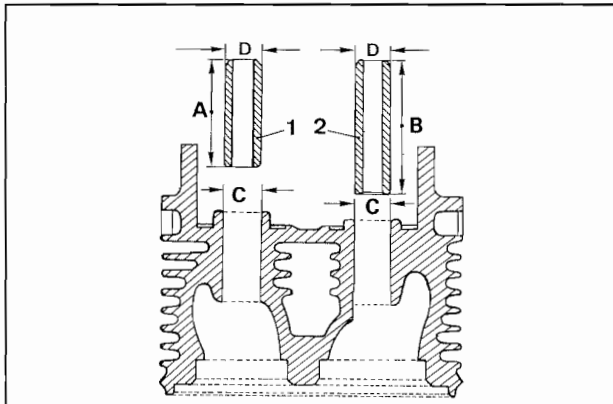
2 Welded portion

3 Chromium-plated portion

4 Portion made of X 45 Cr Si 8 UNI 3992

5 Portion made of X 70 Cr Mn Ni N 216 UNI 3992

α $45^{\circ}15' \div 45^{\circ}25'$



Valve guides and cylinder head

Intake and exhaust valve guides are both made of phosphoric cast iron.

Components:

1 = Exhaust valve guide

2 = Intake valve guide

Dimensions (mm)

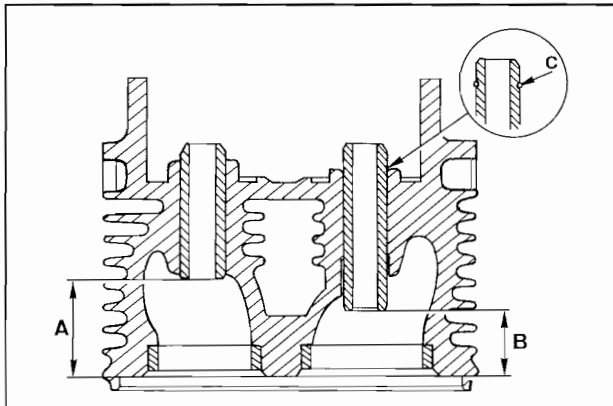
A = 42.00

B = 48.50

C = $14.000 \div 14.018$

D = $14.050 \div 14.060$

Valve guides with outside diameter increased by 0.5 mm. are also available; in such cases valve guide bore C should be increased by 0.5 mm.



Valve guide insertion

Heat cylinder head up to $160 \div 180^{\circ}\text{C}$

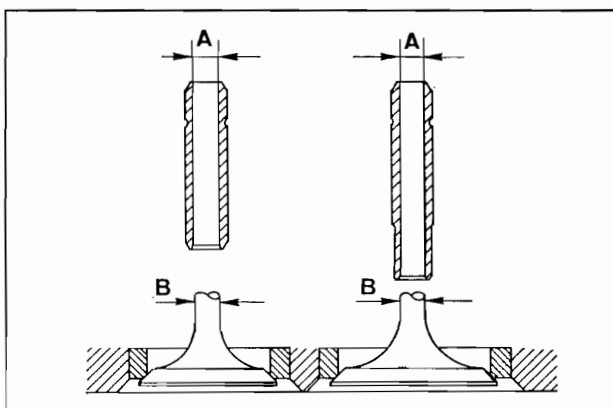
Press guides considering the A and B distances from the head plane.

Dimensions (mm):

A = $30.80 \div 31.20$

B = $24.80 \div 25.20$

Note: If guides are seated with stop ring C, first locate the ring in place and then position guides without considering A and B.



Dimensions and clearance between guides and valves (mm)

A = $8.030 \div 8.060$

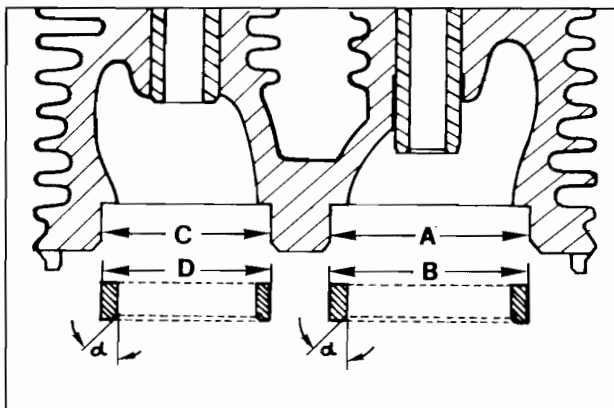
B = $7.985 \div 8.000$

(A-B) = $0.030 \div 0.060$

(A-B) limit value = 0.15

VII

DISASSEMBLY AND REASSEMBLY



Valve seats and cylinder head

Dimensions (mm.):

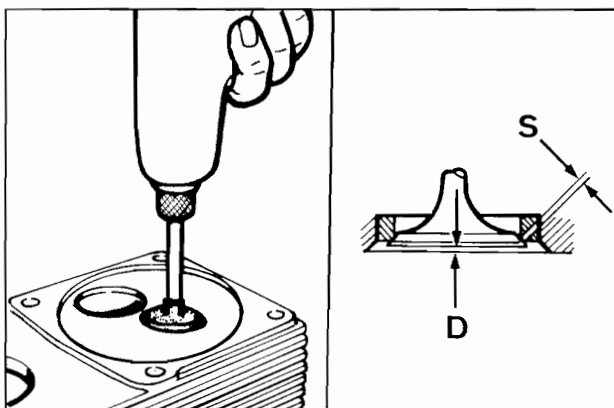
A = 41.990 ÷ 42.020 (intake valve housing dia.)

B = 42.120 ÷ 42.140 (intake valve seat dia.)

C = 35.990 ÷ 36.020 (exhaust valve housing dia.)

D = 36.120 ÷ 36.140 (exhaust valve seat dia.)

Press valve seats into the housing and cut α at 45°

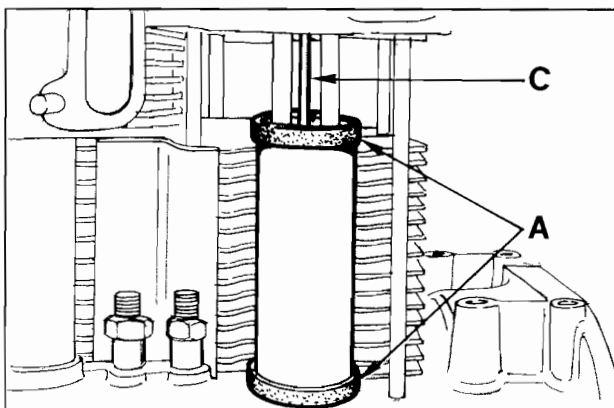


Valve seat lapping

After cutting lap valve seats with fine emery paste in oil suspension. (Lapping compound)

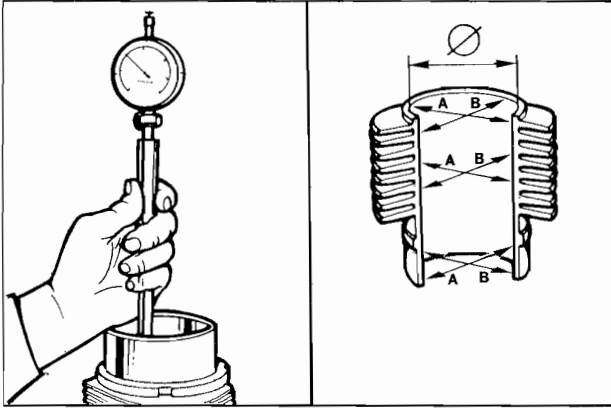
The sealing surface **S** should not exceed 2 mm.

Valve recess after lapping **D** = 0.75 ÷ 1.25 mm; maximum worn limit 1.65 mm.



Pushrod tube

When refitting check that gaskets **A** and rocker arm lubrication tube **C** are inside their seats.



CYLINDER

Measure diameter between two diametrically opposed points at three different heights.

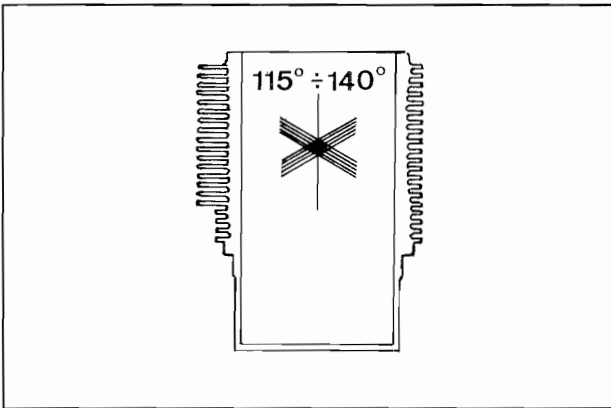
For 8LD600-2 $\varnothing = 90.00 \div 90.02$ mm

For 8LD665-2 and 8LD665-2/L $\varnothing = 95.00 \div 95.02$ mm.

For 8LD740-2 $\varnothing = 100.00 \div 100.02$ mm

In case wear exceeds 0.10 mm bore the cylinder and fit oversize piston and rings.

In case of less wear replace piston rings only.



Checks and cylinder roughness

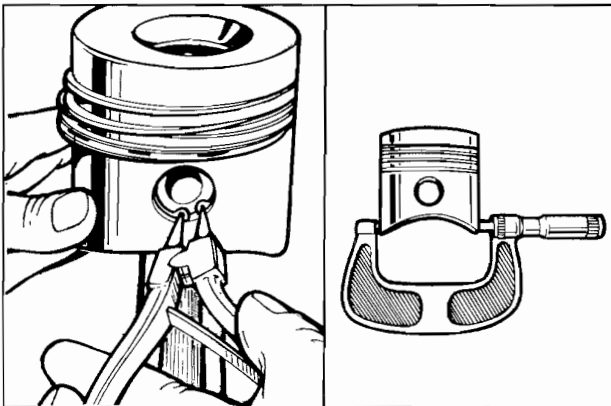
The cylinder should show no blowholes or porosity.

Seal both ends of cylinder and pressurize with compressed air at 4 Bar for 30 secs. Immerse in water and check for leakage.

Fins must be intact.

Cross hatch pattern must range between $115^\circ \div 140^\circ$: they must be uniform and clear in both directions.

Average roughness should range between 0.5 and 1 μm .



PISTON

Remove circlips and remove piston pin.

Remove piston rings and clean grooves.

Measure diameter at 2 mm from the bottom of skirt.

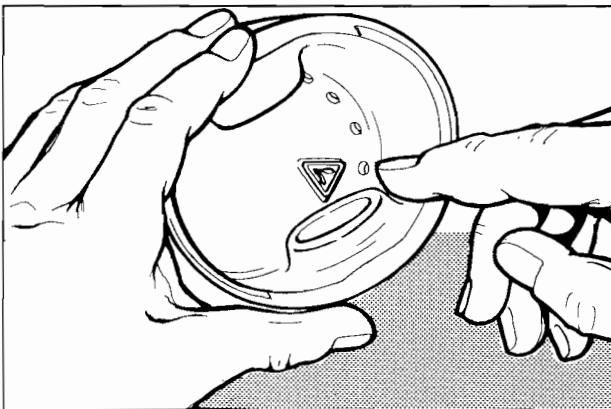
For 8LD600-2 $\varnothing = 89.840 \div 89.850$ mm

For 8LD665-2 and 8LD665-2/L $\varnothing = 94.920 \div 94.940$ mm

For 8LD740-2 $\varnothing = 99.800 \div 99.810$ mm

In case of diameter wear above 0.05 mm replace piston and piston rings.

Note: Oversize pistons of 0.5 and 1.0 mm. are available.



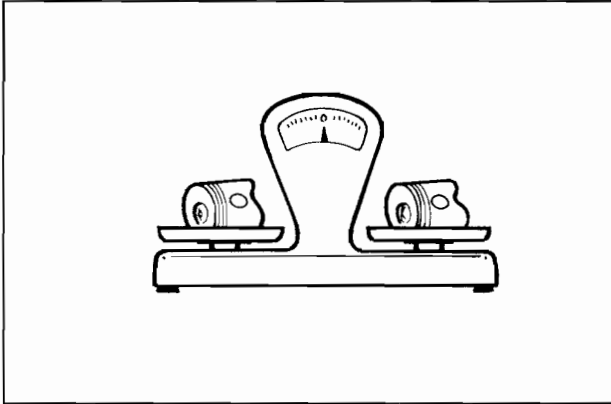
Checking that piston is an original part

When replacing piston as well as any other engine component check that spare parts are original.

The logo confirming this is stamped inside.

VII

DISASSEMBLY AND REASSEMBLY



Piston weight

Weigh pistons when replacing them in order to avoid unbalance. The difference in weight should not exceed 6 g.



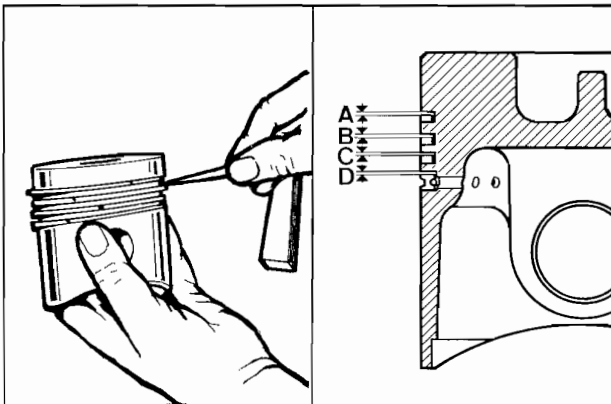
Piston rings - End gaps (mm)

Place piston rings squarely into the unworn part of the lower cylinder and measure the end gap.

1st chromium-plated ring	A = 0.40 ÷ 0.65
2nd torsional (internal tapered) ring	A = 0.40 ÷ 0.65
3rd torsional (internal tapered) ring	A = 0.40 ÷ 0.65
4th oil control ring	A = 0.30 ÷ 0.60

Note: 8LD600-2 and 8LD740-2 pistons feature 4 piston rings; 8LD665-2 and 8LD665-2/L pistons have 3 piston rings (one internal tapered ring missing).

In 8LD600-2 the 3rd ring is stepped (see below).



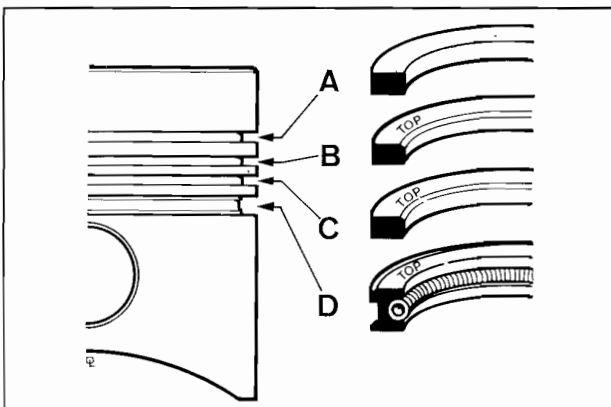
Piston rings - Clearance between grooves (mm)

For 8LD600-2 and 8LD740-2

A	= 0.110 ÷ 0.147; limit value = 0.250
B	= 0.060 ÷ 0.097; limit value = 0.190
C	= 0.060 ÷ 0.097; limit value = 0.190
D	= 0.050 ÷ 0.090; limit value = 0.180

For 8LD665-2 and 8LD665-2/L

A	= 0.070 ÷ 0.110; limit value = 0.220
B	= 0.050 ÷ 0.090; limit value = 0.180
D	= 0.040 ÷ 0.080; limit value = 0.170

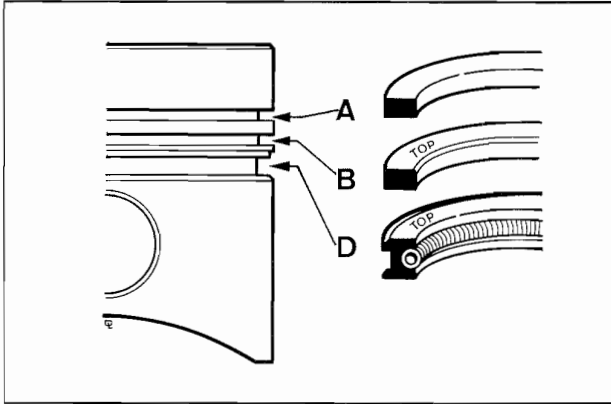


Piston rings - Fitting sequence 8LD600-2 and 8LD740-2

- A** = 1st chromium-plated ring
- B** = 2nd torsional (internal tapered) ring for 8LD740-2, with rectangular section for 8LD600-2
- C** = 3rd torsional (internal tapered) ring for 8LD740-2 and stepped for 8LD600-2
- D** = 4th oil control ring

Note: Before fitting the piston into the cylinder stagger the ring gaps at approximately 90°.

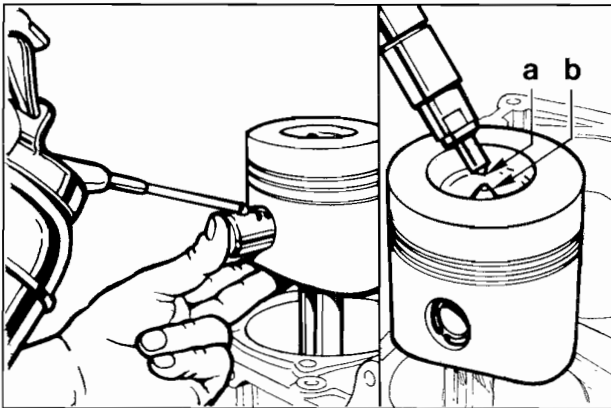




Piston rings - Fitting sequence (8LD665-2 and 8LD665-2/L)

- A = 1st chromium-plated ring
- B = 2nd torsional (internal tapered) ring
- D = 3rd oil control ring

Nota: Before fitting the piston into the cylinder stagger the ring gaps at approximately 120°.

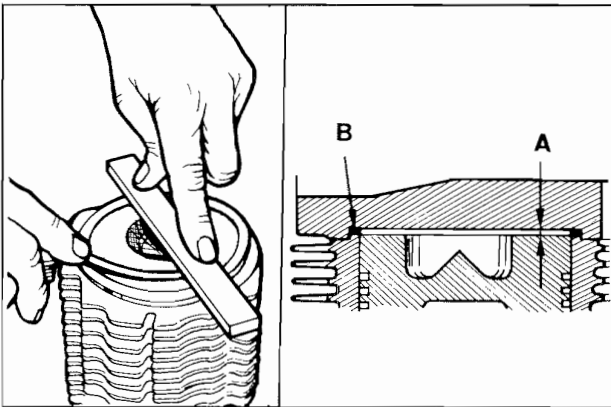


Piston - Refitting

Connect piston to connecting rod in a way that the combustion chamber center **b** is directly under nozzle tip **a**.

Lubricate piston pin and introduce it into the piston by exerting pressure with your thumb.

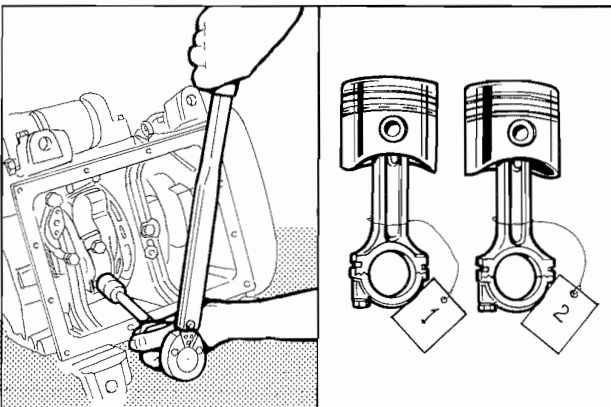
Check that both circlips are well inside their seats.



Piston clearance

- A = Piston clearance
- B = Copper head gasket

A (0.75 ÷ 0.80 mm) is determined by placing the piston at top dead center and measuring with a feeler gauge and straight edge, the distance the piston is below or above the cylinder face. **B** copper gasket (available in various thicknesses) is then selected to ensure clearance is correct. Gaskets are available in the following thicknesses: 0.45; 0.50; 0.55; 0.60; 0.65; 0.70; 0.75; 0.80; 0.85; 0.90; 0.95; 1.00; 1.05; 1.10; 1.15 mm.



CONNECTING ROD

Remove oil pan and internal oil screen.

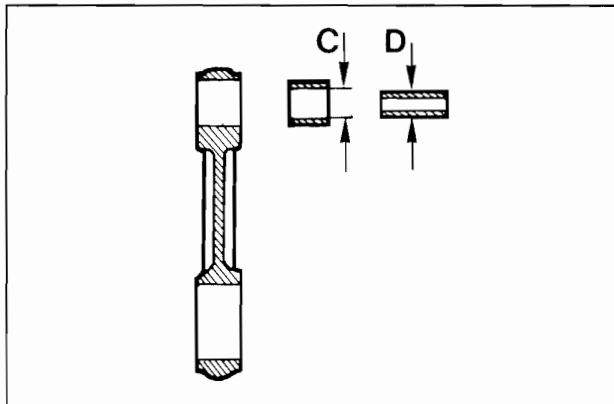
Straighten locking tab and unscrew connecting rod, big end bolts.

Both connecting rod/piston units should be fitted back into the corresponding cylinders; mark them to avoid mistakes.

See Page 26 for specifications as to the tightening of connecting rod big end bearing.

VII

DISASSEMBLY AND REASSEMBLY



Connecting rod small end bearing and pin

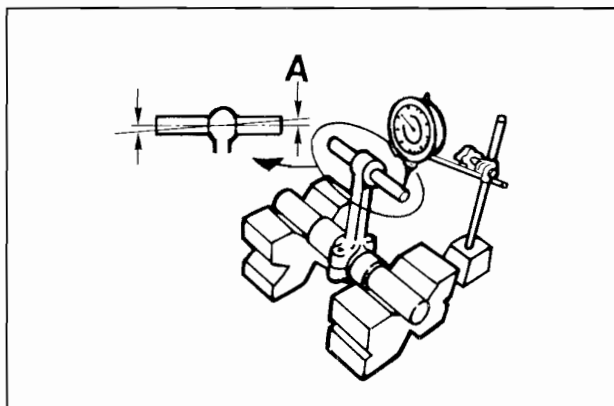
Dimensions (mm):

C = 28.020 ÷ 28.030 (with machined bushing in place)

D = 27.995 ÷ 28.000

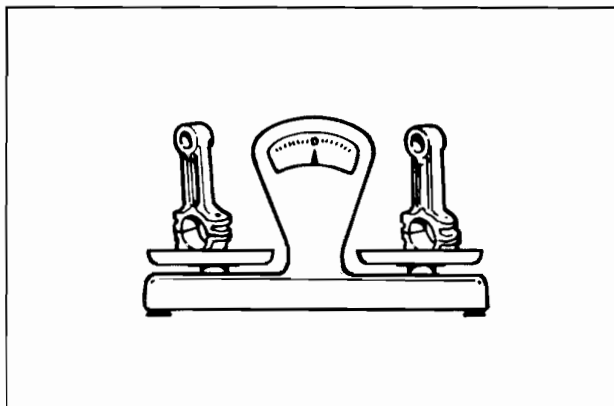
Clearance (mm):

(**C-D**) = 0.020 ÷ 0.035 (**C-D**) limit value = 0.070



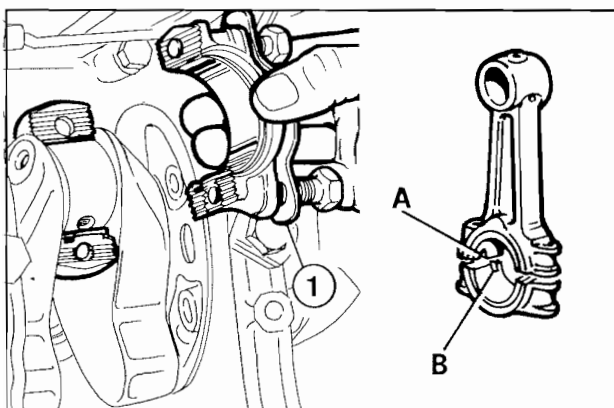
Connecting rod alignment

Check alignment of small end and big end bearing bores using fitted mandrels; axial misalignment **A** = 0.02 mm; maximum limit 0.05 mm.



Connecting rod weight

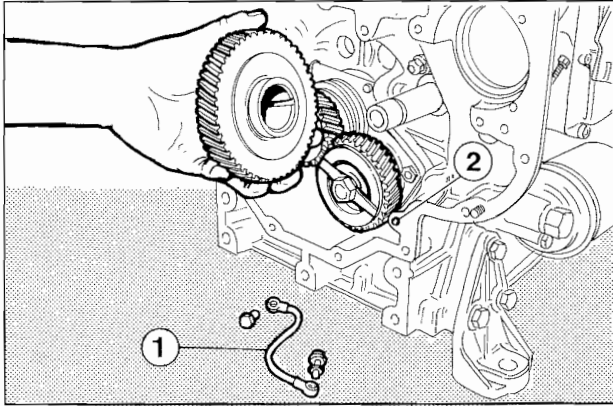
Weigh connecting rods when replacing them in order to avoid unbalance. The difference in weight should not exceed 10 g.



Connecting rod big end bearing

Both locating notches **A** and **B** must be on the same side when refitting. Tighten bolts at 5 Kgm and close locking tab. See Page 30 for dimensions.





Camshaft gear

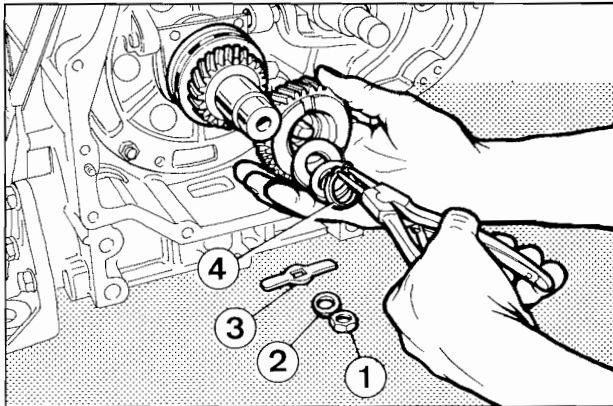
Remove lubrication tube **1**, if any, and remove camshaft gear. The cylindrical type of coupling makes gear removal easier since no puller is required.

See Page 18 for nut tightening.

See Page 33 for timing.

Note: When hydraulic pump is not assembled on engine, also tube **1** has not to be fitted.

In this case be sure there is a cap on hole **2**.

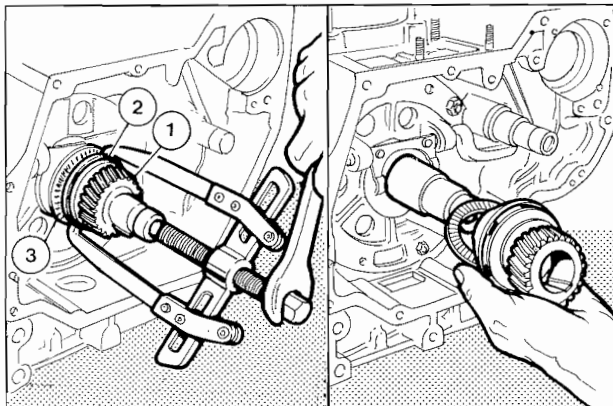


Oil pump gear

Besides driving the oil pump via coupling **3**, this gear connects the crankshaft gear with the camshaft gear. Remove nut **1**, washer **2**, coupling **3** and circlip **4**.

When refitting match the two timing marks with those of the crankshaft gear and camshaft gear.

Tighten nut **1** at 4 Kgm.



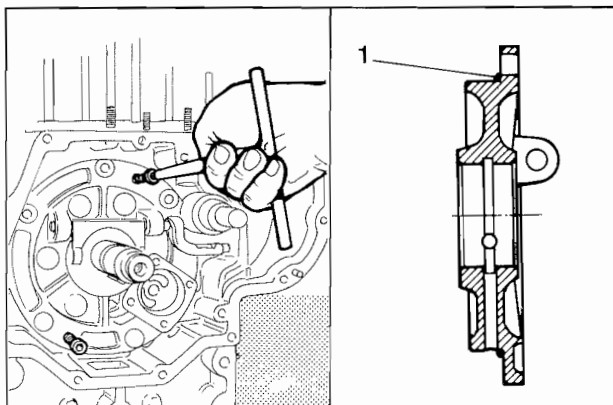
Crankshaft gear

Components:

- 1** Crankshaft gear
- 2** Governor crankshaft gear bell
- 3** Thrust bearing

The crankshaft gear can be extracted together with the governor using a puller for bearings.

Clamp with both puller ends behind governor bell **2**. Move thrust bearing **3** to prevent it from becoming damaged.



Main bearing support, gear side

Remove main bearing by means of two M8x1.25 screws with fully threaded length of 30 mm.

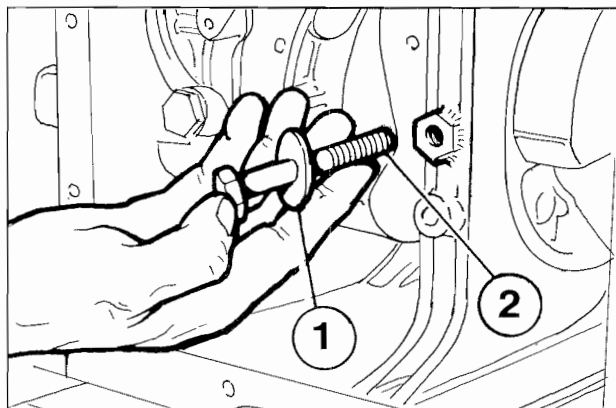
When refitting check that oil seal ring **1** is well inside its seat.

See page 31 for dimensions.

Engines for generator sets have different supports (see Page 36).

VII

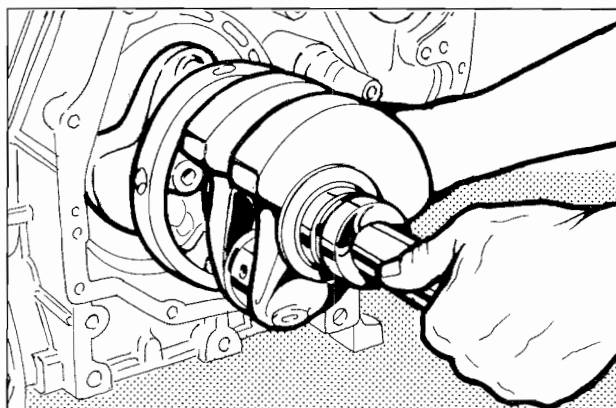
DISASSEMBLY AND REASSEMBLY



CRANKSHAFT

Center main bearing support, locating bolt

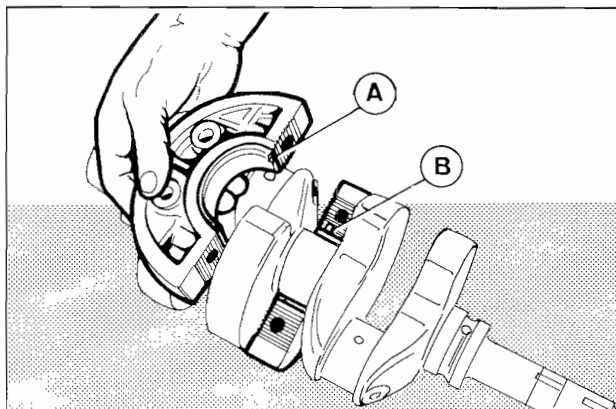
Straighten locking tab 1 and unscrew bolt 2 before removing crankshaft.



Crankshaft removal

To remove the crankshaft tap lightly on the flywheel side end using a soft-headed hammer.

When refitting align center main bearing support so that the locating bolt hole coincides with the crankcase hole.



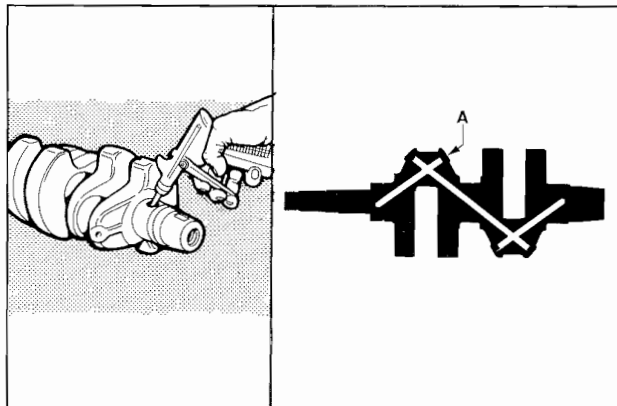
Crankshaft center main bearing support

When refitting, both locating notches **A** and **B** must be located on the same side.

Tighten screws at 2.5 Kgm.

See Page 31 for dimensions.

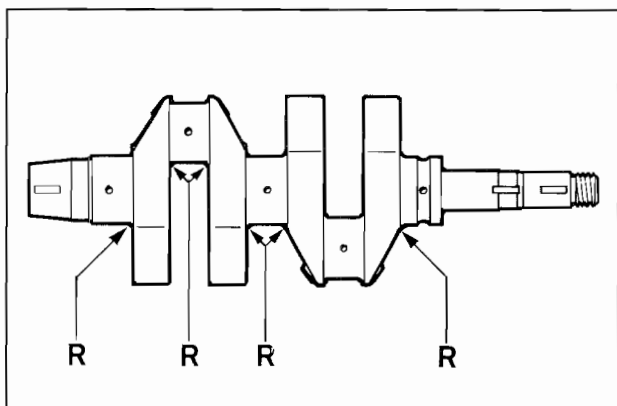




Crankshaft lubrication ducts

Remove plugs, clean duct **A** with a pointed tool and blow in compressed air.

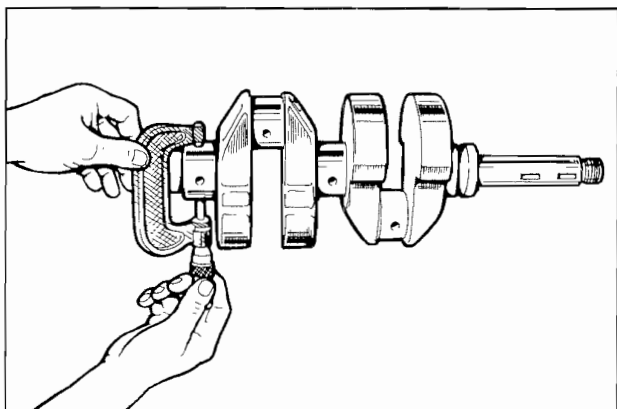
Screw plugs back in place and check for sealing.



Crankshaft journal radii

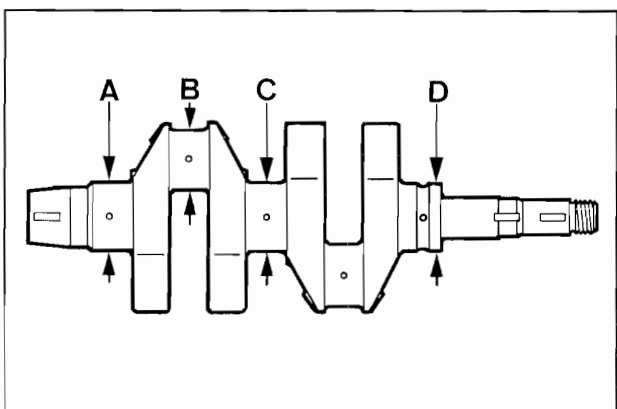
The radius **R** connecting journals to shoulders is $2.8 \div 3.2$ mm.

Note: When grinding main journals or crank pins restore the **R** value to original specification.



Checking main journals and crank pins

Use an outside micrometer gauge



Main journal and crank pin diameter (mm)

A = $54.930 \div 54.950$

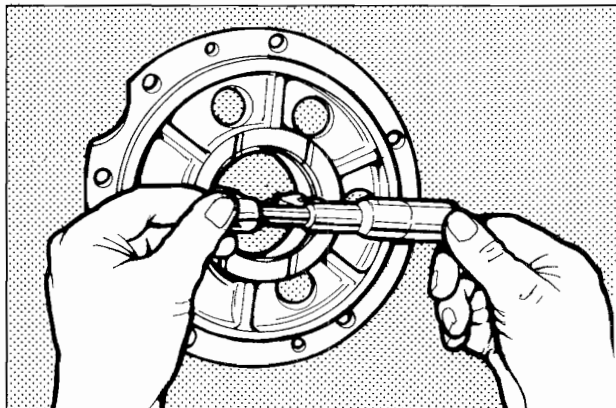
B = $49.989 \div 50.000$

C = $55.340 \div 55.350$

D = $54.930 \div 54.950$

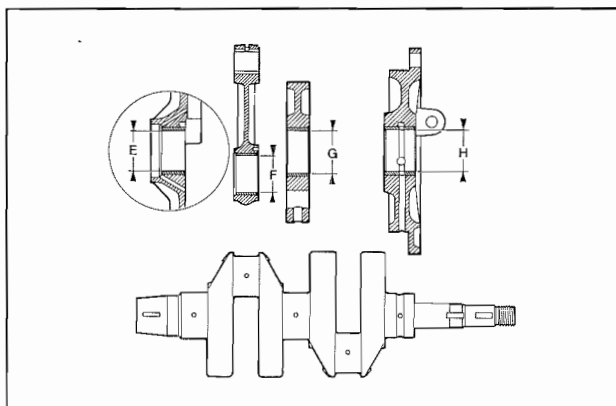
VII

DISASSEMBLY AND REASSEMBLY



To measure main bearing inside diameter

Use an inside micrometer gauge



Main bearing and connecting rod big end bearing inside diameter

Dimensions (mm):

E = 55.000 ÷ 55.020

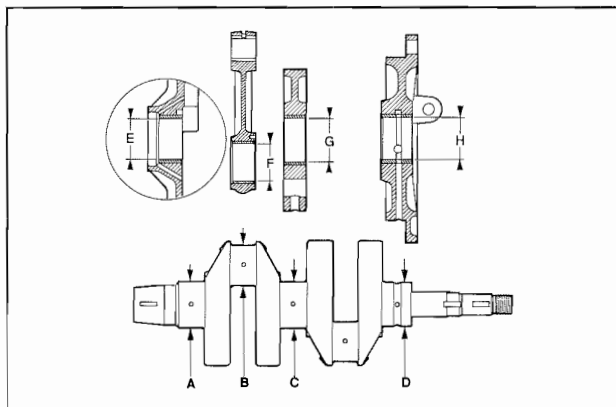
F = 50.035 ÷ 50.066

G = 55.404 ÷ 55.435

H = 55.000 ÷ 55.020

The above dimensions refer to installed or tightened bearings.

Note: Both main bearings and connecting rod big end bearings are available with inside diameter size measuring 0.25 and 0.50 mm less than the standard version.



Clearance between main journals/crank pins and connecting rod bearings (mm)

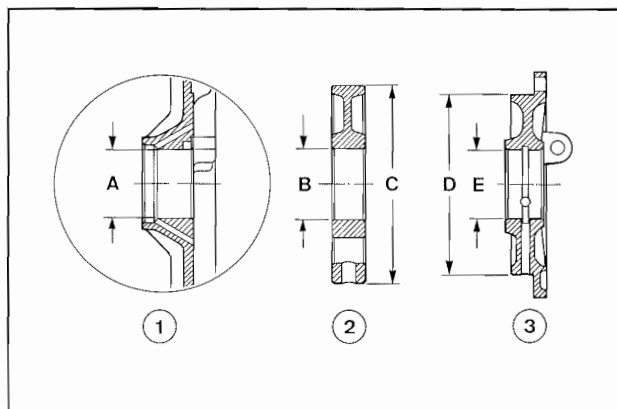
(E-A) = 0.050 ÷ 0.084; limit value = 0.160

(F-B) = 0.035 ÷ 0.077; limit value = 0.150

(G-C) = 0.051 ÷ 0.094; limit value = 0.190

(H-D) = 0.050 ÷ 0.084; limit value = 0.160





Main bearing supports

1 Flywheel side

2 Center

3 Gear side

Dimensions (mm)

A = $60.000 \div 60.020$

B = $59.074 \div 59.093$

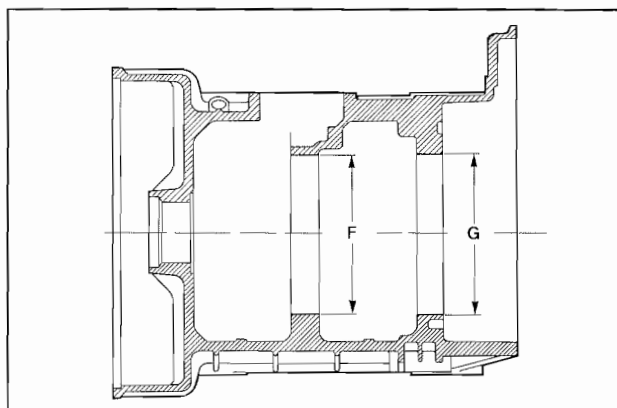
C = $155.000 \div 155.017$

D = $156.980 \div 157.000$

E = $60.000 \div 60.020$

Note: Flywheel side support 1 is part of the crankcase and cannot be pulled out.

If, due to seizure, the housing of bearing support 1 is damaged, increase diameter A by 1 mm and fit a bearing with 1 mm larger outside diameter, available from your dealer.

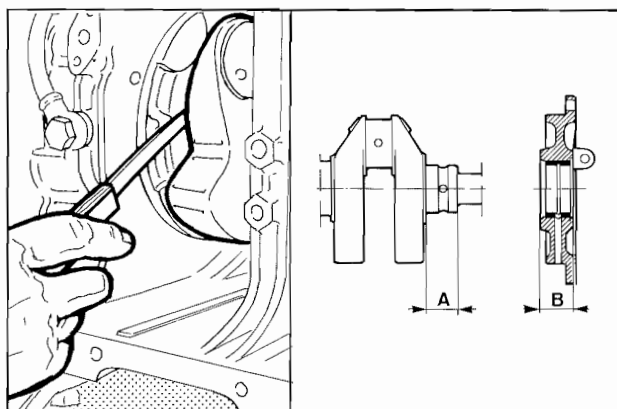


Main bearing housings

Dimensions (mm):

F = $155.000 \div 155.025$

G = $157.000 \div 157.025$



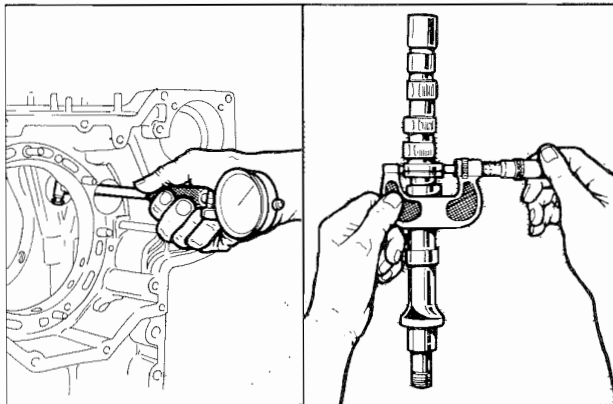
Crankshaft end play

Dimensions (mm):

A = $34.10 \div 34.15$

B = $33.90 \div 33.95$

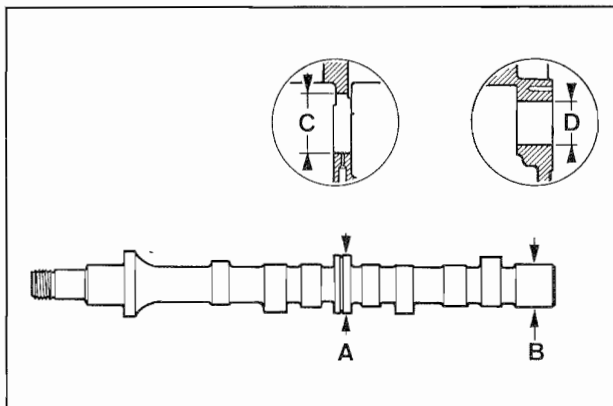
Check crankshaft end play after refitting the crankshaft pulley and tightening its nut at 30 Kgm; the crankshaft end play is equal to $0.15 \div 0.25$ mm and is not adjustable. If this value cannot be obtained check A and B, and possibly replace the parts whose size is inadequate.



CAMSHAFT

To measure camshaft journal and housings

Use an inside micrometer gauge for housings and an outside micrometer gauge for journals.



Dimensions of camshaft journals and housings (mm)

A = 40.940 ÷ 40.960

B = 29.940 ÷ 29.960

C = 41.000 ÷ 41.025

D = 30.000 ÷ 30.025

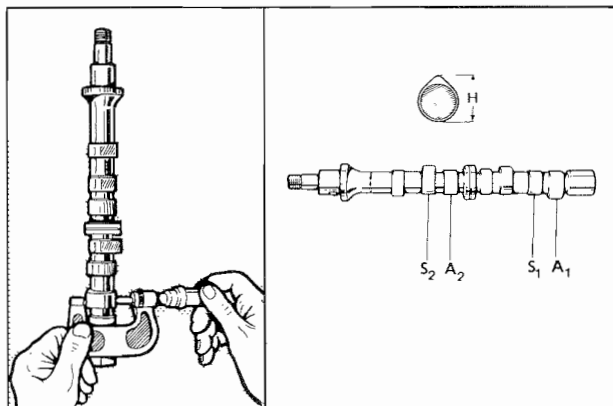
Clearance (mm)

(C-A) = 0.040 ÷ 0.085;

(C-A) limit value = 0.170

(D-B) = 0.040 ÷ 0.085;

(D-B) limit value = 0.170



Intake/exhaust lobe height

A₁ = 1st cylinder intake cam

S₁ = 1st cylinder exhaust cam

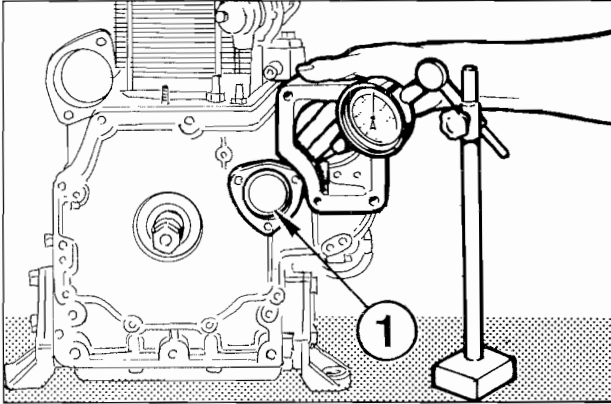
A₂ = 2nd cylinder intake cam

S₂ = 2nd cylinder exhaust cam

Exhaust and intake cams feature the same height H.

H = 34.02 ÷ 34.07 mm

Replace camshaft if wear has caused H to exceed the above minimum value by 0.1 mm.

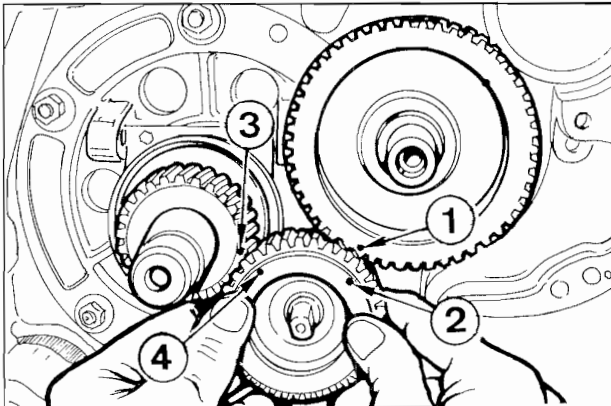


Camshaft end play

Check camshaft end play after removing cylinder head, injection pump and fuel feed pump from the engine. Camshaft end play should be $0.10 \div 0.32$ mm but is not adjustable.

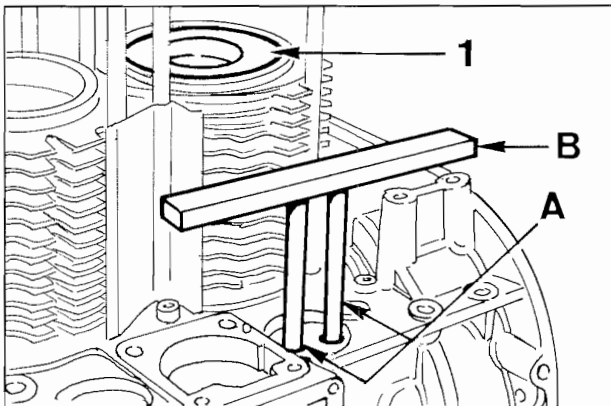
Check that cover 1 screws and thrust plate bolts inside the gear cover are tightened at 2.5 Kgm.

Place the dial gauge on the camshaft gear outer part; push and pull the gear as required.



Camshaft timing

Fit camshaft gear by making timing mark 2 coincide with timing mark 1 on the camshaft gear and timing mark 4 with timing mark 3 on the crankshaft gear.



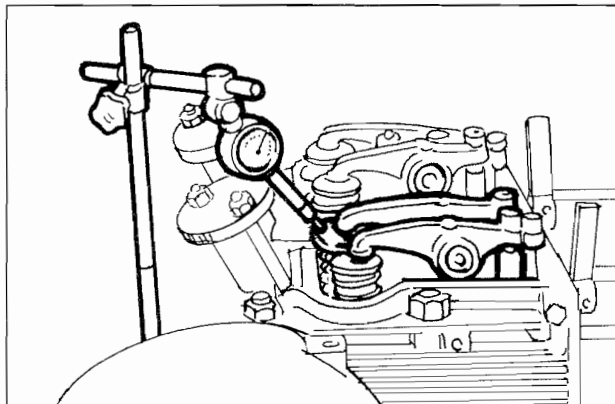
Valve timing without considering timing marks

Locate piston 1 (on flywheel side) at the top dead center. Position two small cylinders A of the same height onto the tappets. Rotate camshaft stopping when cylinder 1 tappets are in overlap position.

By means of straight edge B check that tappets are at the same height. Place oil pump gear between crankshaft and camshaft gear.

VII

DISASSEMBLY AND REASSEMBLY



Valve timing check

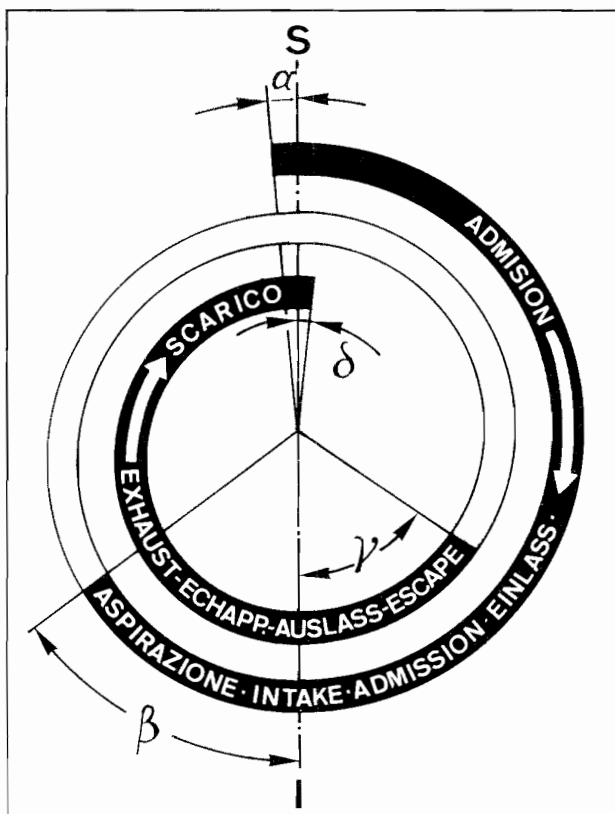
Check valve timing at the crankshaft. The values shown are checked at the flywheel circumference (with flywheel of 291 mm. diameter each degree corresponds to 2.5 mm).

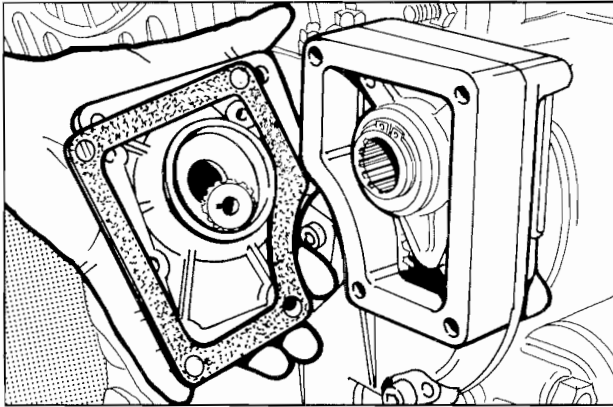
Set valve clearance at $0.65 \div 0.70$ mm (after checking restore the value at $0.15 \div 0.25$).

Set dial gauge on intake valve to a zero value; by rotating the crankshaft according to its direction of rotation you can measure α (intake valve opening advance relative to top dead center S) and β (intake valve closing delay relative to bottom dead center I).

Follow the same procedure for exhaust valves checking γ (exhaust valve opening advance) and δ (exhaust valve closing delay).

$\alpha = 2^\circ$
 $\beta = 34^\circ$
 $\gamma = 34^\circ$
 $\delta = 2^\circ$





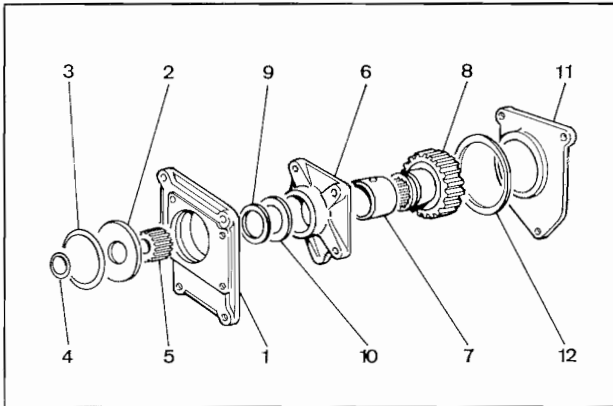
Hydraulic pump p.t.o.

Hydraulic pumps of group 1 or 2 can be installed on the 3rd p.t.o.

Note: The maximum torque from the 3rd p.t.o. is 4 Kgm i.e. 14 HP at 2540 r.p.m. for 3000 r.p.m. engines and 12 HP at 2200 r.p.m. for 2600 r.p.m. engines.

Reduction ratio: 1:1.18

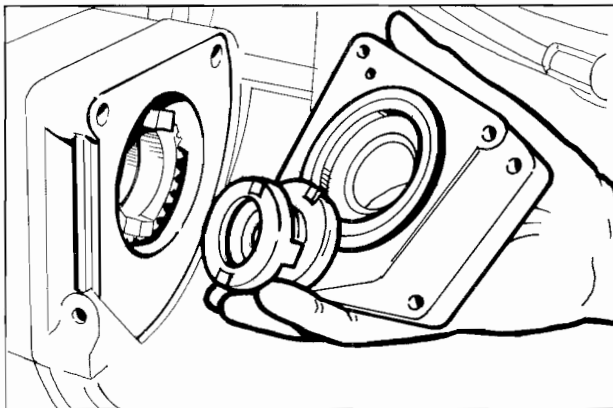
The figure shows details of a group 1 hydraulic drive for the 3rd p.t.o.



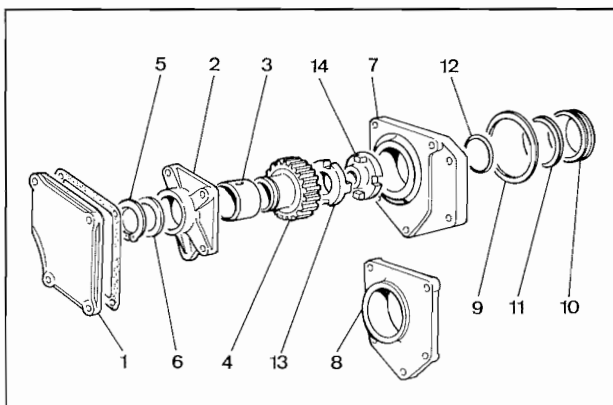
Hydraulic pump p.t.o., group 1, for external mounting

Components:

- 1 Pump support
- 2 Centering ring
- 3 Seal ring
- 4 Seal ring
- 5 Pump drive
- 6 Support
- 7 Bearing
- 8 Drive gear
- 9 Circlip
- 10 Washer
- 11 Cover
- 12 Circlip



Hydraulic pump, group 2, for 4th p.t.o.

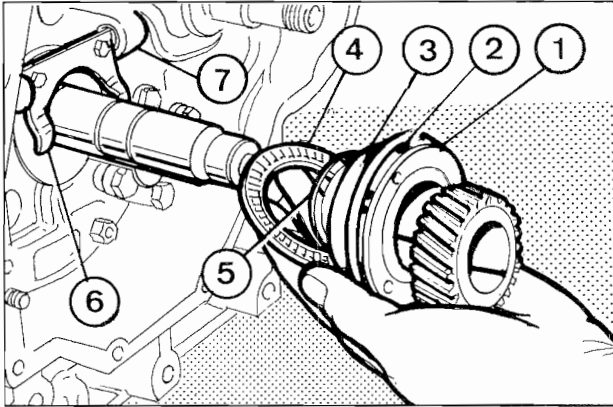


Hydraulic pump mounts, group 1 and 2, for 4th p.t.o.

Components:

- | | |
|----------------------|----------------------|
| 1 Cover | 2 Bracket |
| 3 Bearing | 4 Gear |
| 5 Circlip | 6 Washer |
| 7 Gr. 2 pump support | 8 Gr. 1 pump support |
| 9 Seal ring | 10 Centering ring |
| 11 Seal ring | 12 Seal ring |
| 13 Coupling | 14 Half coupling |

Note: It is possible to install pumps on both the 3rd and 4th p.t.o. - Thus driving two (2) pumps simultaneously.

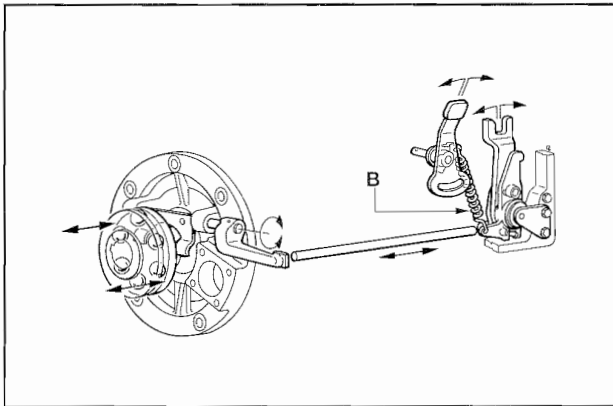


MECHANICAL SPEED GOVERNOR

Ball type, centrifugal governor housed inside the crankcase. The number of balls is a function of the set peak speed: 4 balls are usually provided from 2600 to 3000 r.p.m. while 6 are required below 2600 r.p.m.

Components:

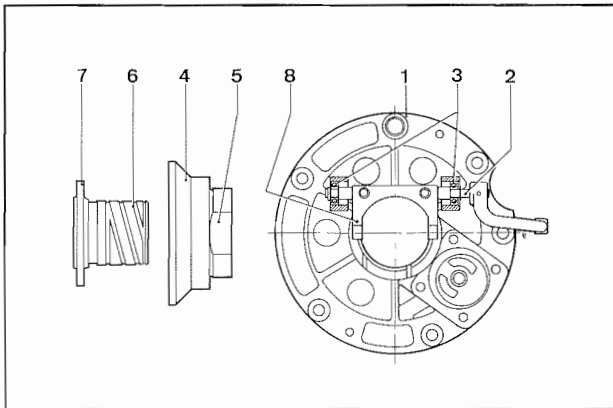
- 1 Fixed bell
- 2 Ball
- 3 Mobile bell
- 4 Thrust washer
- 5 Circlip
- 6 Governor fork
- 7 Bracket



Mechanical speed governor operation

Balls are moved to the periphery of the fixed bell by the centrifugal force and thus axially shift the mobile bell connected to the injection pump rack by a yoke and linkage.

The governor spring **B** placed under tension by the accelerator control offsets the balls centrifugal force. Balance between the two forces keeps speed at an almost constant level in spite of load variations.

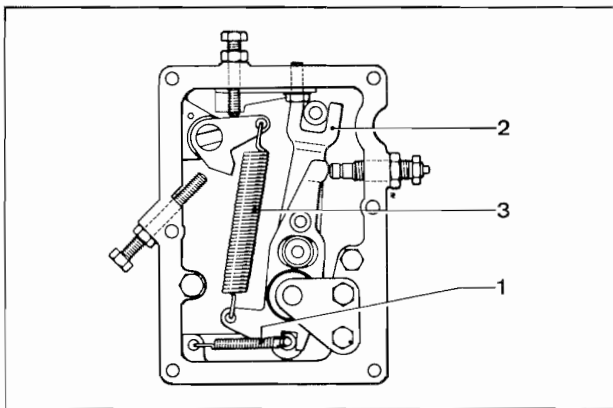


Mechanical speed governor components for special generator sets

Main bearing support 1 has two ball bearings 3. Journal 2 measures 7 mm. in diameter which is suitable for bearings 3.

The mobile bell 4 has two areas 5 where fork 8 blocks become engaged. Sleeve 6 of the fixed bell 7 is grooved.

Note: 1500 r.p.m. engines features a different type of spring **B**. Furthermore, the journal contains three ball bearings.

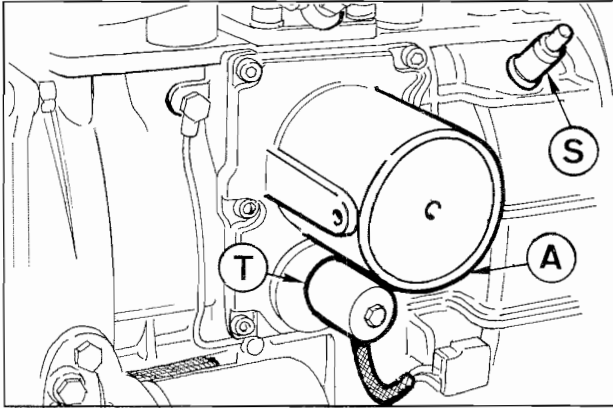


Spring for extra fuel supply at starting

Components:

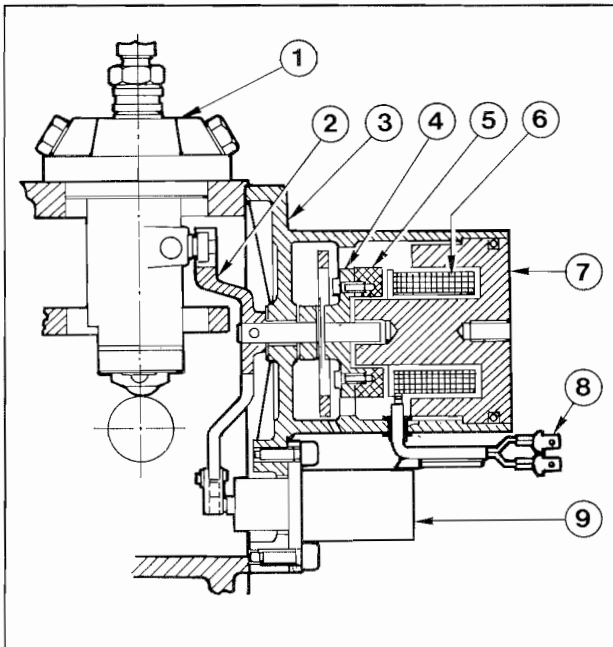
- 1 Extra fuel spring (for starting)
- 2 Injection pump control yoke
- 3 Governor spring

The device is operated automatically: when the engine is stopped spring 1 acts on injection pump control yoke 2 providing maximum fuel delivery, until the engine starts and the governor controls the injection pump rack.

**ELECTRONIC SPEED GOVERNOR**

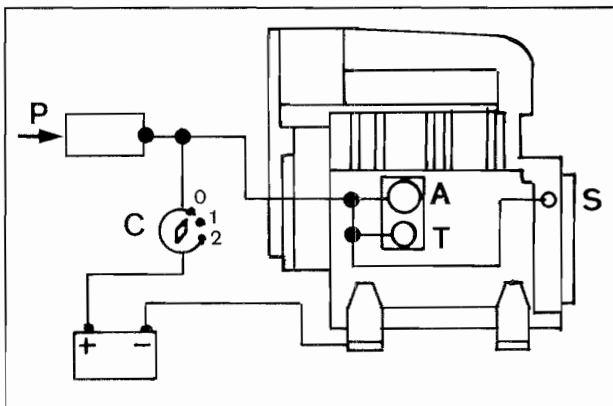
A = Actuator
S = r.p.m. sensor
T = Electromagnet

An electronic speed governor can be fitted upon request. The crankcase features a hole for sensor S introduction.

**Electronic speed governor**

Components:

- 1 Injection pump
- 2 Delivery control level
- 3 Actuator A mounting flange
- 4 Mobile retainer
- 5 Actuator magnet
- 6 Stator coils
- 7 Stator
- 8 Cable ends for connection to control box E (Page 38)
- 9 Electromagnet

**Electronic speed governor layout**

Components: A = actuator; C = key; P = potentiometer; T = electromagnet; S = sensor

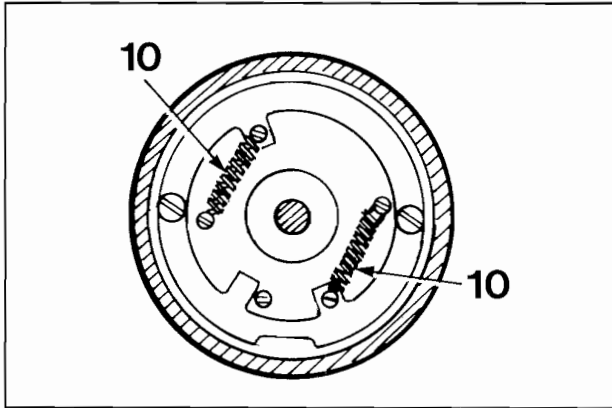
The device consists of an actuator A controlling the injection pump rack, an r.p.m. sensor S and an electromagnet T controlling fuel delivery and supplying extra fuel at starting. Control box E (see Page 38) Controls fuel delivery as a function of the load and of the speed set through potentiometer P.

The potentiometer can be fitted on the control box or on the control panel (see P1 Page 38).

The whole system makes it possible to keep the engine speed constant independently of the load conditions. It detects speed through the r.p.m. sensor mounted on the crankcase at the ring gear level. As the number of revolutions changes the device immediately performs the required corrections by means of the actuator acting on the injection pump. Electromagnet T responds to max. fuel delivery (fuel flow setting) and (when energized) enables the injection pump rack to reach its maximum stroke (extra fuel supplied at starting).

VII

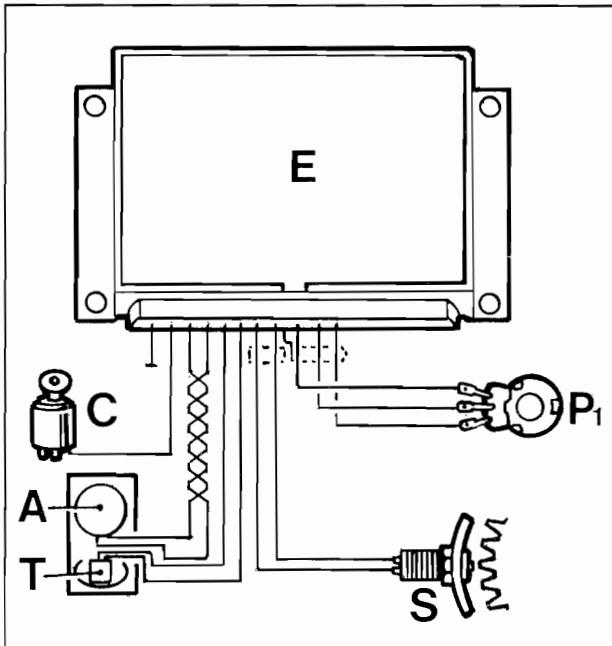
DISASSEMBLY AND REASSEMBLY



Starting with electronic speed governor

(see layout on Page 37)

In position **O** the engine is not working and no part is energized. The rack rod is in stop position (retained by two springs **10** inside actuator **A**). By rotating key **C** to position **2** the electromagnet withdraws allowing the rack rod to reach its highest delivery being connected to the actuator at its max. level of energization. When the engine, immediately after starting, reaches 1000 r.p.m. the controller reduces the actuator position and, after one second, switches off the electromagnet then, 0.5 seconds later, returns to its normal position with engine speed set through potentiometer **P**.



Engine running with electronic speed governor

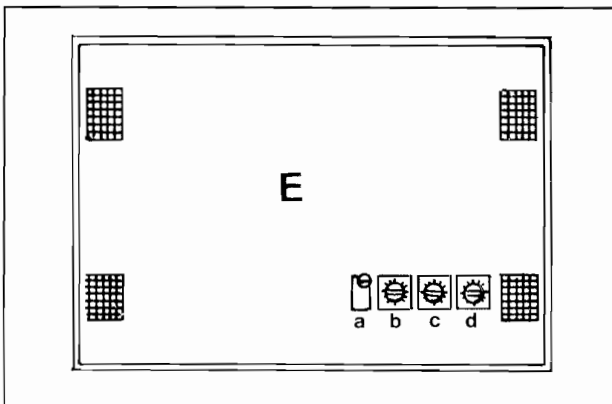
The engine starts running at the pre-set speed.

Potentiometer **P** is located either inside the control box **E** or on control panel **P1**.

In case of an external potentiometer **P1** the engine speed can be set at any point between the idling and full speed in on-load conditions (setting performed on the control box in the test room).

The electronic control box **E** controls actuator **A** (by sending or cutting off the power supply) to keep the speed set through **P1** independently of the absorbed load.

Control box **E** prevents the engine from starting (or stops it) in case of no power supply or in case connection with r.p.m. sensor **S** is broken (or short-circuited).



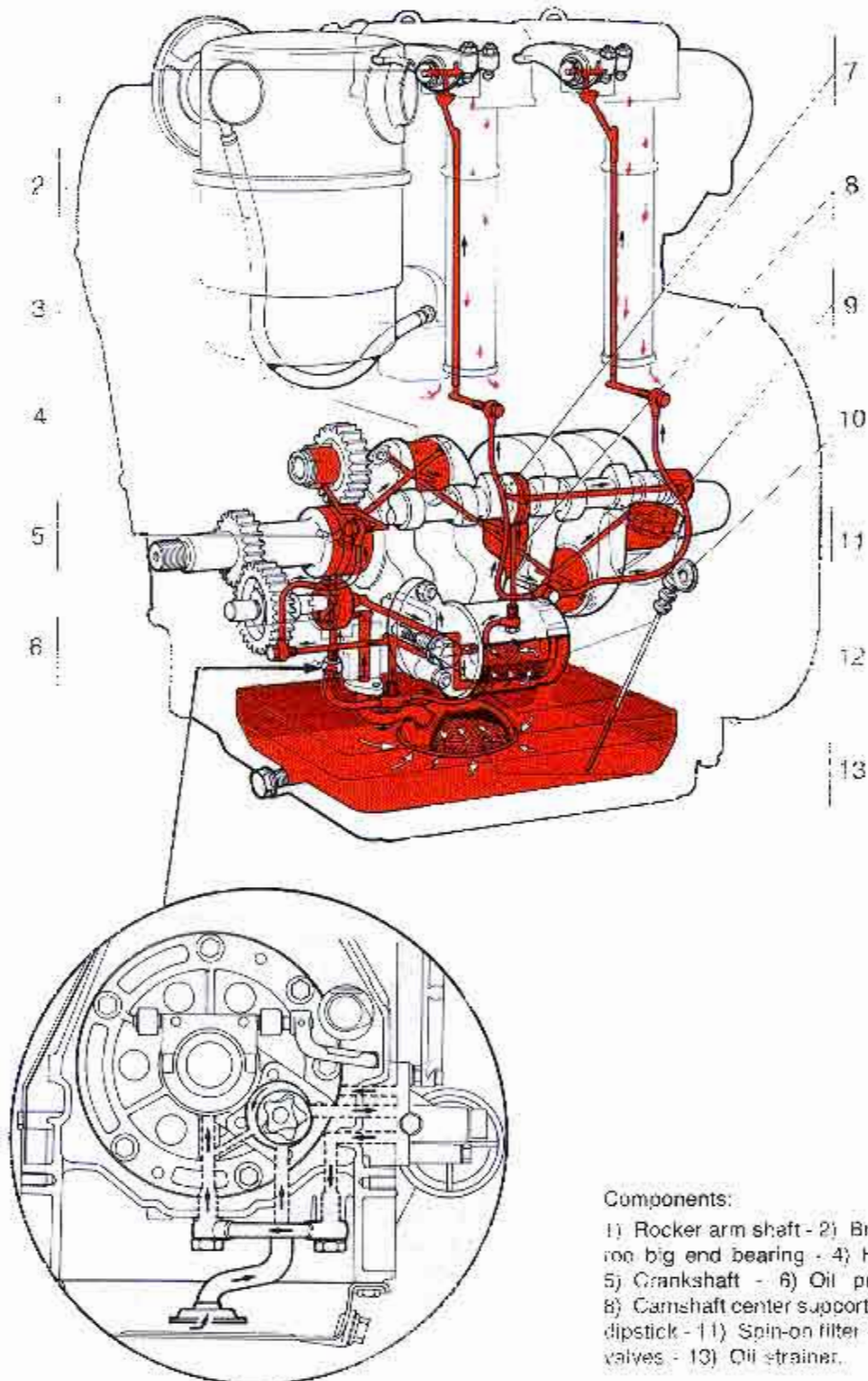
Electronic speed governor control box

Control box **E** features four setscrews which must be positioned on the test bed (torque dynamometer) along with the engine.

- a) Setscrew for speed control (r.p.m.)
- b) Setscrew for sensitivity adjustment when the engine is running at full speed
- c) Setscrew for sensitivity adjustment at low speed
- d) Setscrew for extra fuel release; once correctly positioned, this set-screw is generally sealed.



LUBRICATION SYSTEM LAYOUT

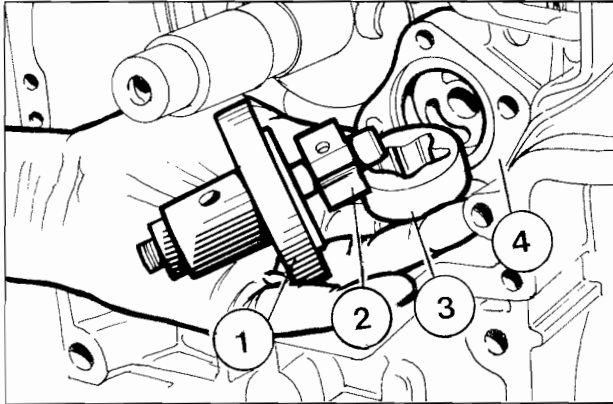


Components:

- 1) Rocker arm shaft - 2) Breather - 3) Connecting rod big end bearing - 4) Hydraulic pump drive - 5) Crankshaft - 6) Oil pump - 7) Camshaft - 8) Camshaft center support - 9) Oil fill cap - 10) Oil dipstick - 11) Spin-on filter - 12) Oil pressure relief valves - 13) Oil strainer.

VIII

LUBRICATION SYSTEM



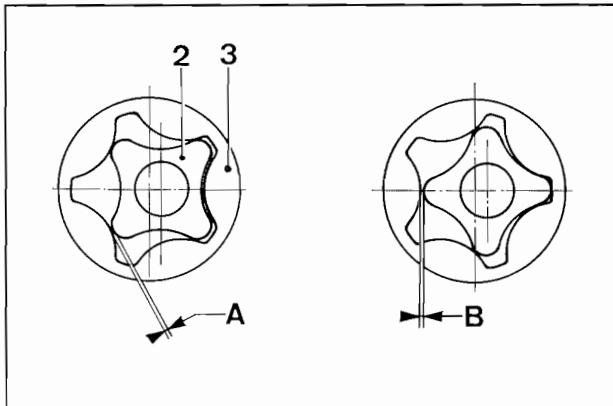
Oil pump

Components:

- 1 Flange
- 2 Internal rotor
- 3 External rotor
- 4 Crankcase

Check rotors 2 and 3, especially for flatness, and replace them if warped; when refitting apply a few drops of gasket cement Arexon between flange 1 and crankcase 4.

Tighten bolts at 2.5 Kgm and check that end play does not exceed 0.13 mm.

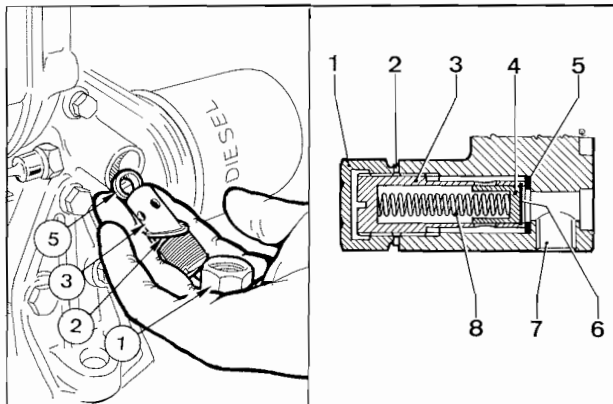


Oil pump rotor clearance (mm).

In position **A** check minimum clearance between the internal rotor 2 and the external rotor 3; it should be $0.12 \div 0.063$ with maximum limit of 0.10.

In position **B** check maximum clearance, it should be $0.025 \div 0.10$ with maximum limit of 0.17.

Oil pump capacity at 3000 r.p.m. is 12 l/min.



Oil pressure relief valve

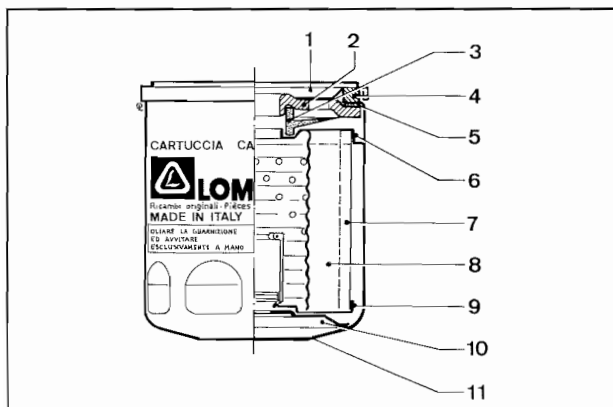
Components:

- 1) Cap - 2) Copper gasket - 3) Bushing - 4) Piston - 5) Rubber gasket - 6) Ring - 7) Hole for pressure switch connection - 8) Spring

Note: By-pass at an oil temperature of $40 \div 50^\circ\text{C}$ and pressure of 3 bar should be less than 1 l/min.

When refitting, screw bushing 3 so that it touches gasket 5.

Do not tighten excessively since gasket 5 might be damaged causing an oil pressure drop in the system.



Oil filter cartridge

Components:

- 1 Retainer
- 2 Plate
- 3 Valve
- 4 Gasket
- 5 Gasket
- 6 Upper cover
- 7 Blade
- 8 Filtering element
- 9 Assembly
- 10 Belleville washer
- 11 Canister

Characteristics:

Max. working pressure = 13 bar

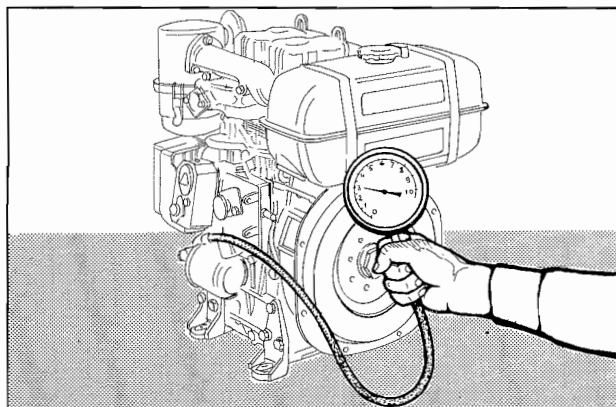
Working pressure in a 3000 r.p.m. engine with oil temperature of $40 \div 50^\circ\text{C}$ is $4.5 \div 5.5$ bar.

Filtering area = 955 cm^2

Type of filtration $20 \mu\text{m}$

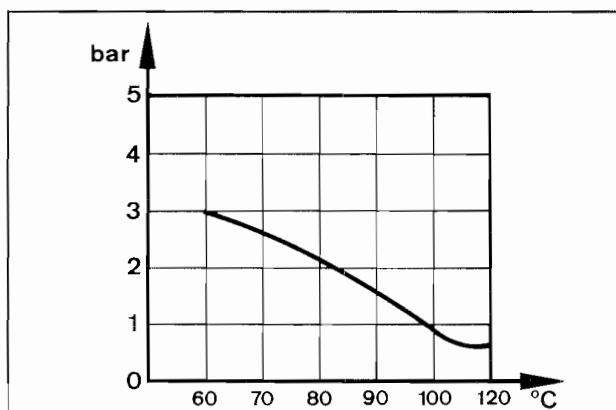
By-pass valve opening pressure $1.4 \div 1.8$ bar.





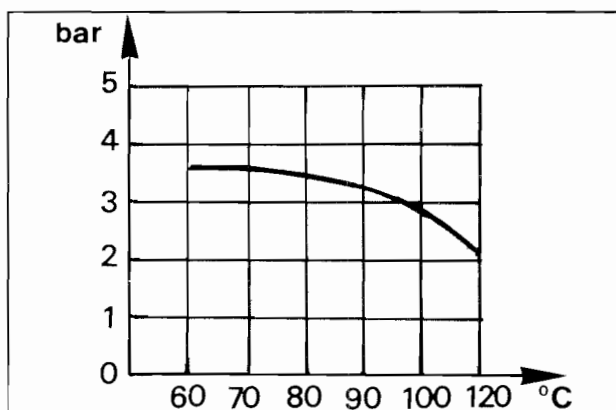
Oil pressure check

Once the engine is filled with oil and fuel, connect a 10 bar pressure gauge to the oil filter fitting. Start the engine and check pressure as a function of the oil temperature.



Oil pressure curve at idling speed

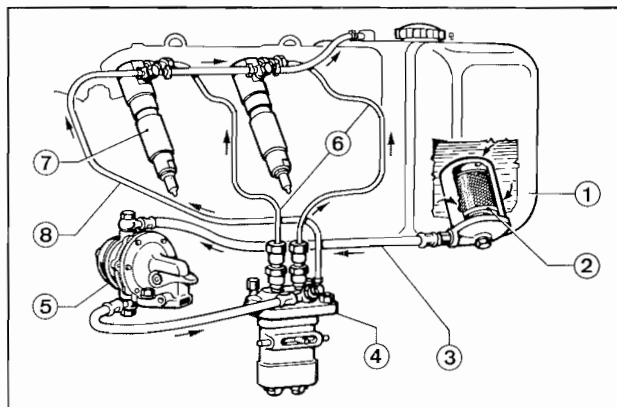
The curve is obtained at the oil filter with constant engine speed of 1200 r.p.m. in no-load conditions. Pressure is given in bar and temperature in centigrades.



Oil pressure curve at full speed

The curve is obtained at the oil filter with engine working at 3000 r.p.m. at the **N** power. Pressure is given in bar and temperature in centigrades.

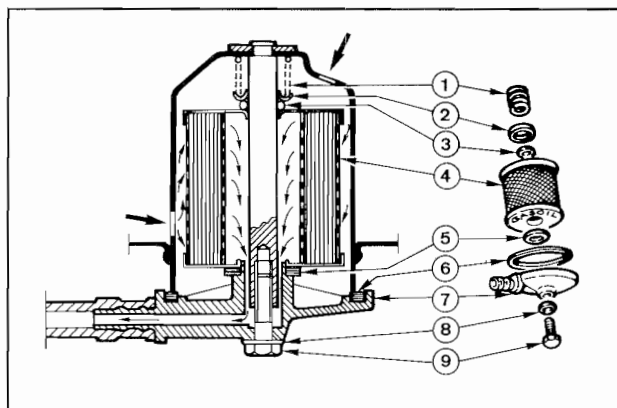
Note: After the running-in period the lube oil maximum temperature should be below the sum of the environmental temperature + 95°C.



Fuel feeding/injection circuit

Components:

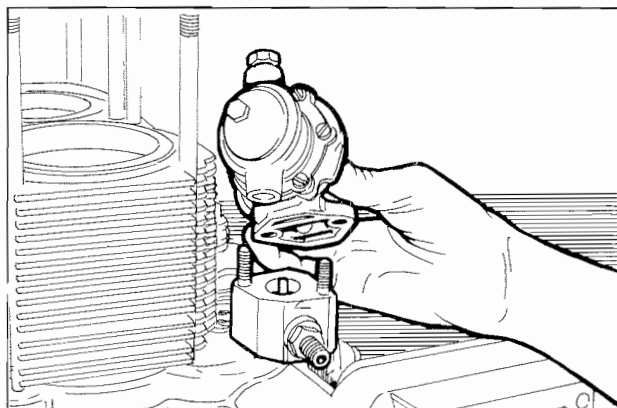
- 1 Tank
- 2 Filter
- 3 Fuel feeding tube
- 4 Injection pump
- 5 Fuel feeding pump
- 6 Injection line
- 7 Injector
- 8 Injector leakoff line and self-bleeding system



Fuel filter

Components:

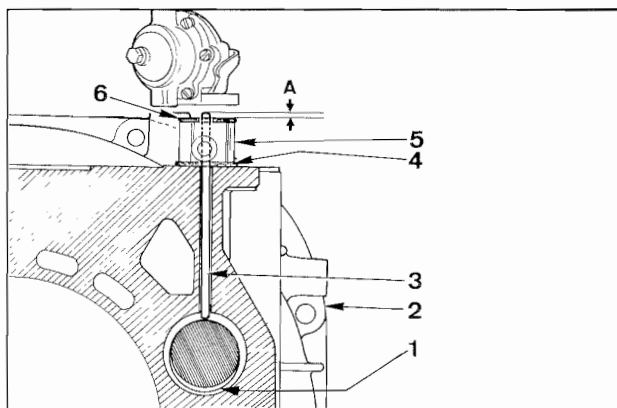
- 1 Spring
- 2 Disc
- 3 Ring
- 4 Cartridge
- 5 Gasket
- 6 Gasket
- 7 Cap
- 8 Ring
- 9 Bolt



Fuel feeding pump

The fuel feeding pump is of the diaphragm type operated by a camshaft eccentric through a push rod. It features an external lever for manual operation.

Characteristics: when the control eccentric rotates at 1500 r.p.m. minimum delivery is 64 l/h while self-regulation pressure is 0.4 ÷ 0.5 bar.



Fuel feeding pump drive rod protrusion

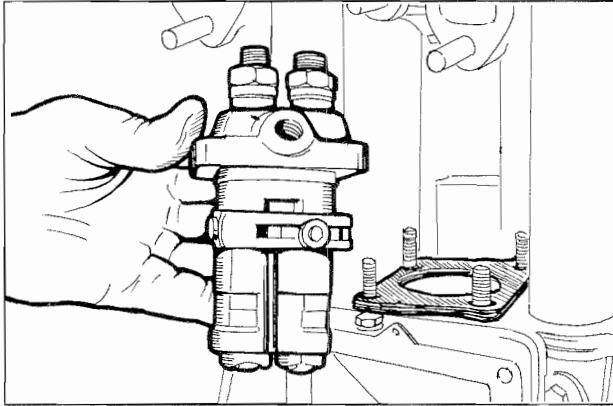
Components:

- 1 Camshaft eccentric
- 2 Crankcase
- 3 Push rod
- 4 Gasket
- 5 Support
- 6 Gasket

Drive rod **A** protrudes 0.8 ÷ 1.2 mm. from the crankcase; it can be adjusted by means of gaskets.

Gaskets 4 and 6 are supplied in the following thicknesses: 0.50; 0.80; 1.00 mm.

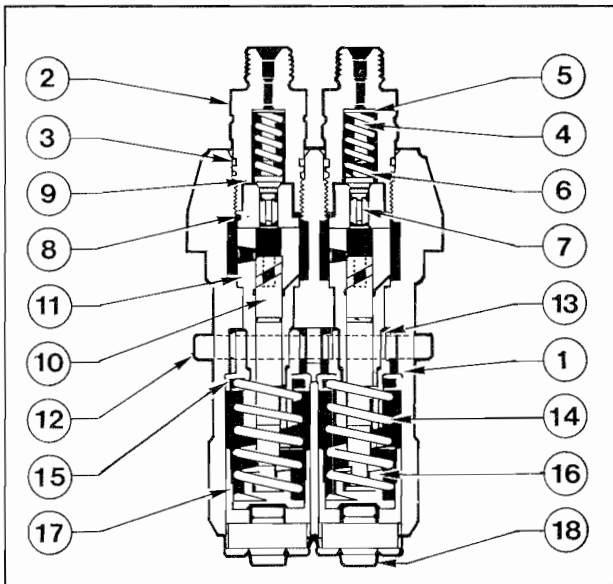
Push rod 3 length is 119.95 ÷ 120.05 mm.



INJECTION PUMP

The Bosch injection system consists of a single-body pump with plungers featuring constant stroke and feeding one cylinder each. The pump, mounted on the crankcase, is directly operated by the camshaft.

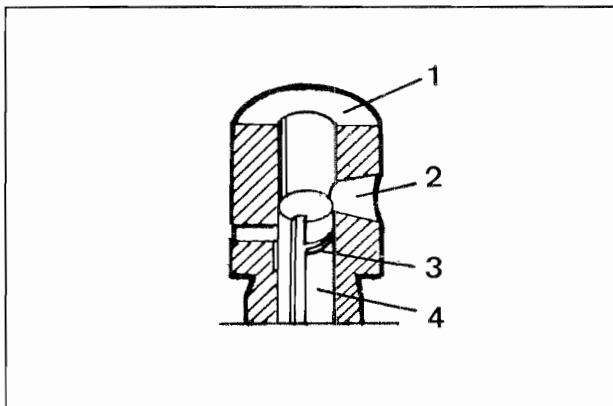
Speed governor, extra fuel and stop device are separate from the pump (see Page 36 and 59).



Injection pump

Components:

- | | |
|-------------------|-------------------|
| 1 Pump body | 2 Union |
| 3 Seal ring | 4 Filler |
| 5 Shim | 6 Spring |
| 7 Delivery valve | 8 Seat |
| 9 Gasket | 10 Plunger |
| 11 Barrel | 12 Rack rod |
| 13 Sector gear | 14 Spring |
| 15 Upper retainer | 16 Lower retainer |
| 17 Tappet | 18 Tappet roller |

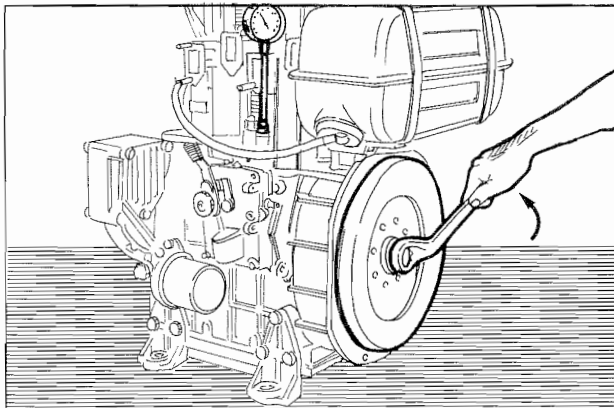


Plunger

- 1 Barrel
- 2 Fuel feeding port
- 3 Control helix
- 4 Plunger

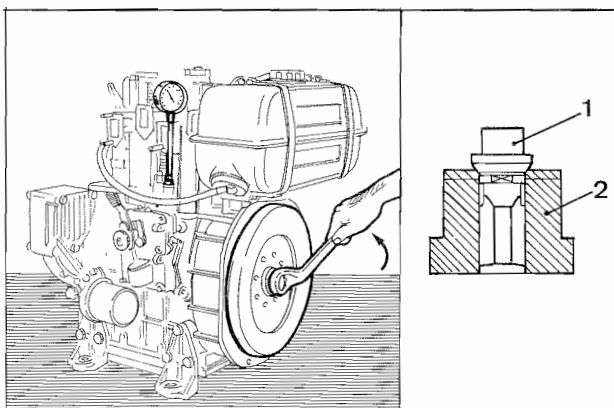
Plunger diameter is 7.0 mm, in all series of engines.

Note: Every plunger matches with its own barrel. For this reason they are not interchangeable.



Checking plunger and barrel for internal leakage

Connect the delivery union with a 600 bar pressure gauge with safety valve. Adjust rack rod at half-stroke. Turn flywheel according to its direction of rotation so that the plunger puts the circuit under pressure. Replace plunger if the displayed pressure is below 300 bar. Repeat the same operation for the other plunger.



Checking injection pump delivery valve sealing

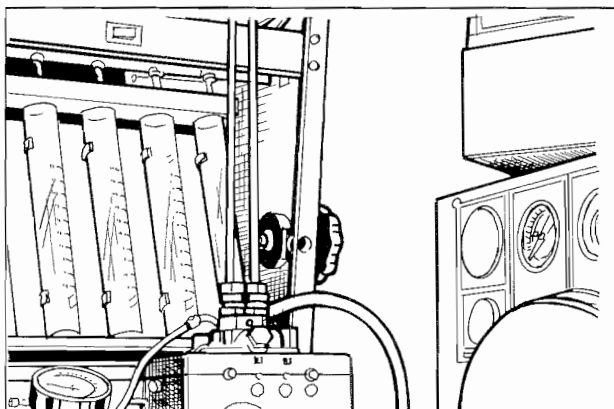
Components:

1 Valves

2 Seat

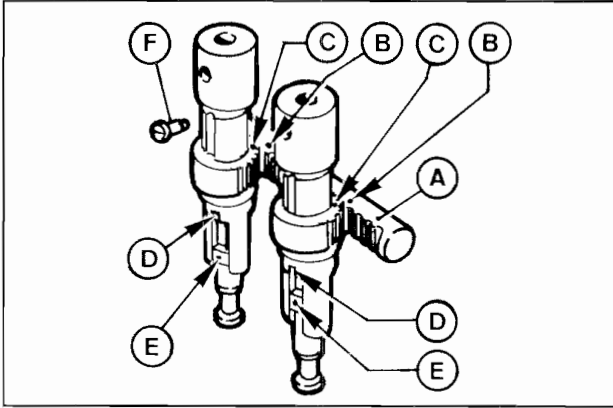
Adjust pump rack at half-stroke. Turn flywheel according to its direction of rotation so that the plunger puts the circuit under pressure. During this operation the displayed pressure will gradually reach a peak followed by a sudden drop which corresponds to valve closing. Pressure drop should be $30 \div 50$ bar. Replace the valve if pressure drop is below this value.

Repeat the same operation for the other plunger.



Test data for injection pump delivery

Control rod max. force	Rod stroke from max deliv. point	R.P.M.	Delivery	Max. plunger difference
Newton	mm		mm ³ · stroke	mm ³ · stroke
0.50	10	750	23 ÷ 27	3
	10	1500	26 ÷ 33	4
	11.5	500	7 ÷ 14	3.5
	0	150	80 ÷ 95	—



Assembly of injection pump components

After replacing the worn-out components, reassemble the pump as follows:

Introduce sector gears into the pump body by making reference points **C** match with the **B** points on the rack.

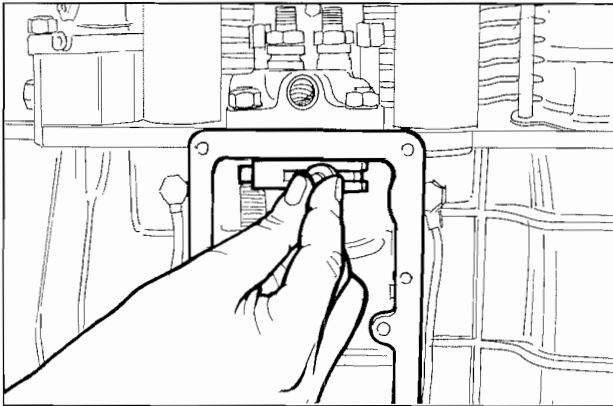
Fix barrels with the eccentric screws **F** on the pump body.

Fit valves with seats, springs, fillers and delivery unions tightening them at $3.5 \div 4$ Kgm.

Fit plungers by making reference points **E** match with the sector gear **D** points.

Fix retainers and springs; lock tappet with special stop.

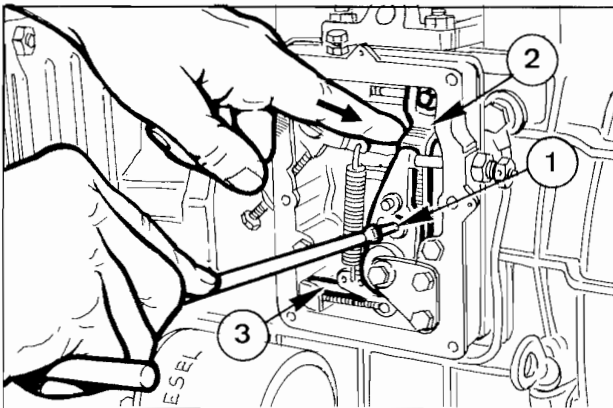
Check that both plungers have the same delivery by performing the necessary measurements at the test bed; if delivery is not the same set screw **F**.



Mounting injection pump on the engine

Tighten screws at 2.5 Kgm

Check that rack rod slides smoothly; if not, the engine may fail to start or hunt.



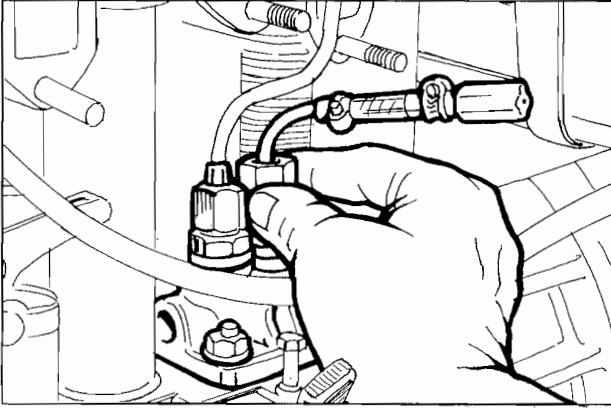
Injection pump/mechanical speed governor adjustment

Loosen screw 1

Move injection pump lever 2 to maximum delivery (to the right).

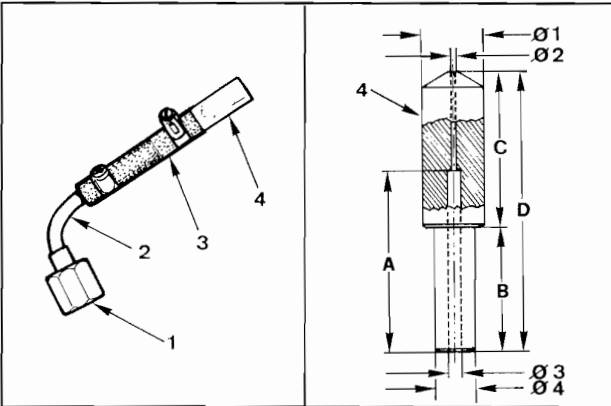
Check that drive rod 3 closes the speed governor; keeping lever 2 pressed to the right the drive rod should have no clearance.

Tighten screw 1.



(STATIC) INJECTION TIMING

Disconnect injection line on cylinder 1 making sure not to loosen the pump delivery union. Attach the timing tool shown below.



Injection timing checking device

Components:

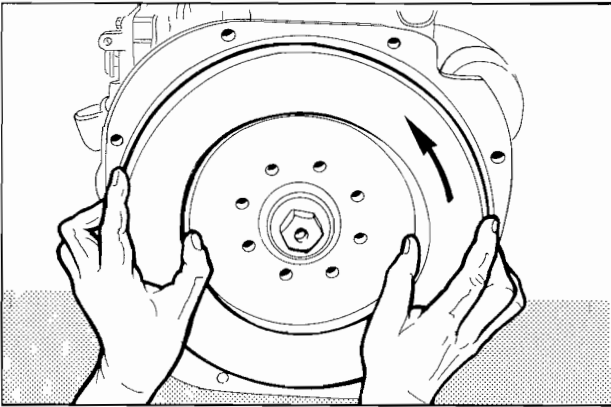
- 1 Fitting
- 2 Tube
- 3 Sleeve
- 4 Transparent body, part. No. 7271-9727-003;

This device allows for immediate monitoring of the fuel flow through its transparent portion.

Dimensions (mm):

$\varnothing_1 = 10.00$; $\varnothing_2 = 0.60$; $\varnothing_3 = 2.00$; $\varnothing_4 = 6.50$.

A = 29.00; B = 20.00; C = 25.00; D = 45.00



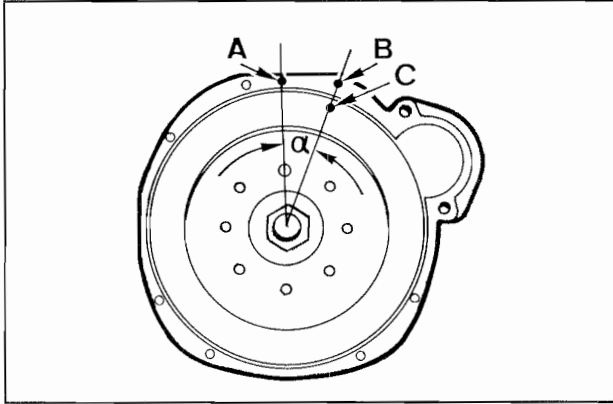
Injection timing check

Top up the tank checking that fuel level is at least 10 cm above checking device.

Adjust injection pump rack rod at half-stroke.

Turn the flywheel according to the engine direction of rotation and check that fuel reaches the checking device.

Repeat this last operation; during compression proceed slowly and stop immediately when the fuel is seen to pass through the checking device hole; bring flywheel back by 5 mm: this is the so-called static injection timing.



Injection timing reference marks on crankcase and flywheel

A = Piston reference mark at the top dead center

B = Injection timing reference mark compared to A

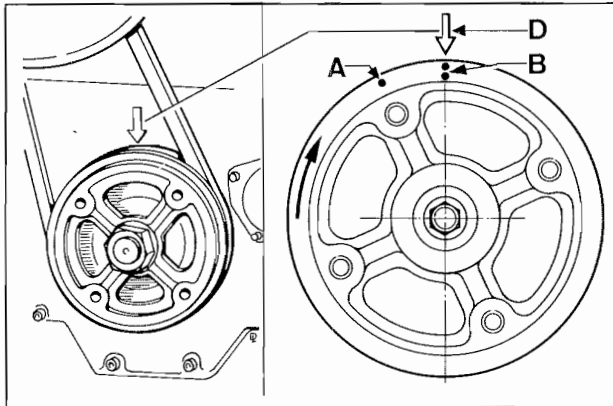
A ÷ B = Distance in mm.

C = Piston reference mark in injection timing position.

α = Reference angle in degrees.

Engine type	(A ÷ B) mm *	α
8LD600-2	61 ÷ 66	24° ÷ 26°
8LD665-2		
8LD740-2		
8LD665-2/L	53 ÷ 58	21° ÷ 23°

* Values given in mm. have been detected at the periphery of a standard flywheel with 291 mm. diameter.



Injection timing reference marks on the pulley

A = Piston reference mark at top dead center

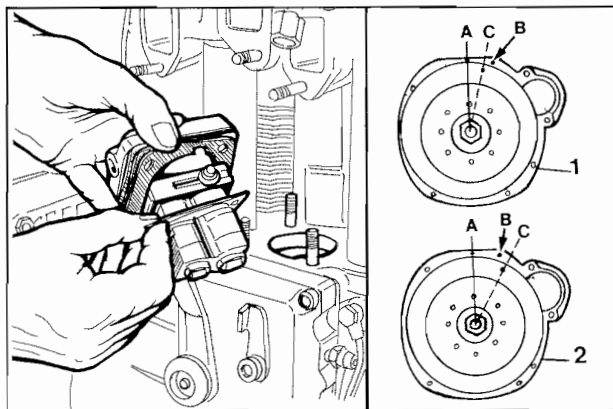
B = Piston reference mark in injection timing position

(A ÷ B) = Distance in mm.

D = Piston reference arrow at top dead center, obtained with a casting process

α = Reference angle in degrees

Engine type	(A ÷ B) mm		α
	Pulley dia. 136 mm	Pulley dia. 140 mm	
8LD600-2	28.4 ÷ 30.8	—	24° ÷ 26°
8LD665-2			
8LD665-2/L	—	25.6 ÷ 28.0	21° ÷ 23°
8LD740-2	—	29.3 ÷ 31.7	24° ÷ 26°

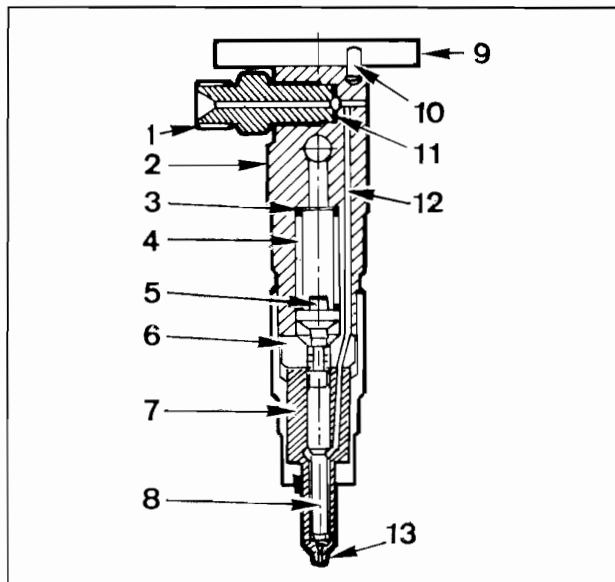


Injection timing correction

If reference mark C does not match with B follow examples 1 and 2.

- 1) Example of late injection timing: remove shims under the pump to make C match with B.
- 2) Example of early injection timing: add shims under the pump to make C match with B.

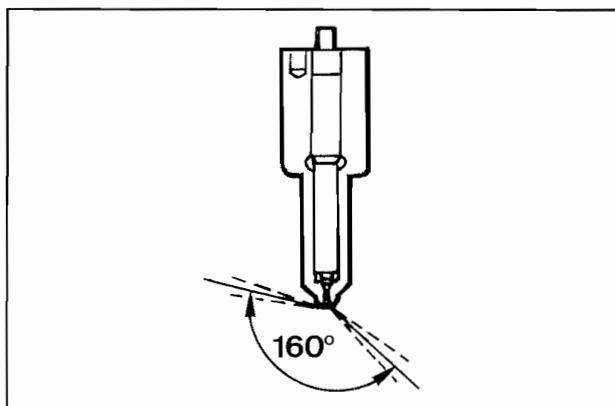
Note: By adding or removing a 0.1 mm shim under the pump C is delayed or advanced by approximately 3 mm.



INJECTOR

Components:

- 1 Intake fitting
- 2 Nozzle holder
- 3 Shim
- 4 Spring
- 5 Pressure rod
- 6 Intermediate flange
- 7 Nozzle
- 8 Needle valve
- 9 Fixing flange
- 10 Taper pin
- 11 Gasket
- 12 System duct
- 13 Sump



Nozzle

Features:

Hole number and diameter = 4x0.28 mm.

Jet angles = 160°.

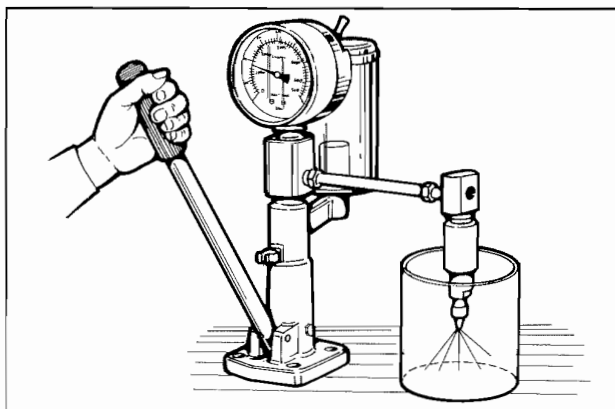
Needle valve elevation = 0.20 ÷ 0.22 mm

Hole length = 0.7 mm

Sump diameter and length = 1x1.5 mm

Clean nozzle tip with a brass brush.

Check that holes are not obstructed using a mandrel with steel wire with 0.28 mm. dia.



Injector setting

Connect injector to a hand pump and check that setting pressure is 210 ÷ 220 bar; make the required adjustments, if any, by changing the shim over the spring.

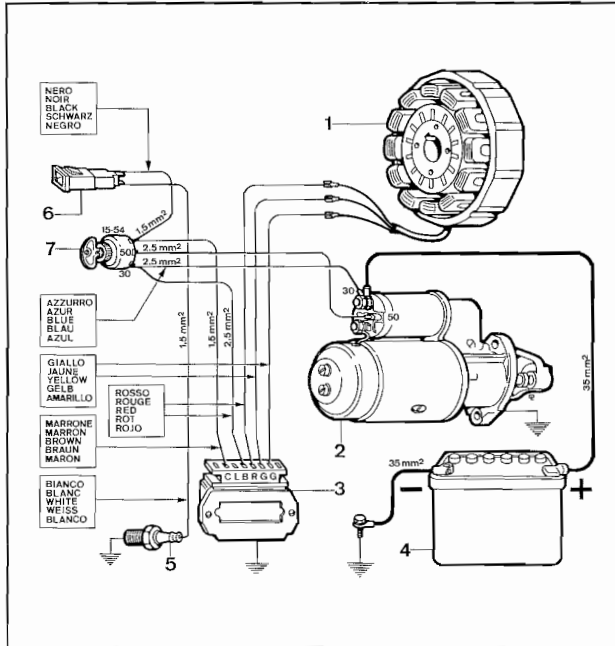
When replacing the spring, setting should be performed at a 10 bar greater pressure (220 ÷ 230 bar) to allow for bedding during operation.

Check needle valve sealing by slowly moving hand pump until approximately 180 bar.

Replace nozzle in case of dripping.

X

ELECTRICAL SYSTEM

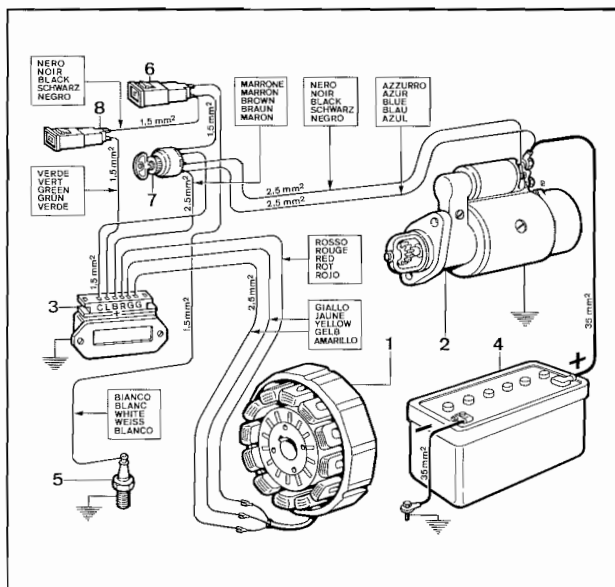


STANDARD ELECTRIC EQUIPMENT

Electric starting layout without battery charging light

Components:

- 1 Alternator
- 2 Starting motor
- 3 Voltage regulator
- 4 Battery
- 5 Pressure switch
- 6 Oil pressure warning light
- 7 Key switch

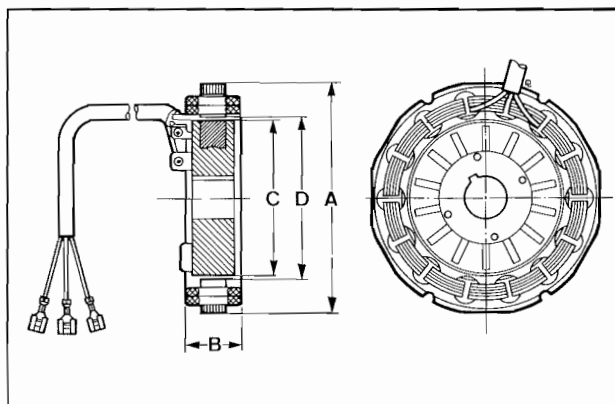


Electrical starting layout with battery charging light

Components:

- 1 Alternator
- 2 Starting motor
- 3 Voltage regulator
- 4 Battery
- 5 Pressure switch
- 6 Oil pressure warning light
- 7 Key switch
- 8 Battery charging light

Note: Battery, which is not supplied by Lombardini, should feature 12V voltage and capacity not below 70 Ah.



12.5 V, 14 A Alternator

Features a fixed armature winding housed in the bell inside the blower housing.

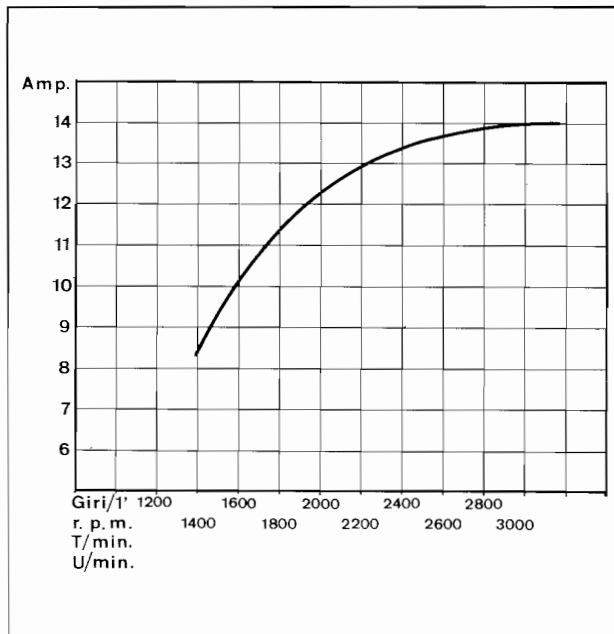
The rotating permanent magnet inductor is located on the blower shaft.

Dimensions (mm):

- A = 111.701 ÷ 111.788
- B = 31.000 ÷ 33.500
- C = 76.226 ÷ 76.300
- D = 77.400 ÷ 77.474

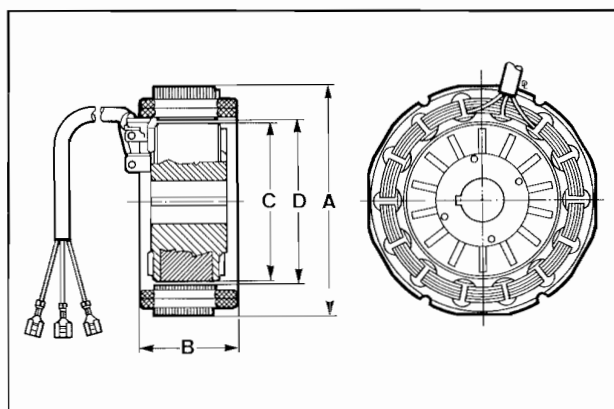
Note: Clearance between armature winding and inductor (air gap) should be 0.55 ÷ 0.63 mm.



**Alternator battery charger curve (12.5 V, 14A)**

The curve was obtained at room temperature of +25°C with 12.5V battery voltage.

Note: The r.p.m. shown in the table refers to the engine.

**12 V, 21 A Alternator**

Features a fixed armature winding housed in the bell inside the blower housing.

The rotating permanent magnet inductor is located on the blower shaft. See Page 12.

Diameter size (mm):

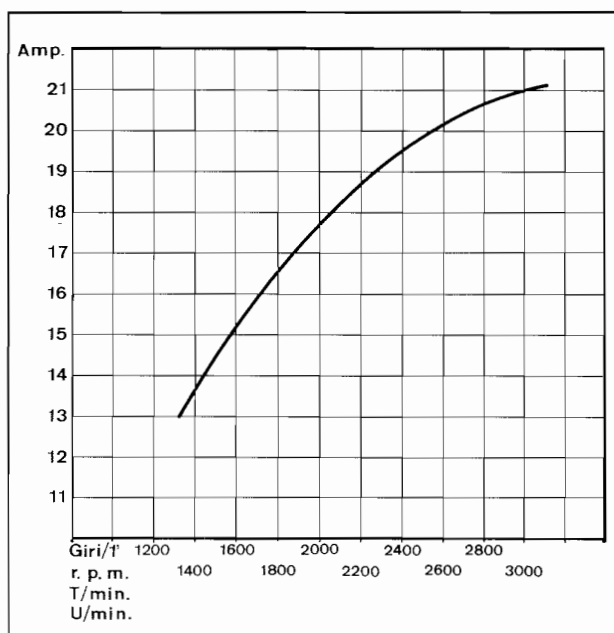
$$A = 111.701 \div 111.788$$

$$B = 49.500 \div 52.000$$

$$C = 76.226 \div 76.300$$

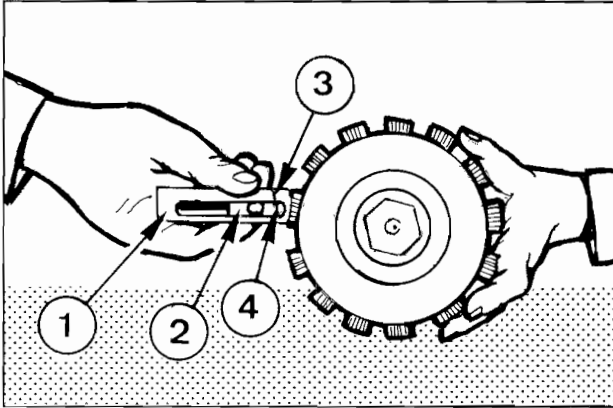
$$D = 77.400 \div 77.474$$

Note: Clearance between armature winding and inductor (air gap) should be 0.47 ÷ 0.63 mm.

**Alternator battery charger curve (12 V, 21 A)**

The curve was obtained at room temperature of +25°C with 12.5V battery voltage.

Note: The r.p.m. shown in the table refers to the engine.

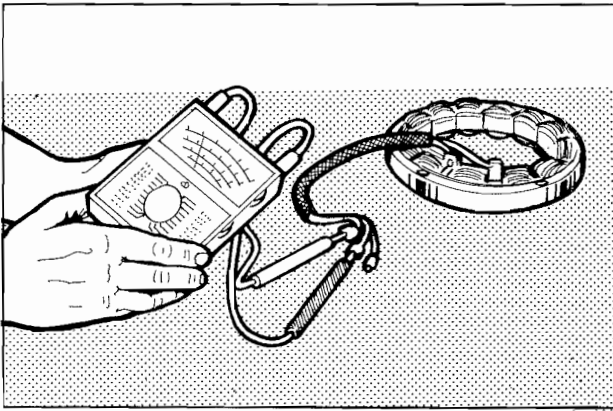


Magnetization checking tool (Part No. 7000-9727-001)

Components:

- 1 Casing
- 2 Slider
- 3 Casing reference line
- 4 Slider reference line

Rest the tool end horizontally onto the magnetic poles. Hold slider so that its reference line coincides with the casing reference line. Release slider: if no attraction occurs the rotor is demagnetized; therefore replace alternator.

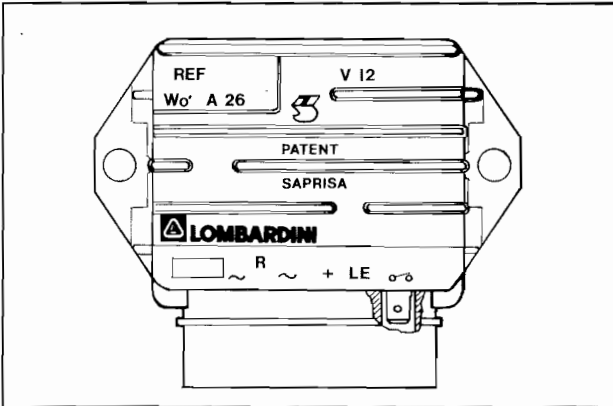


Checking for cable continuity

Check that stator windings have no unsoldered connections, burnt areas or grounded wires.

Using an ohmmeter check for continuity between the red cable and the two yellow ones.

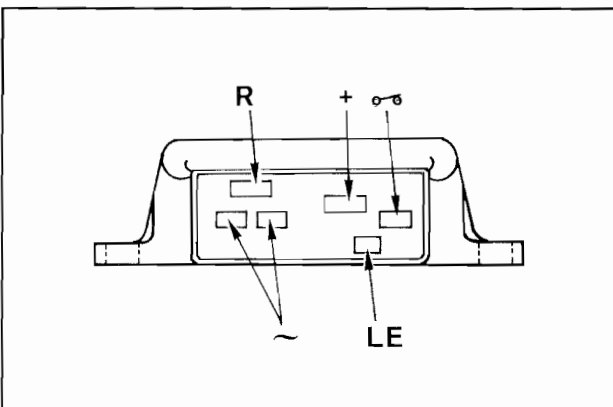
Furthermore, check that they are insulated from the ground.



VOLTAGE REGULATOR

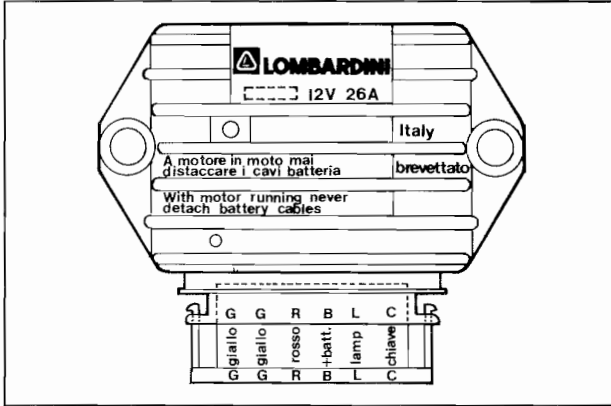
Type LOMBARDINI, supplied by SAPRISA and DUCATI: Voltage 12V, maximum current 26A. References for SAPRISA connections with the corresponding DUCATI connections.

SAPRISA	DUCATI
~	G
R	R
+	B
LE	L
⏏	C

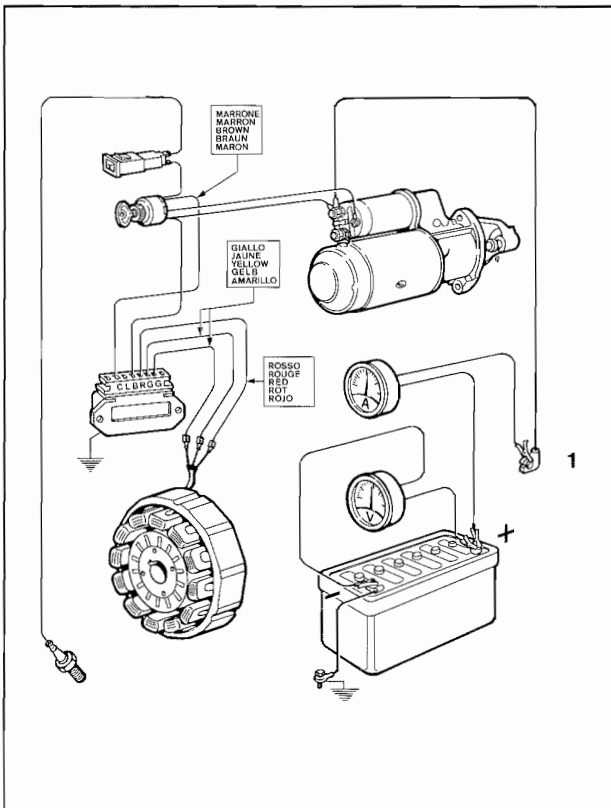
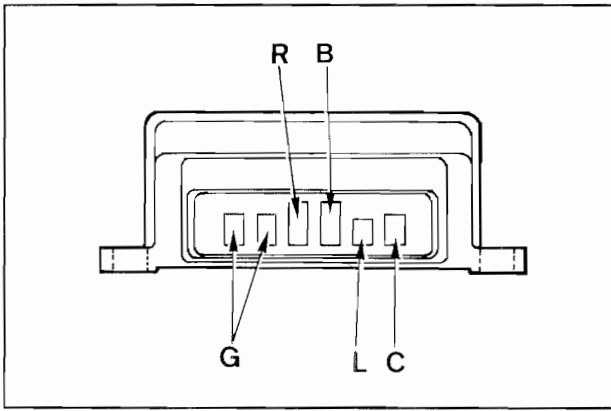


To avoid wrong connections 3 different size connections are supplied.

SAPRISA	DUCATI	CONNECTION SIZE mm	
		WIDTH	THICKNESS
~	G	6.25	0.8
R	R	9.50	1.2
+	B	9.50	1.2
LE	L	4.75	0.5
⏏	C	6.25	0.8



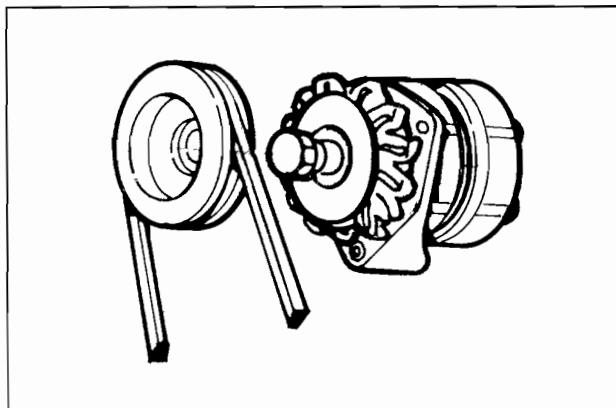
The voltage regulator fits to both circuits with and without battery charging light; in the latter case connections LE (SAPRISA) and L (DUCA-TI) are not used.



How to check voltage regulator for proper operation

Check that connections correspond to the layout.
Disconnect the terminal from the battery positive pole.
Connect a d.c. voltmeter between the two battery poles.
Fit an ammeter between the positive pole and the corresponding cable 1 terminal.
The ammeter should be suitable for reading the required value (14 or 21 A) and for withstanding the starting motor peak absorption (400 ÷ 450 A).
Start a couple of times until battery voltage drops below 13V.
When battery voltage reaches 14.5V the ammeter current suddenly drops down to almost zero.
Replace regulator if recharge current is zero with voltage below 14V.

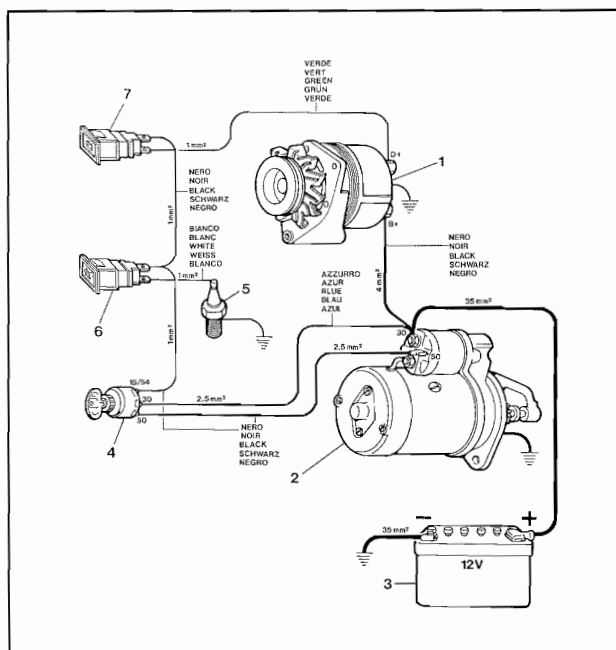
Warning: When the engine is running do not disconnect battery cables or remove the key from the control panel.
Keep regulator away from heat sources since temperatures above 75°C might damage it.
No electric welding on engine or application.



Alternator type Bosch G1 14 V, 33 A

The alternator is of the claw-pole rotor type with build-in voltage regulator. The rotating motion is conveyed by the engine through a "V" belt and sheave.

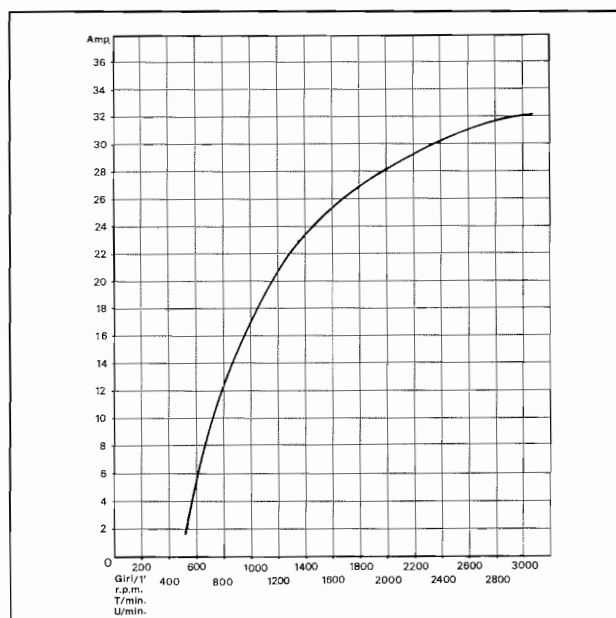
Features: 12V rated voltage. Max. current 33A at 7000 alternator r.p.m. RH direction of rotation.



Alternator type Bosch G1 14 V, 33 A layout

Components:

- 1 Alternator
- 2 Starting motor
- 3 Battery
- 4 Key switch
- 5 Pressure switch
- 6 Oil pressure warning light
- 7 Battery charging light

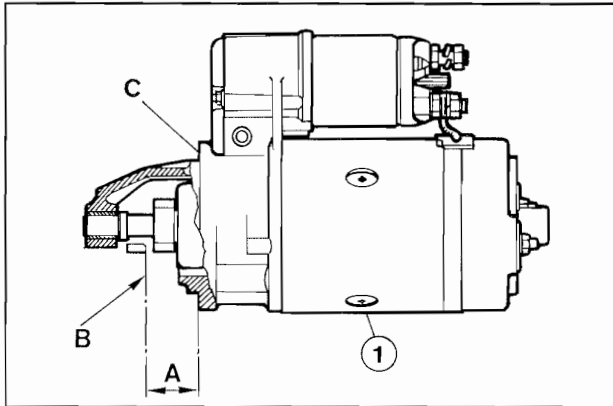


14 V, 33A Bosch G1 alternator battery charger curve

The curve was obtained at room temperature of +25°C

Battery terminal voltage is 12.5 Volt

The r.p.m. shown on the table refers to the engine.



STARTING MOTOR

Made by MARELLI and BOSCH.

Apply to their distributors for any type of repair.

1) Magneti Marelli starting motor type E100, 1,5/12 V

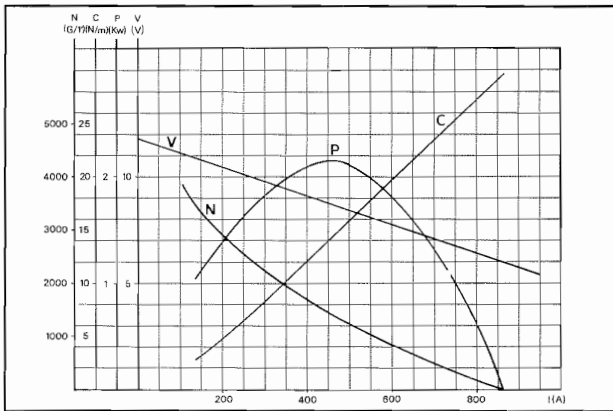
RH direction of rotation

A = 29.5 ÷ 31.5 mm

B = Ring gear plane

C = Flange plane

Warning: The flywheel should not project from ring gear plane B.



Characteristic curves for starting motor type Magneti Marelli E100, 1,5/12 V

Curves were obtained at room temperature of +20°C with 88 Ah batteries.

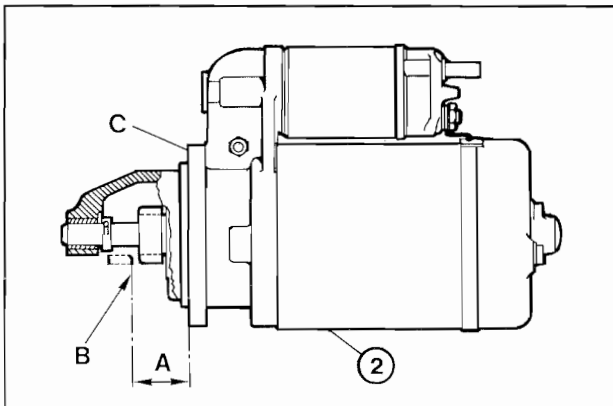
V = Motor terminal voltage in Volt

P = Power in kW

C = Torque in N/m

N = Motor speed in r.p.m.

I (A) = Absorbed current in Ampere



2) Bosch starting motor type GF - 12V, class 1.5 (optional)

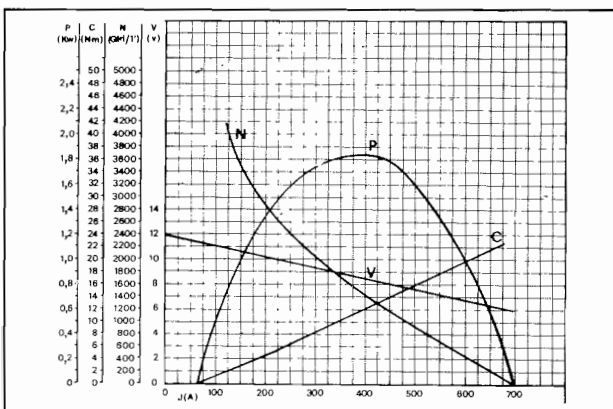
RH direction of rotation

A = 29.5 ÷ 31.5 mm

B = Ring gear plane

C = Flange plane

Warning: Flywheel should not project from ring gear plane B.



Characteristic curves for starting motor type Bosch GF - 12 V, class 1.5

Curves were obtained at room temperature of +20°C with 66 Ah battery.

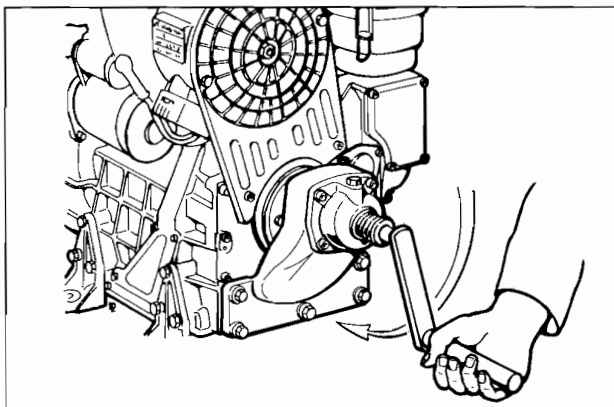
V = Motor terminal voltage in Volt

P = Power in kW

C = Torque in N/m

N = Motor speed in r.p.m.

J (A) = Absorbed current in Ampere



MANUAL STARTING

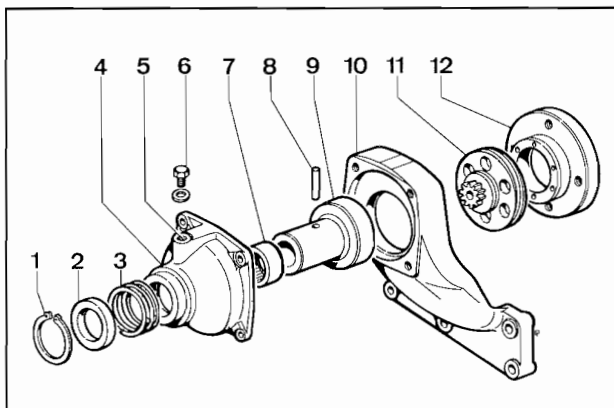
Crank starting

Fitted to the crankshaft with reduction ratio 2:1.

Compression release is required on both heads.

A heavy flywheel is also required.

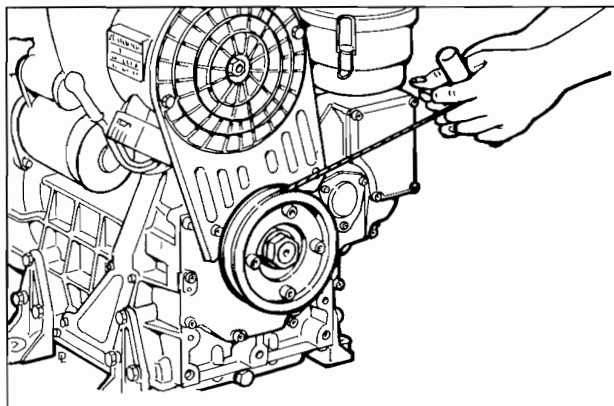
Start by actuating compression release, introducing the crank and quickly turning it by hand according to the engine direction of rotation. Disconnect compression release immediately afterwards.



Crank starting system

Components:

- 1 Circlip
- 2 Ring
- 3 Release spring
- 4 Housing
- 5 Lubrication hole
- 6 Plug
- 7 Roller bushing
- 8 Pin
- 9 Drive gear
- 10 Bracket
- 11 Driven gear
- 12 Sprocket flange



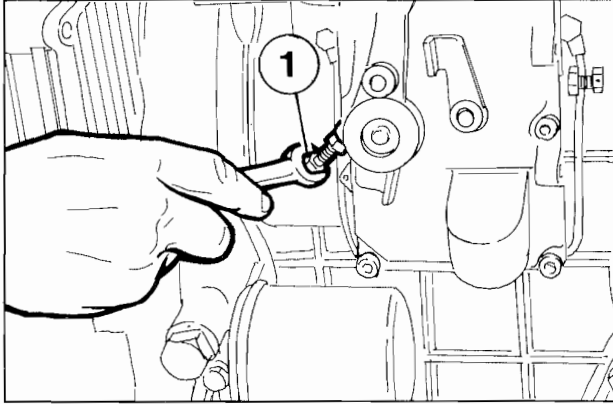
Rope starting

Compression release is required.

Start by winding the rope as indicated by the arrow on the pulley.

Actuate compression release.

Slowly pull the rope until compression is eliminated, then stop. Rewind the rope, pull it very quickly and finally disconnect compression release.

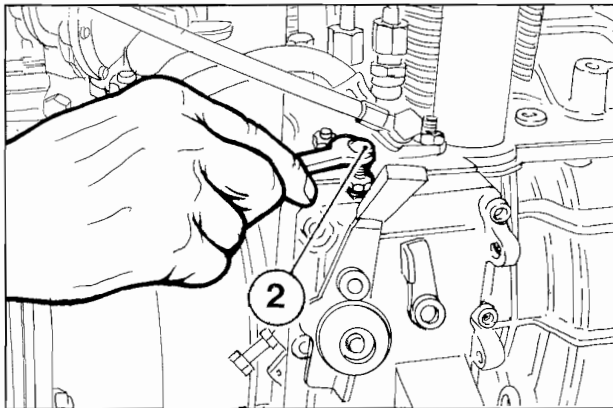


SETTINGS

1) Idle speed setting in no-load conditions

After filling with oil and fuel, start the engine and let it warm up for 10 minutes.

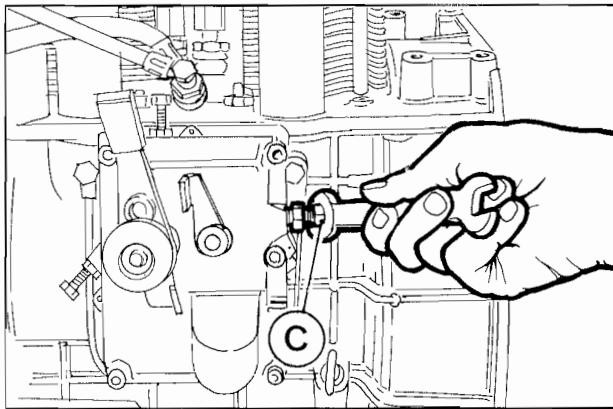
Adjust idle speed at $1000 \div 1200$ r.p.m. by turning setscrew 1; then tighten lock nut.



2) Full speed setting in no-load conditions (standard)

After setting idle speed turn screw 2 and set full speed in no-load conditions at 3200 r.p.m.; then tighten lock nut.

Note: When the engine reaches the pre-set power full speed stabilizes at 3000 r.p.m.



Injection pump delivery setting

This setting should be performed at the torque dynamometer. If not, setting is only approximate.

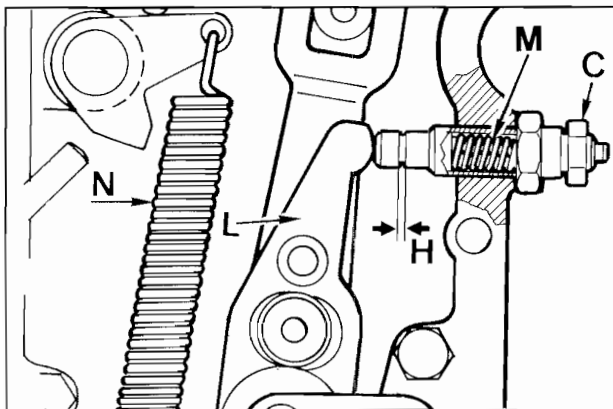
The following steps are required:

Loosen delivery limiting device **C** by 5 turns.

Bring engine to full speed in no-load conditions i.e. 3200 r.p.m.. Tighten limiting device until the engine shows a drop in r.p.m.

Unscrew limiting device **C** by $1\frac{1}{2}$ turn. Tighten lock nut.

Note: If the engine, under full load, generates too much smoke tighten **C**; if no smoke is observed at the exhaust and the engine cannot reach its full power unscrew **C**.



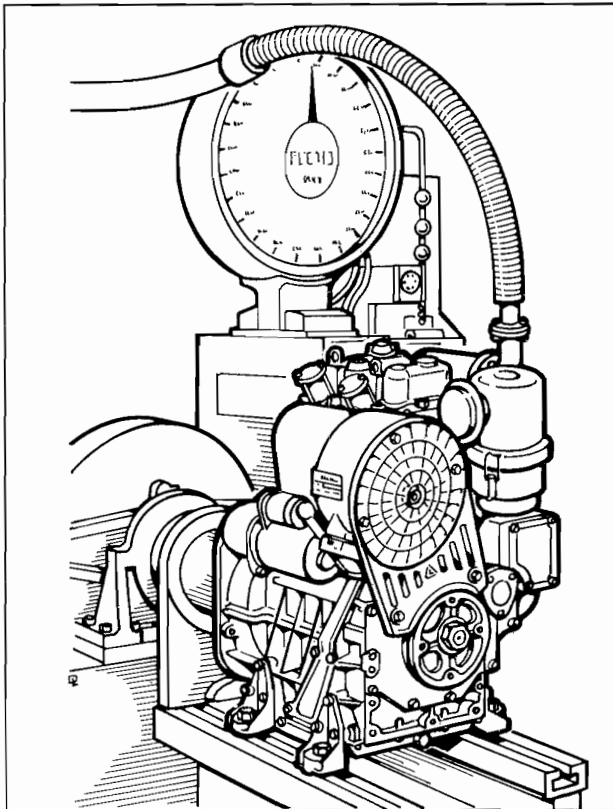
Injection pump delivery limiting and extra fuel device

Limiting device **C** limits the injection pump maximum delivery. It also acts as a torque setting device since spring **N** opposes the resistance of spring **M** inside the cylinder through lever **L**.

The torque setting device allows lever **L** to move over stroke **H** corresponding to $0.15 \div 0.25$ mm.

This consequently increases injection pump delivery with torque reaching its peak value.

Note: In generator sets and power welders, the torque setting device acts as a delivery limiter only. It therefore does not feature spring **M** or stroke **H**.



Injection pump delivery setting with engine at the torque dynamometer

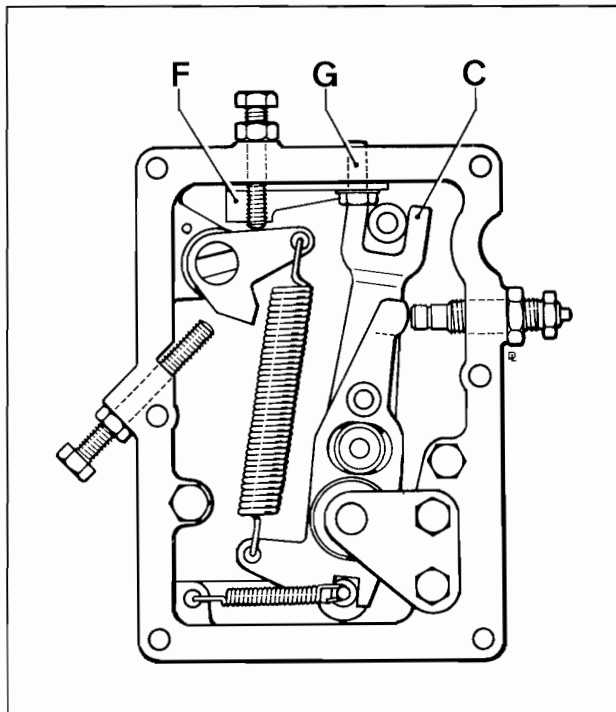
- 1) Bring engine to idling speed
- 2) Unscrew delivery limiting device **C** (see page 54)
- 3) Bring engine to the power and r.p.m. as shown on power curve.
- 4) Check that consumption falls within the table specifications (see below). If consumption is not as indicated change balance conditions at the torque dynamometer by varying the load and adjusting the governor. Under stable engine conditions check consumption again.
- 5) Tighten limiting device **C** until the engine r.p.m. decreases. Lock the limiting device by means of lock nut.
- 6) Release brake completely and check at what speed the engine becomes stable.
Speed governor should comply with the requirements of the class indicated by the manufacturer of the device.
- 7) Stop the engine
- 8) Check valve clearance when the engine has cooled down.

Required settings (as most commonly applies)

Engine	R.P.M.	Power HP (kW)	Specific fuel consumption. *	
			Time (sec.) per 100 cm ³	rev/HP h (rev/kW h)
8LD600-2	3000	N 25 (18,38)	57 ÷ 60	209 ÷ 198 (284 ÷ 270)
8LD600-2	2600	N 23 (16,91)	62 ÷ 65	209 ÷ 199 (284 ÷ 270)
8LD600-2	3000	NB 23 (16,91)	62 ÷ 65	209 ÷ 199 (284 ÷ 270)
8LD600-2	2600	NB 21 (15,44)	68 ÷ 71	207 ÷ 198 (284 ÷ 272)
8LD665-2	3000	NB 28 (20,59)	50 ÷ 53	212 ÷ 200 (288 ÷ 272)
8LD665-2	2600	N 26 (19,12)	55 ÷ 58	207 ÷ 197 (282 ÷ 268)
8LD665-2	3000	NB 26 (19,12)	55 ÷ 58	207 ÷ 197 (282 ÷ 268)
8LD665-2	2600	NB 24,5 (18)	58 ÷ 61	209 ÷ 198 (284 ÷ 272)
8LD665-2/L	2200	NB 22 (16,18)	75 ÷ 77	180 ÷ 175 (245 ÷ 238)
8LD665-2/L	1800	NB 18,5 (13,60)	87 ÷ 89	180 ÷ 175 (245 ÷ 238)
8LD665-2/L	1500	NB 14,7 (10,81)	113 ÷ 116	180 ÷ 175 (245 ÷ 238)
8LD740-2	2600	N 27,88 (20,50)	54 ÷ 57	198 ÷ 188 (269 ÷ 255)
8LD740-2	2600	NB 25,84 (19)	59 ÷ 62	195 ÷ 185 (266 ÷ 253)
8LD740-2	2200	NB 23,80 (17,50)	70 ÷ 72	179 ÷ 174 (243 ÷ 236)
8LD740-2	1800	NB 20 (14,71)	83 ÷ 86	179 ÷ 173 (244 ÷ 236)
8LD740-2	1500	NB 16,32 (12)	102 ÷ 105	179 ÷ 174 (244 ÷ 236)

* The indicated specific fuel consumption refers to the period following approximately 100 working hours.

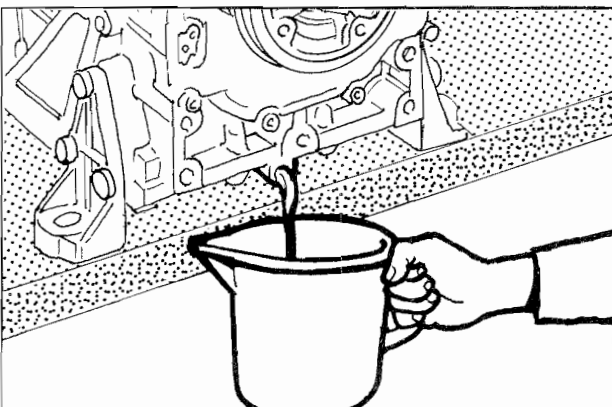
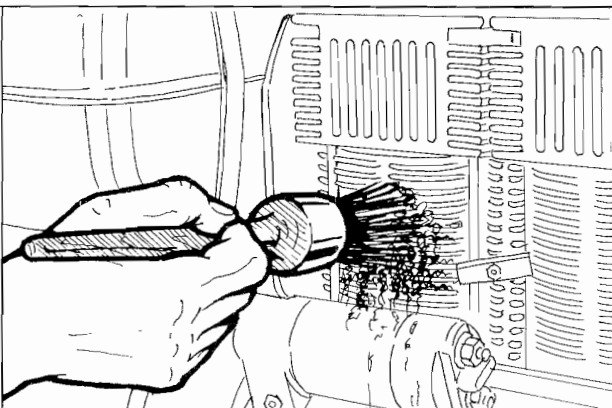
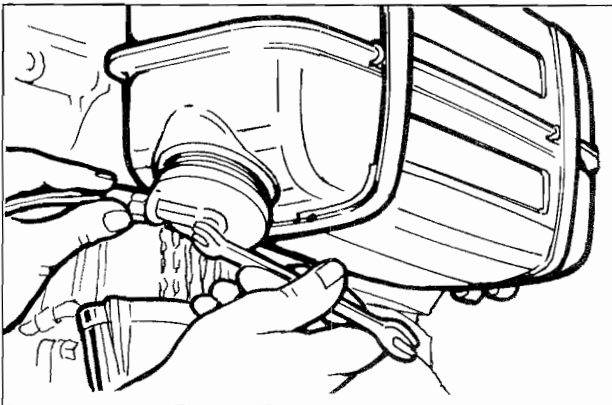
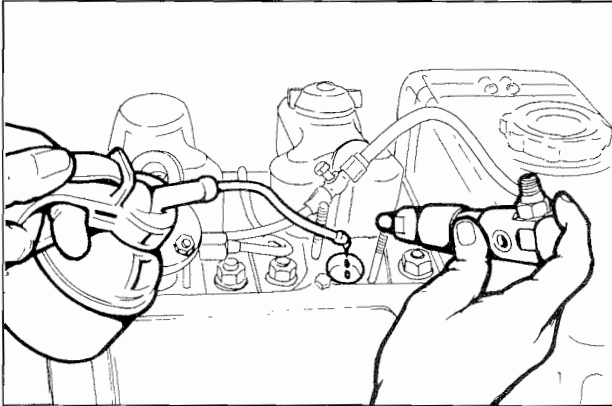




Stop setting

- 1) Completely turn lever **C** counterclockwise and keep it in this position. Retainer **F** should not be in contact with lever **C**.
- 2) Unscrew nut **G** and bring retainer **F** in contact with lever **C**
- 3) Push retainer **F** so that lever **C** is moved backwards clockwise by $1.0 \div 1.5$ mm.
- 4) Lock retainer **F** by screwing nut **G**

Note: Under these conditions no damage can be caused to the injection pump rack rod stops by sudden impacts due to the available electric stops.



STORAGE

Prepare engines as follows for storage over 30 days:

Temporary protection (1 ÷ 6 months).

- Let engine work at idling speed in no-load conditions for 15 minutes.
- Fill crankcase with protection oil MIL-1-644-P9 and let engine run at 3/4 full speed for 5 ÷ 10 minutes.
- When engine is warm empty oil pan and fill with standard new oil.
- Remove fuel tube and empty the tank.
- Remove fuel filter, replace cartridge if dirty and refit.
- Carefully clean cylinder fins, heads and fan.
- Seal all openings with tape.
- Remove injectors, pour a spoonful of oil type SAE 30 into the cylinders and rotate manually to distribute the oil. Refit injectors.
- Spray oil type SAE 10W into exhaust and intake manifolds, rocker arms, valves, tappet etc. Grease all unpainted parts.
- Loosen belt.
- Wrap the engine in a plastic film.
- Store in a dry place, if possible not directly on the soil and far from high voltage electric lines.

Permanent protection (over 6 months)

The following is recommended apart from the above instructions:

- For the lubrication and injection system as well as for moving parts use rustproof oil type MIL-L-21260 P10, grade 2, SAE 30 (Ex. ESSO RUST - BAN 623 - AGIP, RUSTIA C. SAE 30). Let the engine run with rustproof oil and drain any excess.
- Coat external unpainted surfaces with antirust type MIL-C-16173D, grade 3 (Ex. ESSO RUST BAN 398 - AGIP, RUSTIA 100/F).

How to prepare the engine for operation

- Clean engine outside
- Remove protections and covers.
- Remove antirust by an appropriate solvent or degreaser.
- Remove injectors, fill with standard oil, turn crankshaft by a few revolutions, remove oil pan and drain the protective oil.
- Check injectors, valve clearance, belt tension, head tightening, oil filter and air cleaner for proper setting. If the engine is stored over a long period of time (over 6 months) check one of the bushings for corrosion.