industrial engines

section 2

8001 series

workshop manual

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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 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. 8031105
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....3,in line
Bore x stroke.....104 x 115 mm
Displacement.....2,9 l
Compression ratio.....17:1
Automotive rating * .....44 kW(60 CV)
At.....2500 rpm
Intermittent rating.....42 kW(57 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....38 kW(52 CV)
AT.....2500 rpm
Engine rotation:
(see from flywheel) .....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C .....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine:
- intake .....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type DPS

Fixed injection pump delivery start advance.....0°± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-2-3

LUBRICATION

Minimum oil pressure:
- at full throttle.....2,5 Kg/cm²
- when idling.....0,7 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan drive by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self-regulated alternator.....14 V,45 A
- Starting motor power.....3 KW
- Battery (optional).....120 Ah

ENGINE SPECIFICATIONS

Engine type. 8041105
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....4,in line
Boxe x stroke.....104 x 115 mm
Displacement.....3,9 l
Compression ratio.....17:1
Automotive rating * .....59 kW(80 CV)
At.....2500 rpm
Intermittent rating.....56 kW(76 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....50,5 kW 69 CV)
AT.....2500 rpm
Engine rotation:
(see from flywheel) .....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C .....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine:
- intake .....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type DPS

Fixed injection pump delivery start advance.....0°± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-3-4-2

LUBRICATION

Mimimum oil pressure:
- at full throttle.....2,5 Kg/cm²
- when idling.....0,7 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan drive by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self-regulated alternator.....14 V,45 A
- Starting motor power.....3 KW
- Battery (optional).....150 Ah

ENGINE SPECIFICATIONS

Engine type. 8041SI25
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....4,in line
Bore x stroke.....104 X 115 mm
Displacement..... .....3,9 l
Automotive rating * .....85 kW(115 CV)
At.....2500 rpm
Compression ratio.....16,5:1
Intermittent rating.....80 kW(109 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....73 kW(99 CV)
AT..... ...2500 rpm
Engine rotation:
(see from flywheel) ....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C .....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine
- intake.....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type Bosch VE

Fixed injection pump delivery start advance.....0° ± 10'
Fuel injectors setting.....230 + 8 bar
Firing order.....1-3-4-2

TURBOCHARGING

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

LUBRICATION

Minimum oil pressure:
- at full throttle..... .....2,5 bar
- when idling.....0,7 bar

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan driven by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self- regulated alternator.....14 V,65 A
- Starting motor power.....3 kW
- Battery (optional).....150 Ah

ENGINE SPECIFICATIONS

Engine type. 8051105
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....5,in line
Boxe x stroke.....104 x 115 mm
Displacement.....4,9 l
Compression ratio.....17:1
Automotive rating * .....73,5 KW(100 CV)
At..... .....2500 rpm
Intermittent rating.....70 kW(95 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....63 kW(86 CV)
AT.....2500 rpm
Engine rotation:
(see from flywheel) .....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C .....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine:
- intake .....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type VE5

Fixed injection pump delivery start advance.....6°± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-2-4-5-3

LUBRICATION

Mimimum oil pressure:
- at full throttle..... .....3 Kg/cm²
- when idling..... ....0,7 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan drive by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self-regulated alternator.....14 V,45 A
- Starting motor power.....3 KW
- Battery (optional).....176 Ah

ENGINE SPECIFICATIONS

Engine type. 8061I05
4 - stroke Diesel with direct injection
Cylinders,number and arrangement..... ....6,in line
Boxe x stroke.....104 x 115 mm
Displacement..... .....5,9 l
Compression ratio..... .....17:1
Automotive rating * .....89 kW(121 CV)
At.....2500 rpm
Intermittent rating.....84,5 kW(115 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....76 kW 103 CV)
AT.....2500 rpm
Engine rotation:
(see from flywheel) .....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C ....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C ....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine:
- intake .....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type DPS

Fixed injection pump delivery start advance..... 0°± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-5-3-6-2-4

LUBRICATION

Mimimum oil pressure:
- at full throttle.....3 Kg/cm²
- when idling.....0,7 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan drive by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self-regulated alternator.....14 V,45 A
- Starting motor power.....3 KW
- Battery (optional).....176 Ah

ENGINE SPECIFICATIONS

Engine type. 8061125
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....6,in line
Boxe x stroke.....104 x 115 mm
Displacement.....5,9 l
Compression ratio.....17:1
Automotive rating * .....89 kW(121 CV)
At.....2500 rpm
Intermittent rating.....84,5 kW(115 CV)
At.....2500 rpm
Continuous rating(10% overload allowed).....76 kW 103 CV)
AT.....2500 rpm
Engine rotation:
(see from flywheel) .....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....3°
  closes: after B.D.C .....23°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm

Operating clearance between valves and rockers,cold engine:
- intake .....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

Rotary injection pump type DPS

Fixed injection pump delivery start advance.....0°± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-5-3-6-2-4

LUBRICATION

Mimimum oil pressure:
- at full throttle..... .....3 Kg/cm²
- when idling..... .....0,7 kg/cm²

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan drive by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage.....12 V
- Self-regulated alternator.....14 V,45 A
- Starting motor power.....3 KW
- Battery (optional).....176 Ah

ENGINE SPECIFICATIONS

Engine type. 8061SI25
4 - stroke Diesel with direct injection
Cylinders,number and arrangement.....6,in line
Bore x stroke.....104 X 115 mm
Displacement..... .....5,9 l
Compression ratio..... .....16,5:1
Automotive rating * ....114 kW(155 CV)
At.....2500 rpm
Intermittent rating..... ...108 kW(147 CV)
At..... .....2500 rpm
Continuous rating(10% overload allowed).....98 kW(133 CV)
AT..... ....2500 rpm
Engine rotation:
(see from flywheel) ....CCW

* Duty according to DIN 70020
- Ambient reference conditions:
  760 mmHg;20°C;60% relative humidity

TIMING

Valve Timing:

- Intake:
  opens: before T.D.C .....4° 30'
  closes: after B.D.C .....46°
- Exhaust:
  opens:before B.D.C .....48° 30'
  closes: after T.D.C .....6°

Clearance between valve and
rockers for timing checks.....0,45 mm
Operating clearance between valves and rockers,cold engine;
- intake.....0,30 mm
- exhaust.....0,30 mm

FUEL SYSTEM

In line injection pump type PES

Fixed injection pump delivery start advance.....25° ± 1°
Fuel injectors setting.....230 + 8 bar
Firing order.....1-5-3-6-2-4

TURBOCHARGING

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

LUBRICATION

Minimum oil pressure:
- at full throttle.....3 bar
- when idling.....0,7 bar

COOLING SYSTEM

Forced water circulation controlled by centrifugal pump.
Water temperature controlled by thermostat.
Radiator cooling fan driven by V-belt.

STARTING

By starter motor.

ELECTRIC SYSTEM

- Voltage..... .....12 V
- Self- regulated alternator.....14 V,45 A
- Starting motor power.....3 kW
- Battery (optional).....176 Ah

FITTING TOLERANCES

FITTING TOLERANCES

DESCRIPTION	mm
CYLINDER - CONNECTING ROD ASSEMBLY	
I D cylinder liners (fitted and machined)	104 000 to 104 024
Diameter of cylinder liner housing in engine block	106 850 to 106 900
O D standard cylinder liners	107 020 to 107 050
Oversize on O D replacement cylinder liners	0 2
Coupling between liners and cylinders and housings in engine block (interference)	0 120 to 0 200
Length of cylinder liner	198 to 198 5
Diameter of camshaft bush housings	
□ front support	54 780 to 54 805
□ intermediate support	54 280 to 54 305
□ rear support	53 780 to 53 805
Crankshaft bearing housing diameter	84 200 to 84 230
Diameter of tappets housings in engine block	15 000 to 15 018
Diameter of connecting rod bearing housings	67 407 to 67 422
Diameter of small end bush housing	41 884 to 41 846
Thickness of standard connecting rod bearings	1 805 to 1 815
Undersize range of replacement connecting rod half-bearings	0 254-0 508 0 762-1 016
Small end bush O D	41 979 to 42 017
Small end bush I D (with bush fitted)	38 004 to 38 014
Bush small end coupling (interference fit)	0 095 to 0 171
Coupling between piston gudgeon pin and connecting rod small end bush (play)	0 014 to 0 031
Coupling between connecting rod bearings and crankshaft pins (play)	0 033 to 0 087
Maximum tolerance on parallelism f connecting rod, measured 125 mm from stem	0 07
PISTONS - PINS - RINGS	
Diameter of standard replacement pistons measured at right angle to pin axis and 57 mm from base of skirt	103 812 to 103 826
Oversize range of replacement pistons	0 4-0 8
Pistons pin bore dia in piston	37 993 to 38 000
Standard pin diameter	37 983 to 37 990
Groove height for piston rings	
□ 1st groove	2 580 to 2 600
□ 2nd groove	2 550 to 2 570
□ 3rd groove	4 030 to 4 050
Tickness of piston rings:	
□ 1st chromium plated compression ring	2 478 to 2 490
□ 2nd oilscraper ring	2 478 to 2 490
□ 3rd oilscraper ring, with milled slots and inner spring	3 975 to 3 990

DESCRIPTION	mm
Coupling of piston to cylinder liner □ fit clearance	0.174 to 0212
Coupling of pin to gudgeon pin hole on piston - fit clearance	0003 to 0017
Coupling of rings to piston grooves (vertically) - clearance □ 1st chromium plated compression ring □ 2nd oilscraper ring □ 3rd oilscraper ring, milled with slots and inner spring	 0090 to 0122 0060 to 0092 0040 to 0075
Gap between ring ends when introduced into the cylinder liner - clearance □ 1st chromium plated compression ring □ 2nd oilscraper ring □ 3rd oilscraper ring, milled with slots and inner spring	 035 to 055 030 to 055 030 to 0.60
Oversize range of replacement rings	04-08
CRANKSHAFT - BEARINGS	
Standard dia of main journals	79791 to 79.810
Diameter of main journal half-bearing housings	84200 to 84.230
Thickness of standard main journal half-bearings	2169 to 2178
Undersize range of replacement main journal half-bearings	0254-0508 0762-1016
Standard diameter of crankpins	63725 to 63744
Clearance between half-bearings and main journals	0034 to 0.101
Length of rear intermediate main journal	32.000 to 32100
Width of rear intermediate main journal support between thrust washer housings	25010 to 25060
Thickness of standard thrust washers for rear intermediate support	3.378 to 3429
Thickness of thrust washers oversized by 0127 mm	3505 to 3556
Crankshaft end float	0082 to 0334
Maximum tolerance permitted on alignment of main journals - total dial gauge reading	>010
Maximum permitted tolerance on alignment of crankpins relative to main journals	±025
Maximum ovality of main journals and crankpins after grinding	0008
Maximum main journal and crankpin taper after grinding	0.012
Squareness of flywheel support surface relative to its axis of rotation: □ maximum permitted tolerance with dial gauge resting on the side on a diameter 2 to 4 mm less than the maximum diameter of the supporting surface - total dial gauge reading	 >0.02
Coaxiality of flywheel centering seat relative to main journals. □ maximum permitted tolerance with dial gauge resting on housing - total dial gauge reading	 >0.04
CYLINDER HEAD	
Diameter of valve guide housing in head	13950 to 13983
Valve guide OD	13.993 to 14.016
Valve guide oversize	020
Valve guide ID (after fitting on head)	8.023 to 8.043

DESCRIPTION	mm
Interference fit between valve guides and housing in cylinder head	0 010 to 0 066
Diameter of valve stem	7 985 to 8 000
Clearance between valve stem and guide	0 023 to 0 058
Angle of inclination of valve seats on cylinder head { inlet / exhaust	60° ± 5′ / 45° ± 5′
Angle of inclination of seats on valves { inlet / exhaust	60°30′ ± 7′ / 45°30′ ± 7′
Valve head diameter	
□ inlet	45 3 to 45 5
□ exhaust	37 50 to 37 75
Maximum valve off centre with dial gauge stylus resting in midstem position	0 03
Valve fitted depth relative to cylinder head surface	0 7 to 1
Nozzle protrusion over cylinder head	0 05 to 0 7
VALVE SPRINGS	
Free spring height	44 6
Spring height under load of N { 270 ± 14 / 528 ± 26	34 / 2 3
TIMING GEAR	
Camshaft bushes O D	
□ Front	54 875 to 54 930
□ Intermediate	54 375 to 54 430
□ Rear	53 875 to 53 930
Diameter of camshaft bush housing in engine block	
□ front support	54 780 to 54 805
□ intermediate support	54 280 to 54 305
□ rear support	53 780 to 53.805
Bush interference fit in engine block	0 07 to 0 15
Fitted bush i d after reaming	
□ front	51 080 to 51 130
□ intermediate	50 580 to 50 630
□ rear	50 080 to 50 130
Camshaft journal diameter	
□ front support	50 970 to 51 000
□ intermediate support	50 470 to 50.500
□ rear support	49.970 to 50 000
Clearance between camshaft bushes and journals	0 080 to 0 160
Diameter of tappet washer housing in engine block	15 000 to 15 018
Tappet washer O D	
□ measured at top and bottom	14 740 to 14 780
□ measured in centre	14.950 to 14 970
Oversize range of replacement tappet washers	0 1-0 2-0 3
Clearance between tappets and housings at tappet maximum diameter point	0.030 to 0.068
Rocker shaft support housing i d	18 000 to 18 043

DESCRIPTION	mm
Rocker arm shaft diameter	17 982 to 18.000
Clearance between supports and rocker arm shaft	0 to 0061
Diameter of bush housings on rocker arm shafts	20.939 to 20 972
O D rocker arm bushes	21 006 to 21 031
Interference fit between bushes and rocker arm shaft housings	0034 to 0092
Bushing I D with bush fitted	18.016 to 18.034
Rocker arm bushing interference fit in shaft	0016 to 0052

OIL PUMP

Lower bushing housing bore diameter	21 939 to 21 972
Lower bushing O.D	22 000 to 21.979
Lower bushing interference fit in pump body	009 to .061
Drive shaft diameter	12 000 to 11 988
Bushing fitted I D	12 016 to 12.043
Drive shaft clearance in lower bushing	016 to .055
Gear housing height in pump body	41 025 to 41 087
Oil pump gear width	41.000 to 40 961
Gear clearance relative to cover	025 to 126
Control valve housing bore diameter	13 043 to 13 016
Valve diameter	13 000 to 12 982
Valve clearance in housing	016 to 061

PRESSURE RELIEF VALVE SPRING

Free spring height	45
Height of spring under load of kg 46 to 50	37 5
Height of spring under load of kg 90 to 96	30.5

Dynamic balancer (Engine 8041 I 05)

Idler gear jack shaft clearance in gear bushing (1)	0.050 to 0,100
Flyweight gear shaft clearance in front bushing (see 11) (1)	0,050 to 0,100
Drive pinion clearance in bushings (see 18) (1)	0,050 to 0,100
Connecting sleeve spline backlash (see 13)	0,038 to 0,106
Flyweight gear shaft clearance in rear bushing (see 11) (2)	0.013 to 0.061
Pivot clearance in flyweight bushings (see 26 and 27)	0.020 to 0,073
Flyweight bushing interference fit in housing	0,040 to 0,100
Idler gear jack shaft clearance in bushing (see 34) (2)	0,013 to 0,061
Gear backlash	0,080
Flyweight balancer timing	

(1) Bushing interference fit in housing, 0.063 to 0.140 mm (0.0025 to 0.0055 in)
(2) Bushing interference fit in housing, 0.037 to 0.101 mm (0.0014 to 0.0040 in)

FITTING TOLERANCES

DESCRIPTION	mm
ENGINE BLOCK-CONNECTING RODS	
Cylinder sleeve fitted I.D after finishing	104.000 to 104 024
Cylinder sleeve O.D	107 020 to 107 050
Cylinder sleeve interference fit in block	0 080 to 0 160
Cylinder sleeve bore diameter in block	106 890 to 106 940
Big end bore diameter	67 407 to 67 422
Small end bore diameter	41 846 to 41 884
Big end bearing wall thickness	1 805 to 1 815
Big end bearing undersize range	0 254 - 0 508 - 0 762 - 1 016
Small end bushing O.D	41 979 to 42 011
Small end bushing fitted I.D	38.004 to 38 014
Piston pin clearance in small end bushing	0.014 to 0 031
Small end bushing interference fit in connecting rod	0 095 to 0 171
Crankpin journal clearance in big end bearing	0 029 to 0 087

DESCRIPTION	mm
PISTONS - PINS - RINGS	
Piston diameter 57 mm above base of skirt at right angles to pin	103 812 to 103 826
Piston oversize range	0 4 – 0 8
Pin housing bore diameter in piston	37 993 to 38 000
Ring groove width — Top	2 580 to 2 600
Ring groove width — 2nd	2 550 to 2 570
Ring groove width — 3rd	4 030 to 4 050
Piston pin diameter	37 983 to 37 990
Ring thickness:	
— Top chromed compression ring	2 478 to 2 490
— Oil control ring	2 478 to 2 490
— Slotted and spring-loaded oil control ring	3 975 to 3 990
Piston clearance in cylinder sleeve at right angles to pin and 57 mm from base of skirt	0 174 to 0 212
Pin clearance in piston	0 003 to 0 017
Piston ring side clearance:	
— Top chromed compression ring	0 090 to 0 122
— Oil control ring	0 060 to 0 092
— Slotted and spring-loaded scraper ring	0 040 to 0 075
Ring fitted gap:	
— Top chromed compression ring	0 40 to 0 65
— Oil control ring	0 30 to 0 55
— Slotted and spring-loaded oil scraper ring	0 30 to 0 60
Ring oversize range	0 4 – 0 8

DESCRIPTION	mm
CRANKSHAFT - BEARINGS	
Main journal diameter	79.791 to 79 810
Main bearing housing bore diameter	84 206 to 84 226
Main bearing wall thickness	2 169 to 2 178
Main bearing undersize range	0 254 - 0 508 - 0 762 - 1 016
Crankpin diameter	63 725 to 63 744
Main journal running clearance in bearings	0 058 to 0 097
Rear intermediate main journal width over thrust washer abutment faces	32 000 to 32 100
Rear intermediate main bearing housing width over thrust washer abutment faces	24 610 to 24 990
Thrust washer thickness	3 378 to 3 429
Crankshaft end float with thrust washers in position	0 152 to 0 734

DESCRIPTION	mm
CYLINDER HEAD	
Valve guide housing diameter	13.950 to 13.983
Valve guide O.D	13 988 to 14,016
Valve guide oversize	0 2
Valve guide fitted I.D	8 023 to 8 043
Valve guide interference fit in head	0 005 to 0 066
Valve stem diameter	7 985 to 8 000
Valve stem clearance in guide	0 023 to 0 058
Valve seat angle.	
— Intake	60° ± 5'
— Exhaust	45° ± 5'
Valve face angle.	
— Intake	60°30' ± 7'
— Exhaust	45°30' ± 7'
Valve head diameter:	
— Intake	45 300 to 45 500
— Exhaust	37 500 to 37 750
Valve fitted depth relative to head face	0 7 to 1

DESCRIPTION	mm
VALVE SPRINGS	
Part number	4780108
Spring height under - 270 ± 14 Nm	34
Spring height under - 528 ± 26 Nm	23 8

DESCRIPTION	mm
VALVE GEAR	
Camshaft bushing O.D	
— Front	55 280 to 55 305
— Front intermediate	54 780 to 54 805
— Rear intermediate	54 280 to 54 305
— Rear	53 780 to 53 805
Bushing interference fit in block	0 070 to 0 150
Bushing I D:	
— Front	51,580 to 51,630
— Front intermediate	51,080 to 51 130
— Rear intermediate	50 580 to 50 630
— Rear	50 080 to 50 130
Cánshaft journal diameter:	
— Front	51 470 to 51 500
— Front intermediate	50 970 to 51 000
— Rear intermediate	50 470 to 50 500
— Rear	49 970 to 50 000
Journal clearance in bushings	0 080 to 0 160
Tappet housing bore diameter in block	15 000 to 15 018
Tappet O.D:	
— At top and bottom	14 750 to 14 780
— At centre	14 950 to 14 970
Tappet oversize range	0 1 - 0 2 - 0 3
Tappet clearance in block at maximum width	0 30 to 0 68

DESIGNATION	mm
OIL PUMP	
Internal diameter of bush for drive shaft (installed)	18 016 – 18.059
Diameter of drive shaft	17.984 – 18 000
Clearance between drive shaft and bush	0 016 – 0 070
Internal diameter of bush for driven gear (installed)	15.016 – 15.043
Diameter of pin for driven gear	15 000 – 14 989
Clearance between pin and bush for driven gear	0 016 – 0.054
Height of seat for gears in pump body	16.016 – 16.080
Thickness of pump gears	16.000 – 15.973
Clearance between gears and inside of cover	0.016 – 0.107
Diameter of gear bore in pump body	52.030 – 52.104
Diameter of pump gears	51.970 – 52.000
Clearance between bore in pump body and gears	0.030 – 0.134
SPRING FOR PRESSURE REGULATING VALVE	
Height of spring released	45
Height of spring under load 4.6 – 5.0 kg 9.0 – 9 6 kg	 37.5 30.5

FITTING TOLERANCES

DESCRIPTION	mm
CYLINDER - CONNECTING ROD GROUP	
Cylinder liner i.d (fitted and machined)	104 000 to 104 024
Diameter of cylinder liner seat in engine block	106 850 to 106 900
Standard cylinder liner O D	106 94 to 106 97
Replacement cylinder liners, oversize on O D	0.2
Coupling between liners/cylinders and seats in engine block (interference)	0 120 to 0 040
Length of cylinder liner	198 to 198 5
Diameter of camshaft bush housings □ front support □ intermediate support □ rear support	 54 780 to 54.805 54 280 to 54.305 53 780 to 53.805
Diameter of crankshaft bearing seats	84 200 to 84 230
Diameter of tappets seats in engine block	15.000 to 15 018
Diameter of connecting rod bearing seats	67 407 to 67.422
Diameter of small end bush seat	41 884 to 41 846
Standard connecting rod bearing thickness	1 805 to 1 815
Undersize range replacement connecting rod half-bearings	0 254-0 508 0.762-1.016
O D small end bush	41 979 to 42 017
I.D small end bush (fitted)	38 004 to 38 014
Interference fit between bush and small end	0 095 to 0 171
Coupling between piston pin and small end bush (clearance)	0 014 to 0 031
Coupling between connecting rod bearings and crankshaft journals (clearance)	0 033 to 0 087
Max. tolerance on parallelism of connecting rod axes, measured 125 mm from axes	0 07
PISTONS - PINS - RINGS	
Diameter of replacement standard pistons measured at right angle to pin axis and 57 mm from base of skirt	103 862 to 103 880
Oversize range of replacement pistons	0.4-0 8
Diameter of hole for piston pin	37 993 to 38 000
Diameter of standard piston pin	37 983 to 37 990
Groove height for piston rings □ 1st double taper groove (measured on 101 mm diameter) □ 2nd groove □ 3rd groove	 2 730 to 2 700 2 530 to 2 550 4 030 to 4 050
Tickness of piston rings. □ 1st double taper sealing ring (measured on 101 mm dia) □ 2nd oil scraper ring □ 3rd oil scraper ring, with milled slots and inner spring	 2 575 to 2 595 2 478 to 2.490 3.975 to 3.990

DESCRIPTION	mm
Coupling between piston and cylinder liner. □ clearance	0 120 to 0 162
Coupling between pin and piston boss - clearance	0 003 to 0 017
Coupling between piston rings and grooves (fitted), vertically □ 1st, double taper ring □ 2nd, oil scraper ring □ 3rd, oil scraper ring, with milled slots and inner spring	 0 105 to 0.155 0 040 to 0 072 0 040 to 0 075
Gap between ring ends when introduced in cylinder liner· □ 1st double taper ring □ 2nd oil scraper ring □ 3rd oil scraper ring, with milled slots and inner spring	 0.30 to 0 55 0.60 to 0 85 0 30 to 0 60
Oversize range of replacement piston rings	0 4 - 0 8
CRANKSHAFT - BEARINGS	
Standard dia main journals	79 791 to 79 810
Diameter of main journal half-bearing seats	84 200 to 84 230
Thickness of standard main journal half-bearings	2.169 to 2 178
Undersize range of replacement main journal bearing halves	0 254-0 508- 0 762-1 016
Standard dia of crankpins	63 725 to 63 744
Coupling between half bearings and main journals - clearance	0.034 to 0 101
Length of rear intermediate main journal	32 000 to 32 100
Width of rear main journal intermediate support between thrust washer housings	25 010 to 25 060
Thickness of standard thrust washers for rear intermediate support	3 378 to 3 429
Thickness of thrust washers oversized by 0 127 mm	3 505 to 3 556
Crankshaft end float	0.082 to 0 334
Max permitted tolerance on main journals alignment - total gauge reading	>0 10
Max permitted tolerance on crankpins alignment relative to main journals	±0 25
Max. ovality of main journals and crankpins after grinding	0 008
Max. taper of main journals and crankpins taper after grinding	0 012
Squareness of flywheel mounting face relative to its axis of rotation. □ max permitted tolerance with dial gauge resting on the side on a diameter 2 to 4 mm less than the max diameter of the supporting surface - total dial gauge reading	 >0 02
Coaxiality of flywheel centering seat relative to main journals· □ max permitted tolerance with dial gauge resting on seat, total reading	 >0 04
CYLINDER HEAD	
Diameter of valve guide seats on cylinder head	13 950 to 13.983
O D Valve guides	13.993 to 14 016
Valve guides oversize	0 20
Valve guides I D (after fitting on head)	8 023 to 8 043
Coupling between valve guides and seat on cylinder head interference	0 010 to 0,066

DESCRIPTION	mm
Valve stem diameter	7.985 to 8.000
Clearance between valve stem and its associated guide	0 023 to 0 058
Valve seat angle on cylinder head { intake / exhaust	60° ± 5′ / 45° ± 5′
Seat angle on valves { intake / exhaust	60°30′ ± 7′ / 45°30′ ± 7′
Diameter of valve head	
□ intake	45 3 to 45 5
□ exhaust	37 50 to 37 75
Max. valve eccentricity with dial gauge stylus in midstem position	0 03
Valve depth relative to cylinder head face	0.7 to 1
Standout of injectors relative to cylinder head face	0 05 to 0 7
Valve seat O.D.	39.161 to 39.136
Dia. of valve seat housing on cylinder head	39.000 to 39.025
Interference fit between valve seat and cylinder head	0.161 to 0.111
VALVE SPRINGS	
Free spring height	44.6
Spring height under load of N { 270 ± 14 / 528 ± 26	34 / 23 8
TIMING GEAR	
O.D. camshaft bushes	
□ front bush	54.875 to 54 930
□ intermediate bush	54 375 to 54 430
□ rear bush	53 875 to 53 930
Dia. camshaft bush housings in engine block·	
□ front support	54 780 to 54 805
□ intermediate support	54.280 to 54.305
□ rear support	53 780 to 53.805
Interference fit between bushes and housings in engine block	0 07 to 0.15
I D. of bushes, fitted in seats.	
□ front bush	51 080 to 51 130
□ intermediate bush	50 580 to 50.630
□ rear bush	50 080 to 50 130
Diameter of camshaft support pins:	
□ front support	50 970 to 51.000
□ intermediate support	50 470 to 50 500
□ rear support	49 970 to 50.000
Clearance between camshaft bushes and support pins	0 080 to 0 160
Diameter of tappets washer seat in engine block	15.000 to 15 018
O D tappet washers.	
□ measured at top and bottom	14.740 to 14 780
□ measured in the centre	14 950 to 14 970
Oversize range of replacement tappets	0 1 - 0.2 - 0 3
Clearance between tappets and seats at tappets max diameter	0 030 to 0 068

DESCRIPTION	mm
Diameter of rocker arm shaft hole in support	18 000 to 18 043
Diameter of rocker arm shaft	17 982 to 18 000
Clearance between supports and rocker arm shaft	0 to 0 061
Diameter of housings for bushes on rocker arms	20 939 to 20 972
O D rocker arm bushes	21 006 to 21 031
Interference fit between bushes and rocker arm seats	0 034 to 0 092
I D of bushes, fitted	18 016 to 18 034
Clearance between bushes and rocker arm shafts	0 016 to 0 052
OIL PUMP	
I D drive shaft bushes (fitted)	18 016 to 18.059
Drive shaft diameter	17 989 to 18 000
Clearance between shaft and bushes	0 016 to 0 070
I D. driven gear bush (fitted)	15 016 to 15 043
Driven gear pin diameter	15 000 to 14 989
Clearance between pin and driven gear bush	0 016 to 0 054
Height of gear seat in pump case	16 016 to 16 080
Thickness of pump gear	16 000 to 15 973
Clearance between gears and cover support face	0 016 to 0.107
Diameter of housing for gears in pump case	52 030 to 53.104
Diameter of pump gears	51 970 to 52 000
Clearance between pump case seat and gears	0.030 to 0 134
PRESSURE RELIEF VALVE SPRING	
Free spring height	35 9
Spring height under load of N { 134.55 ± 6 73 { 245 70 ± 12 3	29 23.2

FITTING TOLERANCES

DESCRIPTION	mm
CYLINDER-CONNECTING ROD GROUP	
Cylinder liner internal diameter (fitted and machined)	104 000 – 104 024
Cylinder liner seat diameter in engine block	106 850 – 106 900
External diameter of standard cylinder liners	107 020 – 107 050
Oversize on external diameter of replacement cylinder liners	0 2
Interference fit between liner and cylinder and seat on engine block	0 120 – 0 200
Camshaft bush housing diameter	
□ front support	55 280 – 55 305
□ intermediate support	54 780 – 54 805
□ rear intermediate support	54 280 – 54 305
□ rear support	53 780 – 53 805
Diameter of crankshaft bearing seats	84 200 – 84 230
Engine block tappet seat diameter	15 000 – 15 018
Small end bearing seat diameter	67 407 – 67 422
Big end bush seat diameter	41 884 – 41 846
Thickness of standard connecting rod bearings	1 805 – 1 815
Undersize range for replacement connecting rod half-bearings	0 254 - 0 508 0 762 - 1 016
External diameter of small end bush	41 979 – 42 017
Small end bush internal diameter (measured with bush fitted)	38 004 – 38 014
Small end-bushing (interference fit)	0 099 – 0 171
Piston gudgeon pin - small end bushing clearance	0 014 – 0 031
Connecting rod bearings - crankshaft pins clearance	0 033 – 0 087
Max connecting rod misalignment measured 125 mm from axes	0 07
PISTONS - PINS - RINGS	
Standard piston dia measured at right angle to pin axis and 57 mm from skirt base	103 812 – 103 826
Oversize range of replacement pistons	0 4-0 8
Gudgeon pin hole diameter	37 993 – 38 000
Standard gudgeon pin diameter	37 983 – 37 990
Ring groove width in piston	
□ 1st groove	2 580 – 2 600
□ 2nd groove	2 550 – 2 570
□ 3rd groove	4 030 – 4 050
Ring thickness	
□ 1st compression ring	2 478 – 2 490
□ 2nd oil scraper ring	2 478 – 2 490
□ 3rd oil scraper ring, milled, with slots and internal spring	3 975 – 3 990

DESCRIPTION	mm
Piston fit in cylinder liner (clearance)	0 174 ÷ 0 212
Gudgeon pin clearance in piston boss	0 003 – 0 017
Ring clearance in piston groove (vertical) □ 1st compression ring □ 2nd oil scraper □ 3rd oil scraper, milled with slots and inner spring	 0 090 – 0 122 0 060 ÷ 0.092 0 040 – 0 075
Ring gap clearance fitted in the liner. □ 1st compression ring □ 2nd oil scraper ring □ 3rd oil scraper ring, milled with slots and inner spring	 0 35 – 0 55 0 30 ÷ 0 55 0 30 ÷ 0 60
Oversize range of replacement piston rings	0 4-0 8
CRANKSHAFT - BEARINGS	
Standard main journal dia	79 791 ÷ 79 810
Main bearing housing bore dia	84.200 ÷ 84 230
Standard main bearing thickness	2 169 ÷ 2 178
Undersize range of replacement main bearings	0 254-0.508 0 762-1 016
Standard diameter of crankpins	63 725 ÷ 63.744
Main journal clearance in bearing	0 034 ÷ 0 101
Rear intermediate main journal length	32 000 ÷ 32 100
Rear intermediate main bearing width between thrust washer seats	25 010 ÷ 25 060
Thickness of standard thrust washer for rear intermediate main bearing	3.378 ÷ 3 429
Oversize range of thrust washers	0 127-0 254-0 508
Crankshaft end float	0 082 – 0 334
Max tolerance on main journal alignment, total dial gauge reading	> 0 10
Max tolerance on crankpin alignment relative to main journals	± 0 25
Max ovality of main journals and crankpins after grinding	0.008
Max taper of main journals and crankpins after grinding	0.012
Squareness of flywheel support surface relative to its axis of rotation □ max. tolerance with dial gauge supported on its side on a diameter 2÷4 mm less than the max. diameter of the supporting surface, total dial gauge reading	 0.02
Coaxiality of flywheel centering seat relative to main journals: □ max tolerance with dial gauge resting on housing, total dial gauge reading	 0 04
CYLINDER HEAD	
Diameter of valve guide housing	13 950 ÷ 13 983
Valve guide O D	13 993 ÷ 14.016
Valve guide oversize	0 20

DESCRIPTION	mm
Valve guide int dia (after fitting in head)	8 023 – 8 043
Interference fit - valve guide and housing	0 010 – 0 066
Valve stem dia.	7 985 – 8 000
Clearance between valve stem and guide	0 023 – 0 058
Valve seat angle on cyl head { inlet / exhaust	60° ± 5′ / 45° ± 5′
Seat angle on valves { inlet / exhaust	60° 30′ ± 7′ / 45° 30′ ± 7′
Valve head diameter	
□ inlet	45 3 ÷ 45 5
□ exhaust	37 50 – 37 75
Max valve stem distortion with dial gauge stylus resting in midstem position	0 03
Valve fitted depth in cyl head	0 7 ÷ 1
Injector standout from cyl head surface	0 05 – 0 7
VALVE SPRINGS	
Spring height under load of N { 284 – 256 / 554 ÷ 502	34 / 23 8
VALVE GEAR	
Camshaft bush housing diameter fitted in engine block	
□ front support	55 280 ÷ 55 305
□ front intermediate support	54 780 ÷ 54 805
□ rear intermediate support	54 280 ÷ 54.305
□ rear support	58 780 – 53 805
Interference fit between bushes and seats in engine block	0 07 ÷ 0 15
Bush fitted I D after reaming·	
□ front	51 580 – 51 630
□ front intermediate	51 080 – 51 130
□ rear intermediate	50 580 ÷ 50 630
□ rear	50 080 – 50 130
Camshaft journal dia..	
□ front	51 470 – 51 500
□ front intermediate	50 970 ÷ 51 000
□ rear intermediate	50 470 ÷ 50 500
□ rear	49 970 – 50 000
Camshaft journal clearance in bushes	0 080 ÷ 0 160
Tappet housing bore dia	15 000 ÷ 15 018
Tappet washer O D	
□ measured at top and bottom	14 740 ÷ 14 780
□ measured at middle	14 950 ÷ 14 970
Oversize range replacement tappets	0 1 - 0 2 - 0 3
Clearance between tappets and housings at max tappet diameter	0 030 ÷ 0 068
Rocker arm shaft support hole dia	18 000 ÷ 18 043
Diameter of rocker arm shafts	17 982 ÷ 18 000

DESCRIPTION	mm
Clearance between supports and rocker arm shafts	0 – 0 061
Diameter of bush housings on rocker arm shafts	20 939 – 20 972
Rocker arm shaft bushes O D	21 006 – 21 031
Interference fit between bushes and rocker arm housings	0 034 – 0 092
Fitted bush I D	18 016 ÷ 16 034
Clearance between bushes and rocker arm shafts	0 016 – 0 052
OIL PUMP	
Drive shaft bushes I D (fitted)	18 016 ÷ 18 059
Drive shaft diameter	17 989 ÷ 18 000
Clearance between drive shaft and bushes	0 016 – 0 070
Driven gear bush I D (fitted)	15 016 – 15 043
Driven gear pin diameter	15 000 – 14 989
Clearance between driven gear pin and bush	0 016 ÷ 0 054
Gear seat height in pump body	22.016 ÷ 22 080
Pump gear thickness	22 000 ÷ 21 953
Clearance between gears and cover contact surface	0 016 ÷ 0 127
Diameter of gear seats in pump body	53 030 ÷ 52 104
Pump gears diameter	51.970 ÷ 52 000
Clearance between pump body seat and gears	0 030 ÷ 0 134
OIL PRESSURE RELIEF VALVE SPRING	
Free spring height	45
Spring height under load of kg 4 6 – 5 0 9 0 – 9 6	 37 5 30 5

FITTING TOLERANCES

DESCRIPTION	mm
CYLINDER-CONNECTING ROD ASSEMBLY	
Internal diameter of cylinder liners (fitted and machined)	104 000 ÷ 104 024
Diameter of cylinder liner seats on engine block	106 850 ÷ 106 900
O.D standard cylinder liners	106 94 ÷ 106 97
Oversize on O.D of spare cylinder liners	0 2
Interference fit between liners and seats on engine block	0 040 – 0 120
Camshaft bush housing diameters □ front support □ intermediate support □ rear intermediate support □ rear support	 55 280 – 55 305 54 780 – 54 805 54 280 ÷ 53 306 53 780 ÷ 53 305
Diameter of crankshaft bearing housings	84 200 ÷ 84.230
Diameter of tappets seat in engine block	15.000 – 15 018
Diameter of connecting rod bearing housings	67 407 ÷ 67 422
Diameter of small end bush housing	41 884 – 41 846
Standard connecting rod bearing thickness	1 805 ÷ 1 815
Undersize range of spare connecting rod bearings	0 254 - 0 508 0 762 - 1 018
Small end bush O D	41.979 – 42 017
Small end bush I D (fitted)	38 004 ÷ 38 014
Interference fit between bush and small end	0 099 – 0 171
Clearance between piston pin and small end	0 014 – 0 031
Clearance between connecting rod bearings and crankshaft pin	0 033 ÷ 0 087
Max connecting rod parallelism tolerance measured 125 mm from stem	0 07
PISTONS - PINS - RINGS	
Standard spare piston diameter measured at right angle to pin axis and 12 mm from base of skirt	103 862 ÷ 103 880
Oversize range of spare pistons	0.4 - 0 8
Piston pin bore diameter	37 993 ÷ 38 000
Standard piston pin diameter	37 983 ÷ 37 990
Ring groove width in piston □ 1st double taper groove (measured on 101 mm dia.) □ 2nd groove □ 3rd groove	 2.730 ÷ 2 700 2 530 ÷ 2 550 4 030 – 4 050
Piston ring thickness □ 1st double taper ring (measured on 101 mm dia.) □ 2nd oil-scraper ring □ 3rd oil-scraper ring, slotted, spring loaded	 2.595 ÷ 2.575 2 478 ÷ 2 496 3 975 ÷ 3 990
Clearance between piston and cylinder liner	0 162 – 0 12
Clearance between pin and piston boss	0 003 – 0 017

DESCRIPTION	mm
Ring clearance in piston (vertical)·	
□ 1st double taper ring	0 105 ÷ 0.155
□ 2nd oil-scraper ring	0.040 ÷ 0.072
□ 3rd oil-scraper ring, slotted, spring loaded	0 040 ÷ 0.075
Gap between ring ends fitted in cylinder liners:	
□ 1st double taper ring	0 30 ÷ 0.55
□ 2nd oil-scraper ring	0.60 ÷ 0.85
□ 3rd oil-scraper ring, slotted, spring loaded	0 30 ÷ 0 60
Oversize range of spare piston rings	0 4 - 0 8
CRANKSHAFT - BEARINGS	
Standard main journal diameter	79.791 ÷ 79.810
Main bearing housing bore dia	84 200 ÷ 84,230
Thickness of standard main bearing	2.169 ÷ 2 178
Undersize range of spare main bearings	0.254 - 0 508 0 762 - 1.016
Standard diameter of crankpin	63 725 ÷ 63 744
Main journal in bearing - clearance	0.012 ÷ 0 083
Rear intermediate main journal pin length	32 000 ÷ 32.100
Width or rear intermediate main journal support between housing and thrust washers	25.010 ÷ 25 060
Thickness of standard rear intermediate support thrust washer	3 378 ÷ 3 429
Thrust washers oversize range	0 127 - 0 254 - 0.508
Crankshaft end play	0 082 ÷ 0.334
Max. permitted misalignment on main journals (total gauge reading)	> 0 10
Max permitted misalignment between crankpins and main journals	± 0.25
Max main journal and crankpin ovalisation after grinding	0.008
Max main journal and crankpin taper after grinding	0.012
Squareness of flywheel support plane relative to its axis of rotation. □ max. permitted error with dial gauge resting on its side on a diameter 2 ÷ 4 mm less than the max dia. of the support surface; total dial gauge reading	0 02
Concentricity of flywheel centering seat relative to main journals· □ max. permitted tolerance with dial gauge resting on seat; total dial gauge reading	0 04
CYLINDER HEAD	
Diameter of valve guide seats on cyl head	13.966 ÷ 13.983
Valve guide O.D.	13.993 ÷ 14.016
Valve guide oversize	0.20
Valve guide I D. (fitted)	8.023 ÷ 8.043
Interference fit between valve guide and seat on head	0 005 ÷ 0.050
Valve stem diameter	7.985 ÷ 8.000

DESCRIPTION	mm
Clearance between valve stem and guide	0.023 ÷ 0.053
Angle of inclination of valve seats on cyl head { intake / exhaust	60° ± 5′ / 45° ± 5′
Angle of inclination of seats on valves { intake / exhaust	60°30′ ± 7′ / 45°30′ ± 7′
Valve head dia	
□ intake	45.5 ÷ 45 3
□ exhaust	37 75 ÷ 37.50
Max. valve stem distortion over one complete revolution with dial gauge stylus in midstem position	0 03
Valve seat depth	0 7 ÷ 1
Nozzle protrusion over cylinder head surface	0.05 ÷ 0 7
VALVE SPRINGS	
Outside spring height under load of { 284 ÷ 256 kg / 554 ÷ 502 kg	34 / 23 8
VALVE GEAR	
Camshaft bushing housing fitted in engine block	
□ front	55 280 ÷ 55.305
□ front intermediate	54 780 ÷ 54 805
□ rear intermediate	54 280 ÷ 54.305
□ rear	53.780 ÷ 53 805
Interference fit between bushings and seats in engine block	0 07 ÷ 0 15
Bushing fitted I D. after reaming:	
□ front	51.580 ÷ 51 630
□ front intermediate	51 080 ÷ 51.130
□ rear intermediate	50.580 ÷ 50 630
□ rear	50.080 ÷ 50 130
Camshaft journal diameter	
□ front	51.470 ÷ 51.500
□ front intermediate	50 970 ÷ 51.000
□ rear intermediate	50 470 ÷ 50 500
□ rear	49 970 ÷ 50 000
Camshaft journal and bushing fit	0.080 ÷ 0 160
Tappet housing bore dia	15 000 ÷ 15.018
"Crowned" tappet O.D.	
□ measured at top and base	14 740 ÷ 14.780
□ measured in middle	14.950 ÷ 14 970
Oversize range of spare tappets	0 1 - 0 2 - 0.3
Clearance between tappet and housing at max tappet diameter	0.030 ÷ 0 068
Rocker axle bore dia.	18.000 ÷ 18 043
Rocker shaft diameter	17.982 ÷ 18 000
Clearance between rocker shafts and supports	0 ÷ 0 061
Rocker bushing seat dia	20 939 ÷ 20.972
Rocker bushing O D	21 006 ÷ 21 031

DESCRIPTION	mm
Interference fit between rocker bushings and housings	0.034 ÷ 0.092
Bush I.D. (fitted)	18.016 ÷ 18.031
Clearance between bushings and rocker shaft	0.016 ÷ 0.052
OIL PUMP	
Drive shaft bushing I.D (after fitting)	18.016 ÷ 18.059
Drive shaft dia.	17.989 ÷ 18.000
Clearance between drive shaft and bushes	0.016 ÷ 0.070
Driven gear bushing I.D. (after fitting)	15 016 ÷ 15.043
Driven gear pin dia.	15.000 ÷ 14.989
Clearance between pin and driven gear bushing	0.016 ÷ 0.054
Height of gear housing in pump body	22.016 ÷ 22 080
Thickness of pump gears	22.000 ÷ 21.967
Clearance between gears and cover support face	0.016 ÷ 0.127
Diameter of gear housing in pump body	52.030 ÷ 53.104
Diameter of pump gears	51.970 ÷ 52.000
Clearance between pump body housing and gears	0.030 ÷ 0.134
PRESSURE RELIEF VALVE SPRING	
Free spring height	35 9
Spring height under load of N { 134 55 ± 6 73 245 70 ± 12.3	29 23 2

FAULT-FINDING DIAGNOSIS

FAULT	POSSIBLE CAUSE	REMEDY
The engine does not start	Batteries low charge	Check and recharge the batteries Change batteries, if necessary
	Battery terminals corroded or loose	Clean, examine and tighten nuts on battery terminals Change lead terminals and nuts, if badly corroded
	Incorrect timing of injection pump	Check injection pump timing and reset if necessary
	Deposits or water in fuel lines.	Disconnect pipes and clean out with compressed air jet Remove and clean the injection pump Dry out the tank and refill with fuel
	Insufficient fuel reserve	Refuel
	Fuel supply failure	Overhaul or change fuel or transfer pump
	Air bubbles in fuel lines or in injection pump	Check the pipes to detect reasons for air in system and the fuel pump for an eventual diminishment of fuel, check if there is less fuel in the fuel pump, bleed air from inside the injection pump by unscrewing the appropriate plug and working the fuel pump by hand
	Defective starter	Repair or replace starter motor
	Inefficient thermostarter.	Switch on thermostarter at low temperature, if inefficient, change it.
	Electronic stop valve not working.	Change the valve.
The engine stops	Too low idling	Unscrew adjusting screw at end of hand throttle control cable
	Uneven injection pump deliveries	Check deliveries
	Dirt or water in fuel lines	Remove pipes and clean out with compressed air jet Remove and clean injection pump Dry out fuel tank and refill with fuel
	Fuel filters blocked	Remove filter elements and renew them if necessary
	Abnormal clearance between valves and rockers	. Adjust clearance
	Valves burnt out or cracked	Renew the valves.
	Air in fuel and injection systems	Check pipes for possible cracks or loose unions Replace any worn parts, then bleed air from pipes and de-aerate injection pump and fuel filter by unscrewing the appropriate plugs and working the fuel pump by hand
	Fuel filter blocked	Change fuel filter
	Injection pump controls broken	Change faulty parts and check pump timing

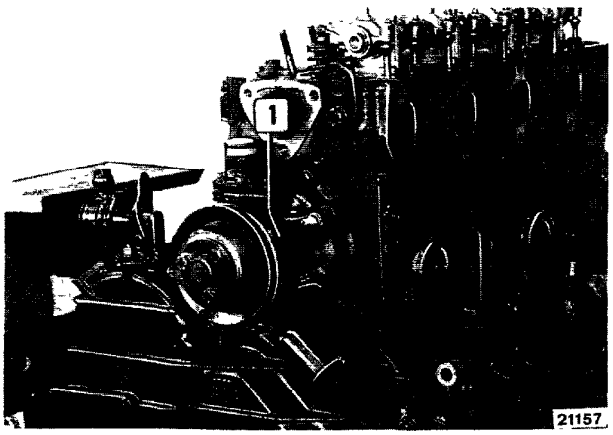
FAULT	POSSIBLE CAUSE	REMEDY
Engine overheating	Water pump faulty	Check clearance between rotor vanes and pump body Overhaul the unit or renew it
	Damaged thermostat	Change the thermostat
	Scale in water passages in engine block and cylinder head	Wash out thoroughly according to instructions for the type of descaler used
	Water pump and drive belt not sufficiently tight	Check and adjust belt tension
	Coolant water level too low	Top up radiator water to correct level
	Incorrect engine timing	Check timing and accurately re-time
	Incorrect injection pump calibration (either too high or too low)	Adjust pump delivery on bench, so that injection is to prescribed delivery
	Air filter blocked	Clean air filter and inherent system
Engine under power and running unevenly	Incorrect injection pump timing.	Check timing and adjust it correctly
	Automatic advance device for injection pump faulty	Check injection pump efficiency on test bench, if not as specified, change automatic advance unit inner spring
	Injection pump plunger excessively worn	Overhaul injection pump and change any worn parts
	Injection pump deregulated; uneven deliveries	Overhaul and adjust injection pump
	Injection nozzles partly blocked, or injectors not working correctly	Clean nozzle holes with suitable tool and carry out complete overhaul of injectors.
	Dirt or water in fuel and injection systems	Thoroughly clean out the system and refuel
	Fuel pump defective	Dismantle the fuel pump and replace it if necessary
	Incorrect clearance between valves and rockers	Check clearance and adjust it accurately

FAULT	POSSIBLE CAUSE	REMEDY
Engine under power and running unevenly	Loss of compression	With tool no 99395682 (Motometer), check that pressure at T D C in the different cylinders is equal and that the pressure reading is 21 kg/cm^2; if less, proceed to overhaul engine
	Air filter blocked	Clean air filter and inherent system
	Injection pump peak capscrew incorrectly adjusted.	Adjust stops correctly
Engine knocking abnormally	Incorrect operation of injectors	Check that pin is not stiff in atomizer body and that setting is to specified values
	Fuel pipes blocked.	Remove the pipes, clean them and change any which are badly damaged
	Incorrect setting of injection pump	Correct pump setting so that injection takes place at the specified advance angles
	Crankshaft knocking due to excessive play of one or more main journals or crankpins or excessive end float	Grind crankpins and fit undersized bearings Change thrust rings with oversized ones
	Crankshaft imbalance	Check shaft alignment, if necessary, adjust it and check balance
	Flywheel capscrew loose	Change loose screws and tighten all screws to recommended torque
	Connecting rods misaligned	Straighten connecting rods in hydraulic press and check that axes are parallel
	Pistons knocking due to piston slap	Rebore cylinder liners and fit oversized pistons
	Noisy piston pins due to excessive play in gudgeon pin holes and in connecting rod bush Bushes loose in housings on connecting rod	Change piston pins and if necessary, also change the pistons Renew the bushes
	Tapping due to noisy valve system	Adjust play between valves and rockers and check that there are no broken springs, and no excessive play between valve stems and guides, tappets and housings
Engine smoke abnormally black or dark grey smoke:	Pump maximum delivery excessive	Remove the pump and adjust deliveries in accordance with the setting table data
	Injection pump excessively retarded (or automatic advance unit faulty).	Correct pump setting, check automatic advance unit
	Injection pump excessively advanced	Correct pump setting
	Nozzle holes (or some of them) partly or completely blocked	Change injectors for a new set, or clean and recondition the original injectors with the appropriate equipment
	Air cleaner blocked or worn out	Clean filter element or change it for a new one

FAULT	POSSIBLE CAUSE	REMEDY
Black or dark grey smoke:	Loss of engine compression due to □ piston rings stuck, □ cylinder liners worn, □ valves deteriorated or misadjusted	Overhaul the engine or simply repair faulty parts
	Unsuitable type of injectors fitted, or some injectors of different type fitted, or out of calibration.	Change or calibrate injectors
	Injection pipes of incorrect i d fitted; pipe ends damaged by repeated blockages	Check state of pipe ends or unions, if necessary, renew the pipes
Blue, greyish blue or greyish white smoke:	Injection excessively retarded or automatic advance unit damaged	Correct pump setting and check automatic advance unit
	Injector needles blocked or faulty injectors	Check whether needles jam or springs are broken
	Oil leaking from piston rings due to jammed rings or wear on cylinder liner walls	Overhaul the engine
	Engine oil leaking through intake valve guide, due to wear on guides or valve stems	Recondition the cylinder head
	Engine too cold (thermostat jammed or resistant).	Renew the thermostat
The engine does not stop	Governor broken	Repair as necessary
	Electric shut-off broken	Repair as necessary
	Governor components stiff.	Overhaul or renew
	Excessive clearance between various parts of the governor	Eliminate all play, allowing only minimum tolerances, change any worn-out parts

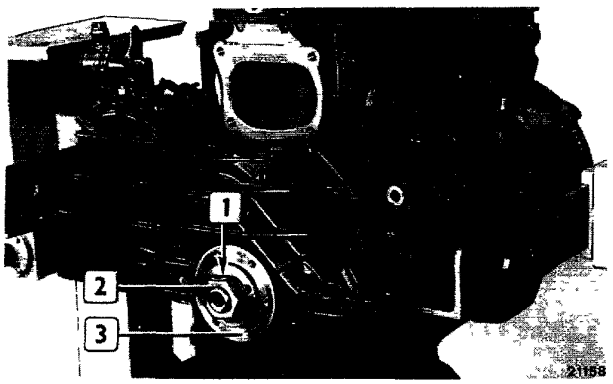
DISMANTLING THE ENGINE

FIGURE 20



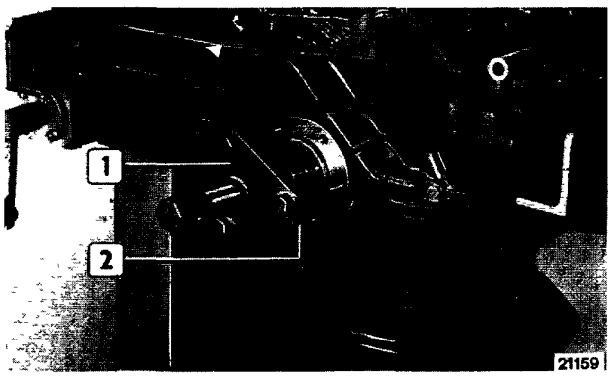
Remove the water pump (1)

FIGURE 21



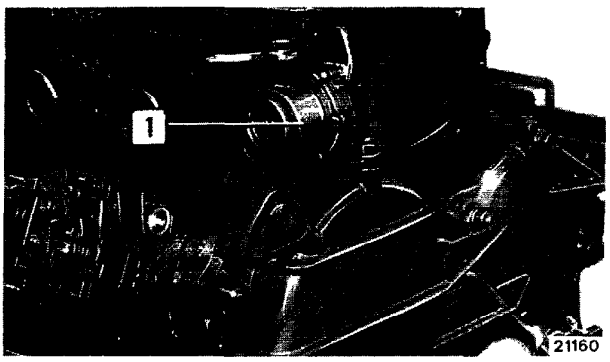
Prevent the flywheel from turning by means of tool 99360352, straighten the lockplate (1) and back off the alternator/water pump drive pulley hub (3) locknut (2).

FIGURE 22



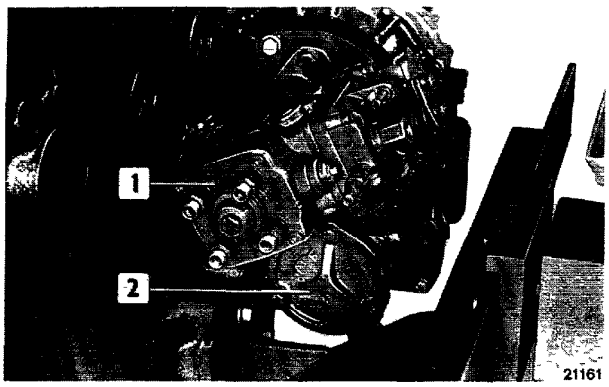
Apply tool 99340033 (1) and withdraw the hub (2)

FIGURE 23



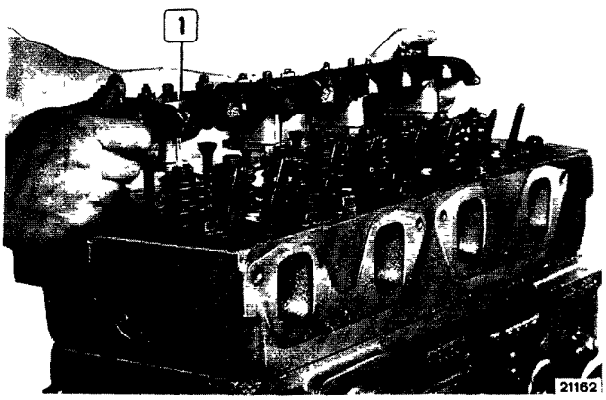
Remove the fuel pump (1)

FIGURE 24



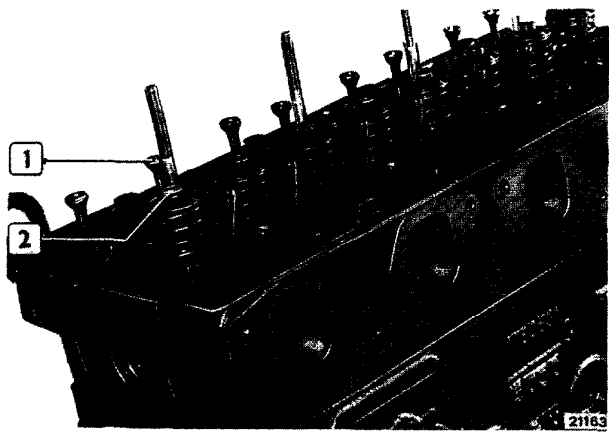
Remove the vacuum pump (2) together with the drive union and injection pump (1).

FIGURE 25



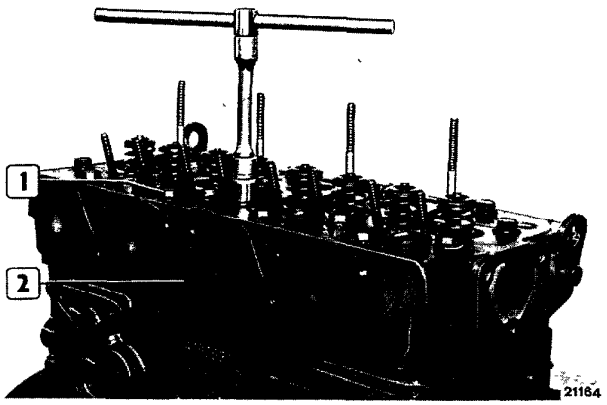
Remove the complete rocker carrier shaft (1)

FIGURE 26



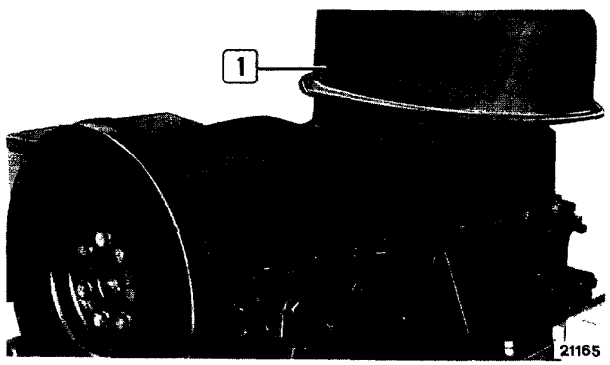
Recover the rocker arm pushrods (1) and the caps from the valve stem (2)

FIGURE 27



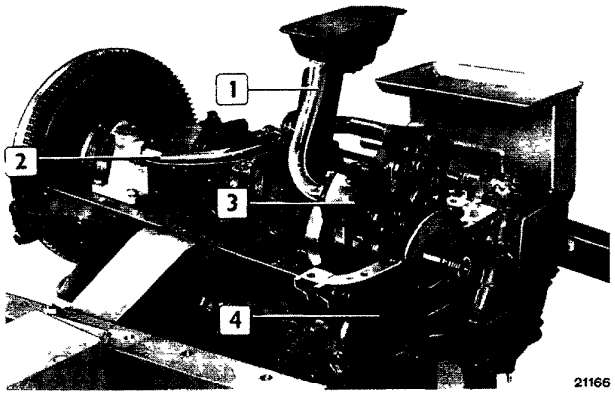
Back off the screws (1) fixing the cylinder head (2), remove the cylinder head and save the gasket.

FIGURE 28



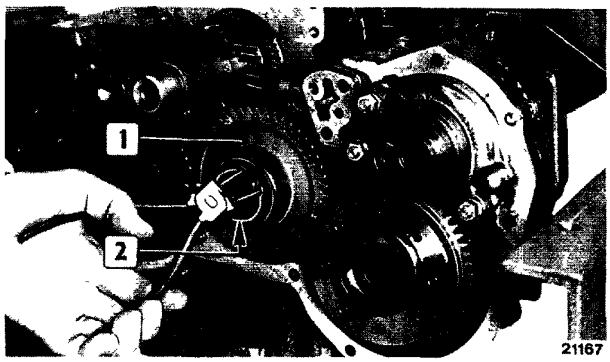
Turn the engine round 180°, then remove the oil sump (1) and save the gaskets.

FIGURE 29



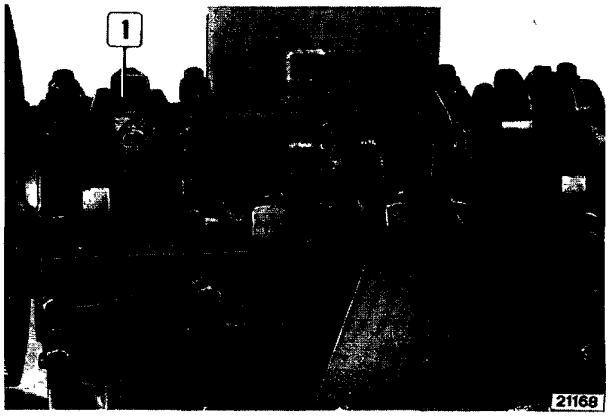
Take off the timing gear front cover (4)
Remove the oil pump (3) and intake (1) and delivery (2) pipes.

FIGURE 30



Remove the retaining snapring (2) and withdraw the idler gear (1).

FIGURE 31

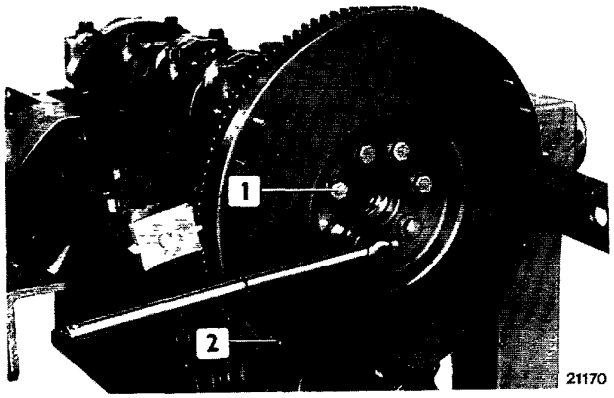


Unscrew the screws, remove the connecting rod caps (1) and recover the half-bearings

FIGURE 32

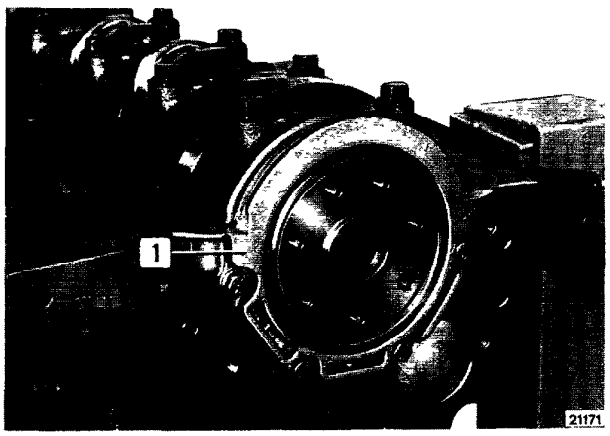
Withdraw the piston/connecting rod assemblies (1) from the top of the engine block

FIGURE 33



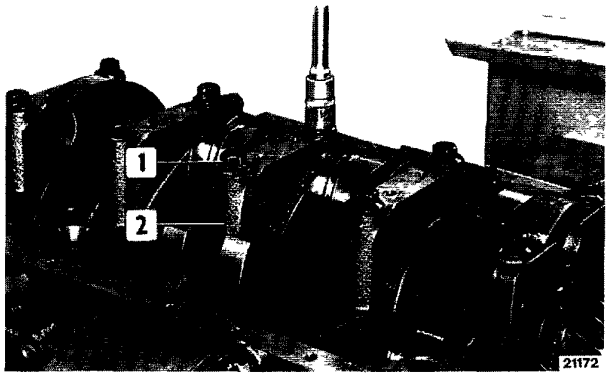
Undo the flywheel (2) setscrews (1) and remove it

FIGURE 34



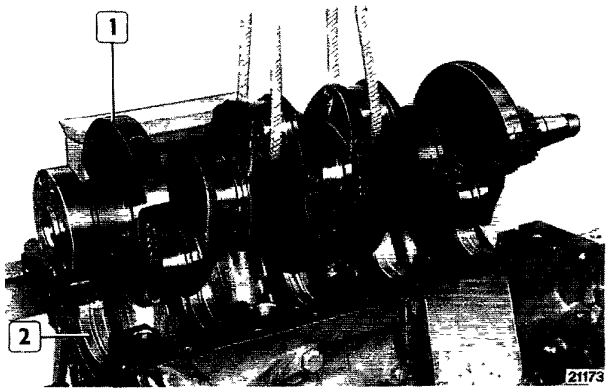
Remove the rear cover (1) complete with sealing ring

FIGURE 35



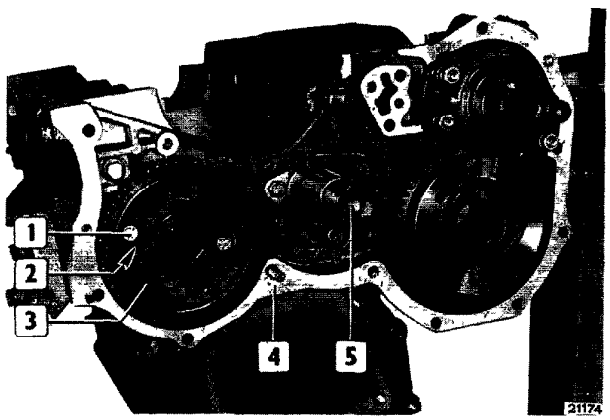
Back off the setscrews (1) of the main journal caps (2) and remove them, recovering the half-bearings

FIGURE 36



Lift up the crankshaft (1) and remove it; recover the main half bearings (2) and the thrust rings

FIGURE 37



Position the camshaft and back off the setscrews (1) of the thrust plate through the holes (2) in the gear, then withdraw the camshaft (3)

Withdraw the tappets from their seats
Remove the timing gear case (4) complete with the injection pump drive gear and vacuum pump.
Remove the idler gear pin (5).

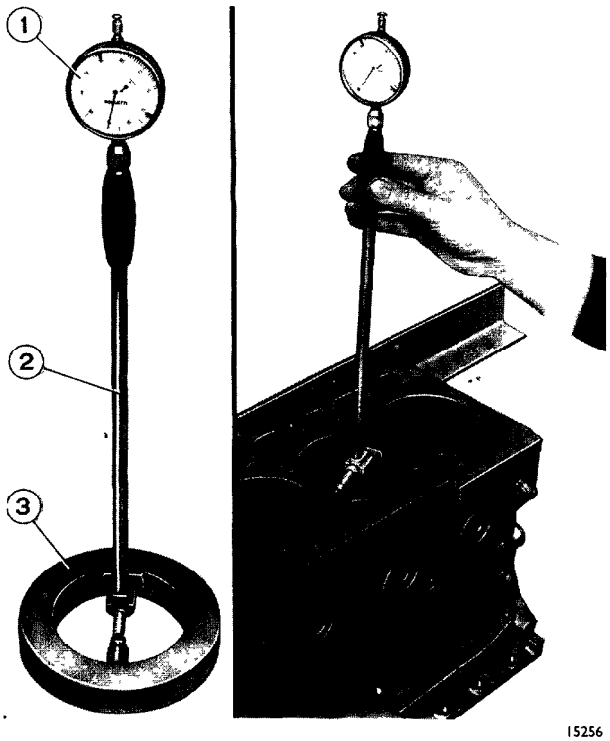
ENGINE BLOCK

After engine disassembly, thoroughly clean the engine block and cylinders

CHECKS AND MEASUREMENTS

NOTE - Never measure the cylinder liners loose, as they are easily distortable; measure the internal diameter with the liner fully fitted

FIGURE 38

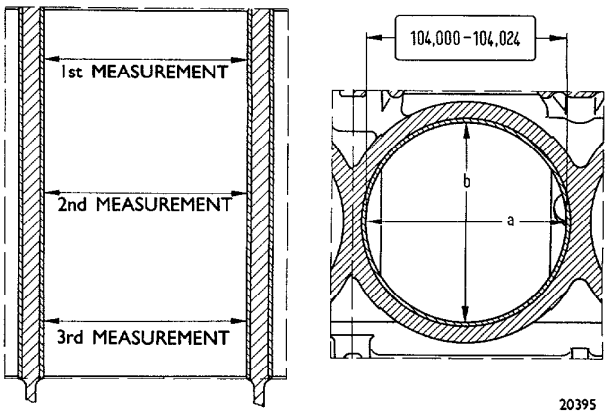


15256

The check of the inside diameter of the cylinder liners to control the degree of ovalisation, taper and wear should be done using a suitable gauge (2) fitted with a dial gauge in thousandths (1) previously zeroed on the ring gauge (3) with a diameter of 104 mm

NOTE - If a 104 mm diameter ring gauge is not available use a moving gauge for outsides

CYLINDER GROUP



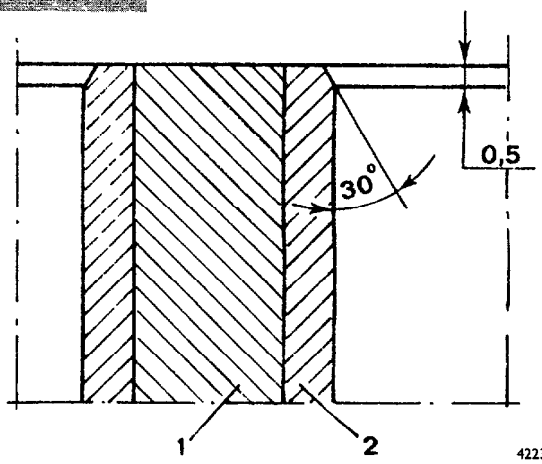
20395

DIAGRAM FOR CHECKING DIAMETERS OF CYLINDER LINERS

The above measurements should be carried out for each individual cylinder at three different heights on the liner and on two planes perpendicular to each other; the first parallel to the longitudinal axis (a) and the 2nd perpendicular to (b) that axis, (b) where, near the 1st measurement, the maximum wear is usually to be found
If ovality, taper or wear are found, arrange to rectify them as a repair job, by grinding the liner if slightly worn or scored, or rebore and then grinding if scoring is deep or ovalisation is marked

NOTE - If regrinding, all liners must be oversized the same (0.4 to 0.8 mm)

FIGURE 40



4223

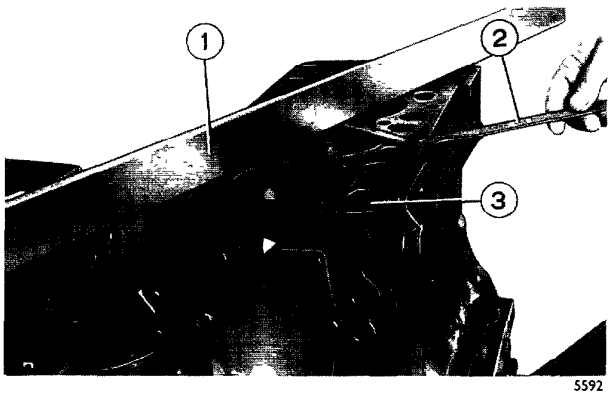
DIAGRAM OF BEVEL TO BE MADE ON CYLINDER LINERS AFTER REGRINDING

Dismantling and refitting cylinder liners in the cylinders should be carried out with a hydraulic press and the appropriate plates
When fitting cylinder liners in their housings in the engine block, under a press, pay attention to the following.

- check that the external diameter of the cylinder liners is 107.020÷107.050 mm and that the internal diameter of their seats in the engine block is 106 850÷106 900 mm,
- smear surfaces to be coupled with engine oil,
- set the liner in its seat in the engine block, then start the pressing;
- after pressing in 70 to 90 mm, check that the load is 12 000÷34 000 N;
- continue pressing and recheck 10 mm before completion that the load is 30.000÷70.000 N

If the press load is not within the above-mentioned limits, remove the cylinder liner and replace it with a new one
After press-fitting the liners should be reamed out and ground They are actually supplied as spares with internal diameter slightly less than the nominal dimension to enable any deformations that may occur during fitting to be corrected
Cylinder liners are supplied as spares with their external diameter oversized by 0 2 mm

FIGURE 41



5592

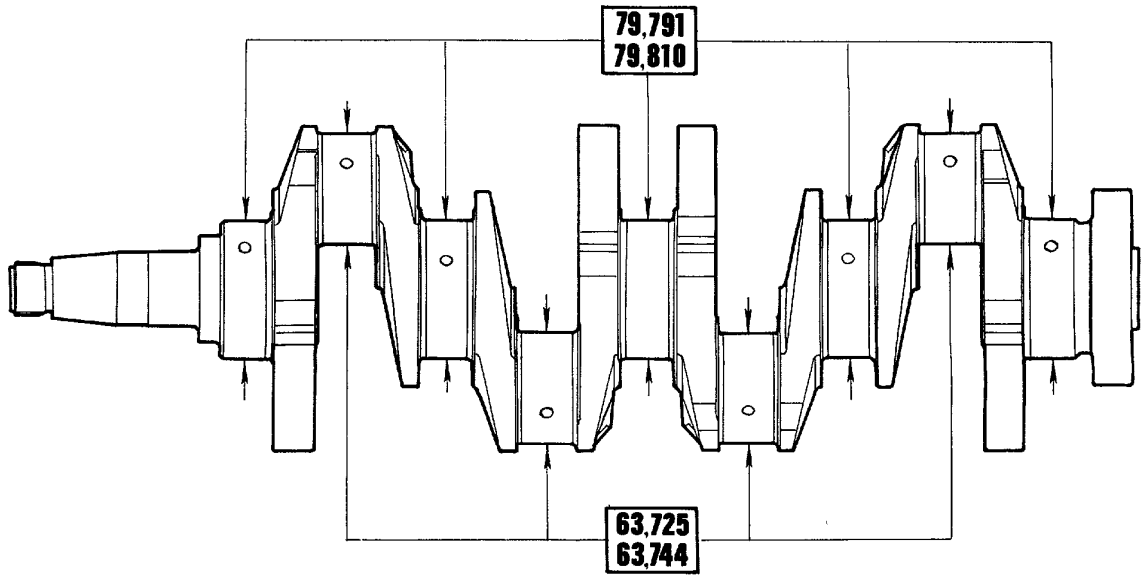
Check the state of the machined plugs of the cylinder group, if they are rusted or if there is the slightest doubt about their sealing capacity, change them.

Check flatness of support surfaces (3) of the cylinder head by means of a straightedge (1) and feeler gauge (2). After detecting distortion areas, smooth the face with a grinder, taking care to remove the minimum possible amount of material

NOTE - Remove centering dowels only if it is necessary to skim the contact face of the block

CRANKSHAFT

FIGURE 42

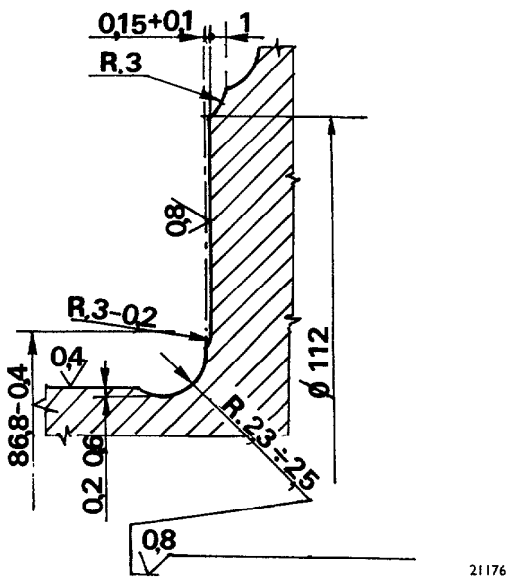


DETAILS OF CRANKSHAFT MAIN JOURNALS AND CRANKPINS

CHECKING AND GRINDING MAIN JOURNALS AND CRANKPINS

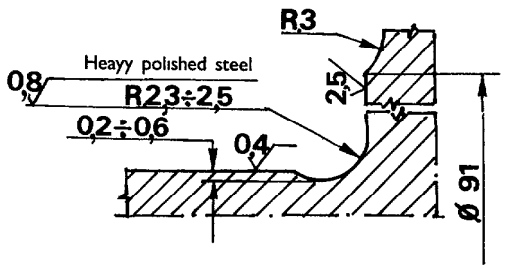
If any traces of seizure, scoring or ovality is found on the main journals and crankpins, they must be reground. Before carrying out grinding, with a micrometer measure the pins and establish on the basis of the undersize range of the bearings to what diameter it is necessary to reduce the pins.

FIGURE 43



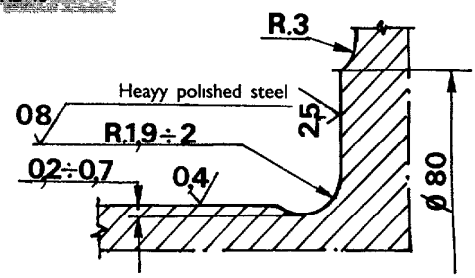
DETAIL OF MAIN THRUST JOURNAL FILLETS

FIGURE 44



DETAIL OF MAIN JOURNAL FILLETS

FIGURE 45

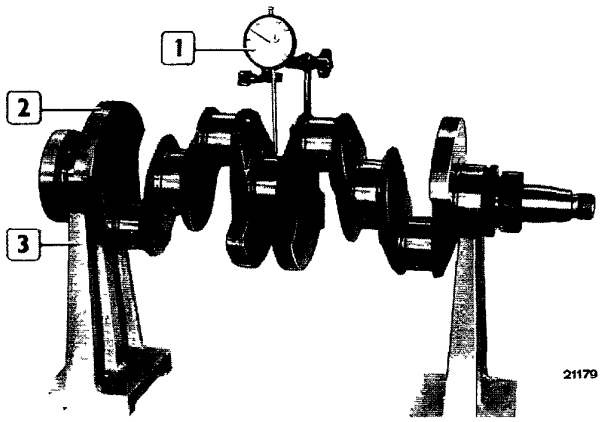


DETAIL OF CRANKPIN FILLETS

When grinding crankshaft pins, pay maximum attention to the fillet values, which must not change at all with reference to the dimensions quoted in Figures 43, 44 and 45

CHECKING MAIN JOURNAL ALIGNMENT

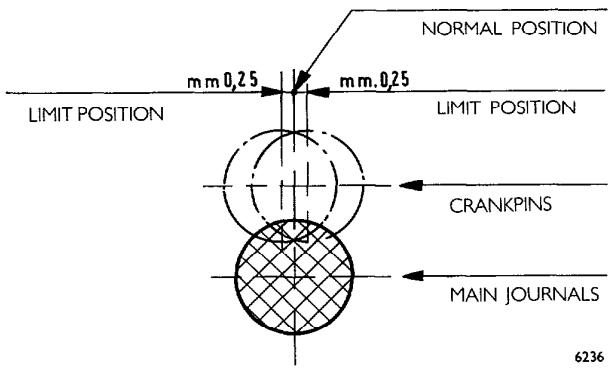
FIGURE 46



This check should be carried out after grinding, with the crankshaft (2) resting on two V-blocks (3), using a dial gauge (1) for checking

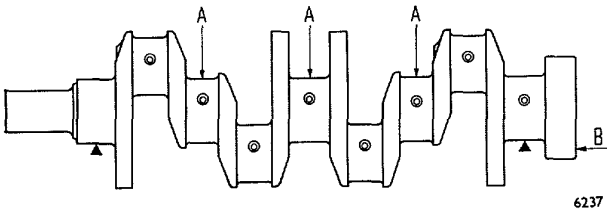
- Alignment of main journals maximum tolerance >0 10 mm (total dial gauge reading)

FIGURE 47



- Crankpins alignment relative to main journals; the axis of each pair of crankpins and that of the main journals should be on the same plane; maximum permitted tolerance at right angle to that plane ±0 25 mm

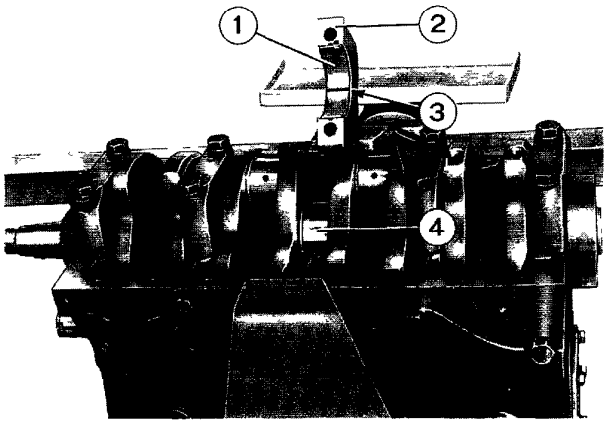
FIGURE 48



- The maximum permitted tolerance for the distance between the shaft rotational axis is ±0 10 mm

Check that the plugs in the lubrication circuit do not leak under an internal pressure of 15 bar if they leak, change them using a suitable driver tool

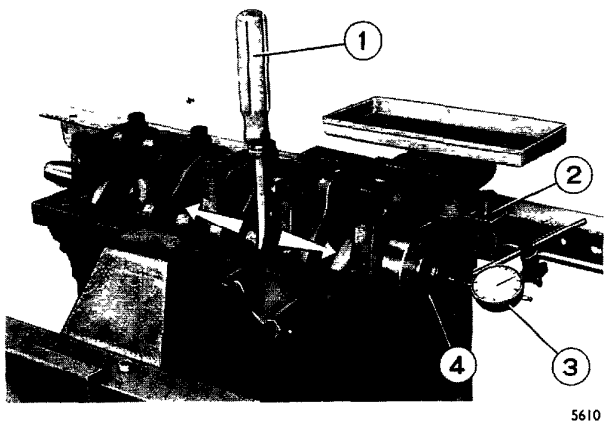
FIGURE 49



To check existing clearance between the journals and their bearings, use a calibrated line, as follows

- thoroughly clean the parts and eliminate all traces of oil;
- arrange the half-bearings in their seats on the supports;
- fit the crankshaft;
- run a calibrated (3) wire along the crankshaft journals (4);
- fit the caps (2) complete with half-bearings, onto their respective supports,
- fit the cap fixing screws and tighten them with a torque wrench at the specified torque, having previously smeared the screws with oil,
- remove the caps from the supports and calculate existing clearance between the half-bearings and the crankshaft main journals by comparing the width of the calibrated wire (3) at the maximum projection point, with the mark on the scale on the case for holding the line.

FIGURE 50



Check and measure crankshaft (4) end float using dial gauge (3).

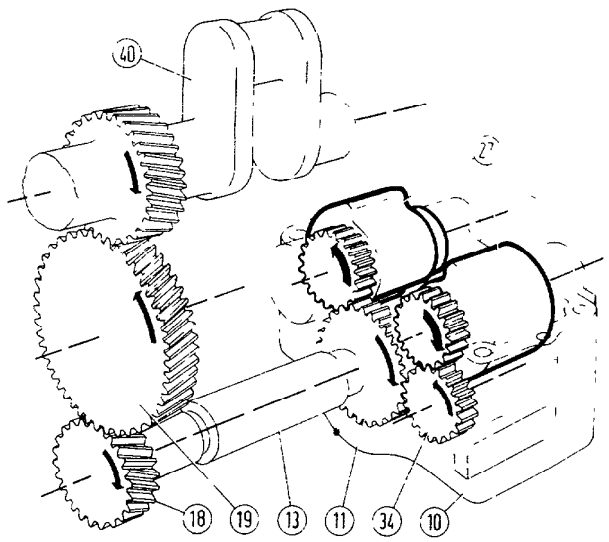
The standard fitting clearance is 0 082 to 0 334 mm If it is found to be greater, change the thrust ring halves for new ones of standard or oversized thickness

DYNAMIC BALANCER

Balancer Overhaul

When removing the dynamic balancer note the following points:

- Drain the engine oil pan and remove the bottom cover



Dynamic Balancer Schematics

10 Housing - 11 Flyweight drive gear - 13 Sleeve - 18 Drive pinion - 19 Intermediate gear - 27 Flyweights - 34 Idler gear - 40 Crankshaft

- Take off the suction scoop, remove the fixing screws of the box to the oil sump and take off the flyweight assembly.

- If necessary, remove gear (18) with attached flange, withdrawing oil pipe and capscrews

To disassemble the flyweight assembly proceed as follows.

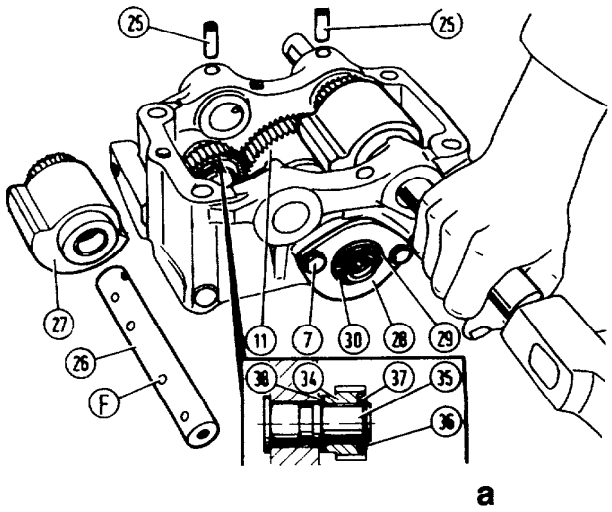
- Withdraw roll pins (25) and take off the weight carriers using a suitable driver

- Remove flange retaining screws (7), retaining ring (30) and flyweight drive gear (11)

- Remove retaining ring (36) and idler gear (34).

Check for wear, replace any defective parts, and ream the new bushings using expansion blade reamers.

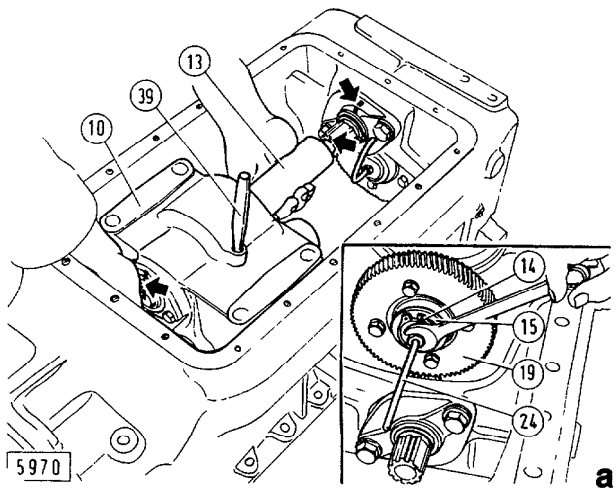
To install bushings, heat the weights in oil at 140 ° to 160 ° C.



a

Removing Flyweight Carriers

a Section through idler gear - F Oil ports - 7 Flange capscrew - 11 Flyweight drive gear - 25 Roll pins - 26 Flyweight carrier - 27 Flyweight - 28 Flange - 29 Thrust washer - 30 Retaining ring - 35 Idler gear carrier - 36 Retaining ring - 37 Thrust washer - 38 Thrust washer



a

Installing Dynamic Balancer (10) with Sleeve (13)

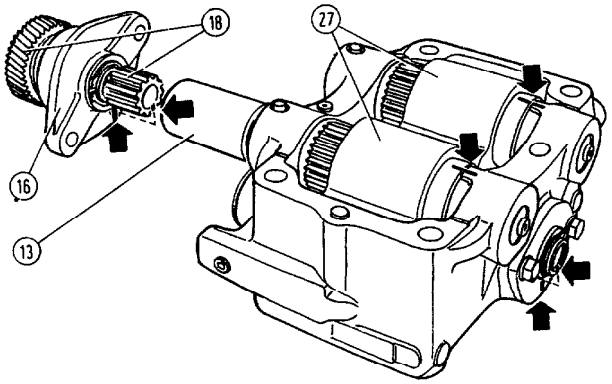
Timing marks arrowed

a Installing oil pipe - 14 Retaining ring - 15 Thrust washer - 19 Intermediate gear - 39 Lockring pin

When assembling parts, make sure that flyweight drive gear (11) and flyweights (27) are positioned so that all reference marks are as arrowed. Note that :

- Idler gear (34) should be positioned with the longer end of hub facing towards the housing wall.

- Roll pin holes (26) in flyweight carriers should be aligned with associated holes in the housing.



Dynamic Balancer Timing Marks

13 Sleeve - 16 Flange - 18 Drive pinion and gear - 27 Flyweights

When installing the flyweights, adjust timing as follows:

- Bring piston No. 1 to T.D.C. position.

- Secure drive pinion (18) to the oil pan, with reference marks aligned as shown.

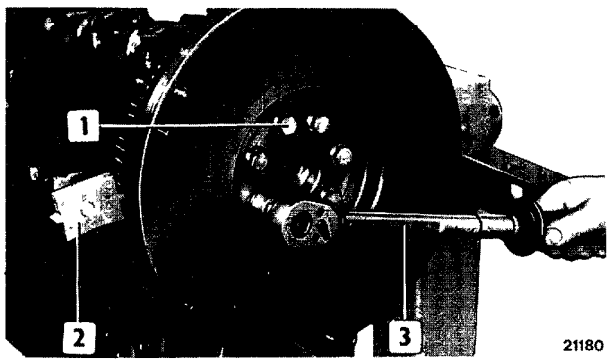
- Lock the flyweights in position with pin (39) and check reference mark alignment,

- Position sleeve (13) and tighten the capscrews to the torque of Nm 110.

CHANGING FLYWHEEL RING GEAR

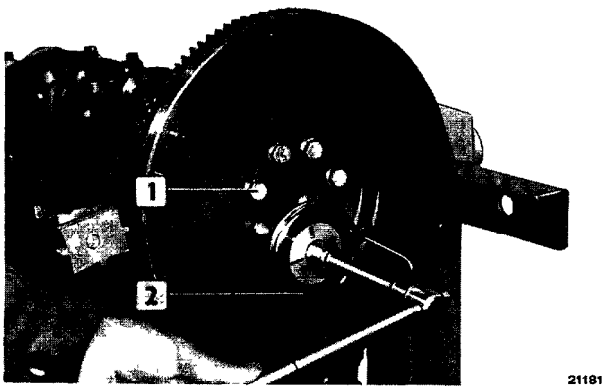
If the teeth of the flywheel ring gear for engine starting are badly damaged, change the ring gear It should be fitted after heating the ring gear to 80°C

FIGURE 51



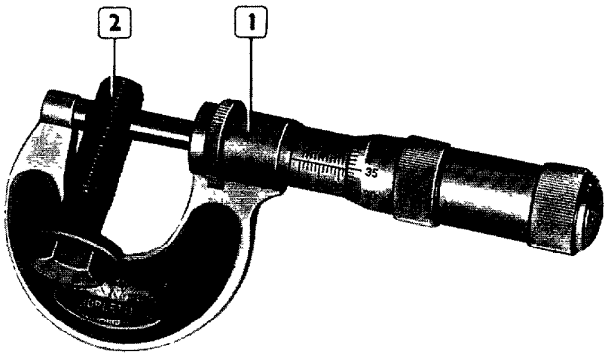
Fitting flywheel Apply tool 99360352 (2) and tighten the setscrews (1) with a torque wrench (3) to a torque of 40 Nm (4 kgm)

FIGURE 52



Fit tool (2) on the socket wrench and tighten the screws (1) a further 60°

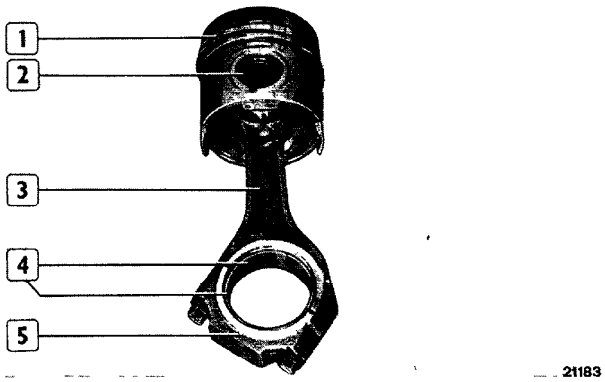
FIGURE 53



Before reusing the setscrews (2) on the flywheel, check with a micrometer (1) that the threaded section diameter of the screws is not less than 11 5 mm

PISTON AND CONNECTING ROD ASSEMBLY

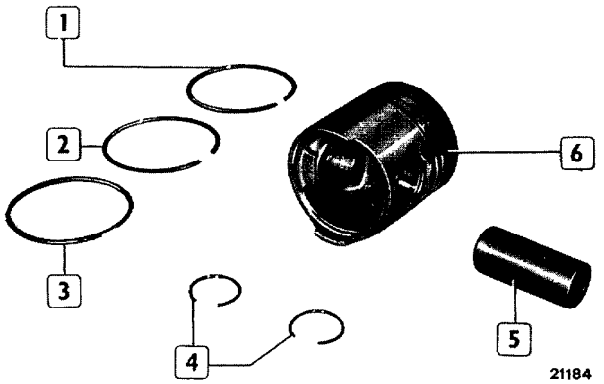
FIGURE 54



PISTON AND CONNECTING ROD ASSEMBLY

1 Piston - 2 Pin - 3 Connecting rod - 4 Half-bearing - 5 Connecting rod cap

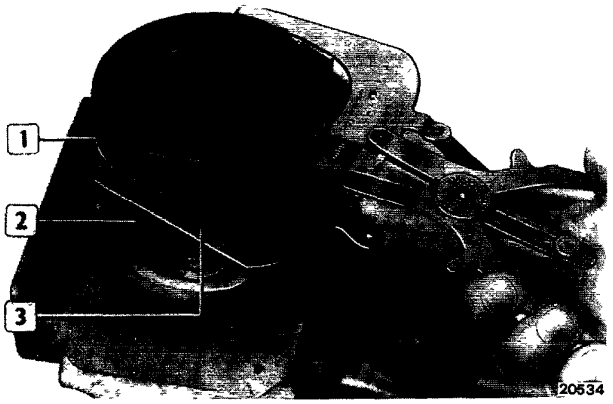
FIGURE 55



PISTON ASSEMBLY

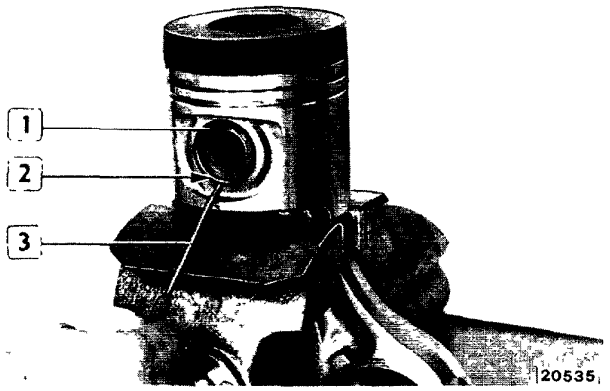
1 Compression ring - 2 Oilscraper ring - 3 Slotted oilscraper ring - 4 Circlips - 5 Piston gudgeon pin - 6 Piston

FIGURE 56



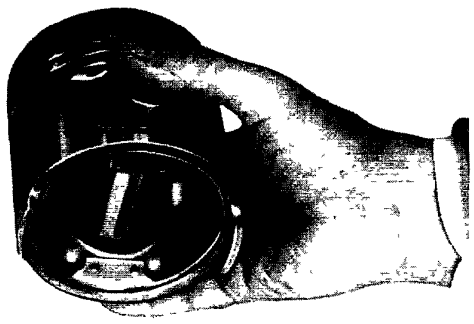
Remove and fit the circlips (1) on the piston (2) by means of pliers 99360183 (3).

FIGURE 57



Remove the piston pin (1) circlips (2) by means of a tracing point (3), as shown in the figure

FIGURE 58

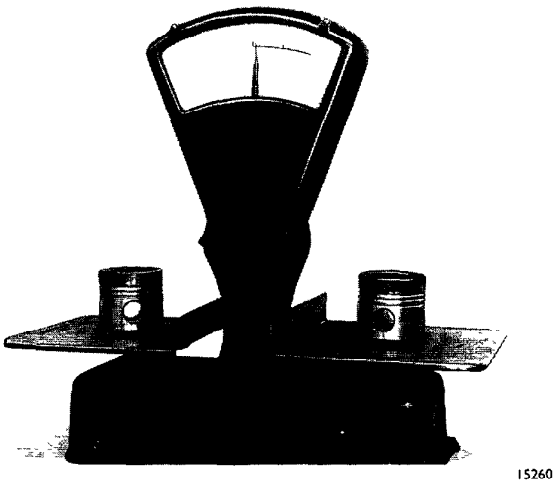


The pins are fitted with play, both on the connecting rod small end and also on the piston

When fitting new pins, check that they are correctly coupled with their housing in the piston by the following test:

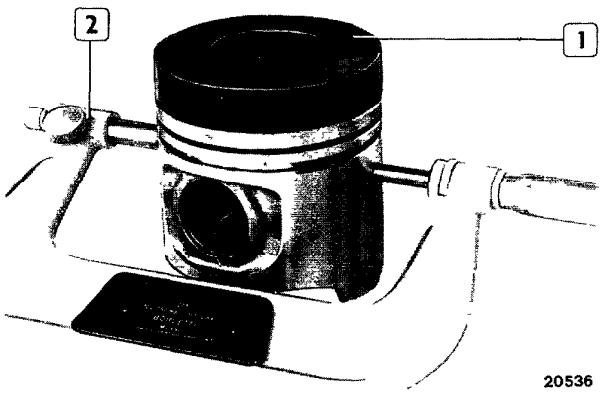
- lubricate the pin and its housing in the piston hub, with engine oil;
- introduce the pin in its housing,
- holding the pin vertical, make sure it starts to slide out under thumb pressure only, not spontaneously

FIGURE 59



Check that the piston weights are within the tolerance Maximum tolerance ±20 g

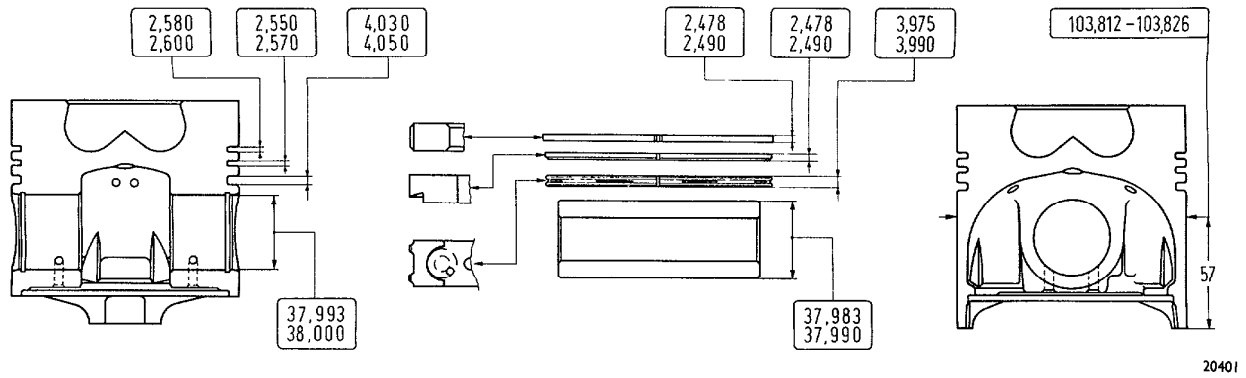
FIGURE 60



Measuring piston diameter (1) with a micrometer (2), to determine fit clearance.

NOTE - The diameter should be measured 57 mm from the base of the skirt for naturally aspirated engines and 12 mm for turbocharged engines.

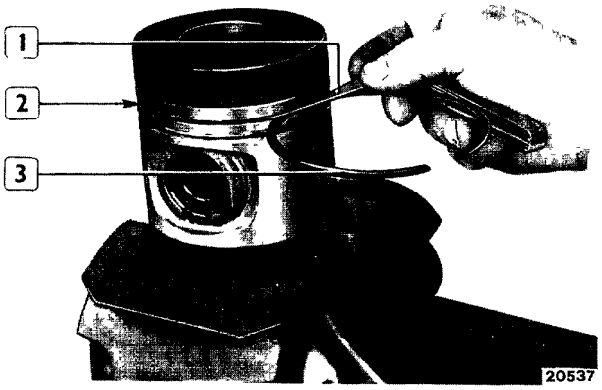
FIGURE 61



DETAILS OF PISTON, PIN AND PISTON RINGS

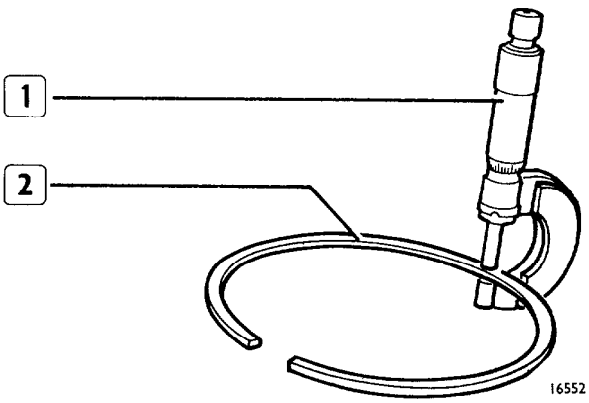
PISTON RINGS

FIGURE 62



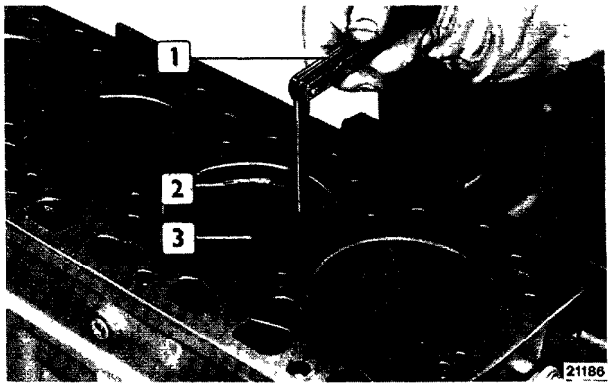
Checking clearance between rings (3) and their grooves in the piston (2), using a feeler gauge (1).

FIGURE 63



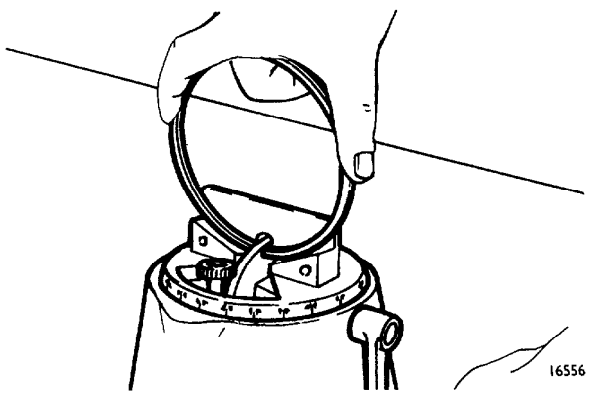
Using a micrometer (1) to check piston ring thickness (2)

FIGURE 64



Measuring gap between piston ring ends (2) introduced into the cylinder liner (3), using a feeler gauge (1).

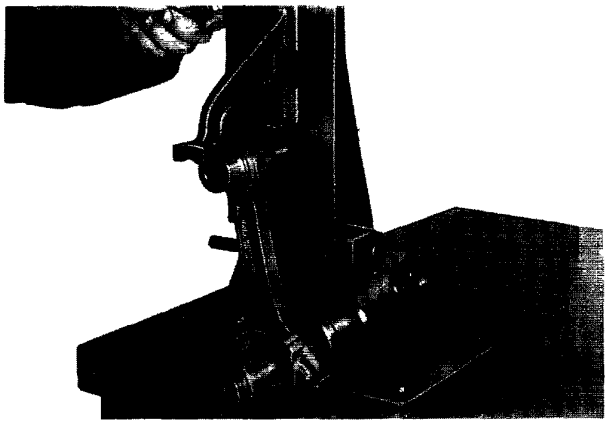
FIGURE 65



If the gap between the ring ends is found to be less than that specified, regrind the ring ends using tool 99360188, if the gap is greater than specified, change the piston rings

CONNECTING RODS

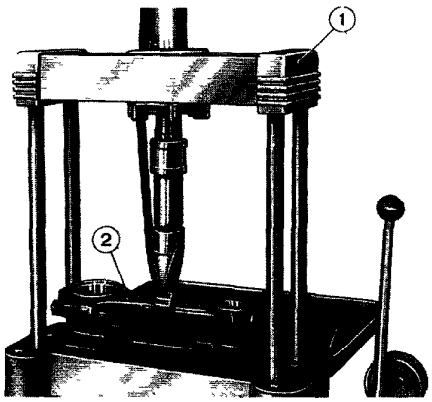
FIGURE 66



15263

Check that axes of connecting rods are parallel Permitted tolerance is 0 07 mm measured 125 mm from the longitudinal axis of the connecting rod

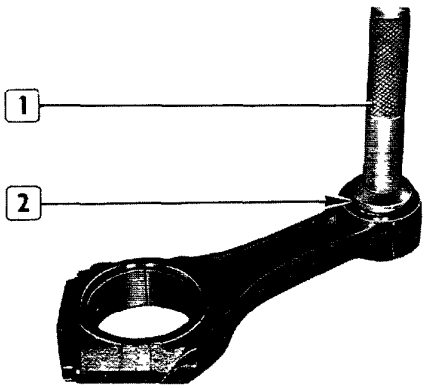
FIGURE 67



3987

Straightening a connecting rod stem (2) using a press (1).

FIGURE 68

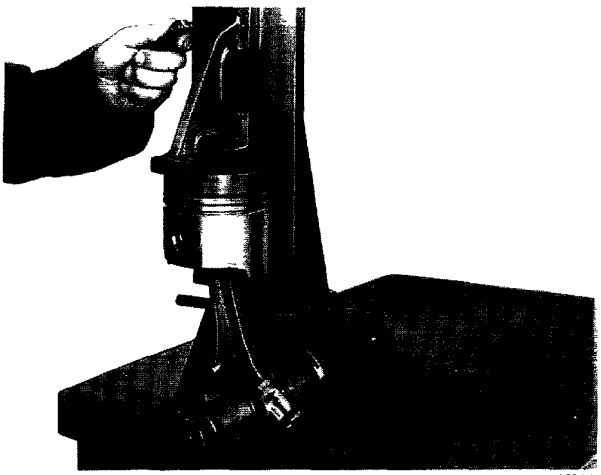


21187

Fitting bush (2) for connecting rod small end, using driver (1)

NOTE - Each connecting rod is marked on the body and cap with a number matching that of the cylinder in which it is to be fitted
If replacing the connecting rod, therefore, it is necessary to number the new one with the same number as the one it replaces

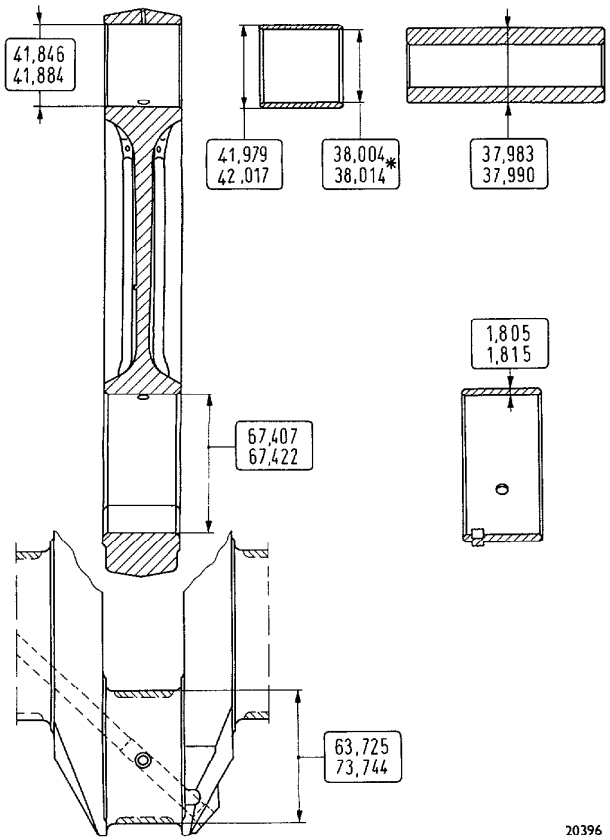
FIGURE 69



15264

NOTE - Before fitting the connecting rod/piston assembly in the engine, check that it is square. It must be perfectly square, if not, trace the cause and change the parts concerned

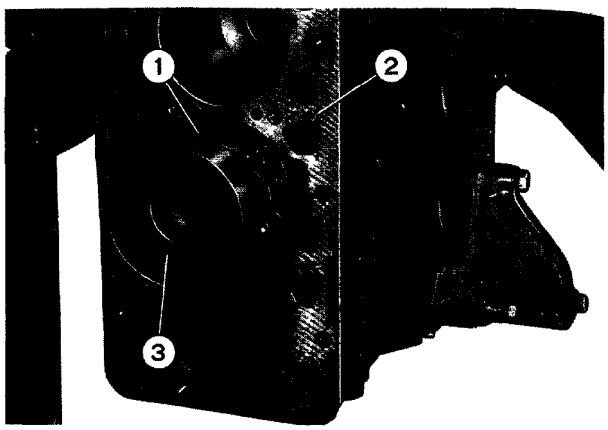
FIGURE 70



DETAILS OF CONNECTING ROD, BUSH, BEARINGS, CONNECTING ROD PIN AND PISTON PIN

* Measured after fitting bush

FIGURE 71



Fitting connecting rod/piston assembly (3) in cylinder liners using compression ring 99360605 (1).

FIGURE 72

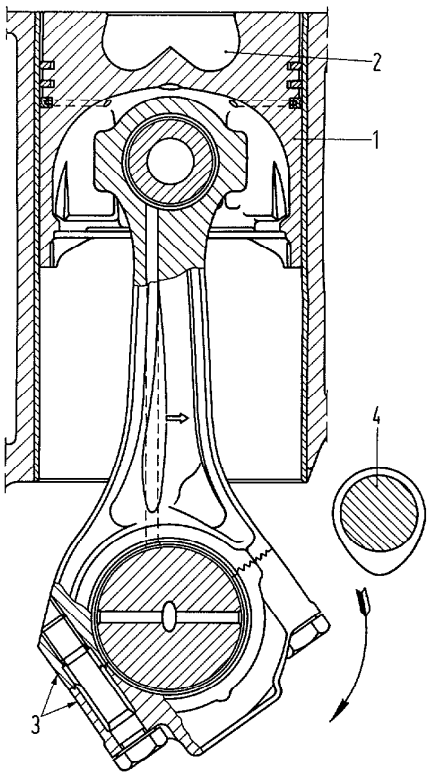
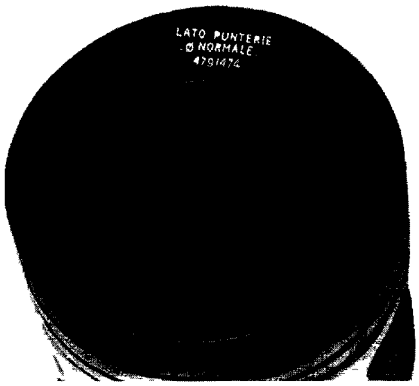


DIAGRAM SHOWING COUPLING OF CONNECTING ROD TO PISTON AND FITTING OF THE GROUP IN THE CYLINDER

1 Piston - 2 Combustion chamber - 3 Stamped number of cylinder to which the connecting rod belongs - 4 Camshaft

NOTE - The connecting rod screws may be reused until the thread diameter measured between 19 and 35 mm from the start of the screw is below 10 5 mm

FIGURE 73



The connecting rod/piston assemblies must be introduced in the liners, making sure that

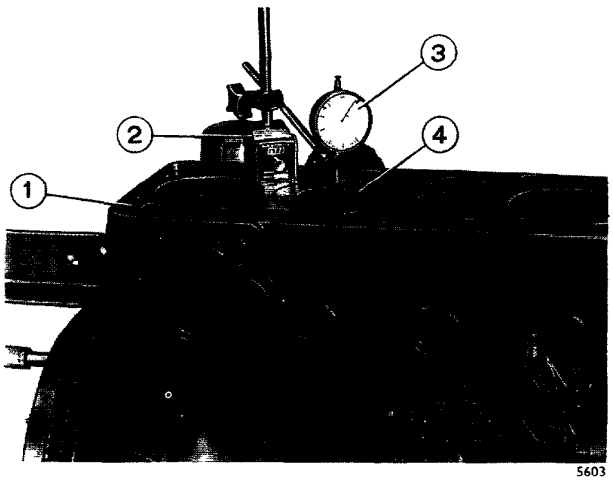
- the connecting rod number corresponds to its associated cylinder number·

The assembly of the connecting rod-piston assembly in the liners should be carried out checking that.

- the number of the connecting rod corresponds to the number of the cylinder;
- the wording "LATO PUNTERIE" (TAPPETS SIDE) stamped on the crown of the piston is turned towards the camshaft,
- the connecting rod numbers are positioned on the opposite side to the camshaft;
- the ring gaps are offset 120° to each other

Lubricate the pistons well, including the piston rings and the inside of the cylinder liners

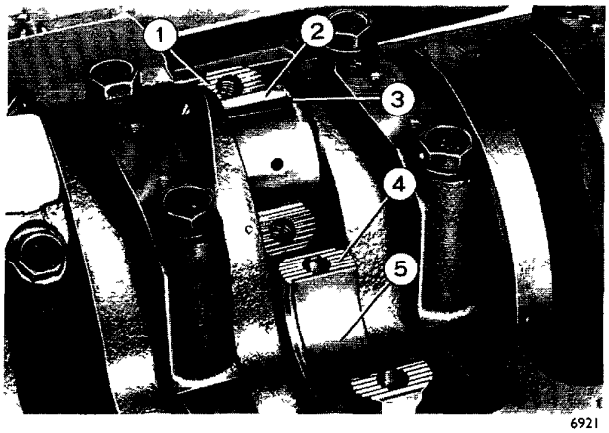
FIGURE 74



5603

After completing assembly, check the position of the pistons (4) at T D C relative to the cylinder head surface, using a magnetic-based dial gauge (3).
The top edge of the pistons should project 0 46 to 0.79 mm from the face of the cylinder head (1)

FIGURE 75



6921

Application of calibrated line (3) to read assembly clearance of connecting rod pins

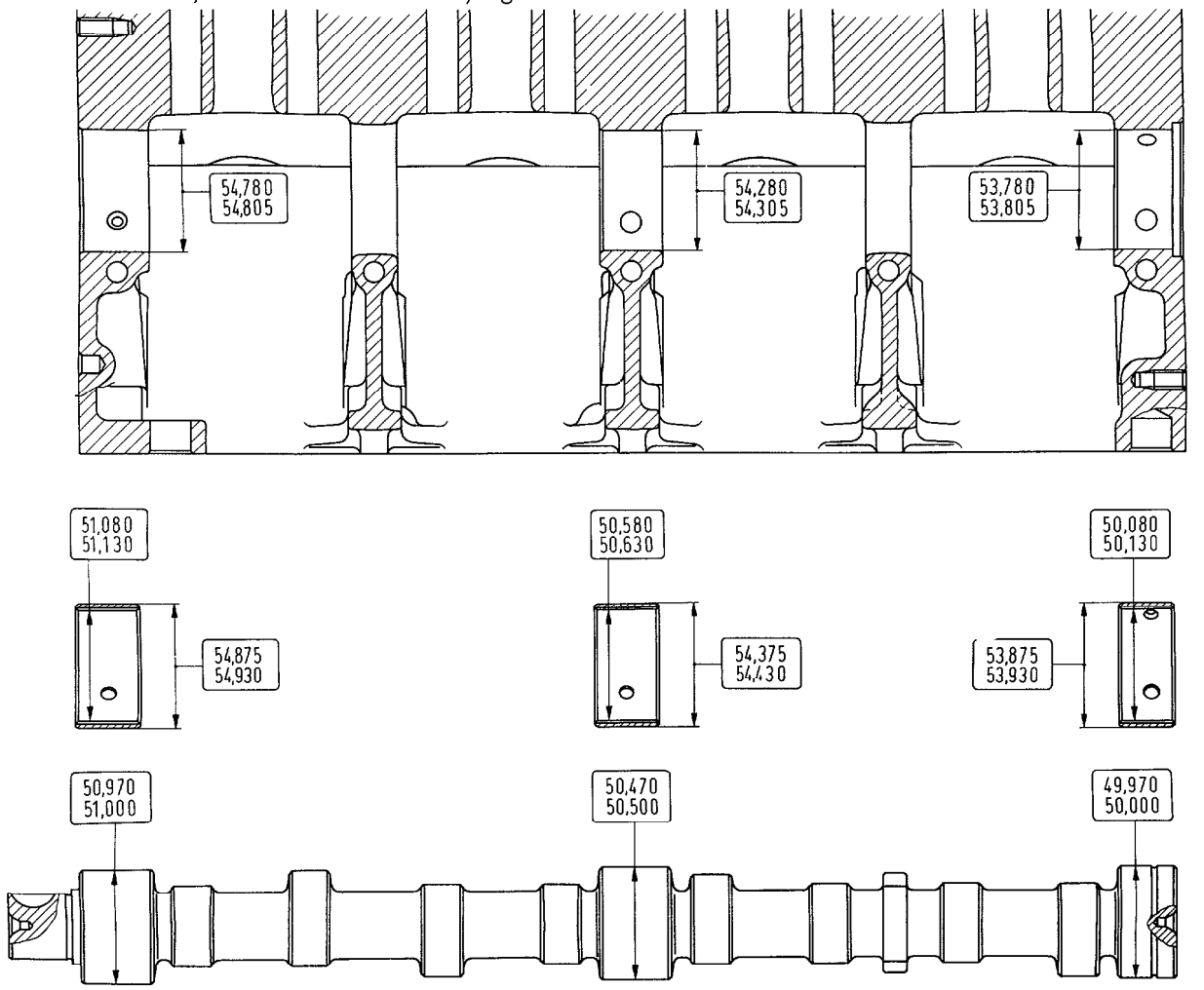
Check clearance as follows·

- thoroughly clean the parts and remove all traces of oil;
- place a piece of calibrated line (3) along the crankshaft pins (2),
- fit the connecting rod cap (4) and tighten the screws to the specified torque (screws must be lubricated);
- remove the cap and calculate existing play by comparing the width of the calibrated line (3) with the mark on the scale on the case for holding the line

CAMSHAFT - BUSHES - TAPPETS 3 - 4 CYLINDERS

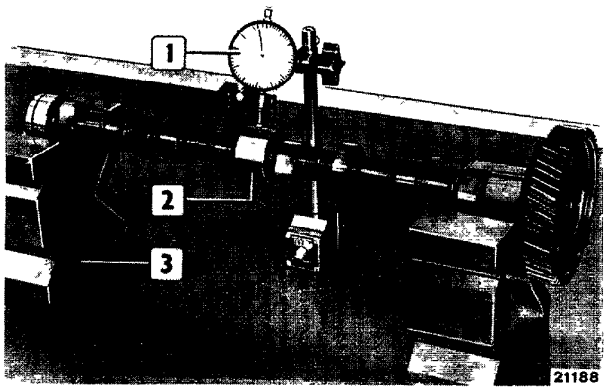
FIGURE 76

The surfaces of the shaft support pins and of the cams should be extremely smooth; if there are any signs of pick-up or scoring, change the shaft and its bushes



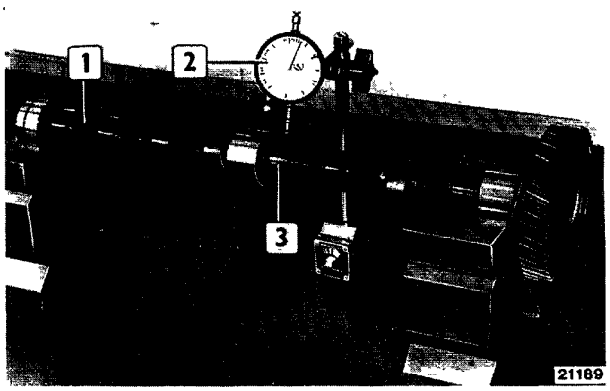
DETAILS OF CAMSHAFT, BUSHES AND HOUSINGS IN ENGINE BLOCK 5619

FIGURE 77



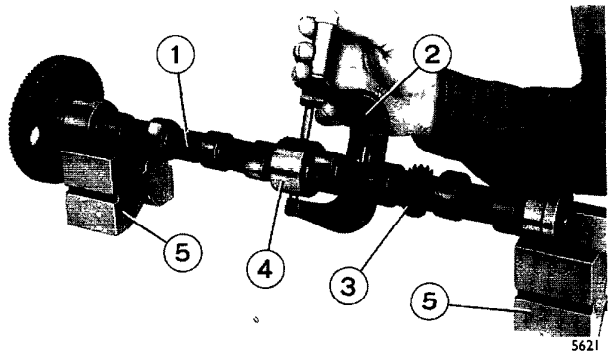
Place the camshaft on two parallel blocks (3) and check with a dial gauge (1), the alignment of the support pins (2), misalignment should not be over 0.020 mm.
If misalignment is found to be greater than this, straighten the shaft in a press

FIGURE 78



With the camshaft (1) still on the parallel blocks, check the cam lift (3) height with a dial gauge (2); this should be:
- 5 955 mm for the intake cam,
- 6 027 mm for the exhaust cam

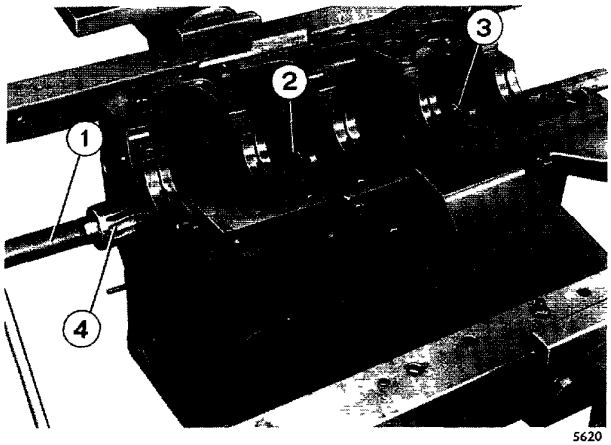
FIGURE 79



5621

To check play, measure the inside diameter of the bushes and the diameter of the camshaft (1) journals (4); actual play is obtained from the difference
If play over 0.160 mm is found, change the bushes and if necessary, also change the camshaft

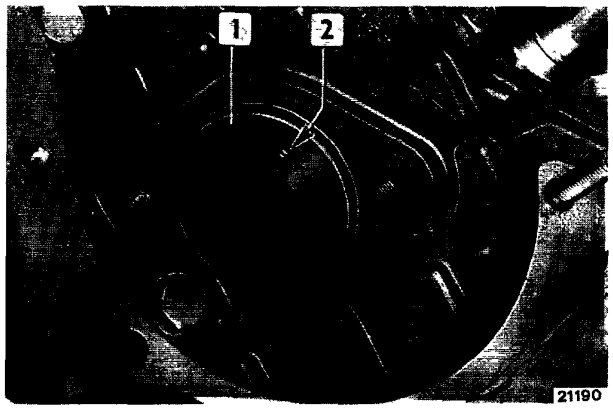
FIGURE 80



5620

To remove and fit the bushes use a suitable tool and for skimming the bushes use a suitable miller

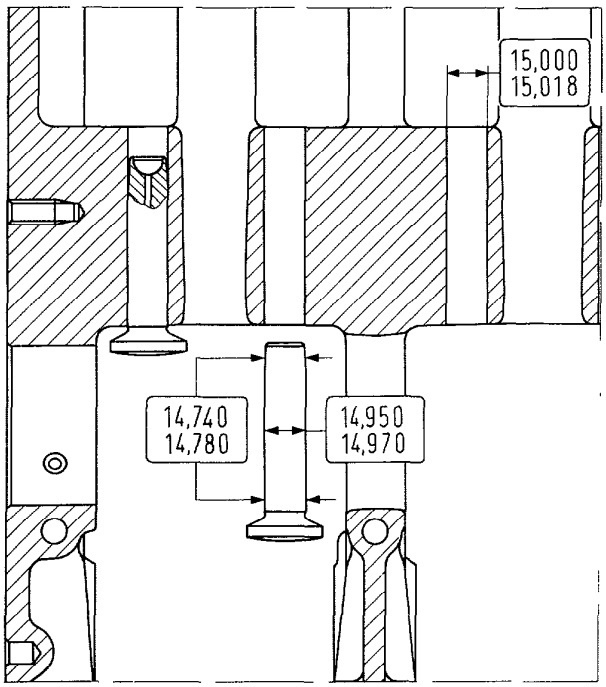
FIGURE 81



21190

NOTE - When fitting the bushes (1) pay attention to the direction of the holes (2), wich should be aligned with those in the engine block to enable the passage of lubrication oil

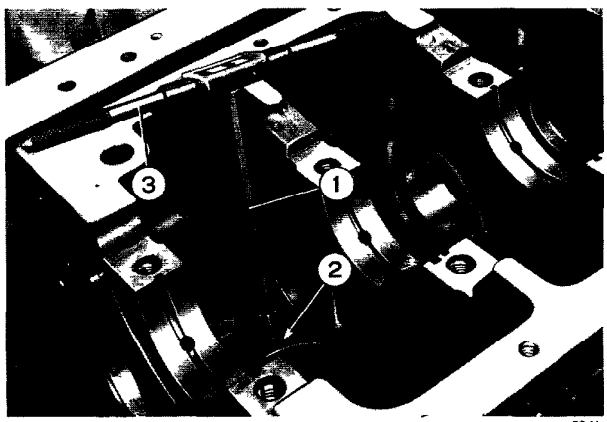
FIGURE 82



20399

DETAILS OF TAPPETS AND THEIR SEATS ON THE ENGINE BLOCK

FIGURE 83



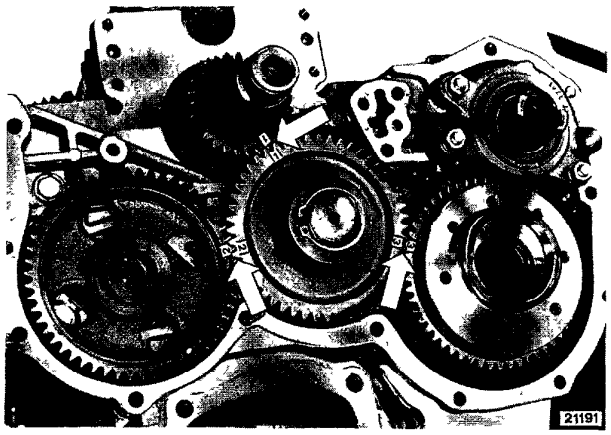
5941

Changing the tappets, because of excessive play in the seats, necessitates fitting oversized tappets and reaming out the seats (2) with the appropriate reamer (1)
Tappets are supplied as spares in normal size and oversized by 0.10, 0.20, 0.30 mm

TIMING CONTROL

Check gears for damage or excessively worn teeth Excessively worn or damaged gears should be replaced When fitting new gears, heat them in a furnace for approximately 10 minutes at a temperature of approximately 150°C, then fit them on the crankshaft and camshaft, inserting the tongues.

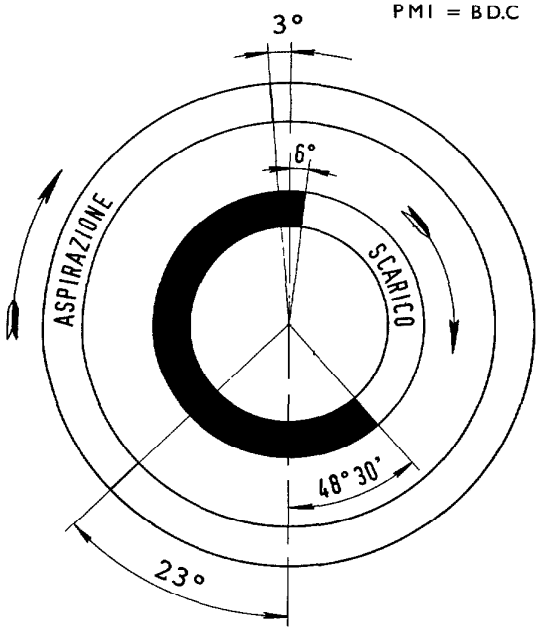
FIGURE 84



When fitting the timing gears, match up the numbers 1, 2 and 3 (ARROWS) cut in the gears.

FIGURE 85

Aspirazione = Intake
PMS = T.D.C
Scarico = Exhaust
PMI = B.D.C



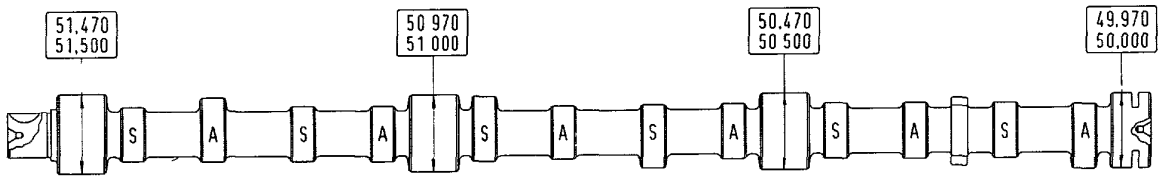
8031I05-8041I05-8041SI25-8051I05

The timing check is carried out as follows

- provisionally set the play between the valves and rockers at 0.45 mm and check with a graduated sector that the advance and retard angles for intake and exhaust correspond to those indicated in the table:

CAMSHAFT - BUSHES - TAPPETS 6 CYLINDERS

FIGURE 70

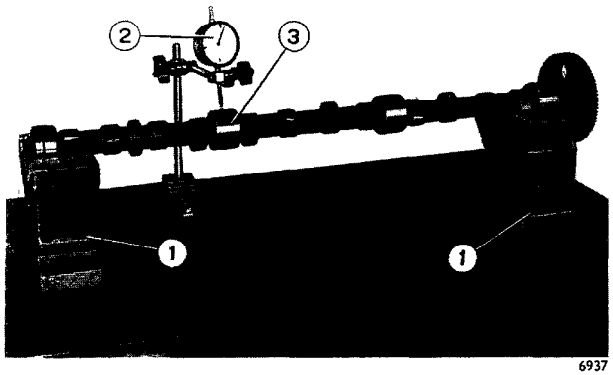


1403

CAMSHAFT DETAILS

The camshaft support pin surfaces and cam lobe surfaces must be mirror smooth; if traces of seizing and scoring are detected, change the shaft and its bushes

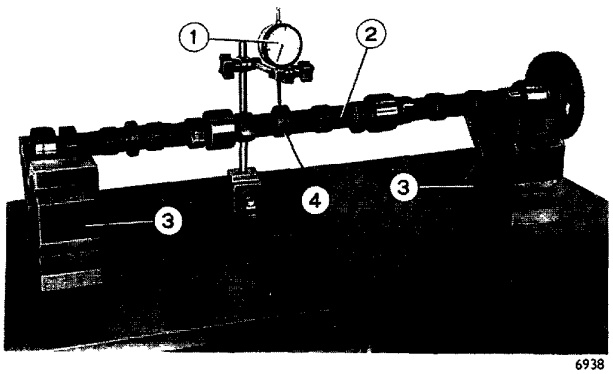
FIGURE 71



6937

Arrange the camshaft on two parallel blocks (1) and use a dial gauge (2) to check alignment of the support pins (3), misalignment should not exceed 0.020 mm
If misalignment is greater than that figure, straighten the camshaft using a press

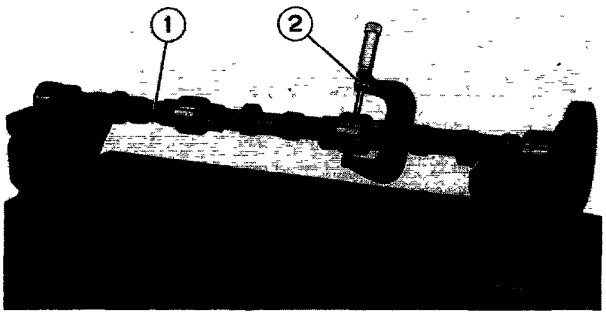
FIGURE 72



6938

With the camshaft (2) still on the parallel blocks (3), check cam lift (4) with a dial gauge (1), this should be
- 5.955 mm for the intake lobe,
- 6.027 mm for the exhaust lobe

FIGURE 73

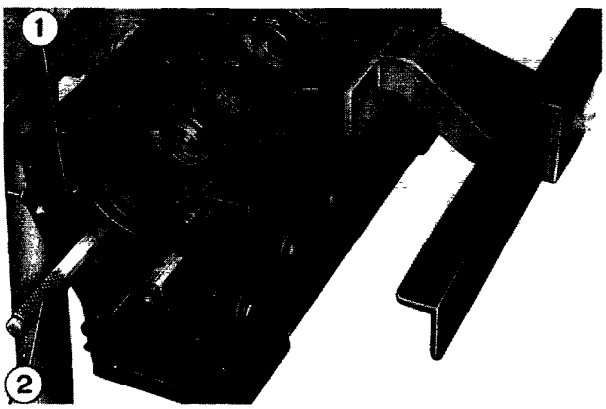


6939

To check clearance, measure the internal diameter of the bushes and the diameter of the camshaft pins (1); actual existing clearance is obtained from the difference between the two
If clearances over 0.160 mm are found, change the bushes and if necessary also the camshaft

BUSHES

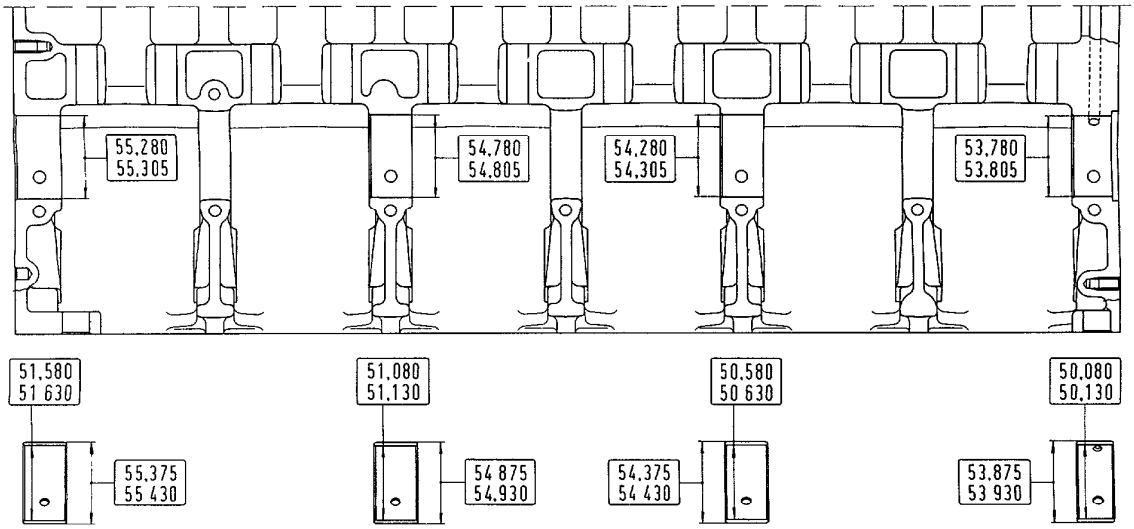
FIGURE 74



8138

Removing/refitting bushes (1) of camshaft, using driver (2)

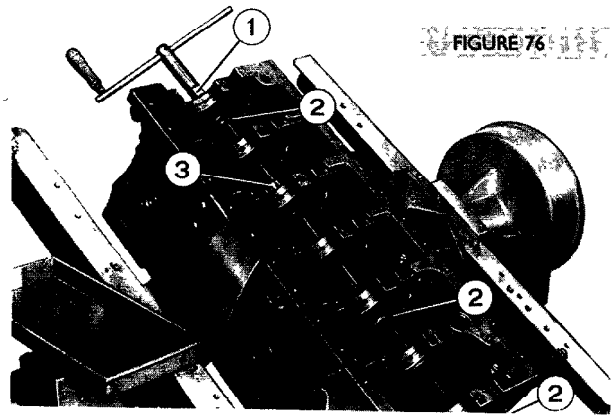
FIGURE 75



1403

CAMSHAFT BUSH DETAILS AND THEIR HOUSINGS IN THE ENGINE BLOCK

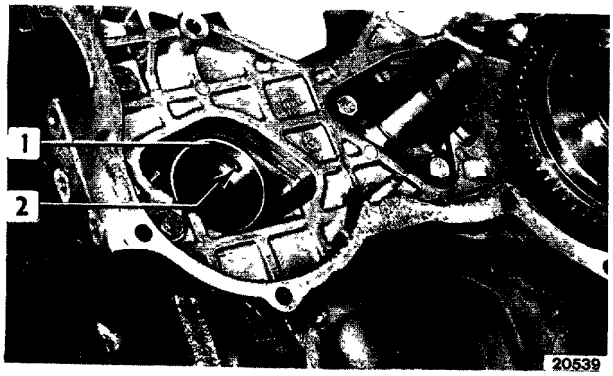
FIGURE 76



6940

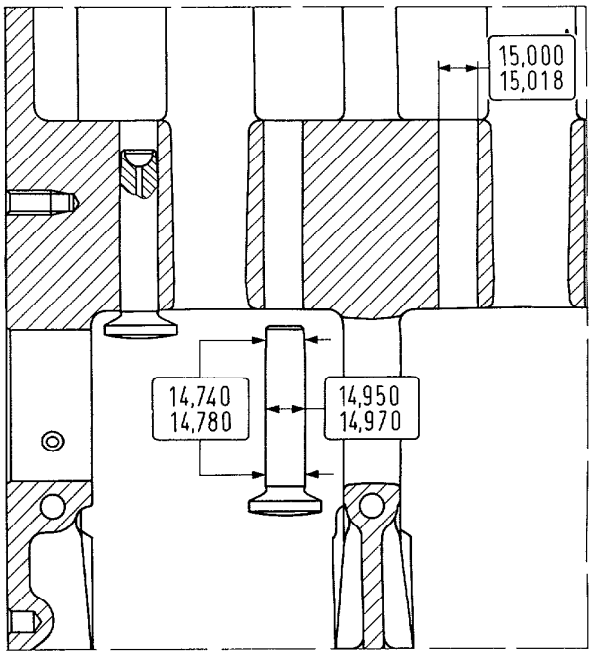
Regrinding camshaft bushes with chuck (1), guide sleeve (2) and cutter (3).

FIGURE 77



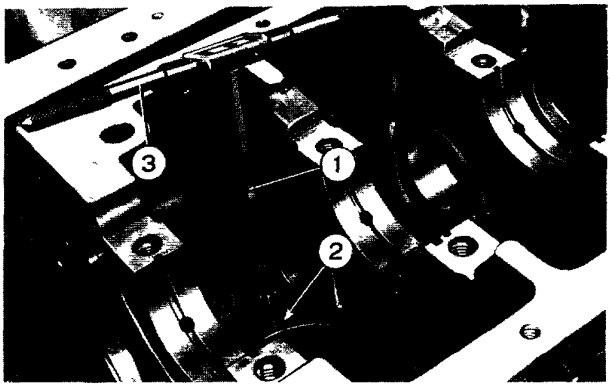
NOTE - When fitting the bushes (1), pay attention to the location of the holes (2), which must be in line with those for the passage of lubricating oil in the engine block

FIGURE 78



DETAILS OF TAPPETS AND THEIR HOUSINGS IN ENGINE BLOCK

FIGURE 79



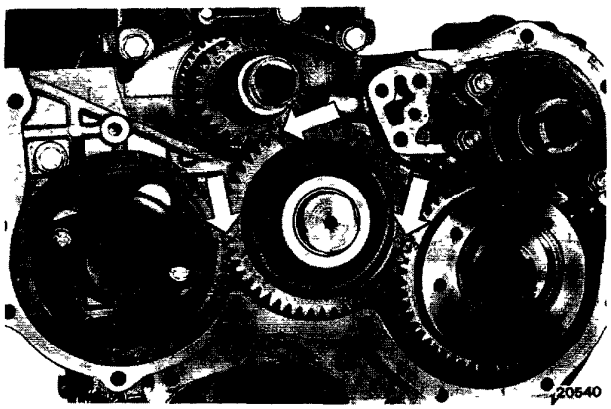
6941

If tappets have to be changed because of excessive play in their seats, fit oversized tappets and ream out their seats (2) with a suitable reamer tool (1).
Tappets are supplied as spares in standard size and oversized by 0 10, 0 20 and 0 30 mm

TIMING CONTROL

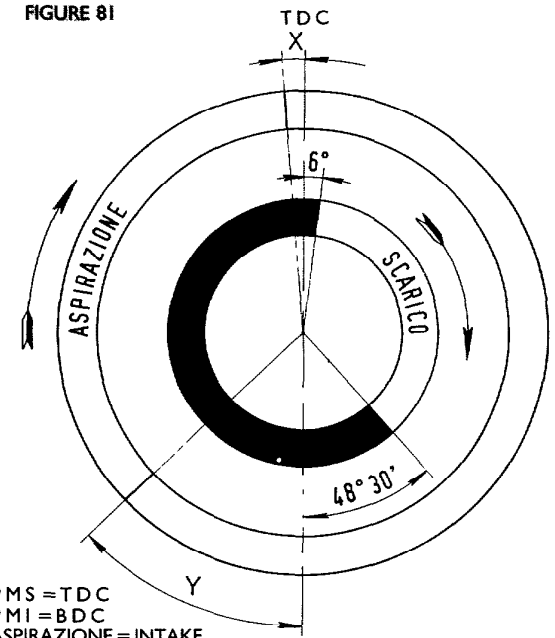
Check the gears for damaged or excessively worn teeth
Change any which are not satisfactory
When fitting the gears, heat them in an oven for approximately 10 minutes at a temperature of approx. 150°C, then shrink them on to the shafts inserting the lugs

FIGURE 80



When fitting the timing gears, match up the numbers 1, 2 and 3 (arrows) cut in the gears

FIGURE 81



PMS = TDC
PMI = BDC
ASPIRAZIONE = INTAKE
SCARICO = EXHAUST

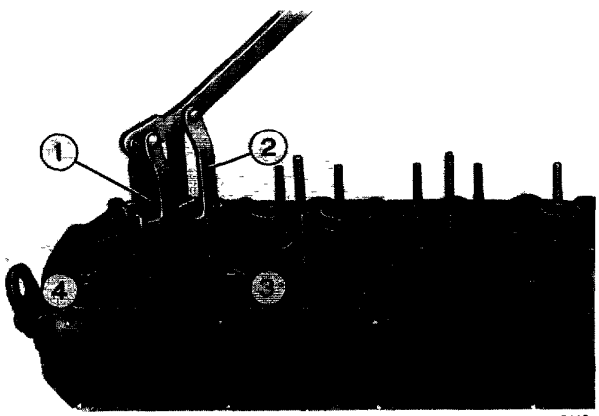
2791

Timing check is carried out as follows:
- provisionally adjust the clearance between the valves and rockers to 0 45 mm and with a scaled quadrant check that the advance and retard angles for intake and exhaust correspond to those indicated in the table:

8061I05	X=3°	Y=23°
8061I25	X=3°	Y=23°
8061SI25	X=4°	Y=46°

CYLINDER HEAD

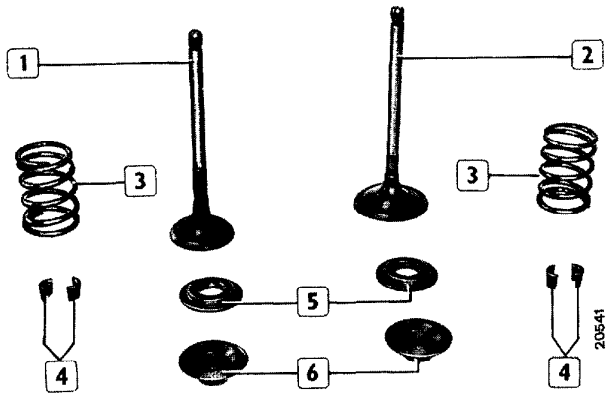
FIGURE 82



5612

Use tool 99360357 (2) to remove and fit the valves

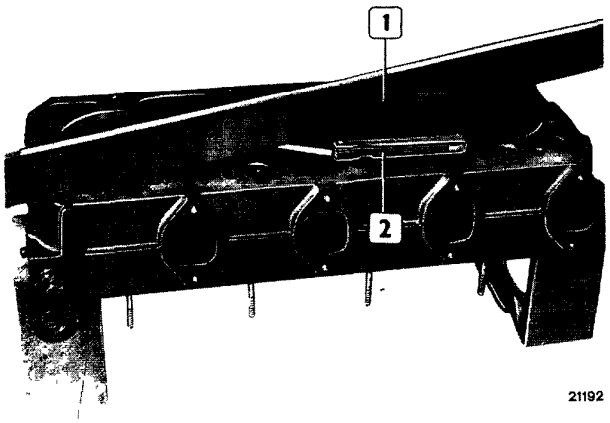
FIGURE 87



COMPONENT PARTS OF VALVE ASSEMBLY

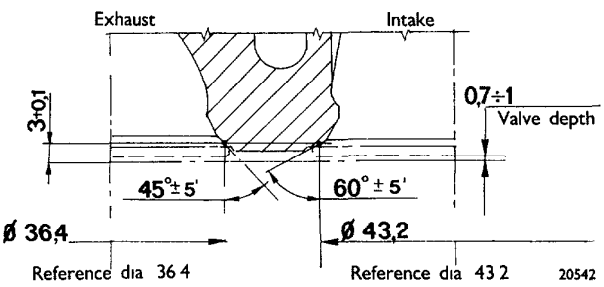
Exhaust valve - 2 Intake valve - 3 Springs - 4 Cotters - 5 Lower washers - 6 Upper washers

FIGURE 88



Check the cylinder head face by means of a straight edge (1) and a feeler gauge (2)
If distortions greater than 0 15 mm are found over the complete length of the surface of the valves, dress the head with a suitable grinder

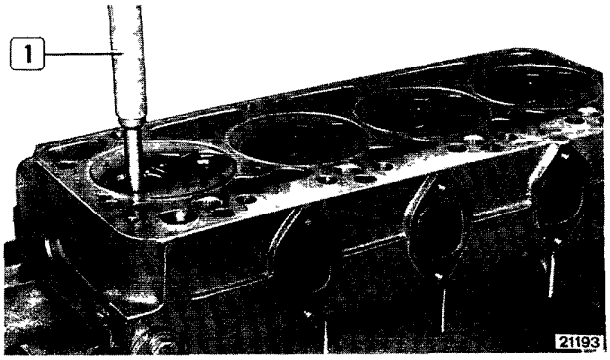
FIGURE 89



DETAILS OF VALVE SEATS

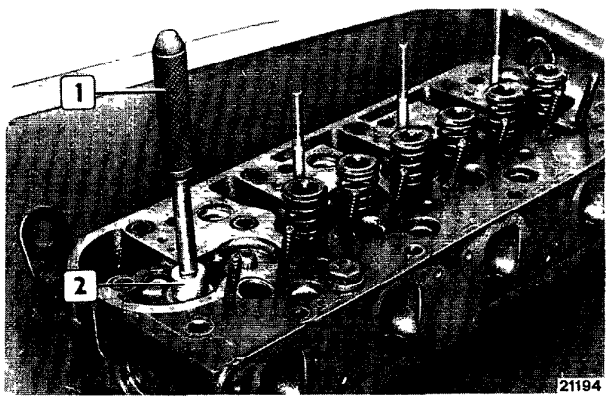
Check hydraulic seal of cylinder head; at a pressure of approximately 5 bar, there should be no leaks
Check centering and play between valve stem and its seat
If excessive play is found, change the valve and if necessary also the valve guide

FIGURE 90



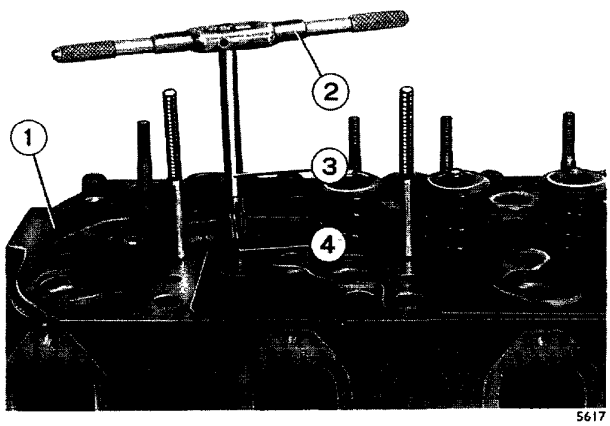
Removing valve guide with drift 99360288 (1)

FIGURE 91



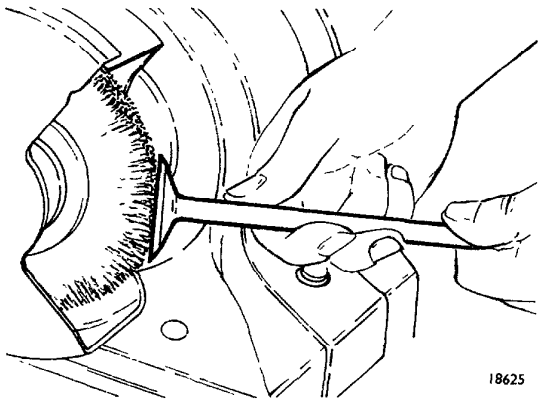
Valve guide assembly using drift 99360288 (1) and part 99360293 (2)

FIGURE 92



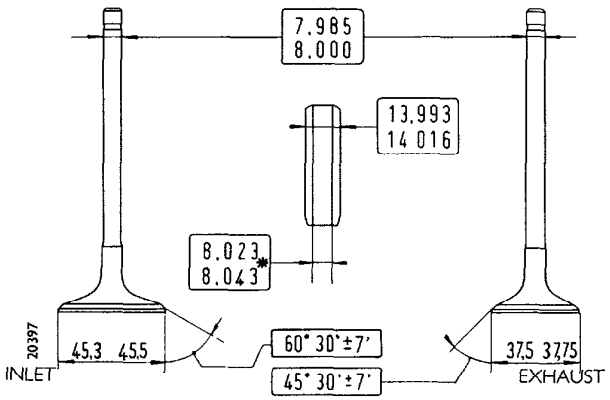
After fitting the valve guides (4), smooth the hole with reamer 99390310 (3)

FIGURE 93



Clean the valve with a wire brush and check for traces of seizure, cracks or excessive wear If necessary, grind seats on valves using grinder 99301014, removing as little material as possible

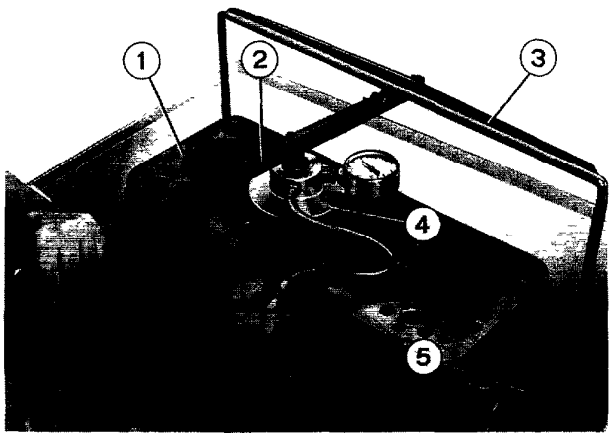
FIGURE 94



DETAILS OF VALVES AND VALVE GUIDES

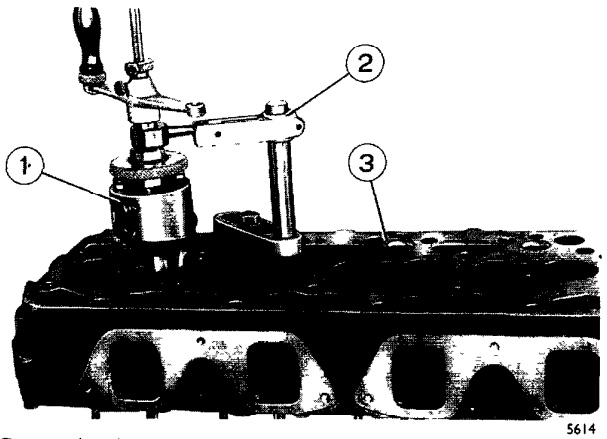
* Measured after fitting valve guides

FIGURE 95



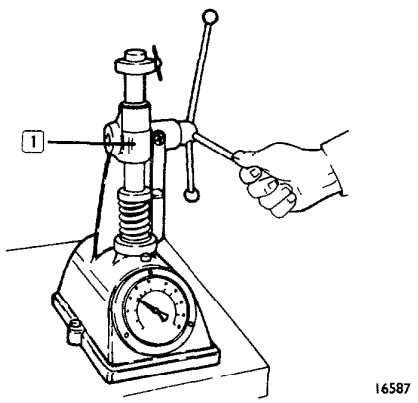
Check seal of cylinder head valves with the appropriate equipment (2, 3, 4, 5).

FIGURE 96



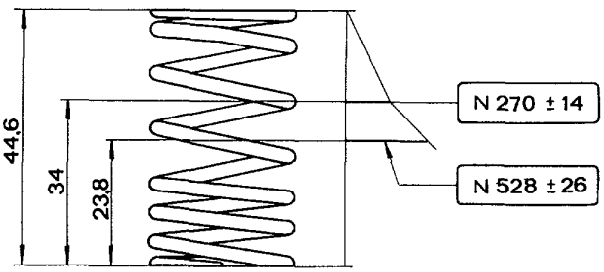
Regrind valve seats on cylinder head to give maximum seal, using "Hunger" tool 99360419 (1)

FIGURE 97



Valve spring rate must be checked with tester 99305049; compare the load and elastic strain data with those for new springs as indicated in Figure 98.

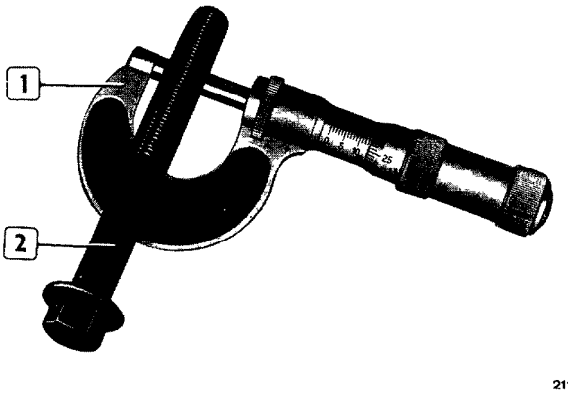
FIGURE 98



DETAILS FOR CHECKING VALVE SPRINGS

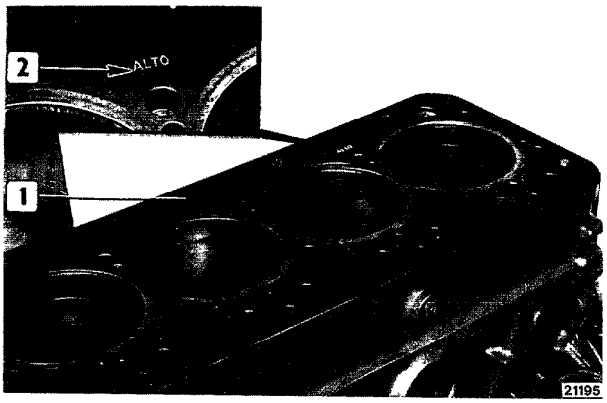
CYLINDER HEAD ASSEMBLY

FIGURE 99



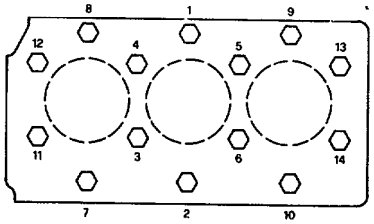
Before reusing cylinder head fixing screws (2), measure with a micrometer (1) that the threaded diameter of the screws is not less than 11.5 mm at any point, if so, change them

FIGURE 100

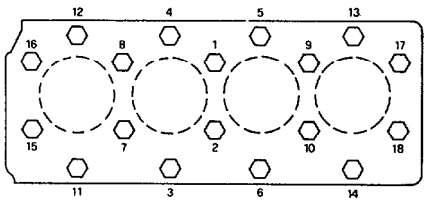


Fit and tighten the cylinder head as follows:

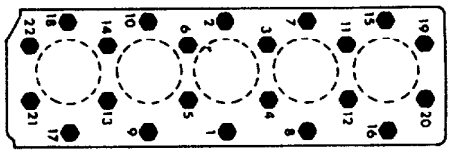
- fit the gasket (1) on the engine block with the word "ALTO" (TOP) (2) turned upwards towards the operator



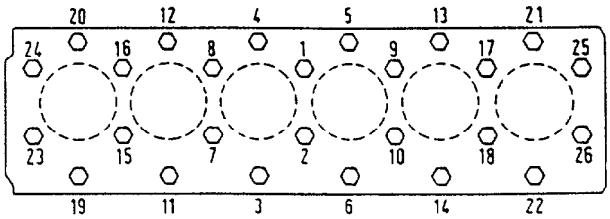
Sequence diagram for tightening screws when fitting cylinder head to engine block (engine 8031 I....



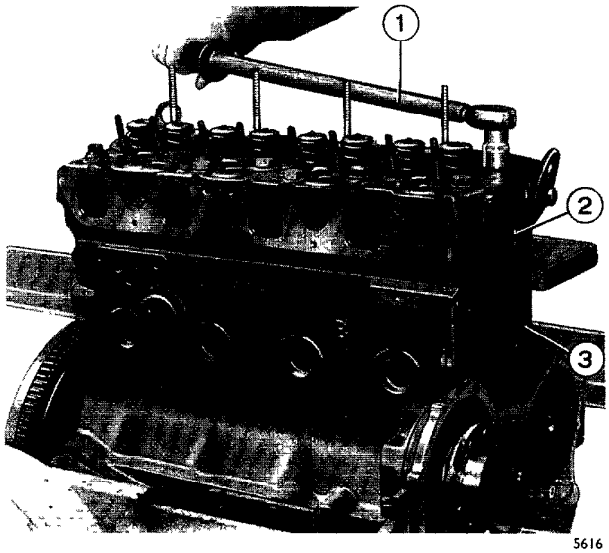
Sequence diagram for tightening screws when fitting cylinder head to engine block (engine 8041 I....



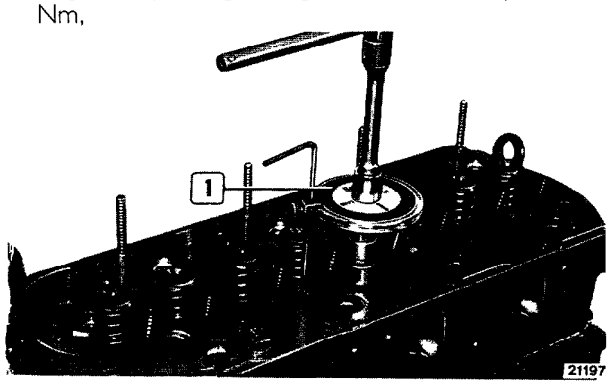
Sequence diagram for tightening screws when fitting cylinder head to engine block (engine 8051 I....



Sequence diagram for tightening screws when fitting cylinder head to engine block (engine 8061 I....



- fit the cylinder head (2), lubricate the screws, insert them and then tighten them by the method and in the order indicated in Figure 101;
- stage 1: pretighten the screws at a torque of 70 Nm with a torque wrench (1),
- stage 2 repeat tightening to the same torque of 70 Nm,



stage 3: fit tool (1) onto the socket wrench and tighten at an angle of 90°;
stage 4 tighten a further 90°

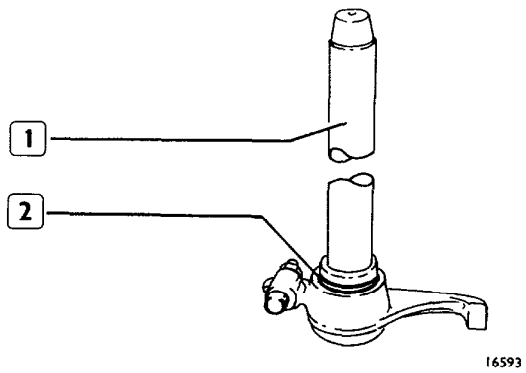
ROCKER ARM SHAFT - PUSHRODS

Check contact surfaces for traces of scoring or pick-up; if flawed, change the parts concerned.

Check clearance between valve rocker arm bushes and rocker arm shaft, and between the bracket and the rocker arm shaft; these should be 0.016 to 0 052 and 0 to 0.061 mm respectively, replace any parts causing greater coupling clearances than the specified figures

Check the plugs fitted at the end of each shaft for perfect seal

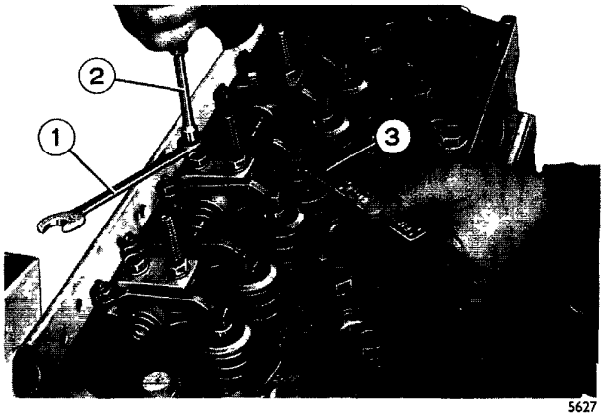
FIGURE 104



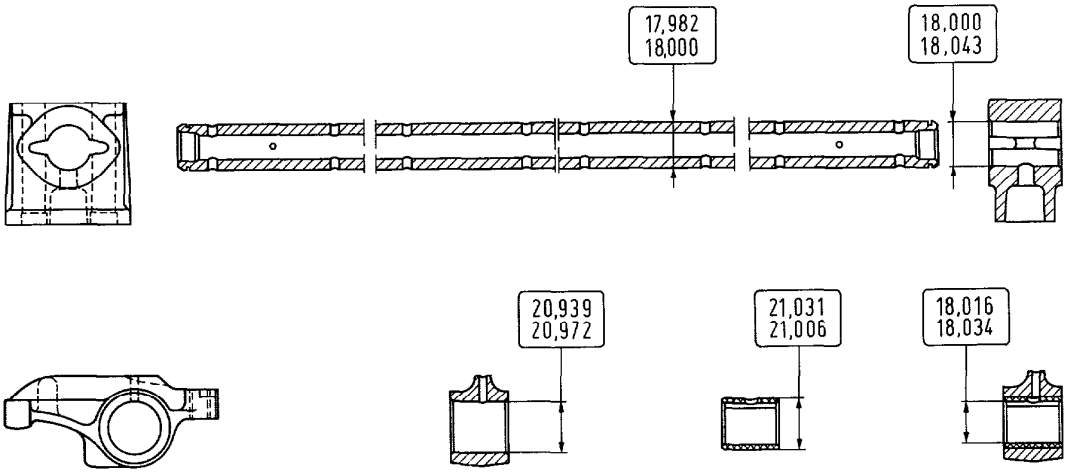
Fitting rocker arm bush (2) using drift (1).

When fitting new bushes, make sure they do not project beyond the sides of the rocker arms

FIGURE 106

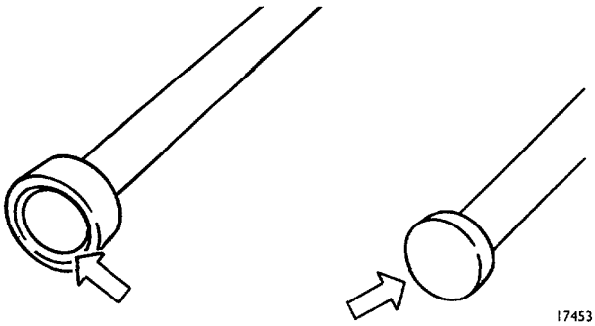


Adjusting clearance between rocker arms and valves using spanner 99350108 (2), box wrench (1) and feeler gauge (3).
Clearance between rockers and valves should be carried out extremely carefully, to avoid altering the specified timing diagram, as would be the case if the clearance were greater or less than the specified figure Working clearance is 0 30 ±0 05 mm for intake and for exhaust Place the cylinder on which clearance is to be adjusted on the firing stroke; the valves of this cylinder will be closed when those of the symmetrical cylinder are in balance condition.



DETAILS OF BRACKET, ROCKER ARM SHAFT, ROCKER ARMS AND ASSOCIATED BUSHES

FIGURE 107

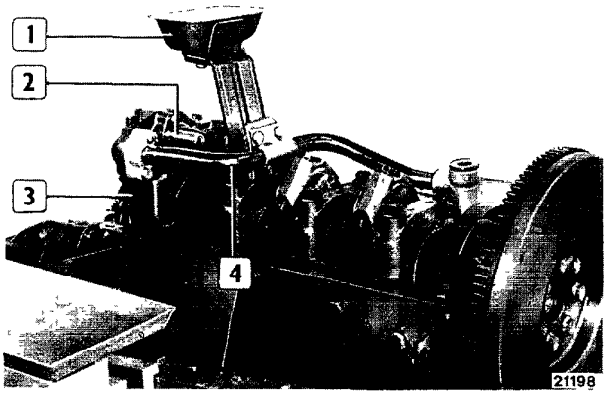


17453

The rocker arm pushrods should show no deformation; the spherical seats in contact with the rocker arm adjusting screw and the tappet (see arrows) should show no signs of pick-up or wear; if so, replace them The intake and exhaust valve pushrods are identical and therefore interchangeable

LUBRICATION

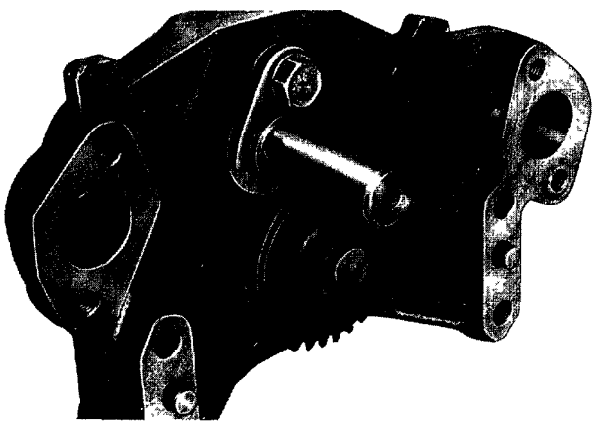
FIGURE 108



LUBRICATION SYSTEM COMPONENTS

1 Oil suction scoop - 2 Pressure relief valve - 3 Oil pump - 4 Delivery line

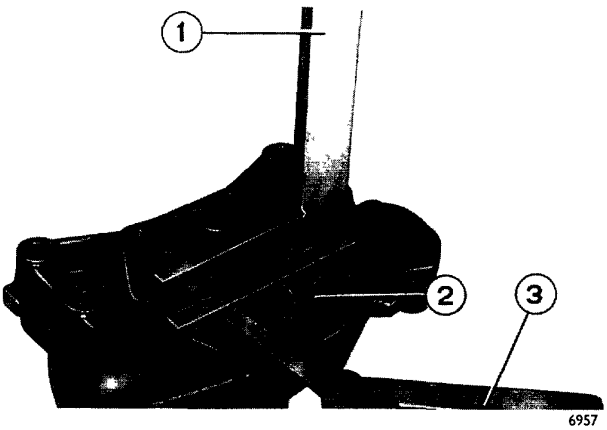
FIGURE 109



6956

Oil pump complete with pressure relief valve

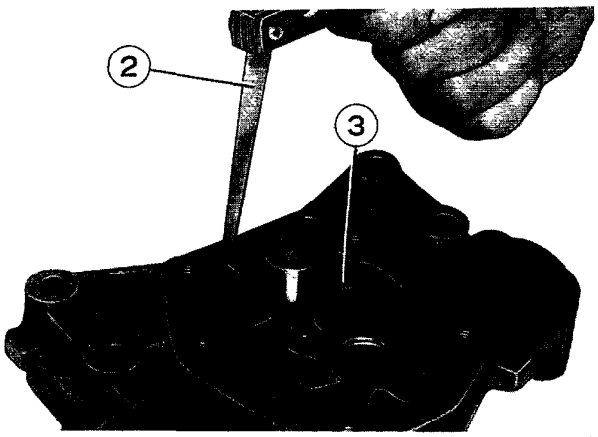
FIGURE 110



6957

When carrying out overhaul, check with a square (1) and feeler (3) that play between the gears (2) and the pump cover contact surface is between 0 016 and 0.107 mm and not over 0 15 mm

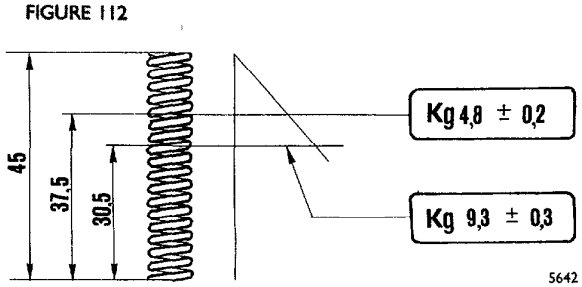
FIGURE 111



6959

With a feeler, check the clearance between the gears (3) and their housings, which should be 0 030 to 0 134 mm, if not, change worn parts

FIGURE 112

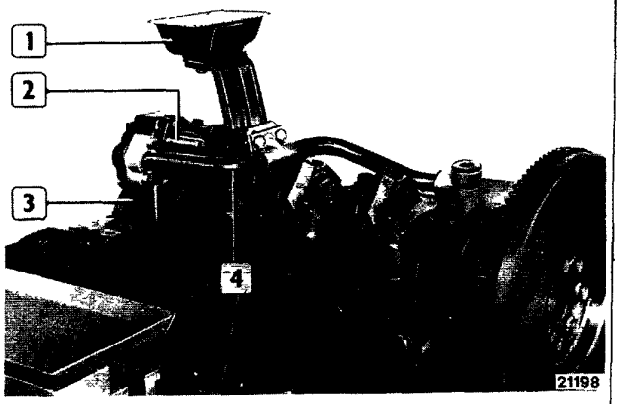


5642

DETAILS FOR CHECKING RELIEF VALVE SPRING

LUBRICATION

FIGURA 108



LUBRICATION SYSTEM COMPONENTS

1 Oil suction scoop - 2 Pressure relief valve - 3 Oil pump - 4 Delivery line

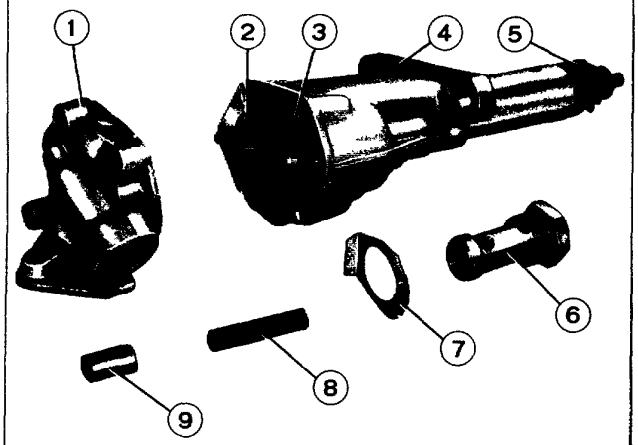


Fig. 58 - Oil pump components

1 Pump body cover - 2. Gear - 3 Gear - 4 Pump body - 5 Pump drive gear - 6 Oil pressure valve body - 7 Retainer - 8 Valve spring - 9 Valve

Oil pump and relief valve inspection

In the course of pump overhaul check clearance between gears (2-3) and pump cover face, correct clearance is 025 to 126 mm, maximum permissible clearance being 15 to 20 mm

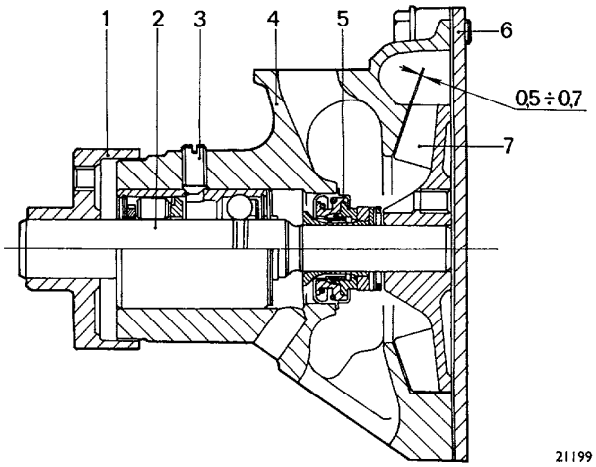
The drive gear (5) is pinned to the oil pump shaft, the pin being staked

Also check clearance between shaft and lower bushing, which should be 16 to 35 mm, and between pump body outer sleeve and bearing in engine block This is necessary because oil pressure has direct access to these parts.

Check that the valve (9,) moves freely in its housing and that it is free from signs of pick-up and score marks Furthermore, using tool . check control spring (8) calibration data.

Valves open at a pressure of 4 8 kg.

Water pump



CROSS-SECTION OF WATER PUMP

1 Hub - 2 Shaft with bearing - 3 Screw - 4 Pump body - 5 Seal - 6 Cover - 7 Rotor

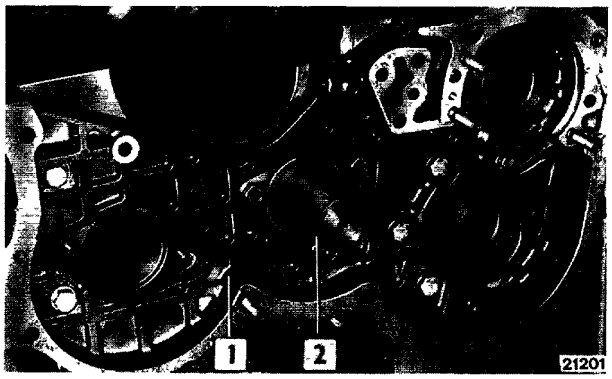
The water pump is of the centrifugal vaned type. The pump bearing is intergrally cast with the rotor shaft and is boxed at the ends
Water seal between the pump body (4) and the shaft (2) is by means of the seal (5)
The seal is fitted in the water pump body (4) so that water cannot leak between the outer surface of the seal and the pump body
The seal fitted in the housing provided for it in the rotor complements the effect of seal (5)
The bearing stop screw (3) must be fixed in its housing with "LOCTITE 242" sealing compound

NOTE - The rotor and fan pulley hub (7 and 1) are fitted on the bearing shaft without retaining pins

When assembling the pump, make sure the rotor (7) is flush with the end of the shaft (2)

ASSEMBLING THE ENGINE

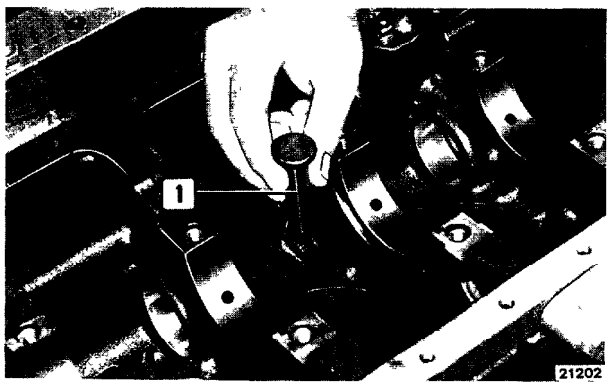
FIGURE 114



Fix the engine block to the revolving overhaul stand no 99322205 by means of brackets 99361033
Fit the camshaft bushes as per the instructions.

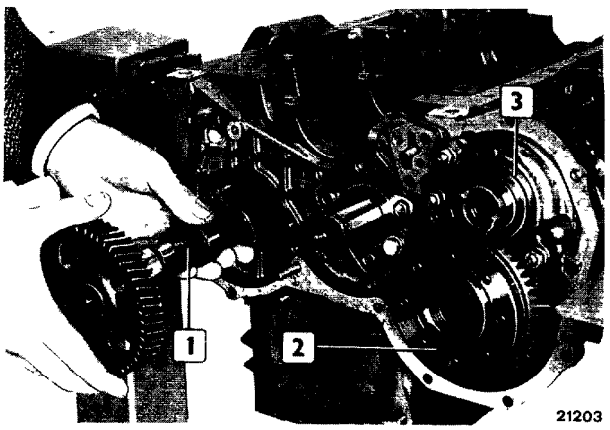
Fix the timing gear (1); fit the pin (2) for the idler gear

FIGURE 115



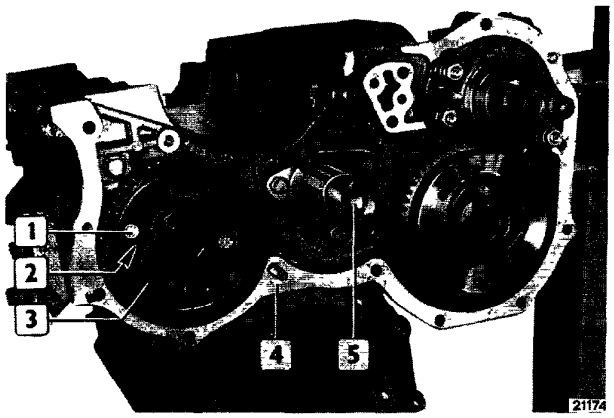
Lubricate the tappets (1) and fit them in their seats on the engine block

FIGURE 116



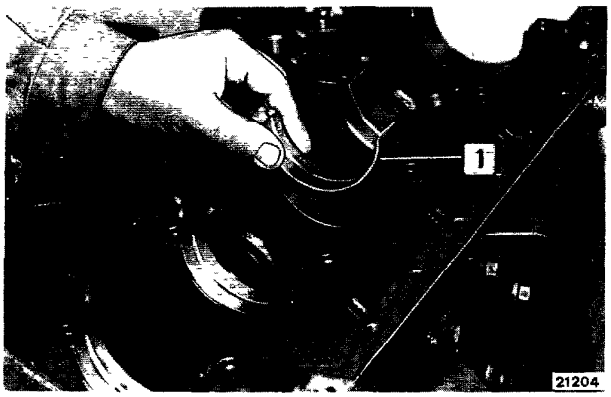
Fit the vacuum pump drive gear (3), the injection pump drive gear (2); lubricate the camshaft supports (1) and insert the camshaft in the engine block

FIGURE 117



Tighten the screws (1) fixing the plate holding the camshaft on the engine block through the holes (2) in the gear (3)

FIGURE 118

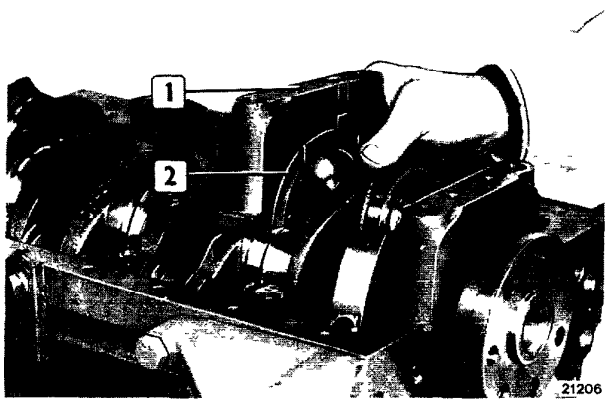


Arrange the half-bearings (1) on the main journal supports, lift the crankshaft with a hoist and cable and gently lower it onto the support half-bearings

FIGURE 119

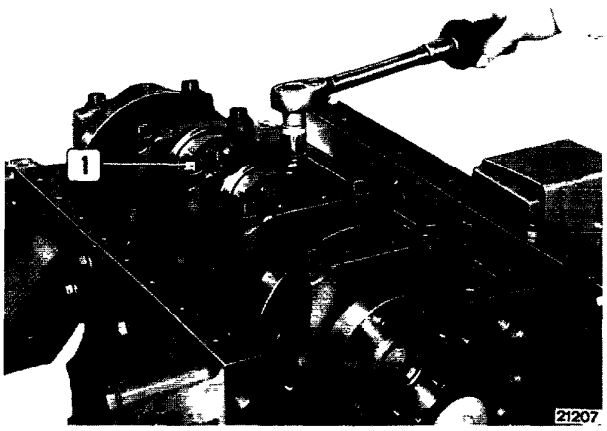
Fit the thrust rings (1) on the last support with the surface covered with anti-friction alloy turned towards the crankshaft.

FIGURE 120



Fit the main journal caps and the half-bearings, before fitting the caps (1), place the thrust washers (2) with the anti-friction alloy coated surface turned towards the crankshaft

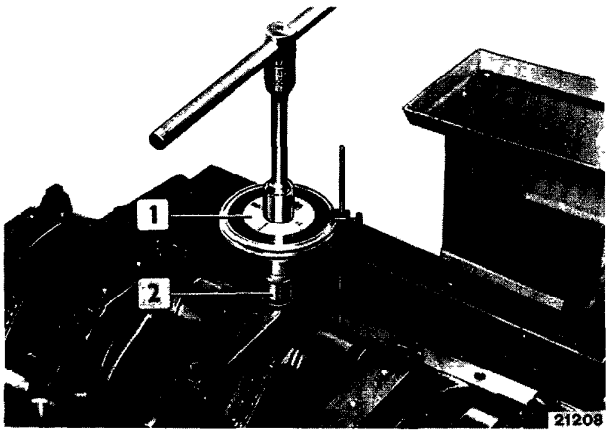
FIGURE 121



Lubricate the fixing screws (1) and tighten them with a torque wrench to 80 Nm torque

NOTE - Before reusing the main journal cap fixing screws, measure the thread diameter 40 to 60 mm from the start of the screw, this should not be less than 13 5 mm; otherwise, change the screws

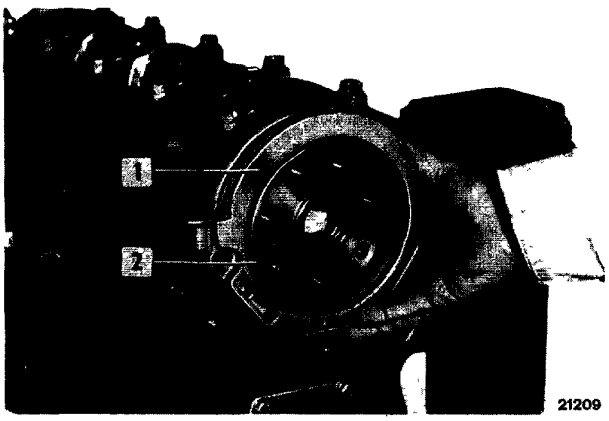
FIGURE 122



Fit tool (1) on the angle wrench (2) and tighten the screws a further 90°.

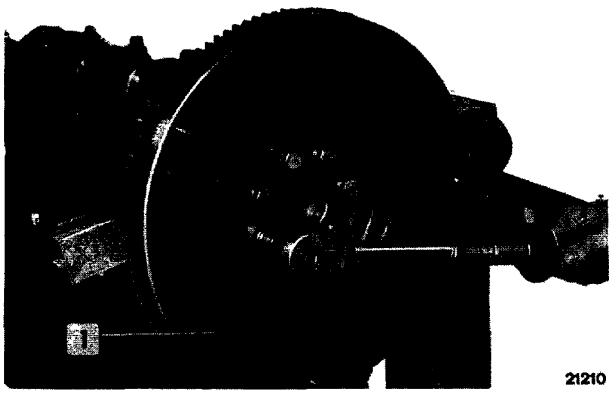
Check the coupling play between the main bearings and the crankpins as instructed
Check the crankshaft end float as described

FIGURE 123



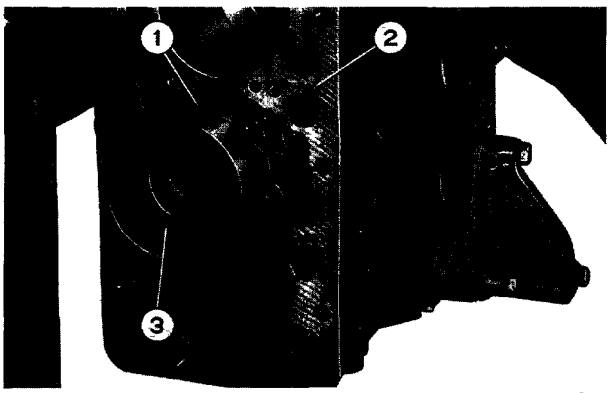
Fit the rear cover (1) complete with oil seal (2) on the engine block, to fit the seal use plate 99360454

FIGURE 124



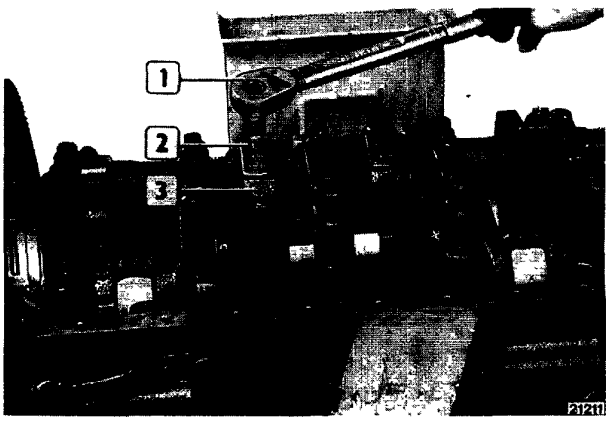
Fit the engine flywheel (1) according to the instructions in the relative

FIGURE 125



Turn the engine round, placing it on the vertical With expander 99360605 (1) fit the piston/connecting rod assemblies (3) in the cylinder liners, as instructed.

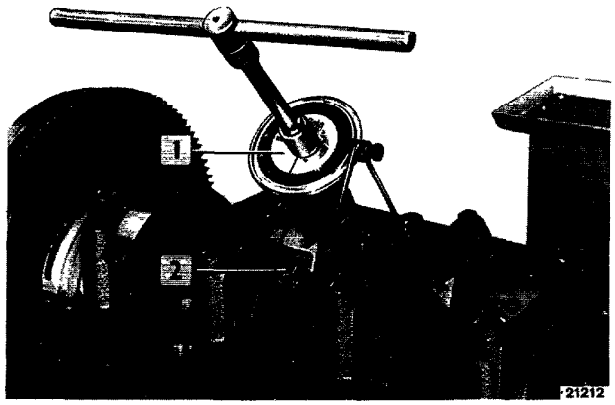
FIGURE 126



Fit the connecting rod caps (2) complete with the half-bearings; turn the engine round, so that the shaft is pointing upwards; with a torque wrench (1), tighten the screws (3) to a torque of 40 Nm; lubricate the screws first.

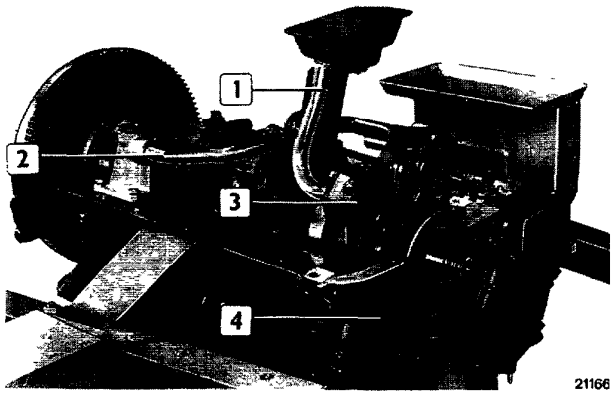
NOTE - Before reusing the connecting rod cap fixing screws, measure the diameter of the thread 19 to 35 mm from the start of the screw; this should not be less than 10 6 mm, otherwise, use new screws

FIGURE 127



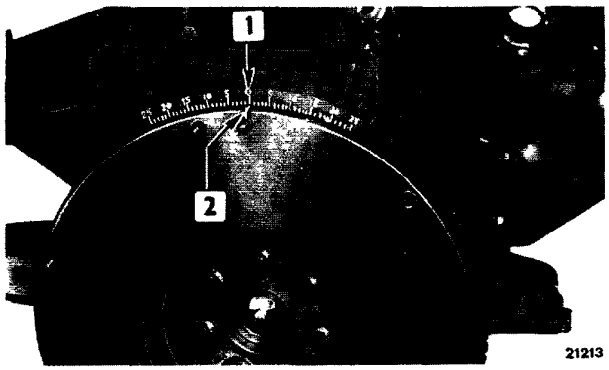
Fit the tool (1) on the angle wrench and tighten the screws (2) a further 60°
Check that it is possible to move the connecting rods axially on the crankpins.

FIGURE 128



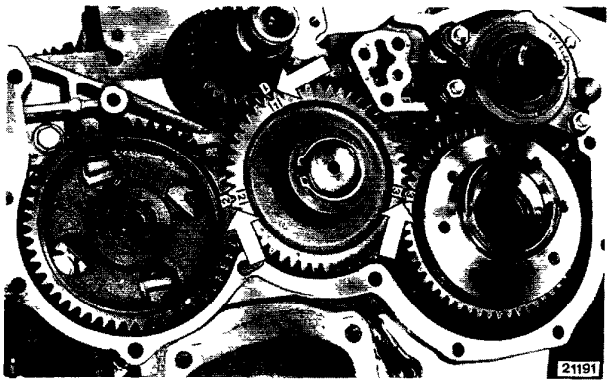
Fit the oil pump (3); fit the speedometer gear mounting and intake and delivery pipes (1 and 2).

FIGURE 129



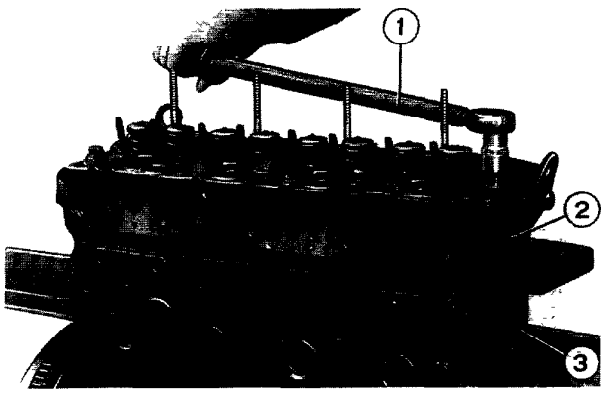
Turn the engine round and bring cylinder no 1 to TDC in the compression phase, this position is obtained when the notch (2) on the flywheel matches up to the 0 (1) on the graduated sector

FIGURE 130



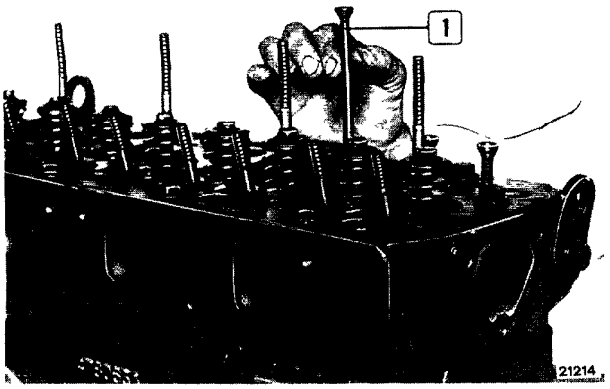
Fit the idler gear, turning it so that the marks 1, 2 and 3 (see arrows) stamped on it match up with the marks cut in the drive gear, the marks on the camshaft driven gear and the injection pump drive gear

FIGURE 131



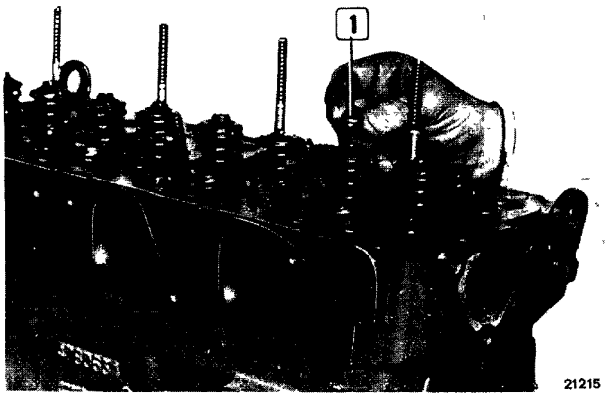
Turn the engine to the normal position. Fit the gasket, fit the cylinder head, then tighten the screws as instructed.

FIGURE 132



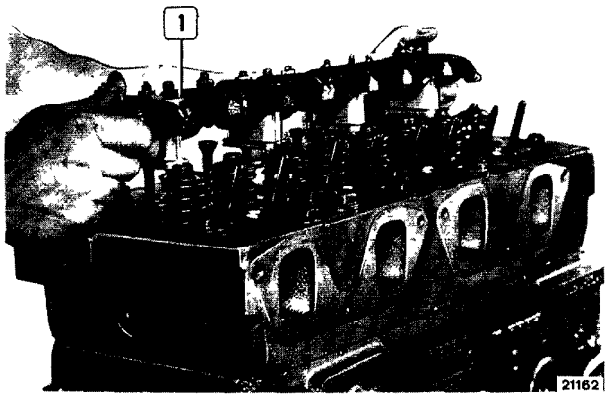
Fit the rocker arm pushrods (1) in their seats

FIGURE 133



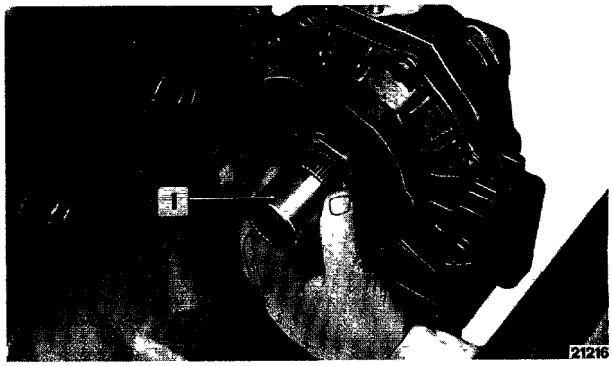
Fit the caps (1) on the valve stems

FIGURE 134



Fit the rocker arm shaft complete (1)
Adjust working play between valves and rocker arms as instructed.

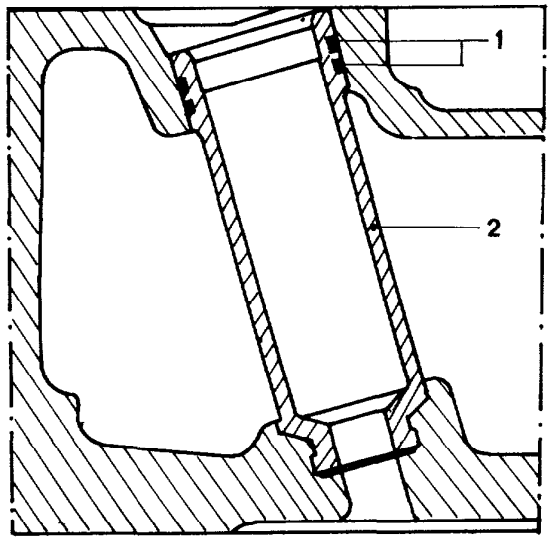
FIGURE 135



Fit the coupling union (1), remembering that the mesh is located by a double tooth and a double cavity

INJECTOR HOLDER CASE

FIGURE 146



If the engine shows loss of compression, especially around the injector seats, the fault is due to incorrect coupling between the injector carrier and the case force fitted in the cylinder head, or between the case and the cylinder head
This can be rectified by regrinding the seat at the end of the case or by replacing the case (2)

Fit the new case as follows
- fit the seal on the new case (1)
- fit the new case with a suitable driver tool,
- using the suitable tool cold head the lower part of the case;
- regrind the seat of the case with a suitable grinder tool, making sure that the nozzle standout from the lower face of the cylinder head is 0.05 to 0 7 mm

ADJUSTING TENSION OF ALTERNATOR AND WATER PUMP DRIVE BELT

Tighten the belt as follows
- back off the nuts of the hinge pin of the alternator,
- back off nut fastening the alternator to the tensioner;
- move the alternator towards the outside and fully tighten the nuts; normal belt tension should be 1 to 1.5 cm with a pressure of 12 kg

Do not overtighten to avoid abnormal stress to the bearings
Belt tightness should be checked regularly

CYLINDER GROUP

The following section describes the points on which engines "SI.. differ from the previously described engine "I..".

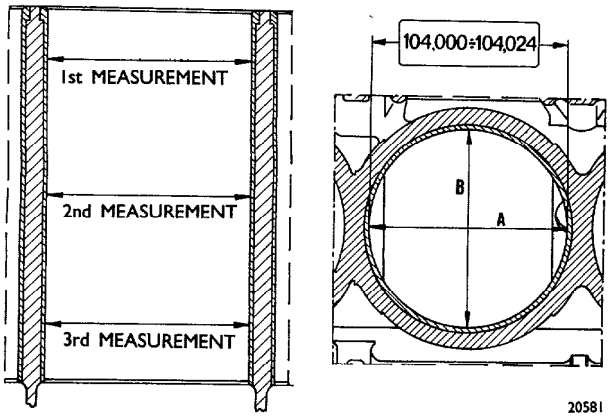
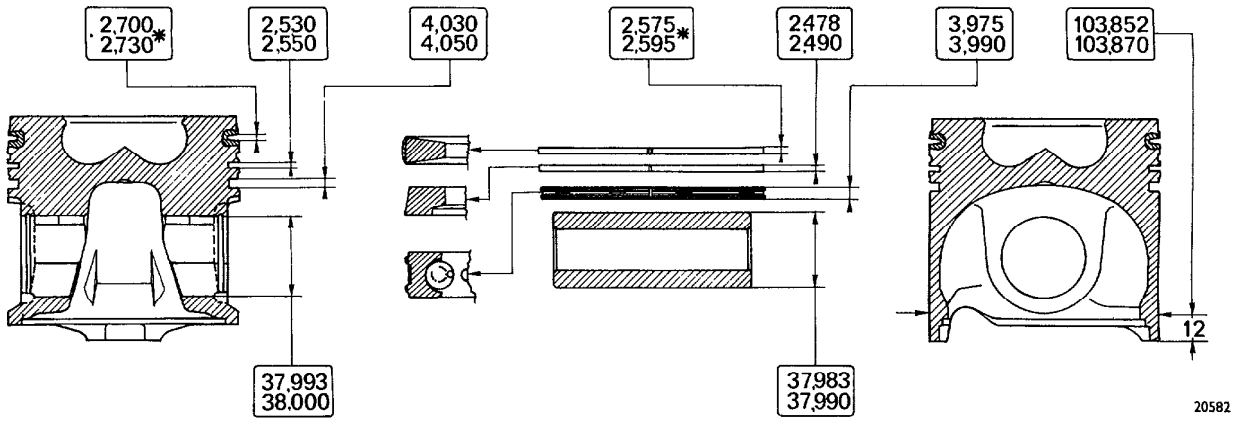


DIAGRAM FOR CHECKING DIAMETER OF CYLINDER LINERS

PISTON AND CONNECTING ROD ASSEMBLY

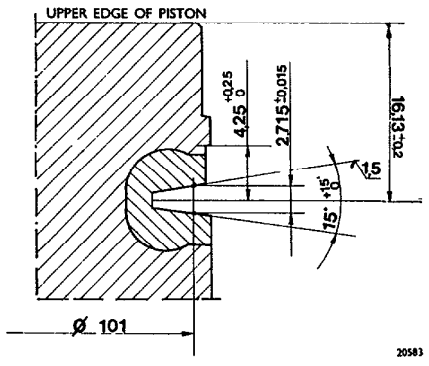
The following section describes the points on which engines "SI.. differ from the previously described engine "I.."

FIGURE 12



MAIN DATA REGARDING PISTON, PISTON RINGS AND PIN

* Measurements were taken on a diameter of 101 mm



DETAIL OF THE FIRST TAPERED GROOVE FOR THE COMPRESSION RING

FITTING CYLINDER LINERS

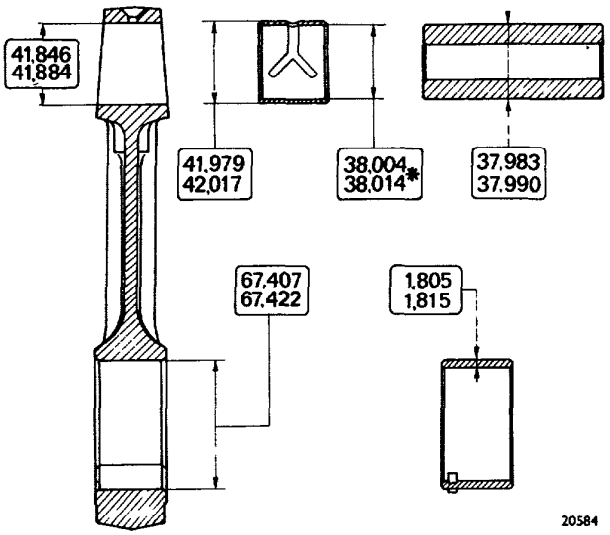
When fitting the cylinder liners in their seats on the engine block – using a press – pay attention to the following

- check that the outside diameter of the liners is mm 106.970 to 106.940 and that the internal diameter of their seats on the engine block is 106.850 to 106 900 mm,
- lightly smear contact surfaces with engine oil;
- set the liner in its seat on the engine block and start press-fitting;
- after pressing in 70 to 90 mm check that the load is over 5,000 N and below 23,000 N;
- continue fitting and check 10 mm before completion that the load is between 10,000 and 40,000 N;
- on completion of fitting, consolidate for 2" with a bedding load over 50,000 N;
- make sure edge of engine block contact with a bedding blow

If the press-fitting load is not within the above limits, remove the cylinder liner and replace it with another. After press-fitting, the cylinder liners must be reamed out and ground.

CONNECTING RODS

The following section describes the points on which engines "SI.. differ from the previously described engine "I..".



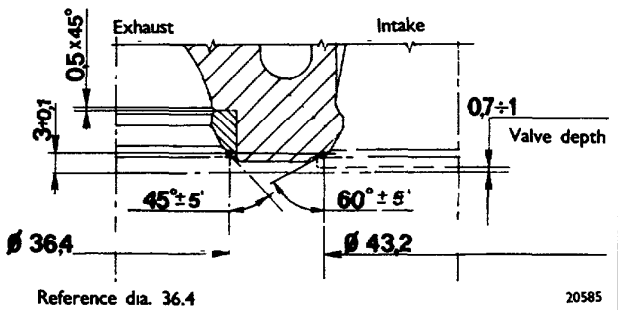
MAIN DATA REGARDING THE CONNECTING ROD, THE PIN BUSH AND THE HALF BEARINGS

* Measurements to be obtained after fitting the bush

NOTE - After fitting the bush in the small end remove the part protruding from the side and then skim the bush to obtain the prescribed diameter

CYLINDER HEAD

The following section describes the points on which engines "SI.. differ from the previously described engine "I..".



MAIN DETAILS OF INTAKE AND EXHAUST VALVE SEATS

TORQUE LOADS

COMPONENT		TORQUE Nm (kgm) min.	max.
Cylinder head capscrew	stage 1: pretightening	70 (7,1)	
	stage 2. pretightening	70 (7,1)	
	stage 3: angle	90°	
	stage 4: angle	90°	
Capscrew, main bearing caps	pretightening	80 (8 2)	
	angle	90°	
Capscrew, connecting rod caps	pretightening	40 (4.1)	
	angle	60°	
Flywheel fixing screw	pretightening	40 (4.1)	
	angle	60°	

SPECIAL TOOL

TOOL NO	DESCRIPTION
99315066	Support frame for removed engine
99340033	Flywheel hub remover
99340035	Remover for pulley hub and water pump impeller
99340205	Sliding hammer
99340214	Tool part for removing clutch shaft guide bearing (for use with 99340205)
99342145	Injector case extractor
99350108	Spanner for rocker arm tappet play adjusting screw
99357051	Spanner for oil pipe plugs in engine block
99360183	Pliers for assembling rings on the piston
99360288	Driver for removing valve guide
99360314	Tool for removing filter cartridges.
99360352	Flywheel restrainer
99360357	Engine valve remover/installer.
99360360	Installer for crankshaft front seal (use with 99370007)
99360454	Installer for crankshaft rear seal (for use with 99370006)
99360458	Drift for fitting sealing gasket for water pump drive
99360467	Test connection for cylinder pressure (for use with 99395682)
99360511	Ring-bolt for lifting and transporting cylinder group
99360605	Tube for inserting pistons in cylinders
99361033	Brackets for fixing engine to revolving stand
99365063	Injector case header tool
99370006	Interchangeable hand-grip for drifts.
99370007	Interchangeable hand-grip for drifts
99386008	Drift for fitting crankshaft core plugs
99390310	Valve guide hole reamer
99390425	Set of screw-taps for threading injector holder cases for removal
99394017	Reamer for reboring the lower part of the injector holder case (use with 99394079)
99394018	Cutter for regrinding injector seat (use with 99394019)
99394019	Guide bush
99395617	Graduated sector for checking engine timing on bench
99395682	Drive cylinder compression tester (for use with 99360647)

SPECIAL TOOLS

TOOL NO.	DESCRIPTION
ENGINE	
99315066	Frame for holding the removed engine
99340033	Flywheel hub remover
99340035	Water pump rotor and hub pulley remover
99340205	Sliding hammer
99342145	Injector case remover
99350108	Rocker arm clearance adjusting screw spanner
99357051	Engine block oil pipe plugs spanner
99360183	Pliers for piston rings assembly on pistons
99360288	Valve guide remover
99360293	Valve guide assembler (use with 99360288)
99360314	Filter cartridge remover
99360352	Flywheel restrainer
99360357	Valve installer/remover
99360349	Crankshaft front seal installer (use with 99370007)
99360365	Crankshaft rear seal installer (use with 99370006)
99360458	Water pump impeller seal installer
99360467	Cylinder compression test union (use with 99395682)
99360500	Sling for lifting crankshaft
99360511	Lug for lifting/transporting cylinder group (order n 2 parts)
99360595	Sling for removing/refitting engine
99360605	Tube for introducing pistons into cylinders (normal and oversized)
99361033	Brackets for fixing engine to revolving stand.
99365063	Spreader tool for injector cases
99370006	Interchangeable hand-grip for drivers
99370007	Interchangeable hand-grip for drivers
99386008	Driver for fitting crankshaft core plugs
99390310	Valve guide hole reamer
99390425	Set of screw taps for threading injector cases for removal
99394017	Reamer for injector housings (use with 99394019)
99394018	Cutter for grinding injector housing seat (use with 99394019)
99394019	Guide sleeve
99395616	Graduated sector for engine timing bench test