marine engines

section 4

8361 series

workshop manual

The data contained in this publication may not have been updated following modifications carried out by the manufacturer, at any time, for technical or commercial reasons and also to conform to the requirements of the law in the various countries.

This publication supplies features and data together with the suitable methods for repair operations to be carried out on each single component of the engine.
Following the supplied instructions and using the inherent specific fixtures, a correct repair procedure will be obtained in due time, protecting the operators from all possible accidents.
Before starting any repair, be be sure that all accident prevention devices are available and efficient
Therefore check and wear what indicated by the safety provision: protective glasses, helmet, gloves, safety shoes.
Before use, check all work, lifting and transport equipment.

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ENGINE SPECIFICATIONS

Engine type 8361M16
4 - stroke Diesel with direct injection
Cylinders, number and arrangement . ...6, in line
Bore x stroke ..... 115 x 130 mm
Displacement..... 8.1 l
Compression ratio..... 17 : 1
Net power at flywheel (*) :
- Pleasure craft..... ..... 118 kW (160 CV)
At..... .....2600 rpm
- Light-duty commercial..... .... 107 kW (145 CV)
At..... .....2400 rpm
- Continuous duty..... 96 kW (130 CV)
At.....2300 rpm
Engine rotation :
(see from flywheel) .... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C..... .... 8 °
closes : after B.D.C..... .... 60 °
- Exhaust
opens : before B.D.C. .... 60 °
closes : after T.D.C. ..... 8 °
Clearance between valve and rockers for timing checks .....0.40 mm
Operating clearance between valves and rockers, cold engine :
- intake .....0.30 mm
- exhaust.....0.50 mm

FUEL SYSTEM

Rotary injection pump type PES 6A
Fixed injection pump delivery start advance ..... 25 ° ± 1°
Fuel injectors setting..... 200 + 8 bar
Firing order..... 1 - 5 - 3 - 6 - 2 - 4

LUBRICATION

Minimum oil pressure :
- at full throttle .. ..3 5 kg/cm^2
- when idling ....0.8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage..... .... 24 V
- Self-regulated alternator..... ..... 28 V, 30 A
- Starting motor power..... ..... 4 kW
- Battery (optional) .... .2 ,each 110 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SM21
4 - stroke Diesel with direct injection
Cylinders, number and arrangement ..... 6, in line
Bore x stroke ..... 115 x 130 mm
Displacement ..... 8.1 l
Compression ratio ..... 15.5 : 1
Net power at flywheel (*) :
- Pleasure craft ..... 155 kW (210 CV)
At ..... 2200 rpm
- Light-duty commercial ..... 140 kW (190 CV)
At ..... 2700 rpm
- Continuous duty ..... 192 kW (175 CV)
At ..... 2000 rpm
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C. ..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- Intake ..... 0.30 mm
- exhaust ..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 23 ° ± 1°
Fuel injectors setting ..... 200 + 8 bar
Firing order ..... 1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure :
- at full throttle ..... 3 5 kg/cm^2
- when idling ..... 0 8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor

ELECTRIC SYSTEM

- Voltage ..... 24 V
- Self-regulated alternator ..... 28 V, 30 A
- Starting motor power ..... 4 kW
- Battery (optional) ..... 2, each 110 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SRM32
4 - stroke Diesel with direct injection
Cylinders, number and arrangement ... .6, in line
Bore x stroke .... 115 x 130 mm
Displacement..... ..... 8.1 l
Compression ratio..... 15.5 : 1
Net power at flywheel (*) :
- Pleasure craft..... ... 236 kW (320 CV)
At .....2400 rpm
- Light-duty commercial..... 184 kW (250 CV)
At .....2200 rpm
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ;
30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for
timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- Intake ..... 0.30 mm
- exhaust..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 18 ° ± 1°
Fuel injectors setting..... 215 + 5 bar
Firing order.....1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure :
- at full throttle ....3.5 kg/cm^2
- when idling .... 0 8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage..... .... 24 V
- Self-regulated alternator..... 28 V, 30 A
- Starting motor power .... 4 kW
- Battery (optional)..... 2, each 110 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SRM37
4 - stroke Diesel with direct injection
Cylinders, number and arrangement.....6, In line
Bore x stroke ..... 115 x 130 mm
Displacement..... 8.1 l
Compression ratio ..... 15.5 : 1
Net power at flywheel (*) :
- Pleasure craft..... 272 kW (370 CV)
At .....2400 rpm
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- Intake ..... 0.30 mm
- exhaust..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 20 ° ± 1°
Fuel injectors setting..... 215 + 5 bar
Firing order.....1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure :
- at full throttle .....3.5 kg/cm^2
- when idling .....0.8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage..... 24 V
- Self-regulated alternator..... 28 V, 30 A
- Starting motor power ..... 4 kW
- Battery (optional).....2, each 110 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SRM40 00/SRM40 01
4 - stroke Diesel with direct injection
Cylinders, number and arrangement ..... 6, In line
Bore x stroke ..... 115 x 130 mm
Displacement ..... 8.1 l
Compression ratio ..... 15.5 : 1
Net power at flywheel (*) :
- Pleasure craft ..... 294 kW (400 CV)
At ..... 2400 rpm
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C. ..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- Intake ..... 0.30 mm
- exhaust ..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 21 ° ± 1°
Fuel injectors setting (8361SRM40.00) ..... 220 + 8 bar
Fuel injectors setting (8361SRM40.01) ..... 240 + 8 bar
Ordine di iniezione ..... 1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure :
- at full throttle ..... 3.5 kg/cm^2
- when idling ..... 0.8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage ..... 24 V
- Self-regulated alternator ..... 28 V, 30 A
- Starting motor power ..... 4 kW
- Battery (optional) ..... 2, each 120 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SRM40.10
4 - stroke Diesel with direct injection
Cylinders, number and arrangement ..... 6, In line
Bore x stroke ..... 115 x 130 mm
Displacement ..... 8.1 l
Compression ratio ..... 15.5 : 1
Net power at flywheel (*) :
- Pleasure craft ..... 294 kW (400 CV)
At ..... 2400 rpm
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C. ..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- Intake ..... 0.30 mm
- exhaust ..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 18 ° ± 1°
Fuel injectors setting ..... 240 + 8 bar
Firing order ..... 1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure.

LUBRICATION

Minimum oil pressure :
- at full throttle ..... 3.5 kg/cm^2
- when idling ..... 0.8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage ..... 24 V
- Self-regulated alternator ..... 28 V, 30 A
- Starting motor power ..... 4 kW
- Battery (optional) ..... 2, each 120 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

ENGINE SPECIFICATIONS

Engine type 8361SRM40.40
4 - stroke Diesel with direct injection
Cylinders, number and arrangement ..... 6, In line
Bore x stroke ..... 115 x 130 mm
Displacement ..... 8,1 l
Compression ratio ..... 15,5 : 1
Net power at flywheel (*) :
- Pleasure craft ..... 293 kW (398 CV)
At ..... 2500 giri/min
Engine rotation :
(see from flywheel) ..... CCW

(*) Net rating at flywheel according to ISO 3046-1
- Ambient reference conditions : 750 mmHg ; 25° C ; 30 % relative humidity.

TIMING

Valve Timing :
- Intake
opens : before T.D.C. ..... 11 °
closes : after B.D.C. ..... 27 °
- Exhaust
opens : before B.D.C. ..... 55 °
closes : after T.D.C. ..... 17 °
Clearance between valve and rockers for timing checks ..... 0.44 mm
Operating clearance between valves and rockers, cold engine :
- intake ..... 0.30 mm
- exhaust ..... 0.50 mm

FUEL SYSTEM

In line injection pump type PES 6P.
Fixed injection pump delivery start advance ..... 18° ± 1°
Fuel injectors setting ..... 240 + 8 bar
Firing order ..... 1 - 5 - 3 - 6 - 2 - 4

TURBOCHARGING

The engine is turbocharged by turbocharger driven by the exhaust gases .
The turbocharger is lubricated with the engine oil under pressure

LUBRICATION

Minimum oil pressure :
- at full throttle ..... 3 5 kg/cm^2
- when idling ..... 0.8 kg/cm^2

COOLING SYSTEM

Cooling by dual water circuit :
- Primary circuit (closed) by fresh water;
- Secondary circuit (open) by sea water.

Water circulation is provided by a self priming pump featuring a neoprene impeller.
Complete sea water circuit is protected from corrosion by replaceable sacrifical anodes.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage ..... 24 V
- Self-regulated alternator ..... 28 V, 30 A
- Starting motor power ..... 4 kW
- Battery (optional) ..... 2, each 120 Ah

MARINE GEAR

Available in different models for their overhauling see the specific manual of the manufacturer.

SEA WATER PUMP

GENERALITIES

The sea water circulation for cooling the fresh water and the marine gear oil is ensured by a self-priming pump type neoprene impeller

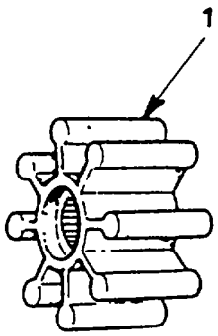
INSTRUCTION FOR USE

Each time the engine is started, check that the sea water intake valve is open. Dry running of the pump would damage the impeller (1) in a very short time.

Under normal operating conditions of the engine check every 800 hours the state of the neoprene impeller, after removing first the cover

Make sure that it is free from cracks or excessive wear of the lobe.

If not replace it.



FRESH WATER_SEA WATER HEAT EXCHANGER

GENERALITIES

When the fresh water circulating in the engine reaches temperature values in excess of .

66 ° C (8361 M 16)

75 ° C (8361 SM 21 / SRM 32 / SRM 37 / SRM 40)

it is convoyed under thermostatic control to the fresh water-sea water heat exchanger, where it is cooled and returned to circulation

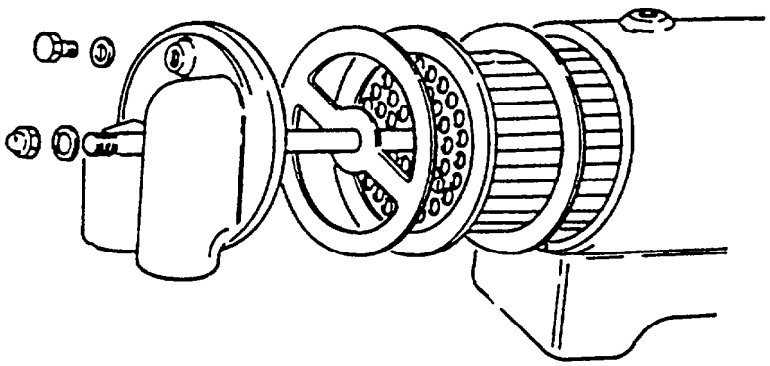
This heat exchanger consists essentially of a cast iron body with the fresh water circulation therein and a copper tube bundle containing the circulating sea water for cooling the fresh water

MAINTENANCE

For ensuring the perfect efficiency of the fresh water-sea water heat exchanger it is necessary to clean periodically the tube bundle:

- Remove the tube bundle from the exchanger body and immerse it into a solution of water and anti-incrustator type "P3" or the like (*) which does not attack copper, brass, aluminium and tin.
- After the end of the reaction (indicated by effervescence) after about 15 to 20 minutes, rinse the tube bundle aboundingly with running water for completely eliminating any residue of the solution and re-assemble the bundle into the exchanger body.

(*) When using solvents observe the prescriptions of the makers.



FITTING TOLERANCES

DESCRIPTION	mm
ENGINE BLOCK - CONNECTING RODS	
Cylinder sleeve bore diameter	115,000 ÷ 115,022
Cylinder sleeve bore oversize	0 6
Cylinder bore diameter in block	122,000 – 122,030
Cylinder sleeve pilot diameter	121,920 – 121 970
Cylinder sleeve fitted clearance in block	0,030 – 0,110
Cylinder sleeve protrusion above block top	0,130 – 0,170
Maximum cylinder sleeve top misalignment	0 030
Sleeve protrusion shim thickness range	3,09-3 11-3,13-3,15-3 17-3,19-3,21-3,23-3,25-3,27-3,29-3,31-3,33-3,35-3,37-3,39-3 41-3,43-3,45-3 47-3,49-3 51
Camshaft bushing housing bore diameter	52,000 – 52,025
Camshaft bushing O.D.	52,098 – 52,136
Camshaft bushing interference fit in housing	0,073 ÷ 0,136
Camshaft bushing fitted I.D	49,055 – 49,090
Camshaft journal diameter	48 950 – 48,975
Camshaft journal running clearance in bushing	0 080 – 0,140
Main bearing housing bore diameter	84,206 – 84,226
Tappet housing bore diameter in block	27,000 – 27,033
Tappet housing oversize	0,30-0 40-0,50
Big end bore diameter	76,698 – 76,713
Small end bushing bore diameter	45,946 ÷ 45,971
Big end bearing wall thickness	2,060 – 2,070
Big end bearing undersize range	0,254-0,508-0,762-1,016
Small end bushing O D	46,069 ÷ 46,120

DESCRIPTION	mm
Small end bushing fitted I.D	42,025 ÷ 42,035
Piston pin clearance in small end bushing	0,019 ÷ 0,035
Small end bushing interference fit in housing	0,098 ÷ 0 174
Crankpin running clearance in big end bearing	0,058 ÷ 0,111
Connecting rod axle misalignment 125 mm from conn. rod	0,050
PISTONS - PINS - RINGS	
Piston diameter at right angles to pin and 30 mm from base of skirt	114,833 ÷ 114,847
Piston oversize	0,6
Piston clearance in cylinder sleeve at right angles to pin and 30 mm from base of skirt	0,153 – 0,189
Pin housing bore diameter in piston	42,013 ÷ 42,019
Ring groove width in piston:	
– top	2,580 ÷ 2 600
– second	2,540 ÷ 2 560
– bottom	4,030 – 4 050
Piston pin diameter	42,000 ÷ 42 006
Piston pin oversize	0,2
Piston ring thickness:	
– top compression ring, chromed	2,478 – 2 490
– second compression ring	2,478 ÷ 2 490
– bottom oil scraper ring, slotted and spring loaded	3,978 ÷ 3 990
Piston ring oversize	0 6
Ring clearance in groove	
– top compression ring	0,090 – 0,122
– second compression ring	0,050 – 0 082
– bottom oil craper ring	0,040 – 0 072

DESCRIPTION	mm
Ring fitted gap	
– top compression ring	0 40 ÷ 0 65
– second compression ring	0 40 ÷ 0,60
– bottom oil scraper ring	0 30 ÷ 0,45
Piston pin clearance in small end bushing	0 019 ÷ 0,035
Pin clearance in piston	0 007 – 0,019
CRANKSHAFT - BEARINGS	
Main journal diameter	79,777 to 79 800
Main bearing housing bore diameter	84,206 – 84,226
Main bearing shell thickness	2,169 – 2,178
Main bearing undersize range	0,254-0,508-0,762-1 016
Crankpin diameter	72 477 to 72 500
Main journal running clearance in bearings	0 050 to 0 111
Big end bearing shell thickness	2,060 – 2,070
Crankpin running clearance in big end bearing	0 058 to 0 0116
Big end bearing undersize range	0,254-0,508-0,762-1,016
Centre main bearing housing width over thrust shoulders	43,024 – 43,074
Centre main journal width over thrust shoulders	50 000 ÷ 50,050
Thrust washer thickness	3,378 ÷ 3,429
Thrust washer oversize	0,127-0,254-0,508
Crankshaft end float	0,068 ÷ 0,270
Maximum main journal misalignment (TIR)	0,100
Crankpin misalignment relative to main journals	± 0,250

DESCRIPTION	mm
Maximum main journal and crankpin ovalty after grinding	0,005
Crankshaft flange face run-out on periphery (TIR)	0,025
Flywheel face run-out over 330 mm diameter (TIR)	0,050
CYLINDER HEAD	
Valve guide housing bore diameter in head	13,995 ÷ 14,018
Valve guide O.D.	14,028 ÷ 14,039
Valve guide oversize	0,4-0,2-0,4
Valve guide fitted I.D	7,987 ÷ 8,012
Valve guide interference fit in head	0,010 ÷ 0,044
Valve stem diameter	7,945 ÷ 7,960
Valve stem working clearance in guide	0,027 · 0,067
Valve stand in:	
— Intake	0,10 ÷ 0,50
— Exhaust	0,40 — 0,80
Valve face angle	45° 15'
Exhaust valve seat housing bore diameter	42,980 ÷ 43,020
Exhaust valve seat O.D.	43,150 ÷ 43,170
Exhaust valve seat interference fit in head	0,130 ÷ 0,190
Injector nozzle stand-out.	
— injector EPPZ 10 F 1	2,70 ÷ 3,50
— injector EPPZ 50 F 15 / EPPZ 70 F 15	2,20 ÷ 3,00
VALVE SPRINGS	
Free height	49,30
Spring height under 23.70 kg	42,00
Spring height under 64.30 kg	29,50

DESCRIPTION	mm
VALVE TIMING GEAR	
Camshaft bushing housing bore diameter	52 000 – 52 025
Camshaft bushing O D	52 098 – 52 136
Camshaft bushing interference fit in block	0 073 ÷ 0,136
Camshaft bushing fitted I D	49 055 ÷ 49 090
Camshaft journal diameter	48,950 – 48 975
Camshaft journal running clearance in bushings	0 080 – 0,140
Tappet housing bore diameter	27 000 – 27,033
Tappet housing oversize	0 30-0 40-0 50
Tappet O.D	26 939 – 26 960
Tappet oversize	0 30-0,40-0,50
Tappet working clearance in block	0,040 ÷ 0,094
Rocker shaft O.D.	21 015 ÷ 21,036
Rocker bracket bore diameter	21 040 ÷ 21,061
Rocker bore diameter	21,050 ÷ 21,080
Rocker shaft clearance in bracket	0,004 ÷ 0,046
Rocker shaft clearance in rocker	0 014 ÷ 0,065

FITTING TOLERANCES

ENGINE BLOCK - CONNECTING RODS

DESCRIPTION	mm
Cylinder sleeve bore diameter	115 000 to 115 022
Cylinder sleeve bore oversize	0 6
Cylinder bore diameter in block	122 000 to 122 040
Cylinder sleeve pilot diameter	121 920 to 121 970
Cylinder sleeve fitted clearance in block	0 030 to 0 120
Cylinder sleeve protrusion above block top	0 130 to 0 160
Maximum cylinder sleeve top misalignment	0 030
Sleeve protrusion shim thickness range	3 09 to 3 51
Main bearing housing bore diameter	84 206 to 84 226
Tappet housing bore diameter in block	27 000 to 27 033
Tappet housing oversize	0 20 - 0 40
Big end bore diameter	76 698 to 76 713
Small end bushing bore diameter	45 946 to 45 971
Big end bearing wall thickness	2 060 to 2 070
Big end bearing undersize range	0 254-0 508-0 762-0 016
Small end bushing O.D	46 069 to 46 120
Small end bushing fitted I D	45 025 to 42 035
Piston pin clearance in small end bushing	0 019 to 0 035
Small end bushing interference fit in housing	0 098 to 0 174
Crankpin running clearance in big end bearing	0 058 to 0 174

PISTONS - PINS - RINGS

DESCRIPTION	mm
Piston diameter at right angles to pin and 35 mm from base of skirt	114 813 to 114 827
Piston oversize	0 6
Piston clearance in cylinder sleeve at right angles to pin and 35 mm from base of skirt	0 173 to 0 209
Pin housing bore diameter in piston	42 008 to 42 014
Piston pin diameter	42 000 to 42 006
Piston pin oversize	0 2
Pin clearance in piston	0 002 to 0 014
Ring groove width in piston	
– top	3 052 to 3 082
– second	2 550 to 2 570
– bottom	4 030 to 4 050
Piston ring thickness.	
– top compression ring, chromed	(3)
– second compression ring	2 478 to 2 490
– bottom oil scraper ring, slotted and spring loaded	3 978 to 3 990

Ring clearance in groove	
– top compression ring	0 052 to 0,082
– second compression ring	0,060 to 0,092
– bottom oilscraper ring	0,040 to 0,072
Ring fitted gap	
– top compression ring	0 40 to 0 65
– second compression ring	0 40 to 0 60
– bottom oil scraper ring	0 30 to 0 45

CRANKSHAFT - BEARINGS

DESCRIPTION	mm
Main journal diameter	79 782 to 79 800
Main bearing housing bore diameter	84 206 to 84 226
Main bearing shell thickness	2 169 to 2.178
Main bearing undersize range	0 254-0 508-0 762-1 016
Crankpin diameter	72 482 to 72 500
Main journal running clearance in bearings	0,050 to 0 106
Big end bearing shell thickness	2 060 to 2.070
Crankpin running clearance in big end bearing	0 058 to 0.111
Big end bearing undersize range.	0 254-0 508-0 762-1.016
Centre main bearing housing width over thrust shoulders	43 024 to 43 074
Centre main journal width over thrust shoulders	50 000 to 50 050
Thrust washer thickness	3 378 to 3 429
Thrust washer oversize	0 127-0 254-0 508
Crankshaft end float	0 068 to 0 270

CYLINDER HEAD

DESCRIPTION	mm
Valve guide housing bore diameter in head	13 995 to 14 018
Valve guide O.D	14 028 to 14 039
Valve guide oversize	0 04 - 0 2 - 0 4
Valve guide fitted I D	7 987 to 8 012
Valve guide interference fit in head	0 010 to 0,044
Valve stem diameter.	7 945 to 7 960
Valve stem working clearance in guide	0,027 to 0,067
Exhaust valve seat housing bore diameter	42,980 to 43,020
Exhaust valve seat O.D	43 150 to 43 170
Exhaust valve seat interference fit in head	0 130 to 0 190
Valve stand in:	
– Intake	0 10 to 0 50
– Exhaust	0 40 to 0 80
Valve face angle	45° 15'

VALVE SPRINGS

DESCRIPTION	mm
Free height	55 3
Spring height under 25±1 kg	43
Spring height under 64±2,5 kg	30.5

VALVE TIMING GEAR

DESCRIPTION	mm
Camshaft bushing housing bore diameter	52 000 to 52,025
Camshaft bushing O D	52.098 to 52.136
Camshaft bushing interference fit in block	0,073 to 0 136
Camshaft bushing fitted I D	49 055 to 49 090
Camshaft journal diameter	48 950 to 48 975
Camshaft journal running clearance in bushings	0.080 to 0 140
Tappet housing bore diameter	27.000 to 27 033
Tappet housing oversize	0 20 - 0 40
Tappet O.D.	26,939 to 26,960
Tappet oversize	0 20 - 0 40
Tappet working clearance in block	0 040 to 0 094
Rocker shaft O D	21 015 to 21 036
Rocker bracket bore diameter	21 040 to 21 061
Rocker bore diameter	21 050 to 21 080
Rocker shaft clearance in bracket	0.004 to 0.046
Rocker shaft clearance in rocker	0,014 to 0 065

FAULT-FINDING DIAGNOSIS

TROUBLE	POSSIBLE CAUSE	REMEDY
The engine does not start	Battery charged partially	Check batteries and charge them If necessary replace them
	Battery terminal connections corroded or loose	Clean, check and tighten nuts on battery terminals Replace cable terminals and nuts, if badly corroded
	Incorrect timing of injection pump	Check and carry out injection pump timing
	Deposits or water in fuel lines	Detach pipes and clean them with air Disasse and clean injection pump Dry fuel tank and refuel
	Insufficient fuel reserve	Refuel
	Defective fuel pump	Overhaul pump or change it
	Air bubbles in fuel lines or in injection pump	Check pipes and fuel feed pump to detect the reasons of air presence. bleed air from injection pump unscrewing the relevant plug and manually operating fuel feed pump
	Defective starter	Repair or replace starter
The engine stops	Too low idling	Adjust idle speed by adjusting screw
	Uneven delivery of injection pump	Adjust delivery If broken, replace pumping element spring Replace tappets plunger and barrel, if seized or not sealing
	Foreign matter or water in fuel pipings	Detach pipes and clean with air Disasse and clean injection pump Clean fuel tank and refuel.
	Fuel filters clogged	Remove filter elements and replace them, if necessary
	Abnormal clearance between valves and valve rockers	Adjust clearance
	Valves burnt, corroded or cracked	Replace valves
	Air in fuel feed or injection systems	Check pipes for possible cracks, check for loose connectors Replace worn parts, then bleed air from pipes and proceed to deaerate injection pump and fuel filter unscrewing the relevant plugs and operating the fuel feed pump manually
	Fuel filter and fuel feed pump valves clogged	Replace fuel filter and overhaul fuel feed pump valves
	Injection pump controls broken.	Replace defective parts and check pump timing
The engine warms up excessively	Defective water pump	Check clearance between impeller blades and pump casing Overhaul the assembly and replace gasket.
	Thermostat failure	Replace thermostat.
	Partially ineffective radiator.	Wash out possible scaling in compliance with the instructions given for the type of scale remover used. Detect and repair possible leaks from radiator hoses
	Scale in water passages in engine block and cylinder head	Wash thoroughly, in compliance with directions given for the type of scale remover used.
	Insufficient tension of water pump belt.	Check and adjust belt tensions

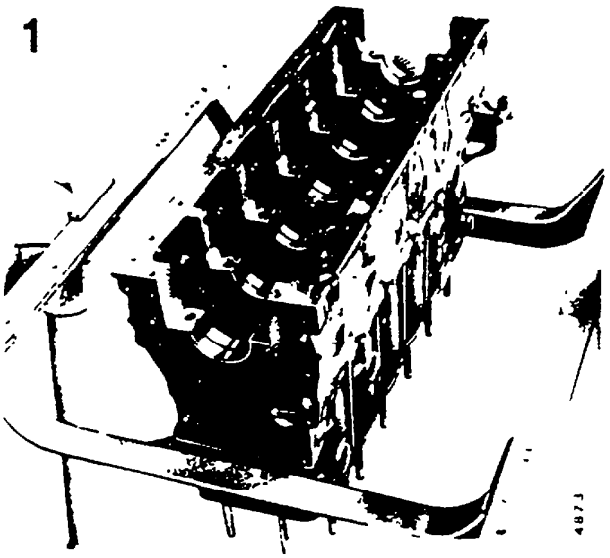
TROUBLE	POSSIBLE CAUSE	REMEDY
The engine warms up excessively	Cooling water level too low	Top up radiator with water
	Incorrect engine timing	Check timing and proceed to correct timing
	Incorrect injection pump calibration (upwards or downwards)	On test bed correct pump delivery so that injection has the prescribed delivery
The engine is under power and its operation is uneven	Incorrect timing of injection pump	Check pump timing and correct it
	Automatic advance of injection pump defective	On test bed check injection pump operation, if the observed values do not comply with the prescribed ones, replace inner springs of advance unit
	Excessive wear in plungers and barrels of injection pump	Ovehaul injection pump and replace worn-out parts
	Incorrect calibration of speed governor	Check governor calibration and again calibrate it, if necessary
	Injector nozzles clogged or incorrect injector operations	Clean nozzle holes with suitable tool and totally overhaul injectors
	Foreign matter or water in injection feed system	Thorougly clean and refill with new fuel
	Defective fuel feed pump	Disassemble pump, and, if necessary, replace pump components
	Incorrect clearance between valves and rockers	Check clearance and proceed to a correct adjustment
	Low compression.	With tool check compression pressure
	Defective turbocharger	Overhaul the assembly or replace it
	Air cleaner clogged	Clean air cleaner and inherent system
	Incorrect adjustment of injection pump peak capscrew or of control rod stop	Adjust stops correctly
The engine knocks abnormally	Uncorrect injector operations	Check that nozzle pin does not cause resistance and calibration is of prescribed value
	Fuel lines clogged	Remove pipes, clean them and replace those which are damaged or clogged
	Uncorrect injection pump timing	Correct pump timing so that injection takes place according to the prescribed advance angles
	Crankshaft knocks because of excessive clearance of one or more main bearings or of high thrust clearance	Recondition cranckshaft journals and mount undersize bearings Replace thrust washer halves with oversized ones
	Cranckshaft unbalanced.	Check shaft alignment; if necessary correct as required and check balance.
	Flywheel capscrew loose.	Replace loose screws and tighten to the prescribed torque value
	Connecting rods out-of-alignment	Straighten connecting rods under a hydraulic press, and check parallelism
	Piston knocks due to slap	Replace cylinder sleeves and pistons

TROUBLE	POSSIBLE CAUSE	REMEDY
The engine knocks abnormally	Noisy piston pins due to excessive clearance in piston and in connecting rod bushing Loose bushings in connecting rod seat	Replace piston pin with an oversize one and adjust piston hubs and connecting rod bushings Replace bushings with new ones
	Tapping due to noisy valve system	Adjust clearance between valves an rockers and check if there are broken springs or excessive clearance between stems and guides, or tappets and seats
The engine smokes abnormally		
1) Black or dark grey smoke:	Excessive pump delivery	Detach pump and adjust delivery according to the data of calibration table
	After starting the automatic fuel excess device does release	Check and, in case, replace this device
	Injection pump retarded excessively (or advance governor defective)	Correct timing, verify governor
	Injection pump excessively advanced	Correct timing
	Nozzle holes (or some of them) partially or totally clogged	Replace injectors with a set of new injectors, or clean and recondition the original ones with suitable fixtures
	Air cleaner clogged or worn-out.	Clean or replace filter element.
	Nozzle pin intermittently locked in open position.	Check injectors, check for possible locked pins, broken springs, too low calibration
	Governor adjustment over max. stated.	Bench adjust governor, according to table data
	Nozzle sprays are sent to the head because of incorrect injector assembly.	Check nozzle protrusion as to head face
	Excessive lift of injector pin due to abnormal wear.	Replace affected nozzle
	Engine compression loss due to – Piston rings stuck. – Cylinder sleeve worn-out. – Valves worn-out or adjusted uncorrectly	Overhaul engine or repair concerned parts
1) Dark grey or black smoke:	Incorrect type of injector, or injectors of different types or uncalibrated	Replace injectors or calibrate them
	Injection pipes of inadequate inside bore, pipe ends squashed because of repeated refitting	Check conditions of ends and connectors Replace where necessary
2) Blue, grey/blue, or clear grey smoke	Excessive injection delay or automatic advance device worn-out	Correct pump timing and check governor
	Injector needles blocked or defective injectors	Check for blocked needles or broken springs
	Oil seeping through piston rings due to stuck rings or to wear of sleeve walls	Overhaul engine

TROUBLE	POSSIBLE CAUSE	REMEDY
2) Blue, grey/blue, or clear grey smoke	Engine oil seeping through intake valve guides, due to wear of valve stems or guides	Recondition cylinder head
	Engine too cold (thermostat missing or not present)	Replace thermostat
Stepless change of max. speed (engine not loaded)	Governor springs too weak, causing an excessive sensitivity from governor	Replace governor springs
	Excessive clearance between the various parts transmitting control to pump	Adjust all clearances among the various parts transmitting control (be sure that pushrod stroke is exactly as prescribed)
The pump does not deliver fuel	Foreign matter in pipes	Clean thorougly
	Dirty fuel filters	Clean thorougly.
	Squashed pipes	Replace pipes or, if possible repair them (the low pressure ones)
	Air in injection pump	Deaerate pump.
The pump does deliver fuel	Plunger tappets may be seized	Remove part and repair it (if failure is minor); if necessary, replace it
	Plunger seized	Change defective pumping element, as barrels and piston are not interchangeable
	Delivery valves seized	If failure is only due to foreign matter, clean valve and sligtly regrind taper faces with an emery cloth, if reasons are different, replace pair valve holder - valve with are not interchageable from each other
The pump does not deliver enough fuel	Imperfect seal unions	Be sure that fuel feeding pipe nut washers are not broken or deformed, then tighten joints very carefully
	Imperfect seal in delivery valves of some elements	Replace the pair valve - tube holder
	Pumping elements worn-out.	Replace pumping elements.
The pump feeds abnormally	Air bubbles in fuel feed pump.	Deaerate fuel feed pump
	Plunger return spring broken.	Replace spring
	The plunger is about to seize	Thorougly clean plunger and its cylinder
	Tappet pin worn-out.	Replace tappet.
Injection start faulty timed	Uneven delivery start.	Adjust delivery start replacing adjusting shims
	Eccentric damaged	Replace camshaft, using the stroboscopic check method
The control rod shakes	Vibration due to high pump stress	Check the efficiency of spring small blocks of adjusting device
	Critical engine rpm.	Check the efficiency of spring small blocks of adjusting device.

TROUBLE	POSSIBLE CAUSE	REMEDY
INJECTORS		
The injector drips	Nozzle and needle valve (pin) are not sealed	Thorougly clean nozzle. if the trouble is due to foreing matter preventing normal operation, otherwise replace the nozzle valve pair
Too high injection pressure	Incorrect injector calibration	Calibrate injector with the greatest care
	Valve seized inside spray nozzle	Replace nozzle-valve pair
	Adjusting spring too strong	Replace spring with a more suitable one
Fuel seeps from injector unions	The upper air bleeder plug is not tightened.	Tighten it
	Nozzle check nut not tightened	Tighten it
Abnormal jet	Nozzle holes clogged by carbon deposits	Clean nozzle holes with.the suitable tool and steel wire of smaller diameter than holes Then clean the whole nozzle
	Holes deformed due to wear.	Replace nozzle-valve pair

1



- Engine block.

ENGINE BLOCK

- Block inspection

Where necessary, carry out a block leakage test to ensure that the casting is free from cracks To test, plug all block apertures and apply water at 6 bar.
Check block top surface for distortion, if necessary, dress using a grinder or by filing after checking by means of a surface plate to assess the amount of distortion

- Cylinder sleeve alignment

Check abutment faces in contact with cylinder sleeves for misalignment relative to engine block top and dress as necessary using cutter **394107** and handle **394102**, bushing **394133** and taper **394134** (see fig 2)
Check by measuring sleeve protrusion at two diametrically opposed points 120 mm from centreline of cylinder under 700 kg load evenly distributed on top of sleeve.
The difference between the two readings should not exceed 030 mm

2

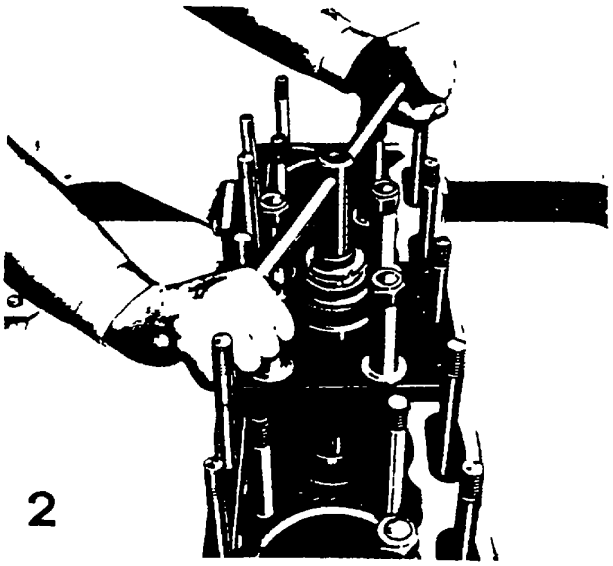


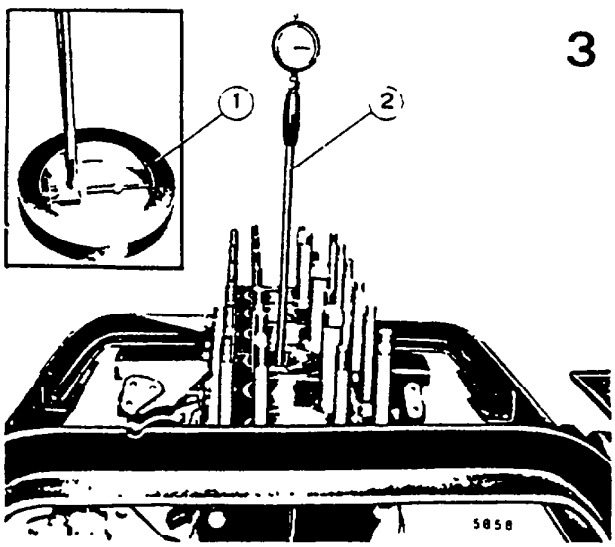
Fig 2 - Regrinding sleeve abutment

Cylinder sleeve inspection

Examine the cylinder sleeve surfaces, there should be no sign of pick-up, scoring, ovality, taper or undue wear.
To check cylinder sleeve bore for ovality, taper and wear, use gauge **A. 395687** (2, Fig. 3) fitted with dial gauge zeroed on ring gauge (1) **A. 396147** (115 mm diameter).
For each cylinder sleeve, the readings at three heights as shown in Fig 4 are taken on two planes, namely one parallel (a, Fig. 4) and the other at right angles (b) to longitudinal centreline of engine
Maximum wear is generally found on (b) plane at the top
During overhaul, bore sleeves to obtain the working clearance
8361 M . . mm. 0.153 to 0.189

between sleeves and oversize pistons, pin centreline, 30 mm. above base of piston skirt
8361 SM SRM mm 0 173 to 0 209
between sleeves and oversize pistons pin centraline, 35 mm above base of piston skirt

3



- Checking sleeve bore diameter.
1 Reference ring gauge **396147** - 2 Gauge **394687**

4

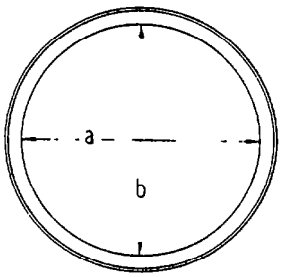
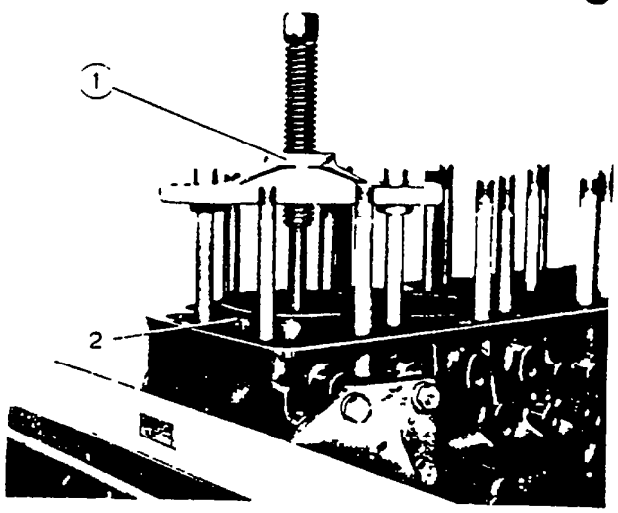


Fig 3 - Checking sleeve bore diameter
1 Reference ring gauge 396147 - 2 Gauge 394687

Fig 4 - Sleeve diameter check.
Misurazione = Measurement

5



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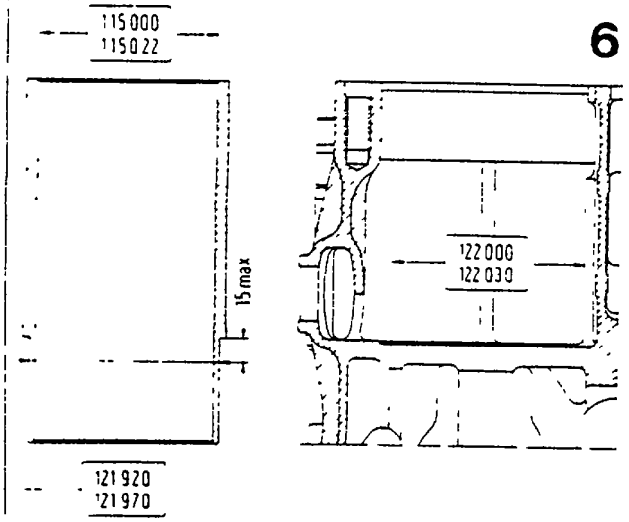


Fig. 5 - Cylinder sleeves withdrawing.
1 Tool 360715 - 2 Cylinder sleeve

Fig. 6 - Sleeve and block bore details.

- Cylinder sleeve fit relative to engine block

Main data on cylinder sleeve and engine block bore are given in fig 6 Sleeve outside diameter is to be measured at no more than 15 mm from shoulder. Fitted clearance should be 0.030 to 0 110 mm 8361 M.. 8361 SM SRM mm 0 030 to 0 120

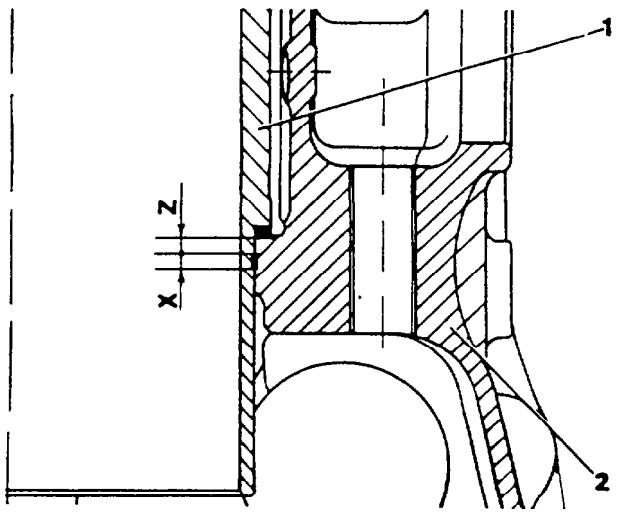
- Cylinder sleeve installation

Before installing cylinder sleeves proceed as follows:
— Clean thoroughly sleeve and block surfaces with chlorothene to remove all old sealing compound
— Degrease surfaces to coated with sealing compound both on block and sleeves (see fig. 7)
— Trace a reference mark on block (cylinder head gasket end) and on relevant sleeve

Check stand-out of sleeves above block; correct protrusion is .130 to 160 mm This amount of protrusion makes for efficient sealing through pressure as cylinder head is tightened

8361 SM SRM Cylinder sleeve protrusion above block top 0 130 to 0 160 mm

7



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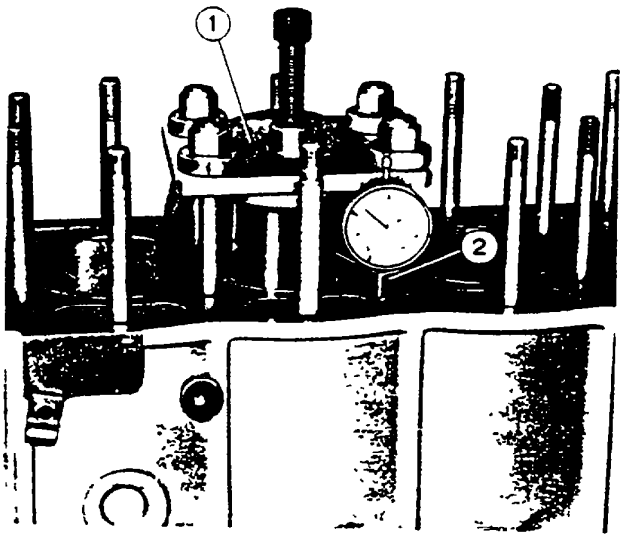


To check stand-out clamp the sleeve in question through **360406/1/3** (1, fig 6a) tightening the tool screw to 14 to 17 Nm, zero gauge **396017** (2 fig 6a) on a surface plate and read amount of protrusion, to adjust, alter thickness of shim inserted between sleeve and engine block

NOTE - Cylinder sleeve shims are available in the following thicknesses 3 09-3 11-3 13-3 15-3 17-3 19-3 21-3 23-3 25-3 27-3 29-3 31-3 33-3 35-3 37-3 39-3 41-3.43-3 45-3 47-3 49 and 3.51 mm

— Withdraw sleeves and smear a thin layer of LOCTITE HVX/PIPE type SEALANT, N° 576, avoid saggings due to excess of compound
— Install sleeves with relevant shims previously determined when checking protrusion from block, position according to reference marks

Sealant curing take place within 24 h

NOTE - If crankshaft with pistons has to be revolved before sealant curing time has lapsed, cylinder sleeves should be secured to block by retainers **360712**.

Fig. 8 - **Checking sleeve stand-out from engine block top.**
1 Tool 360406/1/3 - 2 Tool 396017

9

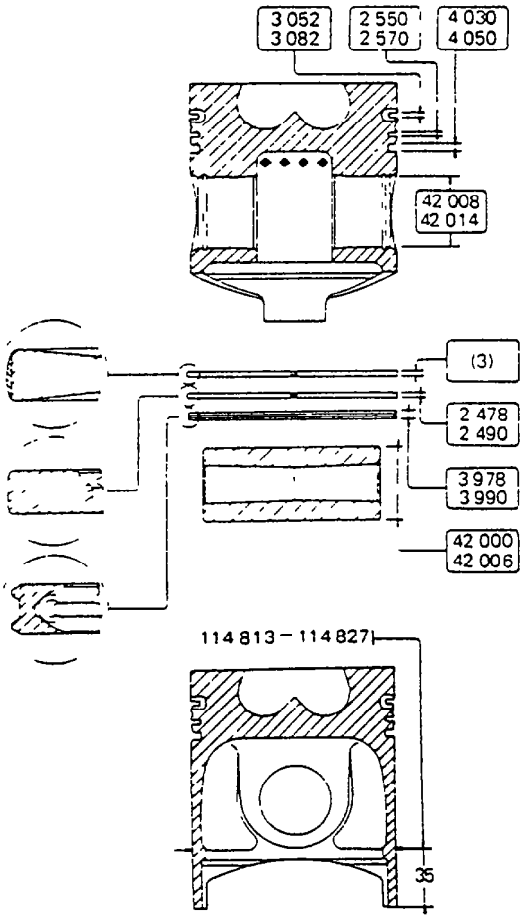
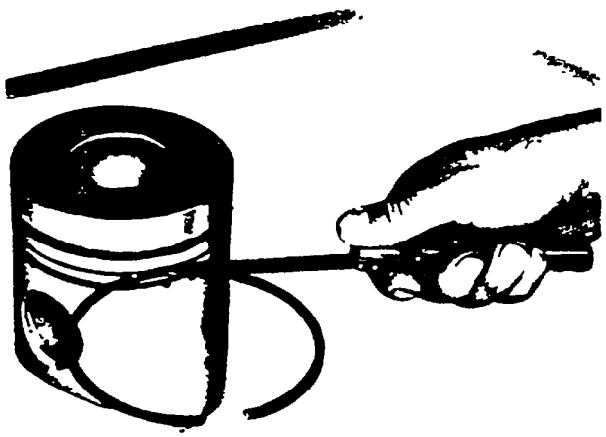


Fig. 9 - Piston, pin and ring data 8361 SM SRM



10

PISTONS AND RINGS

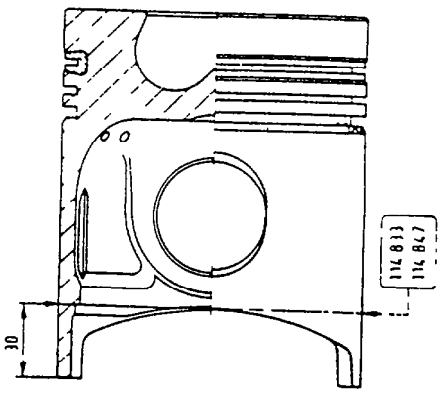
- Piston

Check pistons for pick-up, score marks or cracks and renew without hesitation as necessary

Prior to fitting the pistons, check that they are of the same weight, maximum allowance being ± 15 grams

Check pistons for wea and ovality using a micrometer gauge, piston wear is to be added to that of cylinder sleeves to determine existing clearance

Pistons and rings are available with .6 mm oversize outside diameter.



Piston grade details (8361 M)

- Piston ring clearance inspection

Check as shown, placing the ring in its seat on piston and inserting feeler gauge **395113** (fig. 10).

If piston ring side clearance is found to exceed the specified value, renew the ring in question without hesitation

8361 SM SRM

Piston ring clearance should be as follows.

– Top chromed compression ring	052 to 082 mm
– Second compression ring	060 to 092 mm
– Oil scraper ring . . .	040 to 072 mm

Ring clearance data (8361M engine)

— Top compression ring, chromium plated	0 090 to 0 122 mm
— 2nd compression ring	0 050 to 0 082 mm
— Oil scraper ring	0.040 to 0.072 mm

If the clearance is higher than the maximum permitted, check ring thickness with micrometer (2, fig. 11) to establish whether wear has affected ring or groove and renew either or both as necessary.

Fig. 10 - Checking ring clearance using a feeler gauge.

11

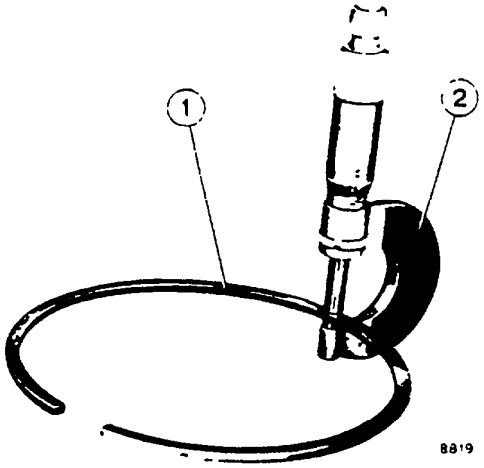


Fig. 11 - Checking ring thickness.
1 Compression ring - 2. Micrometer

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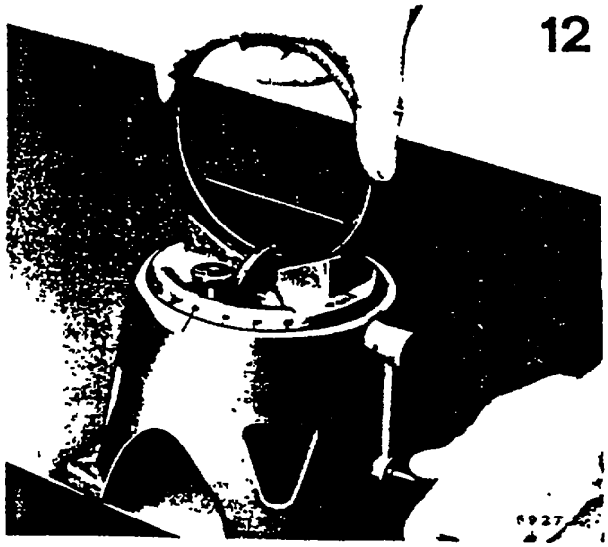


Fig. 12 - Dressing piston ring ends on dresser 360188.

- Piston ring gap inspection

For this check introduce the ring in the cylinder sleeve and use feeler gauge **395113**.
If piston ring gap is found to be lower than prescribed, dress as shown using file **360188** (fig. 12), if the gap is wider than prescribed renew the rings without hesitation.
Piston ring gap should be as follows

– Top chromed compression ring	40 to 65 mm
– Second compression ring . . .	40 to .60 mm
– Oil scraper ring	.30 to 45 mm.

13

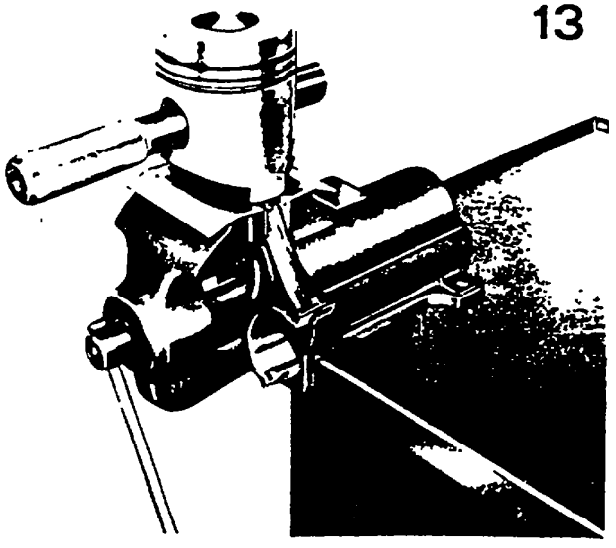


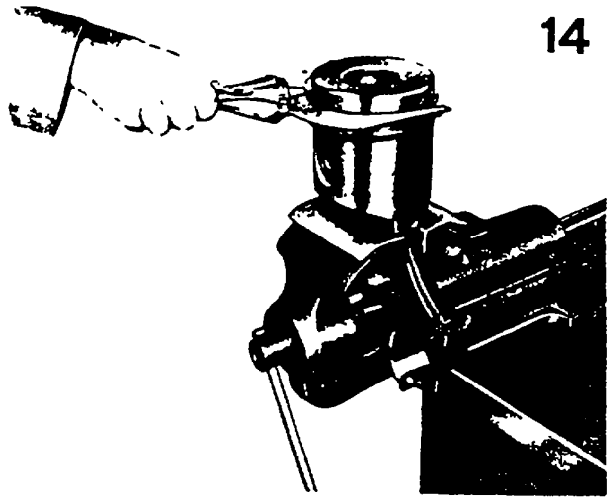
Fig. 13 - Removing piston pin using driver 360182.

- Piston Pin Clearance Check

The piston pin is fitted to the piston with a slight clearance.

In case of excessive clearance, pin or piston bore ovality or deep scoring, renew the gudgeon pin and/or the piston without hesitation.

Disassemble and install piston pin as indicated in fig. 13 using driver **360182**.



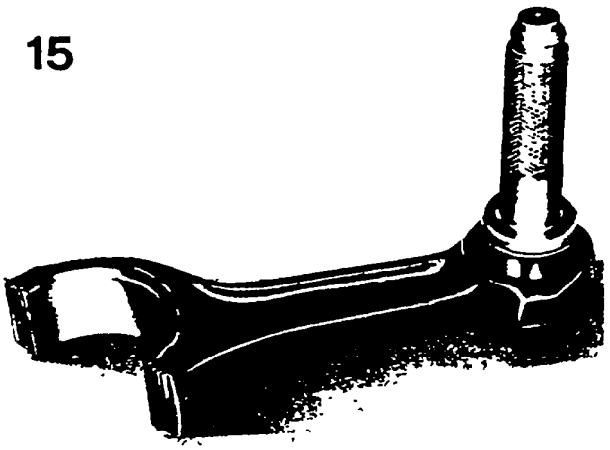
14

- Piston ring assembly

Ensure that the pin retaining rings are free from damage or weakness If found to be inefficient they should be renewed without hesitation.

Top compression ring must be fitted with its inner chamfer and wording 'TOP" uppermost
Secondo compression ring may be fitted either way
Oil scraper ring must be positioned with the spring parting line at 180° to the split
Assembly is carried out as indicated in fig 14 using pliers **360184**

Fig 14 - Installing piston rings using pliers 360184



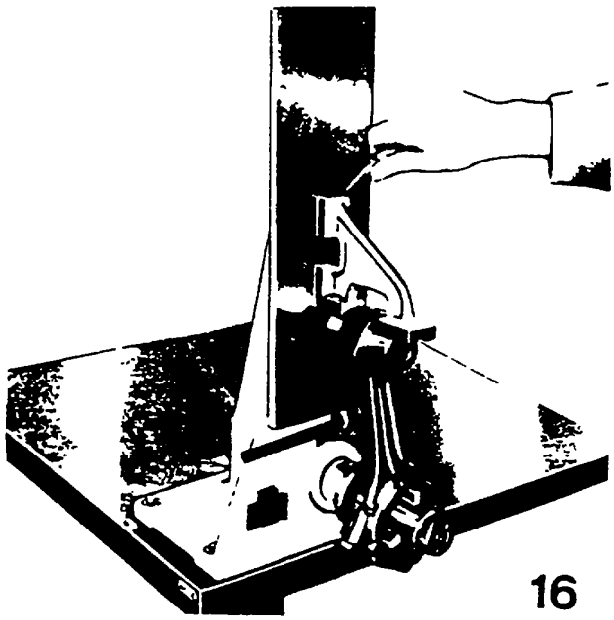
15

CONNECTING RODS AND BUSHINGS

- Bushing inspection and assembly

Small end bushing is press fitted interference fit being 098 to 174 mm Check for bushing looseness in small end
Check bushing bore for pick-up and score marks and renew as necessary slight scratches may be remedied by reaming
Removal and installation of small end bushing should be carried out as indicated in fig 15 using driver **360277**
On assembly check that bushing hole is lined up with lubricant port drilled in connecting rod body

Fig. 15 - Installing small end bushings.
1 Bushins - 2 Driver **360277**



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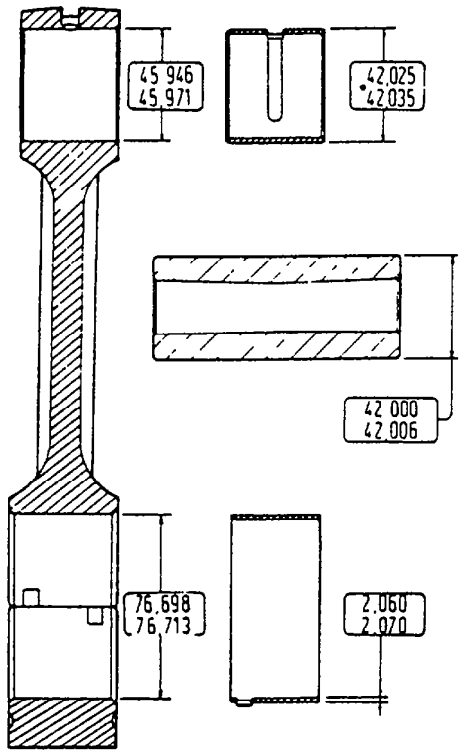
- Connecting rod inspection

Check each connecting rod for distortion as shown in fig 16 , check for connecting rod axis misalignment, maximum allowance being 050 mm
Slight distortion may be remedied by straightening at the press, if distortion is found to be considerable, renew the connecting rod in question without hesitation.

Fig. 16 - Checking connecting rod axis misalignment.



17

- Connecting rod assembly

Each connecting rod is marked on the body and cap by a number corresponding to that of the cylinder to which they belong. Accordingly, when a connecting rod is renewed, the replacement rod must be stamped with the same number as that of the discarded rod.

Connecting rod assembly must be carried out as indicated in the illustration, noting the following points:

- Number of each connecting rod (1, fig. 18) must correspond to the number of the associated cylinder.
- Numbers stamped on connecting rods must face towards side opposite camshaft (2).

Fig. 17 - **Connecting rod, big-end bearing, bushing and piston pin details.**

* With bushings and piston pin details

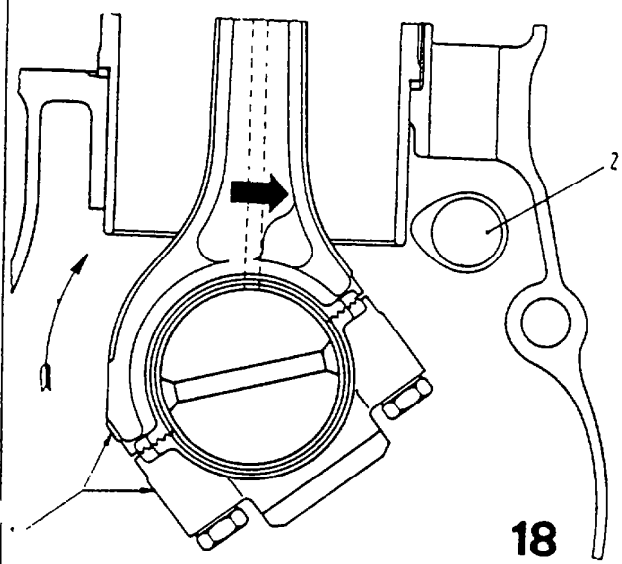


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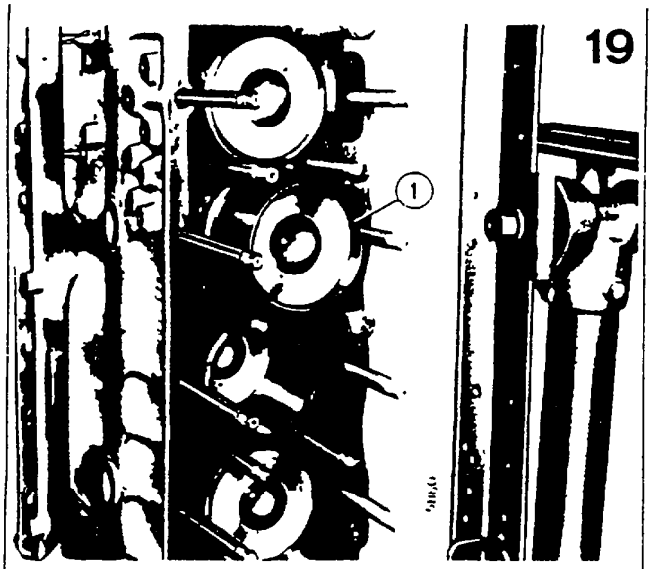
Fig. 18 - **Piston - connecting rod assembly installation diagram.**

1 Connecting rod reference number - 2 Camshaft



– Ring gaps should be spaced 120° apart from one another

To facilitate installation use compressor **360603** (1, fig 19)

Check piston T.D C position relative to engine block top, the correct position is from 164 mm above to 298 mm below block top Check as shown

Fig 19 - Installing pistons
1 Piston ring compressor **360603**

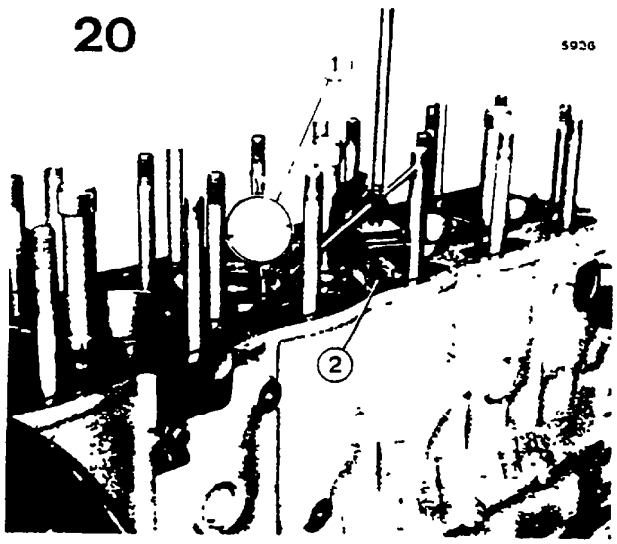


Fig. 20 - Checking piston T D C. position.
1 Dial gauge - 2 Magnetic base

CRANKSHAFT

- Main journal and crankpin dressing

If journals are found to be affected by pick-up or score marks, take a measurement using a micrometer gauge and establish at what diameter the journals in question must be ground, on the basis of the available undersize range and taking into account running clearances which must be as follows. 8361 SM SRM

— Main journals .050 to .106 mm
— Crankpins .058 to .111 mm.

8361 M

Crankshaft journal clearances are as follows

— Main journals 0 050 to 0 111 mm
— Crankpins 0 058 to 0 116 mm

In the course of grinding, pay the utmost attention and care to restore the correct size of fillet radii as shown. Moreover, it is recommended that on completion of grinding, the lubrication ports should be suitably chamfered.

After grinding and prior to shaft installation, check the bearing running clearance as indicated in the illustration, adopting the calibrated wire procedure

- Crankshaft journal alignment check

After regrinding, place crankshaft over V-blocks and check journal misalignment using a suitable dial gauge (see fig. 24).

— The centreline of each pari of crankpins should lie ont he same plane as main journal centreline to withing ±.25 mm (see fig. 24).
— Main journal misalignment (A) should not exceed .10 mm TIR.
— Crankshaft flange runout (B) on periphery should not exceed .025 mm.

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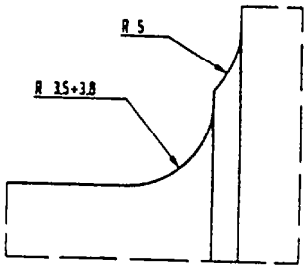

Fig. 22 - Main journal and crankpin fillet radu details.

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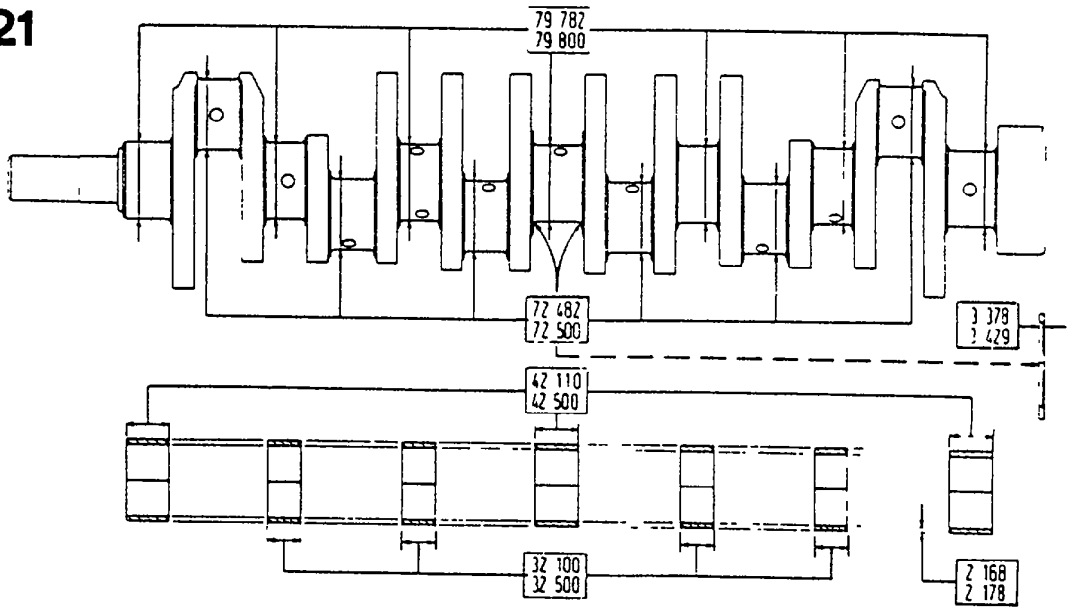

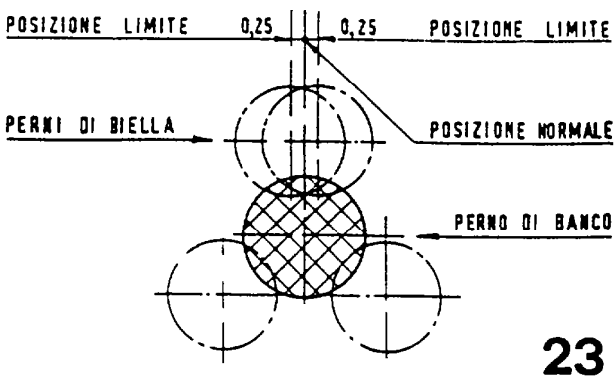

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Fig. 23 - Crankshaft journal misalignment details.

Posizione limite = Max position
Posizione normale = Normal position
Perno di biella = Crankpins
Perni di banco = Main journal

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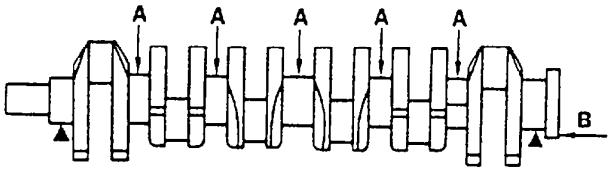

Fig. 24 - Diagram for journal alignment check

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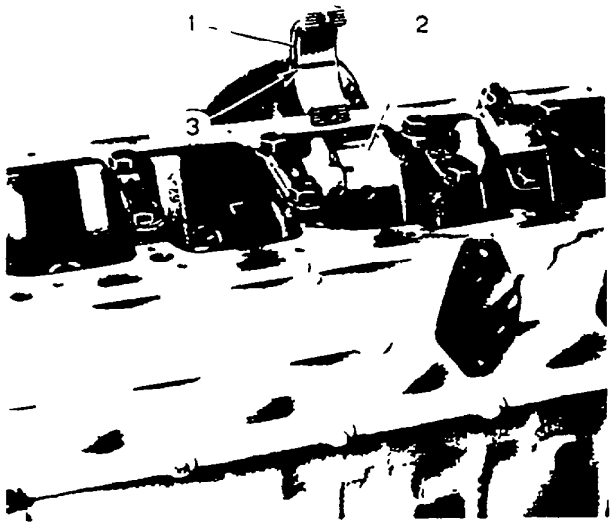

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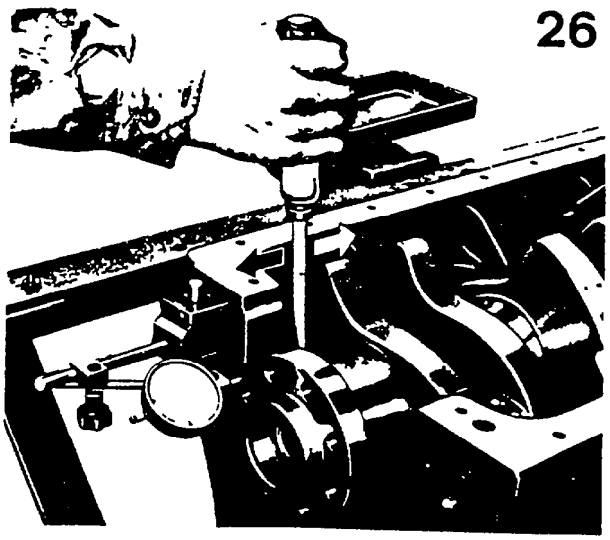

- Crankshaft Bearings and Running Clearance Check

Check the bearings' internal surfaces scratches can be removed using a suitable burnisher Renew if heavily scored or excessively worn

If the bearings are in good condition check clearance between them and the crankshaft-journals using a length of plastigage calbrated wire

Check the journal running clearance using 2 lengths of calibrated wire (fig **25**) in the following way·

- Throughly clean the engine block in the neighbourhood of the bearings to be checked to remove all traces of oil
- Lower cranshaft into position
- Position a length of calibrated wire ont he crankshaft journals parallel to cranshaft longitudinal centreline
- Position main bearing or can rod caps, with attached bearing halves over the bearing housings
- Fit capscrews wet and torque using a torque wrench
- Remove caps from bearing housings, or can rods the calibrated wire will adhere to bearings or main journals.
- Assess the amount of existing clearance by comparing the width of the calibrated wire at the point of maximum deformation to the scale printed on wire container (see fig **25**) The figures given ont he container indicate the amount of clearance in mm

Fig. 25 - Checking crankpins clearance using calibrated wire.
1 Connecting rod cap - 2 Main journal - 3 Calibrated wire

- End float adjustment

Use a magnetic base dial gauge as shown and prize endwise The correct end float is .068 to 270 mm To adjust, alter thrust washer thickness as necessary.
Endwise shaft movement arrowed.

Position thrust washers with grooved white metal lined side facing towards the crankshaft shoulder.

Fig. 26 - Checking crankshaft end float.

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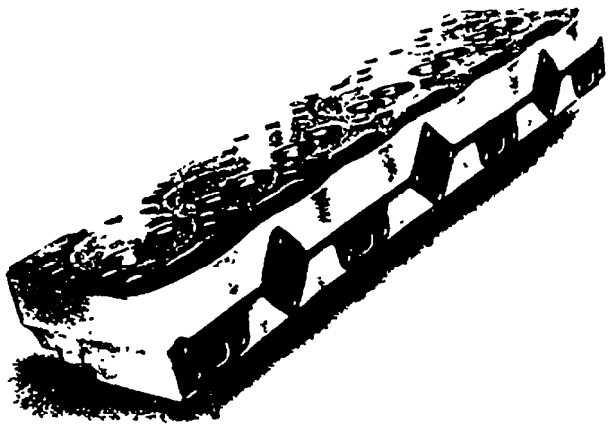

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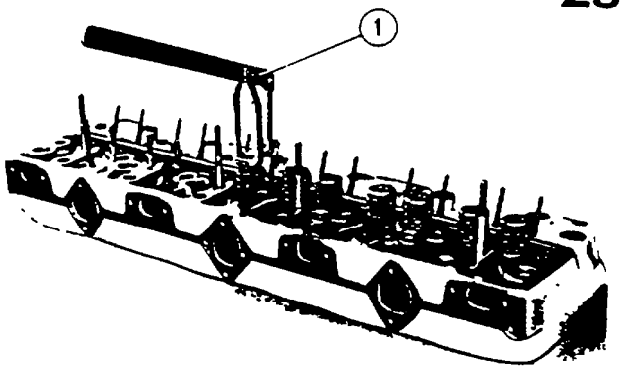

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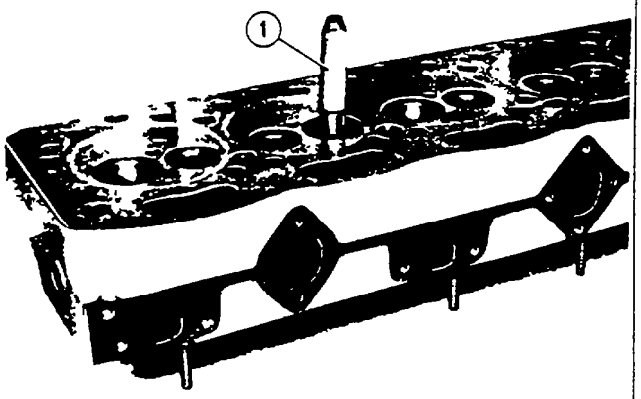

Fig. 29 - Disassembling valve guides.
1 Driver 360409/1.

CYLINDER HEAD

The cylinder assembly is equipped with a cast iron head on which are fitted by interference the exhaust valve seat whereas the seat of the intake valve are bored directly into the head

The intake and exhaust valves are actuated by a concentric, variable flexibility spring, and are centered by the cups and attached to the stem with cotters

The valve guides are driven into the head and require an interference fir between them and the seats If the fit is not tight, the guides must be replaced either with regular ones or with others having an oversized (0,04 - 0,2 - 0,4 mm) outer diameter

- Cylinder head face inspection

To check for cylinder head face distortion smear a surface plate with a light coat of carbon black and apply to head face If necessary, skim using a surface grinder removing as little material as possible

Fig. 27 - Cylinder head.

Fig. 28 - Disassembling cylinder head
1 Compressor 360357

- Valve removal and installation

Place cylinder head on bench and apply pressure to top spring cap using compressor **360357**, as shown in Fig **28** so as to remove the split cones and release the valves; withdraw top and bottom spring cups
Repeat the above sequence on the remaining valves.
Overturn cylinder head and withdraw valves
For assembly, reverse the disassembly sequence

- Leakage test

In the course of overhault, check that the water jackets in cylinder head are free from cracks
To do this apply tool **360438** (to be used with tool **305048**) and admit water at 4 to 5 bar
Under this pressure, the cylinder head should be free from leakage. Renew as necessary

- Valve inspection

After removing the valves from the cylinder head, check both stem and valve face for distortion and signs of pick-up or score marks and renew as necessary

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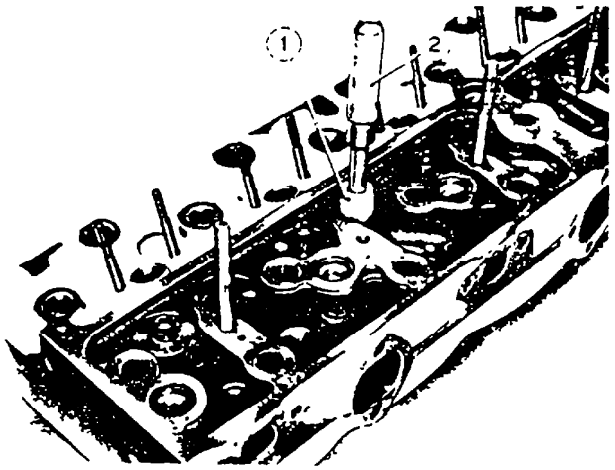

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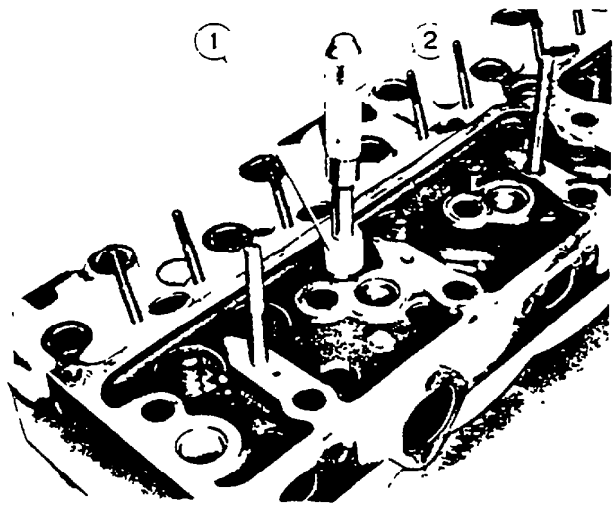

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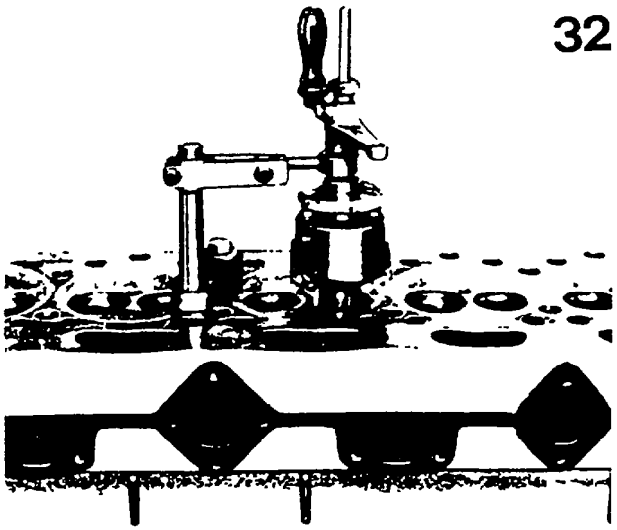


- Valve guide removal and installation

Valve guides are press fitted in the cylinder head
Valve guides should always be tight in their housings
For intake and exhaust valve guide removal, proceed as indicated in Fig 29, using driver **360409 1**

VALVE AND GUIDE DETAILS

Valve guide bore diameter mm	Valve stem diameter mm	Working clearance mm
7 987 to 8 012	7 945 to 7 960	.027 to 067

For intake valve guide installation proceed as indicated in Fig 30 using driver **360409 3**, fitted to installer **360409 1**

VALVE GUIDE FIT DATA

Valve guide housing bore diameter mm	Valve guide outside diameter mm	Interference fit mm
13 995 to 14 018	14 028 to 14 039	010 to 044

For exhaust valve guide installation, proceed as indicated in Fig 31 using driver **360283**, fitted to installer **360409 1**

Fig. 30 - Assembling intake valve guides.
1 Driver **360409 3** - 2 Handle **360409 1**

Fig. 31 - Assembling exhaust valve guides
1 Driver **360283** - 2 Handle **360409 1.**

- Valve seat dressing

Valve seat and face dressing becomes necessary when valve sealing is inefficient
For valve seat dressing proceed as indicated in Fig. **32**, using dresser **360419.**

- Valve spring inspection

Valve springs should be tested for cracks or weakness; check spring rate using tester **305049** as indicated in Fig. **33**.
If spring rate is not as specified, renew springs without hesitation.

Fig. 32 - Re-grinding valve seats using Universal grinder 360419.

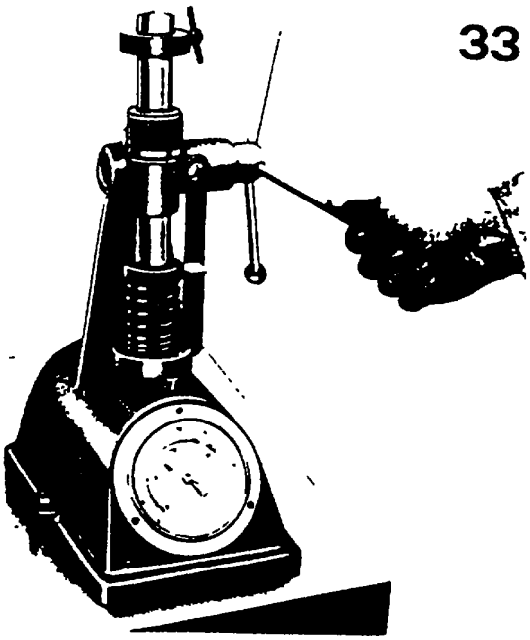
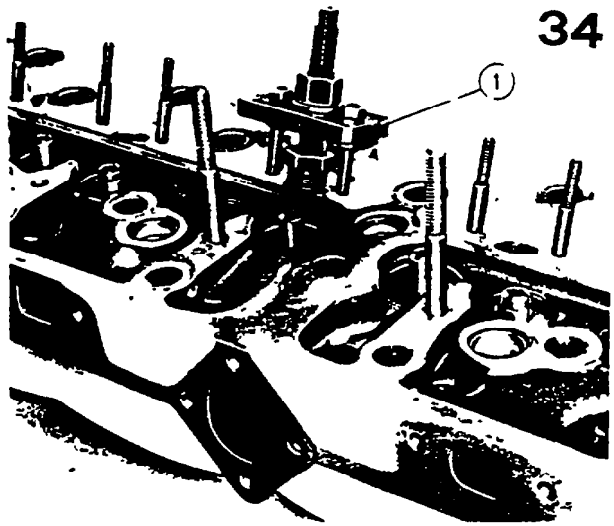


Fig. 33 - Checking springs using tool 305049.



- Injector sleeves

If compression loss through fuel injector sleeves is detected, renew leaking sleeves without hesitation.
To remove tap sleeve with set of taps **390424/1** and withdraw as shown in the illustration (fig 34), using puller **342137**
Install a new sleeve with sealing rings and burnish using burnisher **365059**.
Dress injector seat as indicated in Fig. 35 using cutter **394013 8** and handle with pilot **3904013 12**.

Fig 34 - Disassembling injector sleeves.
1 Puller **342137**

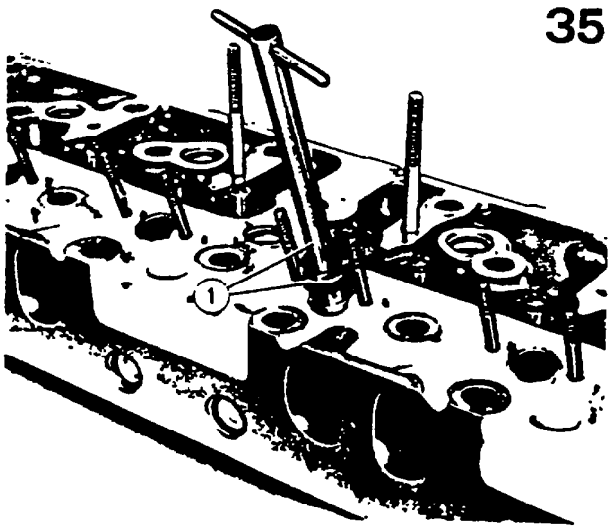


Fig. 35 - Dressing injector sleeves.
1 Pilot **394013 12**

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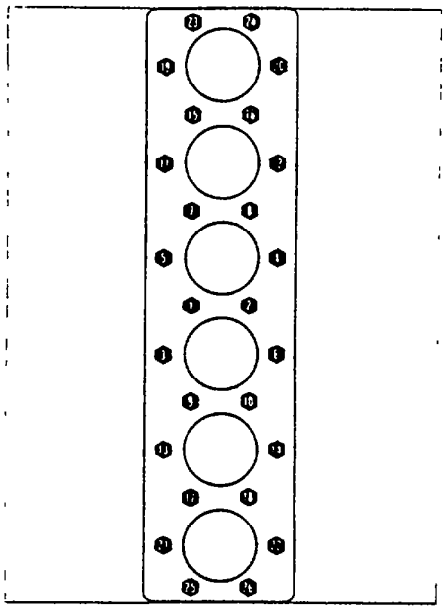


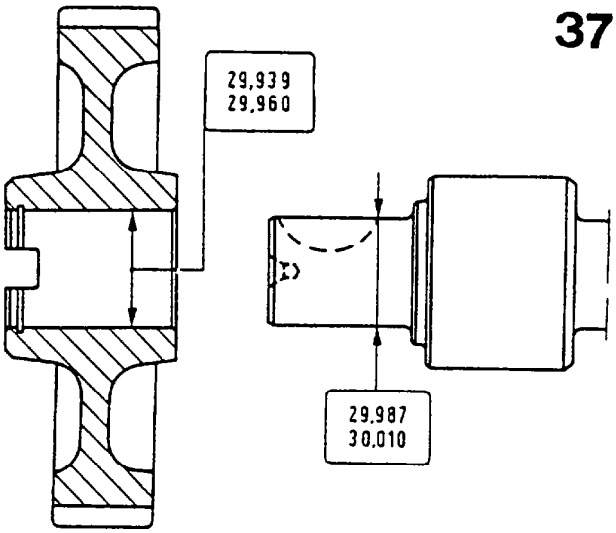
- Cylinder head assembly

To assemble cylinder head proceed as follows:
- Position head gasket on engine block top with "ALTO" mark facing upward.
- Hoist cylinder head and lower on engine block.
- Fit hold-down nuts in the order shown and tighten in three stages as follows:
- Stage 1 - to 88 Nm
- Stage 2 - 90°
- Stage 3 - 90°

Fig. 36 - Cylinder head tightening diagram.

VALVE GEAR

37



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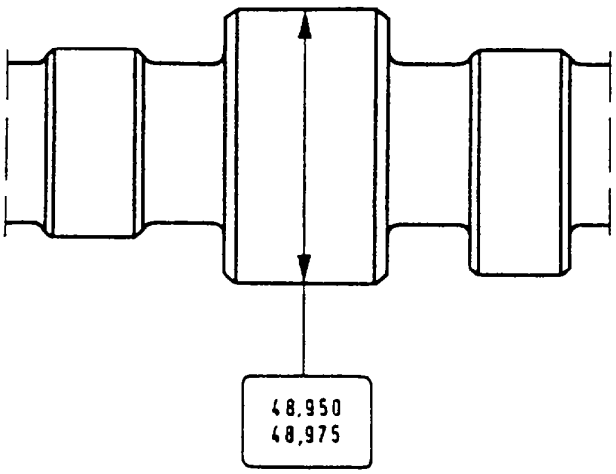

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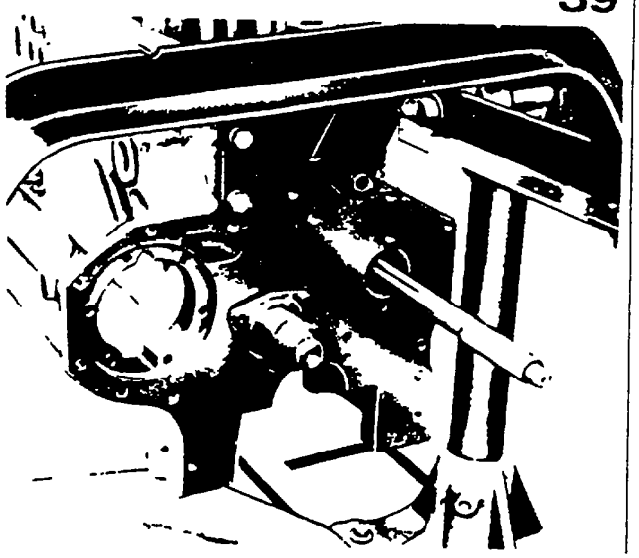

- Camshaft

Crankcase-mounted camshaft runs on 7 bearings and is gear driven from crankshaft.
Camshaft gear is shrunk after heating in oven until a temperature differential of 240° C relative to shaft is obtained

- Camshaft journal and lobe inspection

Camshaft journals should be perfectly smooth; if signs of pick-up or score marks are detected, the shaft should be renewed without any hesitation.
Light scratches may be remedied by means of 0-gradeemery clotch.

Fig. 37 - Camshaft drive gear and housing details.

Fig. 38 - Camshaft details.

- Camshaft bushing inspection

Bushings should be tight in their housings, if found to be loose, the bushings should be renewed without hesitation.
Check bushing bore, the surface should be perfectly smooth and free from pick-up or scoring; renew as necessary
If light scratch marks are detected, dress the bushings with a suitable burnisher
For bushing removal or assembly, use driver **360380** (and grip. **370008**) as shown (fig. **39**)
Following assembly, bushings should be reamed to 49.055 to 49 090 mm dia using handle **390352** with **390365** and centralizers **390364**

Fig. 39 - Camshaft bushing replacement.

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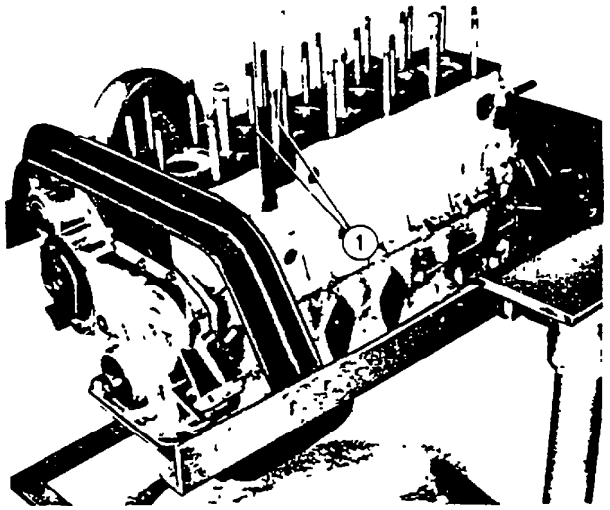
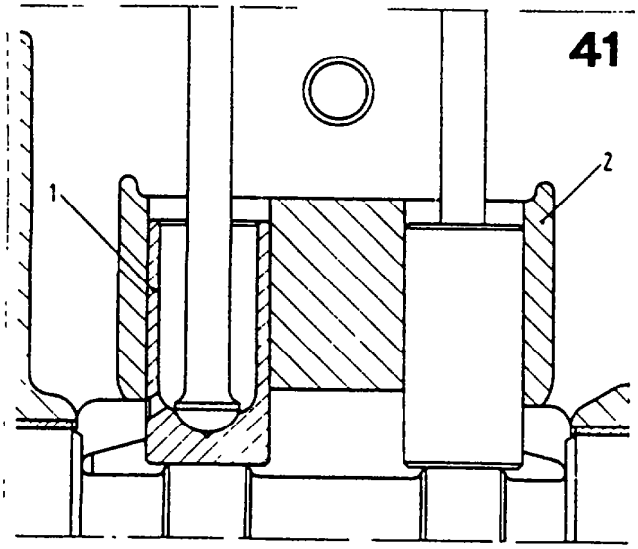


- Tappet inspection

Tappets are accessible upon removal of cylinder head and may be withdrawn from engine block using remover **360404** as shown (fig. **40**).
Tappet surface in contact with camshaft lobe should be smooth and free from dents
Light imperfections may be remedied by means of a very fine abrasive stone

Fig. 40 - Tappet removal.
1 Remover **360404**

41



- Tappet clearance inspection

Normal tappet working clearance in engine block is 040 to .094 mm.
If excessive clearance is detected, replace the tappets (1, fig. **41**) with oversize equivalents after opening out the housings (2) in the engine block.
20 - 40 - 50 mm oversize tappets are available.

Fig. 41 - Detailed section through engine
1 Tappets - 2 Housings in engine block

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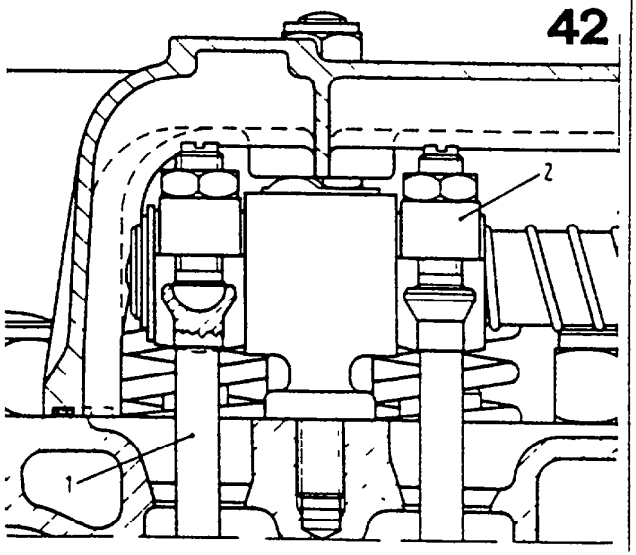
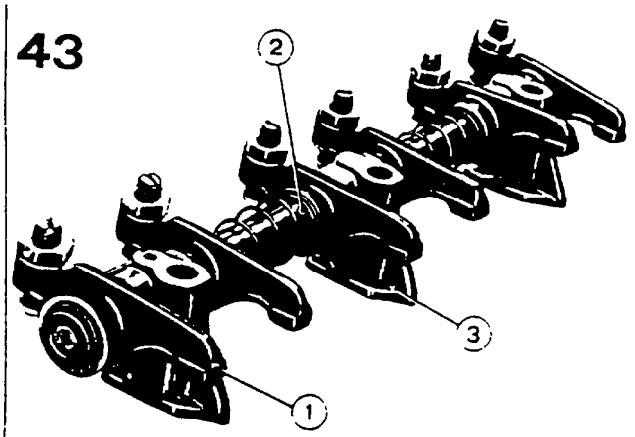


- Pushrod inspection

Pusnrods (1, fig **42**) should not be distorted and the spherical seat in contact with rocker (2) should be free from any pick-up or roughness whatever if defective renew without hesitation.

Fig 42 - Detailed section through engine.
1 Pushrod - 2 Rocker



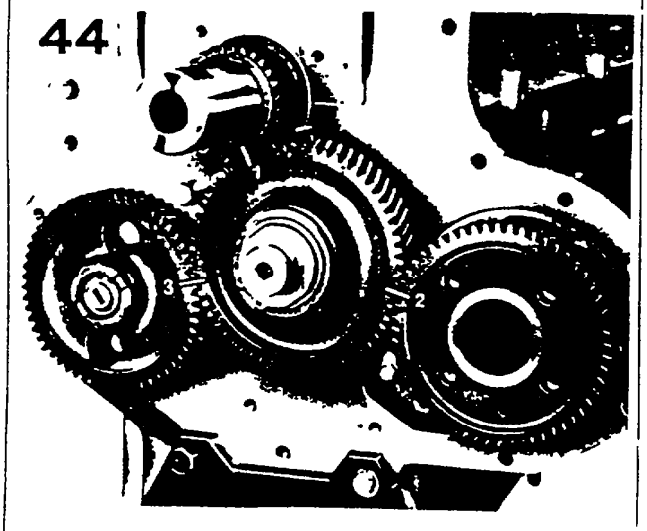


Fig. 44 - Camshaft drive gears.
Reference marks to be aligned for correct valve timing arrowed

- Bracket, rocker and rocker shaft inspection

Check shaft surface (2, Fig **43**) and rocker bore (1) for pick-up or score marks and renew as necessary
Light scratches may be remedied by means of an extra fine grade abrasive stone
Check rocker shaft clearance in rocker, the correct clearance should be 014 to 065 mm Shaft clearance in bracket (3) should be 004 to 046 mm, if excessive clearance is detected renew the affected parts without hesitation

Fig 43 - Rocker shaft.
1 Rocker - 2 Shaft - 3 Bracket

- Valve timing

For valve timing proceed as follows
- Adjust valve clearance to 40 mm
- Apply a graduated sector with 0 facing downward at rear of engine
- Turn camshaft until intake and exhaust valves of cylinder No 1 are fully closed which is equivalent to compression stroke Such condition may also be obtained by bringing the valves of the symmetrical cylinder in a condition of balance
- Install all valve timing gears as indicated in Fig **44**, ensuring that the reference marks stamped on the gears are in register
- Slowly turn the crankshaft and check on the graduated sector that valve opening and closing occurs as specified in the timing diagram,
- Adjust valve clearance to the normal value, cold, on all cylinders

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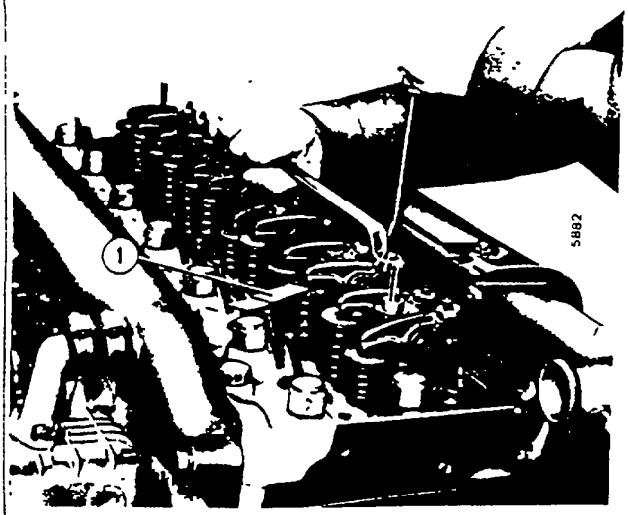


- Valve clearance adjustment

Valve clearance adjustment should be carried out with the utmost attention in order not to alter the timing Indeed, excessive clearance causes noise or retards valve opening and advances valve closing, whereas insufficient clearance has a reverse effect.

If no clearance exists, the valves remain constantly just open, which results in premature valve and seat deterioration

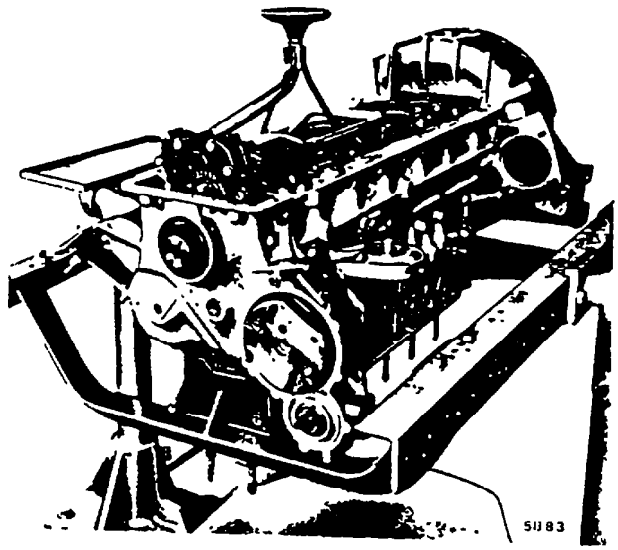
To adjust valve clearance proceed as follows

- Slowly turn crankshaft until the cylinder of the valves to be adjusted is on firing stroke The valves of this cylinder are closed when those of the symmetrical cylinder are in a condition of balance
- Hold adjusting screw stationary with a suitable screwdriver (or using tool **352137**) and slacken retaining nut using a suitable wrench insert feeler gauge **395113** (1, fig **46**) between rocker and valve and actuate screwdriver to turn adjusting screw until feeler gauge blade binds slightly At this point hold adjusting screw stationary and tighten nut

Cold valve clearance should be 30 mm intake and 50 mm exhaust

After valve clearance adjustment on one cylinder, repeat the same procedure ont he remaining cylinders

Fig. 46 - Valve clearance adjustment.
1 Feeler gauge **395113**



47

LUBRICATION SYSTEM

Lubrication system includes a gear type oil pump in bottom of engine block (1, fig. 47) attached to front main bearing housing and driven through a crankshaft-mounted gear

The pump incorporates two lines for suction (2) and delivery (3) to cartridge filter.

Oil pressure relief valve is situated on cartridge filter support . If oil pressure exceeds rated setting, relief valve is activated to return part of the oil to the sump until normal pressure is restored.

Fig. 47 - Engine without oil sump.
1 Oil pump - 2 Oil pump suction piping - 3 Oil pump delivery piping - 4 Cartridge filter support.

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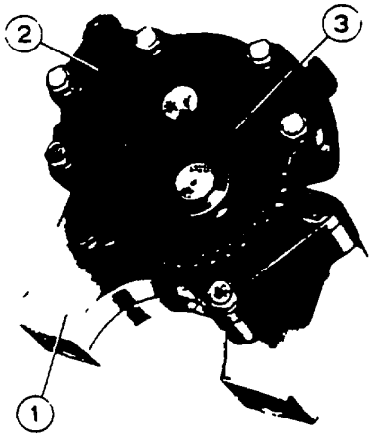

Fig. 48 - Oil pump.
1 Front main bearing - 2 Oil pump - 3 Drive gear

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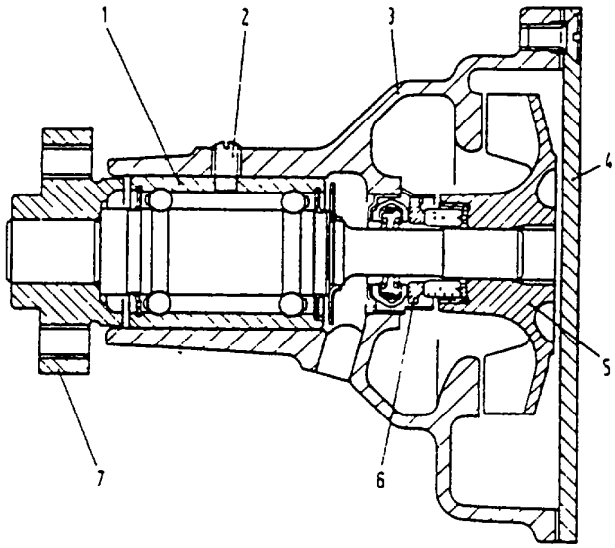

Fig. 50 - Section through water pump.
1 Bearing - 2 Retainer screw - 3 Pump body - 4 Cover - 5 Impeller - 6 Seal - 7 Hub.

- Water pump

Water pump is of the centrifugal vane type.
To install water pump proceed as follows:
- Fit bearing (1, fig. 50) to pump body (3), acting only on outer race, and lock in position by means of capscrew (2) which will subsequently have to be staked on pump body
- Air heat hub (7) until a 130° to 150° C differential is established between hub and shaft.
- Shrink hub on shaft placing an adequate support on opposite end in order not to damage the balls.
- Fit seal (6) on water pump body.
- Air heat impeller assembly (5) until a 90° to 110° C temperature differential between impeller and shaft is obtained and couple the parts applying a suitable support on the opposite end to avoid damaging balls. Check that impeller depth relative to cover (4) is 7 to 1 mm.

On completion of assembly, check impeller and hub rotating torque, the correct rotating torque is 1.5 kgm. Finally, check seal for leakage at 1.15 to 1.25 bar.

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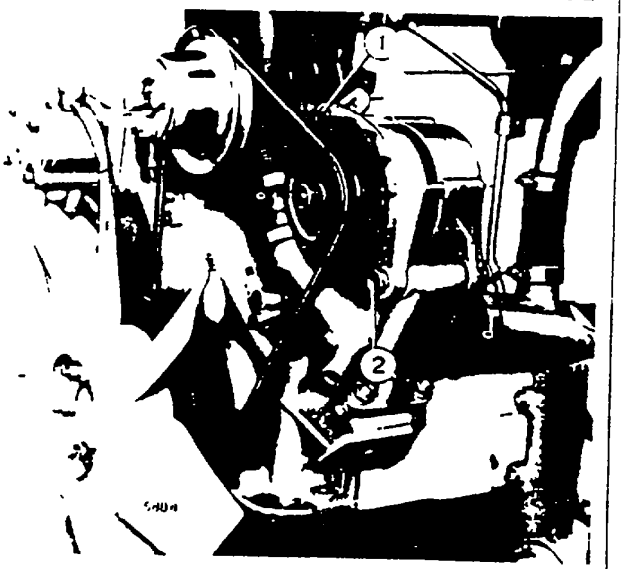

- Water pump and alternator drive belt

Check and if necessary adjust belt tension noting that belt yield is 10 to 15 mm under 12 kg approximately
To increase belt tension proceed as follows:
- Back off nut (1, fig. 52) on alternator pivot pin
- Back off retaining nut (2)
- Move alternator outward and fully tighten pivot nut and retaining nut

Fig. 52 - Regulating fan, water pump and alternator drive belt tension.
1 Pivot nut - 2 Lock nut

TORQUE LOADS

Engine Model (b)	Cylinder head (c) Tightening torque Nm*	Valve clearance (d) Intake mm	Valve clearance (d) Exhaust mm	Injectors setting (e) bar	Injectors Tightening torque (f) Nm	Rod cap Tightening torque (g) Nm*	Main bearing cap Tightening torque (n) Nm*	Damper Tightening torque (i) Nm*	Flywheel Tightening torque (l) Nm*
8361M16	88+90°+90°	0.30	0.50	200+5	19	40+35°	55+75°	270+180°+180°	100+60°
8361SM21	88+90°+90°	0.30	0.50	200+8	19	40+35°	55+75°	270+180°+180°	100+60°
8361SRM32	88+90°+90°	0.30	0.50	215+5	19	40+35°	55+75°	270+180°+180°	100+60°
8361SRM37	88+90°+90°	0.30	0.50	215+5	19	40+35°	55+75°	270+180°+180°	100+60°
8361SRM40.00	88+90°+90°	0.30	0.50	220 + 8	25	40+35°	55+75°	270+180°+180°	100+60°
8361SRM40.01	88+90°+90°	0.30	0.50	240 + 8	25	40+35°	55+75°	270+180°+180°	100+60°
8361SRM40.10	88+90°+90°	0.30	0.50	240 + 8	25	40+35°	55+75°	270+180°+180°	100+60°
8361SRM40.40	88+90°+90°	0.30	0.50	240 + 8	25	40+35°	55+75°	270+180°+180°	100+60°

SERVICE TOOLS

CODE FOR MANUAL	CORRESPONDENT CODE FOR ORDER	
340005/301	99341009	Legs, puller, crankshaft-mounted oil pump drive gear and camshaft gear (use with 99341000/001/015 and 99345052)
340046	99340046	Remover, positioning pin
340046/11	99340050	Pair of exchange connectors for 99340036
340206/801	99340205	Puller, slide hammer, water pump impeller
342137	99342145	Remover, injector sleeve
345050	99345050	Steady
345052	99345052	Puller, crankshaft pulley hub
347093	99347093	Remover, steering pump and compressor cover bushing
350135	99350135	Remover, cartridge filter
352137	99352137	Wrench, valve clearance adjustment
357051	99357051	Wrench, engine block oil port core plug
360182	99360182	Remover/replacer, engine piston
360184	99360184	Pliers, engine piston ring
360185	99360185	Pliers, compressor piston rings
360277	99360277	Remover/replacer, small end bushing
360283	99360283	Installer, exhaust valve guide use with 99360288)
360304	99360304	Handle, flywheel rotator (use with 99360307)
360307	99360307	Rotator, flywheel (use with 99360304)
360357	99360357	Remover/replacer, engine valve
360380	99360380	Remover/replager,camshaft bushing (use with 99370008)
360404	99360404	Remover, engine tappet
360406/1	99360488	Preloader, cylinder sleeve (use with 99360490)
360406/3	99360490	Fitting, cylinder sleeve compression for 99360488 and 9939607
360409/1	99360288	Handle , intake and exaust valve guide (use with specific drivers)
360409/3	99360492	Installer, intake valve gui (usewith 99360288)
360419	99360419	Dresser, universal, HUNGER ,valve seat
360435	99360435	Connection, engine cylindercompression tester (use with 99395682)
360437	90360437	Steady, flywheel

CODE FOR MANUAL	CORRESPONDENT CODE FOR ORDER	
360438	99360438	Plate, cylinder head leakage test (use with 99305048
360500	99360500	Sling, crankshaft
360502	99360502	Eyes, lift, cylinder head
360503	99360503	Eyes, lift,engine block
360603	99360603	Compressor, piston ring
360712	99360712	Retainer, cylinder sleeve
361002/25	99361020	Brackets, engine (use with revolving stand 99322220)
365059	99365059	Burnisher, injector sleeve
370005	99370005	Handle, interchangeable,driver
370006	99370006	Handle, interchangeable,driver
370008	99370008	Handle, interchangeable,driver
370136	99370136	Installer, valve timing gear to crankshaft and oil pump drive gear
370362	99370362	Installer, front crankshaft seal (use with 99360006)
370421	99370421	Installer, camshaft gear
374178/1	99374511	Handle
374178/11	99374521	Remover replacer, injection pump support bushing Remover replacer, steering pump and compressor cover bushing Remover replacer, valve timing intermediate gear bushing. (Use with 99374511)
374195	99374195	Installer, rear crankshaft seal (use with 99370005)
390352	99390352	Handle, camshaft bushing
390364	99390364	Centralizers, camshaft bushing (use with 99390352 and 99390365)
390365	99390365	Cutter, camshaft bushing (use with 99390352 and 99390634)
390424/1	99390789	Taps, injector sleeve
394013/8	99394031	Reamer, injector sleeve
394013/12	99394150	Handle/pilot, injector seat in sleeve (use with 99394031)
394102	99394102	Handle, cylinder sleeve housing cutter
394107	99394107	Cutter, cylinder sleeve housing (use with 99394102, 9939433 and 99394134)
394116	99394116	Reamer engine valve guide

CODE FOR MANUAL	CORRESPONDENT CODE FOR ORDER	
394133	99394133	Bushing (use with 99394134 and 99394107)
394134	99394134	Taper (use with 99394102 and 99394107)
395113	99395113	Adjuster, valve rocker
396017	99396017	Gauge cylinder sleeve height
396147	99396147	Gauge, ring zeroing, cylinder sleeve (use with 99395687)
360715	99360715	Tool, cylinder sleeve removal.