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ENGINE

8045.25...

**Service
manual**

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ENGINE 8045.25...

SERVICE MANUAL

Print No. 604.06.494 - English

NOTICE

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IMPORTANT

This Manual applies to all the engines in the 8045.25 Class. Components specific to single Versions are covered in the individual Manuals of the machines equipped with these engines. Part numbers for specific tool orders are listed in Section "SERVICE TOOLS".

For the fuel injection equipment refer to the following publications:

- CAV Fuel Injection Pumps Service Manual - Print No. 604.06.484.
- Fuel Injection Equipment Calibration Data - Print No. 604.07.047.

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SAFETY RULES

GENERAL

Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling, or servicing machine.

Read and heed all machine-mounted safety signs before starting, operating, maintaining, fueling or servicing machine.

Machine-mounted safety signs have been color coded yellow with black borders and lettering for warning and red with white borders and lettering for danger points.

Do not allow unauthorized personnel to service or maintain this machine. Do not perform any work on equipment that is not authorized. Follow the Maintenance and Service procedures. Study the Operation and Maintenance Instruction Manual before starting, operating, maintaining, fueling or servicing this machine.

Always wear safety glasses with side shields.

Do not wear rings, wrist watches, jewelry, or loose or hanging apparel, such as ties, torn clothing, scarves, unbuttoned or unzipped jackets that can catch on moving parts. Wear proper safety equipment as authorized for the job. Examples: hard hats, safety shoes, heavy gloves, ear protectors, safety glasses or goggles, reflector vests, or respirators. Consult your employer for specific safety equipment requirements.

Do not use controls or hoses as handholds when climbing on or off machine. Hoses and controls are movable and do not provide a solid support. Controls may also be inadvertently moved causing accidental machine or equipment movement.

Do not jump on or off machine. Keep two hands and one foot, or two feet and one hand, in contact with steps and grab-rails and handles at all times.

Machine should not be serviced with anyone in the operator's seat unless they are qualified to operate the machine and are assisting in the servicing.

Keep operator's compartment, stepping points, grab-rails and handles clean of foreign objects, oil, grease, mud or snow accumulation to minimize the danger of slipping or stumbling. Clean mud or grease from shoes before attempting to mount or operate the machine.

Never attempt to operate the machine or its tools from any other position than seated in the operator's seat.

Keep operator's compartment clear of loose objects.

If movement of an attachment by means of the machine's hydraulic system is required for service or maintenance, do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachment or tool, make sure to set brakes, sound horn and call for an all clear. Raise attachment slowly.

Always block with external support any linkage or part on machine that requires work under the raised linkage, parts, or machine according to local or national requirements. Never allow anyone to walk under or be near unblocked raised equipment. Avoid working or walking under raised blocked equipment unless you are assured of your safety.

Never place head, body, limbs, fingers, feet or hands into an exposed portion between uncontrolled or unguarded

scissor points of machine without first providing secure blocking.

Never lubricate, service or adjust a machine with the engine running, except as called for in the Operation and Maintenance Instruction Manuals. Do not wear loose clothing or jewelry near moving parts.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets local or national requirements to reach the service point. If such ladders or platforms are not available, use the machine handholds and steps as provided. Perform all service or maintenance carefully.

Shop or field service platforms and ladders used to maintain or service machinery should be constructed and maintained according to local or national requirements.

Disconnect batteries and TAG all controls according to local or national requirements to warn that work is in progress. Block the machine and all attachments that must be raised according to local or national requirements.

Never check or fill fuel tanks, storage batteries or use starter fluid near lighted smoking materials or open flame due to the presence of flammable fluid.

Brakes are inoperative when manually released for servicing. Provision must be made to maintain control of the machine by blocking or other means.

Always place the fuel nozzle against the side of the filler opening before starting and during fuel flow. To reduce the chance of a static electricity spark, keep contact until after fuel flow is shut off.

Use only designated towing or pulling attachment points. Use care in making attachment. Be sure pins and locks as provided are secure before pulling. Stay clear of drawbars, cables or chains under load.

To move a disabled machine, use a trailer or low boy truck if available. If towing is necessary, provide warning signals as required by local rules and regulations and follow operation and maintenance instruction manual recommendations. Load and unload on a level area that gives full support to the trailer wheels. Use ramps of adequate strength, low angle and proper height. Keep trailer bed clean of clay, oil and all materials that become slippery. Tie machine down securely to truck or trailer bed and block tracks (or wheels) as required by the carrier.

Never align holes with fingers or hands. Use the proper aligning tool.

Remove sharp edges and burrs from reworked parts.

Use only grounded auxiliary power source for heaters, chargers, pumps and similar equipment to reduce the hazards of electrical shock.

Lift and handle all heavy parts with a lifting device of proper capacity. Be sure parts are supported by proper slings and hooks. Use lifting eyes if provided. Watch out for people in the vicinity.

Never place gasoline or diesel fuel in an open pan.

Never use gasoline or solvent or other flammable fluid to clean parts. Use authorized commercial, non-flammable, non-toxic solvents.

When using compressed air for cleaning parts use safety

Safety Rules

GENERAL (Continued)

glasses with side shields or goggles. Limit the pressure to 2.07 bar (30 psi) according to local or national requirements.

Do not smoke or permit any open flame or spark near when refueling, or handling highly flammable materials.

Do not use an open flame as a light source to look for leaks or for inspection anywhere on the machine.

Be sure all mechanic's tools are in good condition. DO NOT use tools with mushroomed heads. Always wear safety glasses with side shields.

Move carefully when under, in or near machine or implements. Wear required protective equipment, such as hard hat, safety glasses, safety shoes, ear protectors.

When making equipment checks that require running of the engine, have an operator in the operator seat at all times with the mechanic in sight. Place the transmission in neutral and set the brakes and lock. Keep hands and clothing away from moving parts. Shut off engine and disengage the Power Take-Off lever before attempting adjustments or service.

Never use the bucket as a man lift.

The articulation point between frames will not clear a person. Stay clear when engine is running. Support, using device provided when servicing. Return support to carry position and secure before moving machine after servicing. See Operation and Maintenance Instruction Manual.

For field service, move machine to level ground if possible and block machine. If work is absolutely necessary on an incline, block machine and its attachments securely. Move the machine to level ground as soon as possible.

Guard against kinking chains or cables. Do not lift or pull through a kinked chain or cable. Always wear heavy gloves when handling chain or cable.

Be sure cables are anchored and the anchor point is strong enough to handle the expected load. Keep exposed personnel clear of anchor point and cable or chain. **DO NOT PULL OR TOW UNLESS OPERATOR'S COMPARTMENTS OF MACHINES INVOLVED ARE PROPERLY GUARDED** against accidental cable or chain backlash.

Keep maintenance area CLEAN and DRY. Remove water or oil slicks immediately.

DO NOT pile oily, greasy rags — they are a fire hazard. Store in a closed metal container.

Before starting machine or moving attachment check and adjust and lock operator's seat. Be sure all personnel in the area are clear before starting or moving machine and any of its attachments. Sound horn.

Rust inhibitors are volatile and flammable. Prepare parts in well-ventilated place. Keep open flame away — DO NOT SMOKE. Store container in a cool well-ventilated place secured against unauthorized personnel.

Do not carry loose objects in pockets that might fall unnoticed into open compartments.

Keep clutches and brakes on machine and attachments such as Power Control Units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturer at all times. DO NOT ad-

just machine with engine running except as specified.

Wear proper protective equipment such as safety goggles or safety glasses with side shields, hard hat, safety shoes, heavy gloves when metal or other particles are apt to fly or fall.

Wear welder's protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding. Wear dark safety glasses near welding. **DO NOT LOOK AT ARC WITHOUT PROPER EYE PROTECTION.**

Know your jacking equipment and its capacity. Be sure the jacking point used on the machine is appropriate for the load to be applied. Be sure the support for the jack at the machine and under the jack is appropriate and stable. Any equipment up on a jack is dangerous. Transfer load to appropriate blocking as a safety measure before proceeding with service or maintenance work according to local or national requirements.

Wire rope develops steel slivers. Use authorized protective equipment such as heavy gloves, safety glasses when handling.

Handle all parts with extreme care. Keep hands and fingers from between parts. Wear authorized protective equipment such as safety glasses, heavy gloves, safety shoes.

Inspect your seat belt at least twice a year for signs of fraying, wear, or other weakness that could lead to failure.

Where it is necessary to use diesel fuel as a lubricant make sure all smoking material and open flames are extinguished or that no sparks are near. Place all parts in a closed container of clear diesel fuel for use as needed.

To minimize dangers of fire and explosion, it is recommended that before any welding is done on a fuel tank, the tank be completely drained of fuel, fuel lines disconnected and the ends closed to protect them, and the tank be steam cleaned. All traces of fuel must be removed before welding is started. Flood the tank with carbon dioxide (CO₂) before and during welding. Caps must be removed and vents and other openings left open during welding.

Dry ice (solid carbon dioxide) is extremely cold and will freeze flesh on contact. Use care to prevent contact with skin, eyes, or other parts of the body to avoid personal injury.

When work is required under or between components, block with an external support capable of holding the components in place according to local or national requirements.

START UP

Do not run the engine of this machine in closed areas without proper ventilation to remove deadly exhaust gases.

Do not place head, body, limbs, feet, fingers, or hands near a rotating fan or belts. Be especially alert around a pusher fan.

STARTING FLUID IS FLAMMABLE. Follow the recommendations as outlined in the Operation and Maintenance Instruction Manual and as marked on the containers. Store containers in cool, well-ventilated place secure from unauthorized personnel. **DO NOT PUNCTURE OR BURN CONTAINERS.** Follow the recommendation of the manufacturer for storage and disposal.

Safety Rules

ENGINE

Turn radiator cap slowly to relieve pressure before removing. Add coolant only with engine stopped or idling if hot. See Operation and Maintenance Instruction Manual.

Do not run engine when refueling and use care if engine is hot due to the increased possibility of a fire if fuel is spilled.

Never attempt to check or adjust fan belts when engine is running.

Do not adjust engine fuel pump when the machine is in motion.

Never lubricate a machine with the engine running.

Avoid running engine with open unprotected air inlets. If such running is unavoidable for service reasons, place protective screen over all inlet openings before servicing engine.

ELECTRICAL

Be sure to connect the booster cables to the proper terminals (+ to +) and (- to -) at both ends. Avoid shorting clamps. Follow the Operation and Maintenance Instruction Manual procedure.

Always turn the master switch (key switch if so equipped) to the off position when maintaining or servicing machine.

BATTERY GAS IS HIGHLY FLAMMABLE. Leave battery box open to improve ventilation when charging batteries. Never check charge by placing metal objects across the posts. Keep sparks or open flame away from batteries. Do not smoke near battery to guard against the possibility of an accidental explosion.

Check for fuel or battery electrolyte leaks before starting service or maintenance work. Eliminate leaks before proceeding.

Do not charge batteries in a closed area. Provide proper ventilation to guard against an accidental explosion from an accumulation of explosive gases given off in the charging process.

Disconnect batteries before working on electrical system or repair work of any kind.

HYDRAULIC

Fluid escaping under pressure from a very small hole can almost be invisible and can have sufficient force to penetrate the skin. Use a piece of cardboard or wood to search for suspected pressure leaks. **DO NOT USE HANDS.** If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

Shut off engine and be sure all pressure in system has been relieved before removing panels, housings, covers, and caps. See Operation and Maintenance Instruction Manual.

When making pressure checks use the correct gage for expected pressure. See Operation and Maintenance Instruction Manual or Service Manual for Guidance.

ATTACHMENTS

Keep head, body, limbs, feet, hands and fingers away from blade, bucket or ripper when in raised position. Use

authorized blocking as a safety measure before proceeding with service or maintenance according to local or national requirements.

If movement of an attachment by means of the machine's hydraulic system is required for service or maintenance do not raise or lower attachments from any position other than when seated in the operator's seat. Before starting machine or moving attachments or tools, make sure to set brakes, sound horn and call for an all clear. Raise attachment slowly.

Do not use machine to carry loose objects by means other than attachments for carrying such objects.

Never use any gas other than dry nitrogen to charge accumulators. See Operation and Maintenance Instruction Manual.

Keep clutches and brakes on machine and attachments such as power control units, winches and master clutches adjusted according to Operation and Maintenance Instruction Manuals of the manufacturer at all times. **DO NOT** adjust machine with engine running except as specified.

TIRES (APPLICABLE MACHINES)

Be sure tires are properly inflated to the manufacturer's specified pressure. Inspect for damage periodically.

Stand to one side when changing inflation of tires.

Check tires only when the machine is empty and tires are cool to avoid overinflation. Do not use reworked wheel parts. Improper welding, heating or brazing weakens them and can cause failure.

Never cut or weld on the rim of an inflated tire. Inflate a spare tire only enough to keep rim parts in place — a fully inflated tire might fly apart when it is not installed on a machine.

Use care if you must transport (haul) a fully inflated tire.

When servicing tires block the machine in front and back of all wheels. After jacking up, place blocking under machine to protect from falling according to local or national requirements.

Deflate tires before removing objects from the tread.

Never inflate tires with flammable gases. Explosion and personal injury could result.

DESCRIPTION

The 8045.25 is a 4-stroke, direct-injection, turbocharged Diesel-cycle engine.

PISTONS

Cast aluminum alloy pistons with open toroidal combustion chamber in tops and fitted with one wedge section compression ring and two oilscraper rings.

CONNECTING RODS

Of cast iron with rifled small end for lube oil passage.

CRANKSHAFT

Five-bearing, cast iron crankshaft with integral counterweights; induction-hardened crankpins and journals and torsional vibration damper.

CRANKCASE

Cast iron block and replaceable, dry cylinder liners.

CYLINDER LINERS

High phosphor, centrifugally cast and stabilized iron liners.

CYLINDER HEAD

Of cast iron with incorporated, force-fitted valve guides.

VALVE GEAR

Overhead valves, camshaft-operated through tappets, pushrods and rockers; camshaft is located in block and is driven by the crankshaft through timing gears.

FUEL SYSTEM

Fuel transfer pump/injection pump in-line with all-speed governor and automatic advance variator. Fuel delivery rate compensating device based on supercharging pressure.

SUPERCHARGING SYSTEM

By turbocharger.

LUBRICATION SYSTEM

Forced, by crankshaft-driven gear pump. Throw-away cartridge full-flow filter.

COOLING SYSTEM

Coolant circulated by V-belt driven centrifugal pump, thermostat temperature control, horizontal-tube core radiator and heat exchanger (cooler).

STARTING

Electrical by cranking motor.

GENERAL**ENGINE**

Designation code	8045.25
4-stroke,	direct injection Diesel cycle
Number of cylinders	4, in-line
Bore	104 mm
Stroke	115 mm
Total displacement	3908
Compression ratio	16.5 to 1
Compression rating at TDC (*)	over 25 bar
Minimum allowable compression at TDC (*) ... not less than	21 bar
Engine cranking speed	abt.260 RPM

(*) This value is determined by cranking the engine with starter motor only and oil temperature at 40°C to 50°C with injection pump set on stop.

VALVE GEAR

- Intake starts, BTDC 8°
ends, ABDC 23°
- Exhaust starts, BBDC 48°30'
ends, ATDC 6°
- Valve tappet clearance for timing checks 0.45 mm
- Valve tappet clearance for normal operation
 - Intake 0.25 mm
 - Exhaust 0.35 mm

FUEL SYSTEM

Fuel drawn from tank by diaphragm pump. 1 single filter.

DPS fuel injection pump, incorporating an all-speed governor and automatic advance variator; supercharging pressure controlled fuel delivery rate compensator.

Injection pump setting, at beginning of delivery, minimum advance, before TDC in compression: 0° ± 1°

Release order	Injection pump	u-v-w-x
	Engine	1-3-4-2

Release pressure 230 ± 8 bar

SUPERCHARGING

By turbocharger.

LUBRICATION SYSTEM

Forced, by crankshaft-driven gear pump.
Pressure relief valve on oil pump.
1 dual-stage cartridge filter.

Oil pressure rating	idle speed	≤ 0.7 bar
(engine warm)	max governed speed	abt. 6 bar

COOLING SYSTEM

Water circulated by centrifugal pump.
Temperature control thermostat in engine coolant outlet duct.
Radiator/engine cooling fan.
Water/oil heat exchanger.

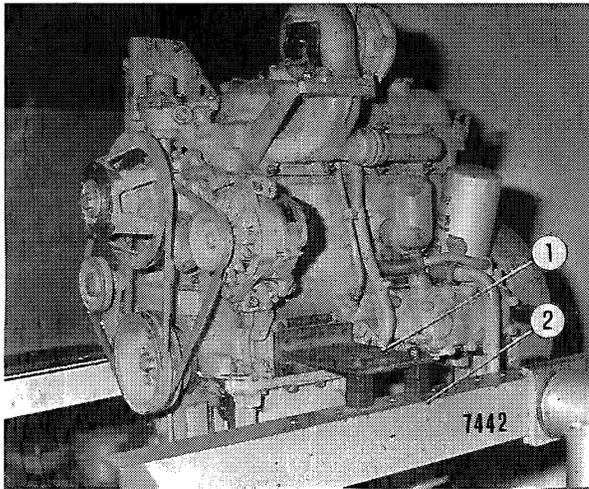
LUBE OIL SUPPLY

Total oil in sump for 1st filling

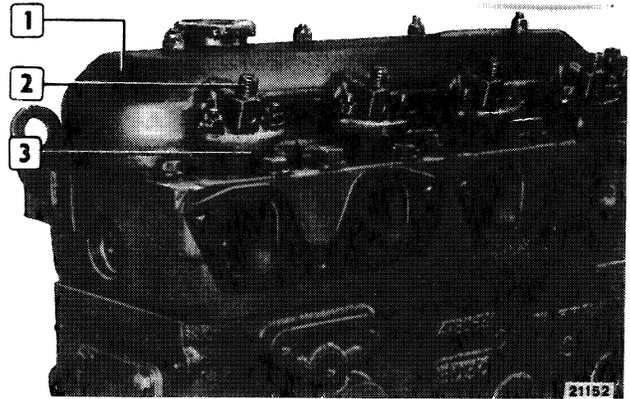
Quantity	
L	Kg
12	11

Grade of oil to be used depends on service temperature as detailed in the Data Table - Operation and Maintenance Instruction Manual.

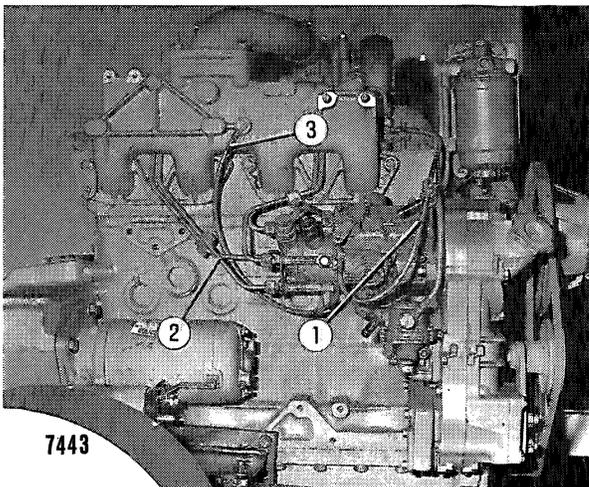
ENGINE DISASSEMBLY



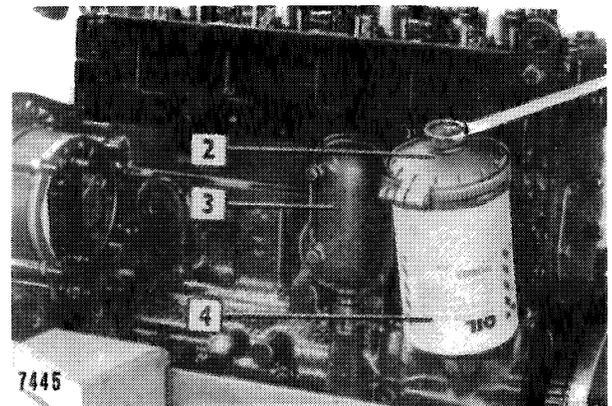
Install brackets 993610335 (1) then the engine on revolving stand 99322205 (2).



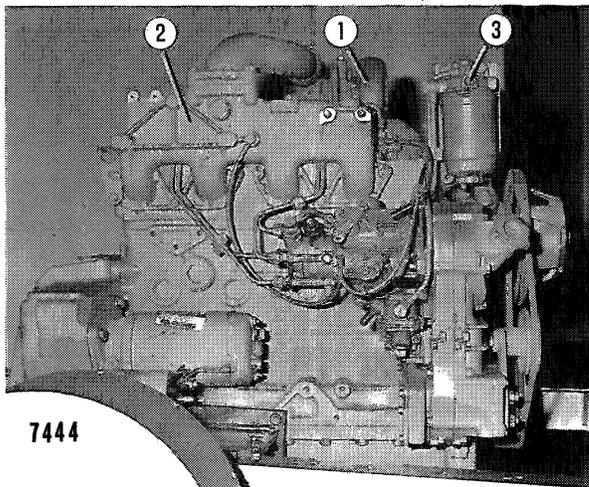
Remove the rocker cover (1), retaining brackets (3) then the injectors (2)



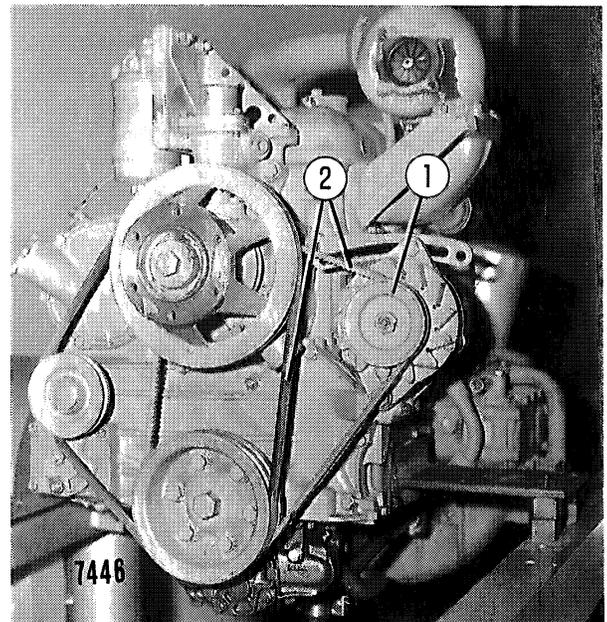
Disconnect the lines for: fuel delivery (2), fuel return (1) and supercharging pressure (3).



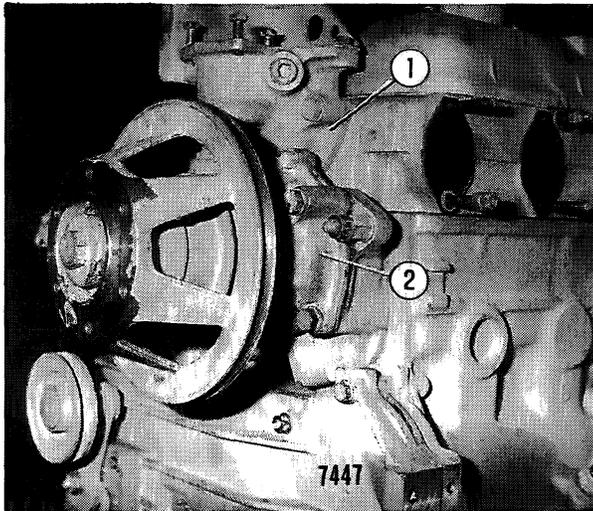
Using special tool 99360314 (2) unscrew oil filter (4) and take off the oil vapor vent (3).



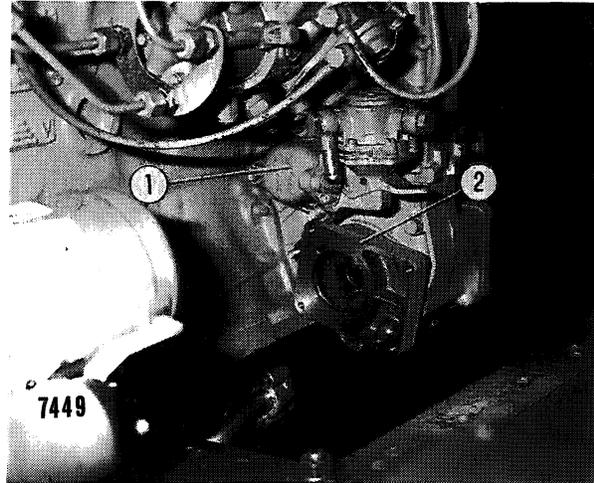
Remove the intake manifold (2), fuel filter (3) and turbocharger (1) complete with exhaust manifold.



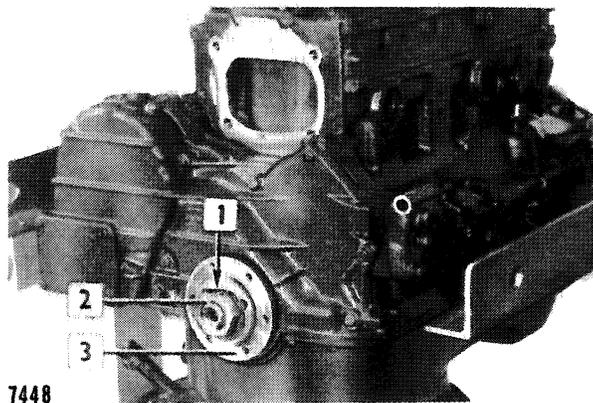
Demount alternator (1) and drive belts (2).



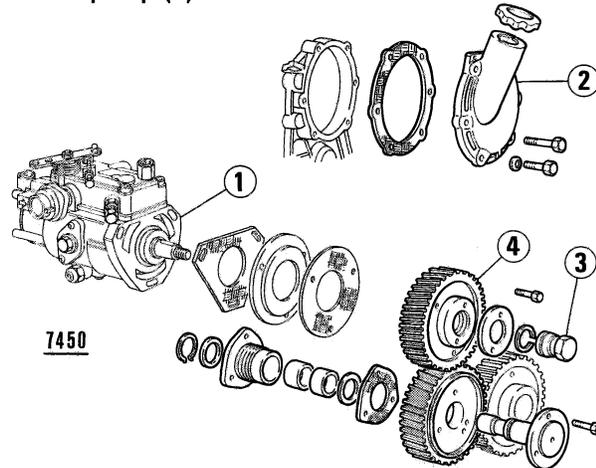
Remove thermostat support (1) and water pump (2).



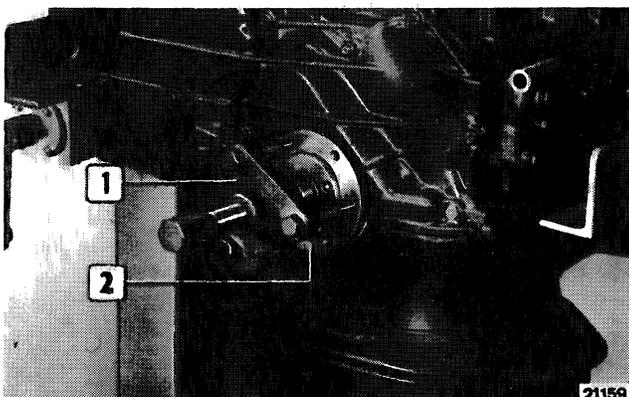
Remove hydraulic pump from support, followed by transfer pump (1).



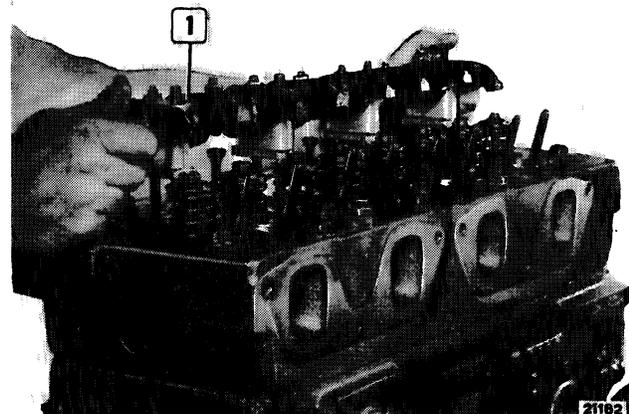
Take off the drive pulley on crankshaft. Lock flywheel in position using special retaining fixture 993600352. Lift the tab of lock plate (1) and with a suitable wrench slacken nut (2) securing the alternator/water pump drive pulley hub (3).



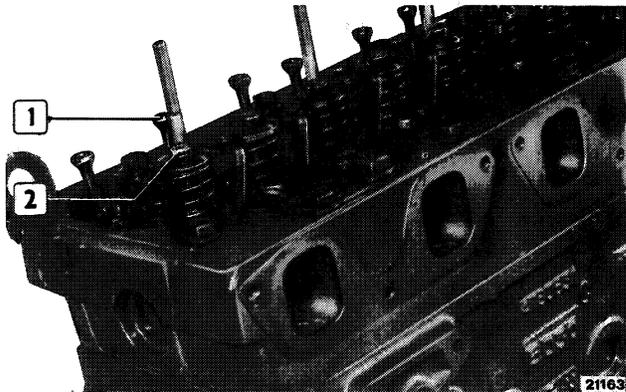
First remove cover (2), backout nut (3) then take down the fuel injection pump (1). The nut serves as puller for drive gear (4).



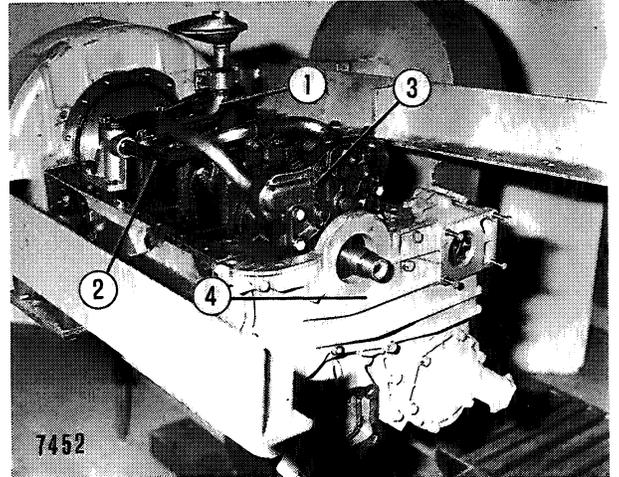
Apply fixture 99340033 (1) and pull out hub (2).



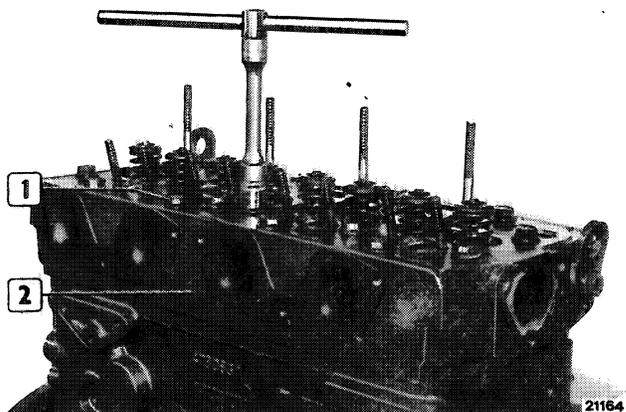
Remove the complete rocker shaft (1).



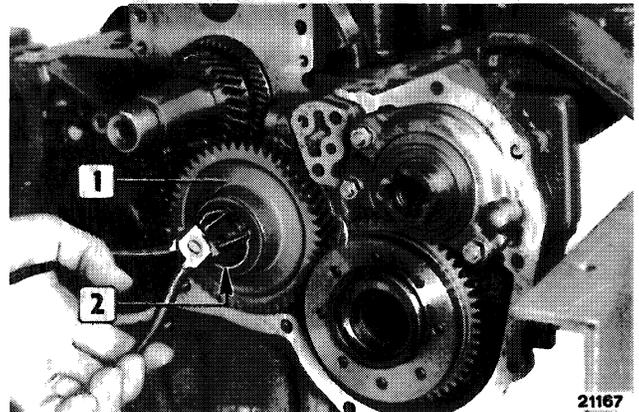
Pickup pushrods (1) and remove tip caps (2) from valve stems.



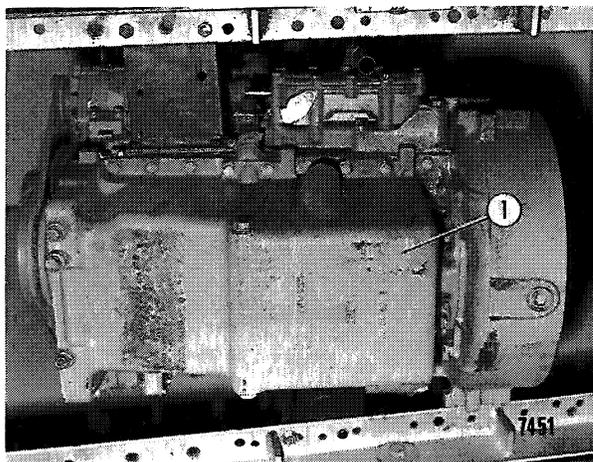
Remove timing gear front cover (4). Take down oil pump (3) and disconnect the inlet and delivery lines (1 and 2).



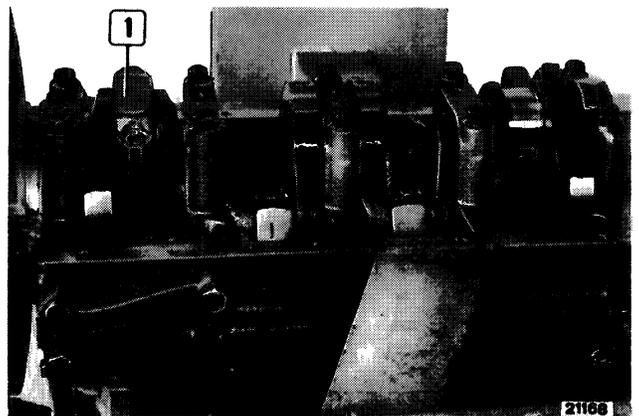
Backout the cylinder head (2) hold-down screws (1) then remove the head and save the gasket.



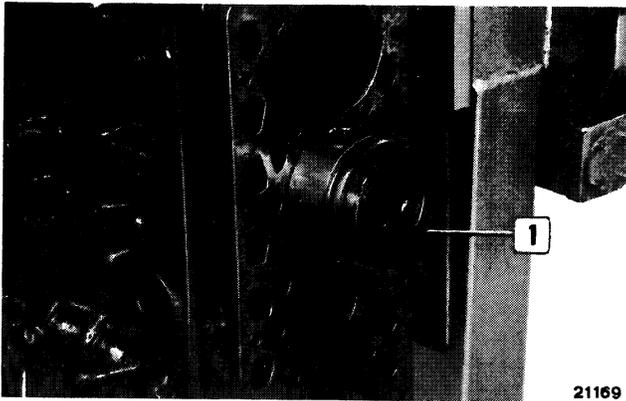
Take out retaining rings (2) and intermediate gear (1).



Swing around engine about 180° on stand, remove oil sump (1) and gaskets.

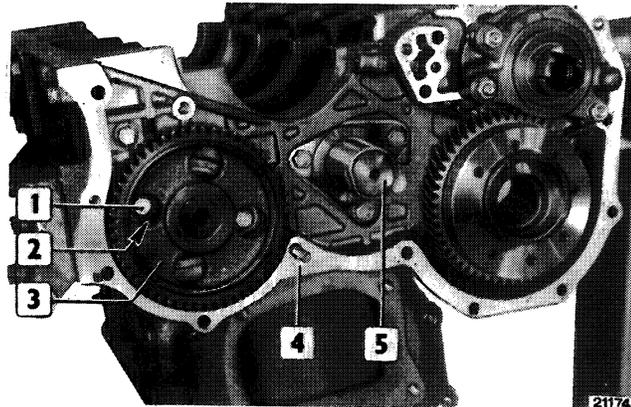


Backout the screws, remove connecting rod caps (1) and pickup the thinwall bearings.



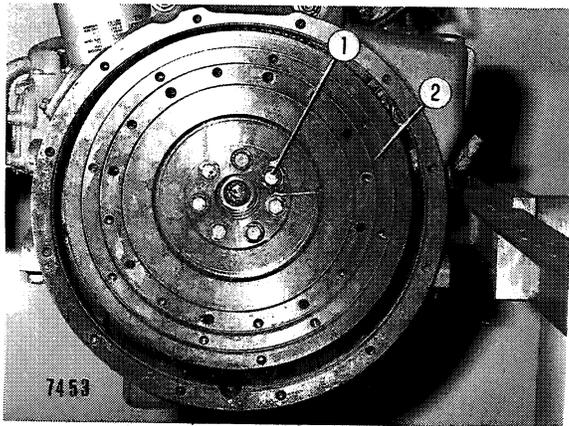
21169

From cylinder block top pull out the piston/con rod assemblies (1).



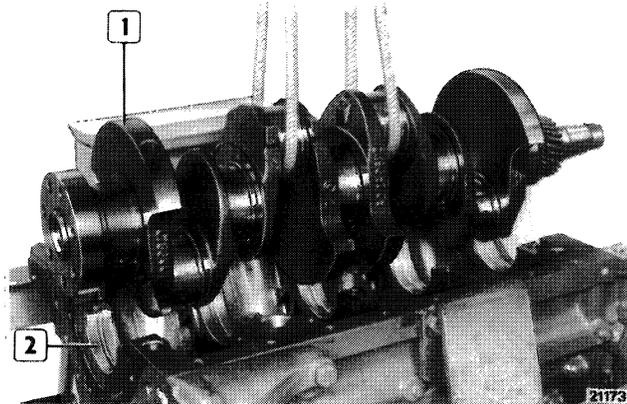
21174

Suitably position the camshaft; through holes (2) in gear, backout screws (1) retaining the thrust plates and pull out camshaft (3).



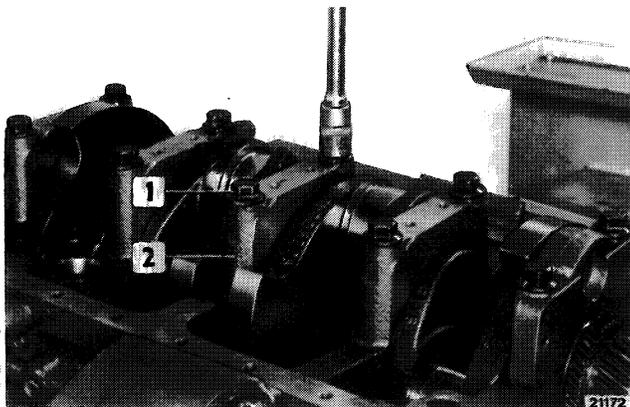
7453

Backout screws (1) securing the engine flywheel (2) and remove the flywheel. Next, backout the flywheel housing screws and remove the housing.



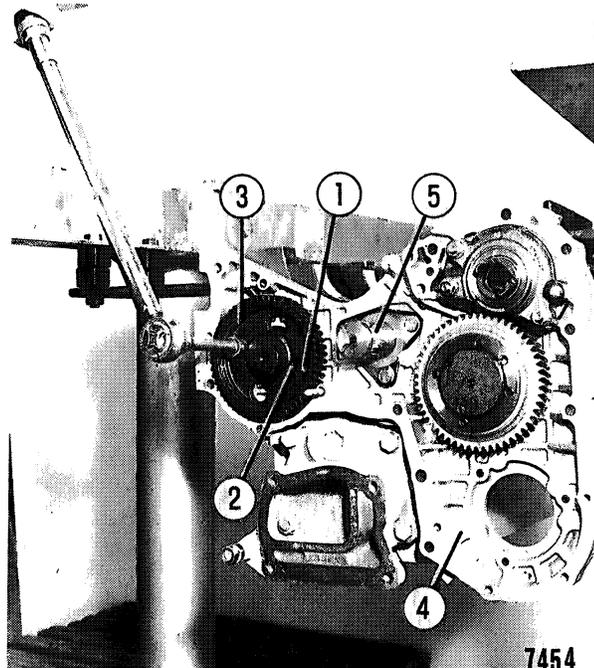
21173

Sling and hoist up crankshaft (1), pickup main bearing shells (2) and associated thrust rings.



21172

Backout the main bearing cap (2) retaining screws (1) and pickup the thinwall bearings.



7454

Suitably re-position camshaft gear (3).

Pull out the tappets.
Remove the timing gear case (4) complete with injection pump and vacuum generator drive gear.

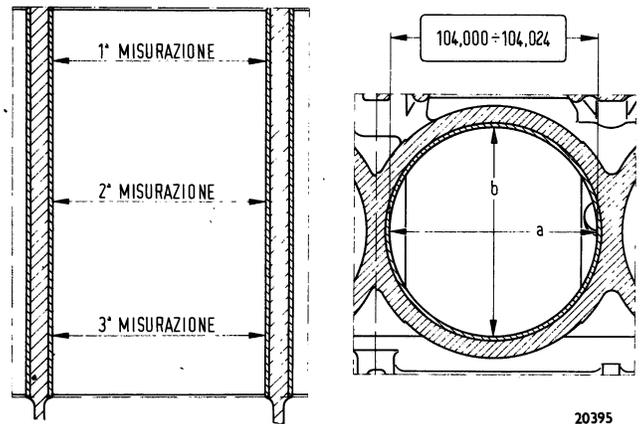
REPAIRS

CYLINDER BLOCK

After having disassembled the engine, clean accurately the cylinder block and crankcase.

INSPECTIONS AND CHECKS

NOTE - Do not measure the bore (I.D.) of liners when these are removed from cylinders owing to their deformability. Inside diameter measurements shall therefore be taken with liner press fitted and seated in barrels.

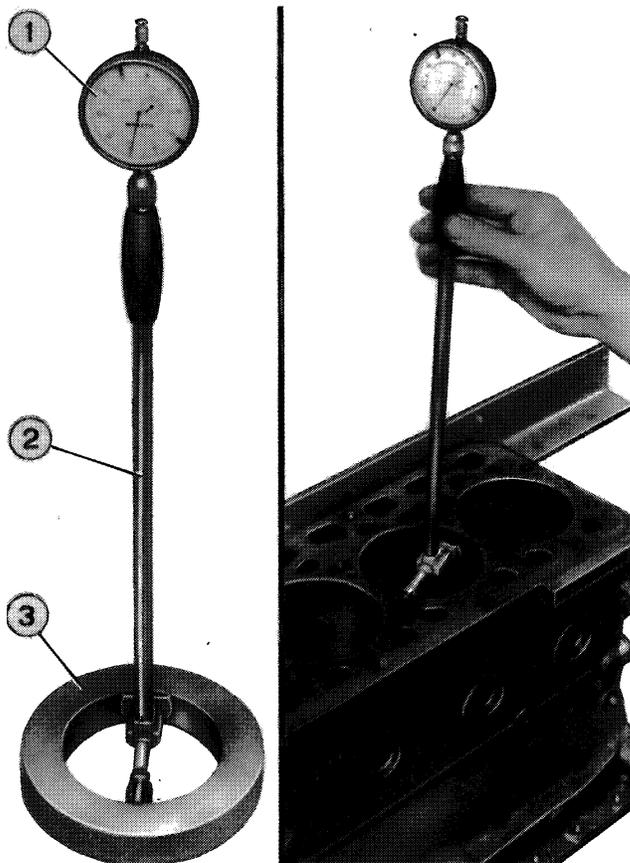


20395

CYLINDER LINER BORE CHECK DATA

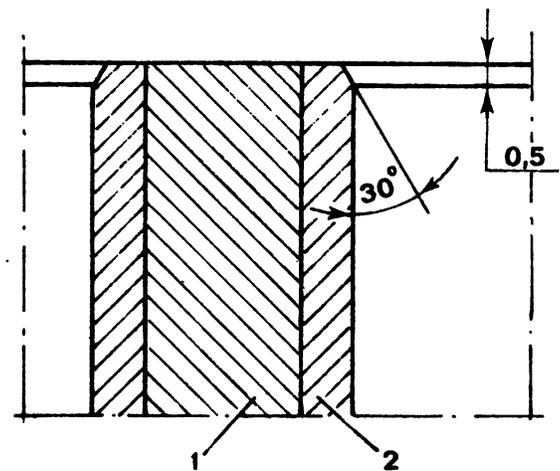
For each cylinder, measurements shall be taken at three different heights and in two perpendicular planes in liner bore: one parallel to longitudinal centerline (a) and the other (b) perpendicular to the first. Normally, maximum wear is found in proximity of the top (first) bore measurement in plane (b). In case ovality, taper or wear are found they may be eliminated by grinding - light wear or scoring - or by reaming and subsequent grinding - deep scoring or marked ovality.

NOTE - When reconditioning is necessary all liners must undergo the same oversizing : 0.4 - 0.8 mm.



15256

Liner bore checks for ovality, taper and wear are carried out using special gauge 99395687 (2) provided with a centesimal dial gauge (1), zeroed earlier in a 104 mm calibrated ring gauge (3).



4223

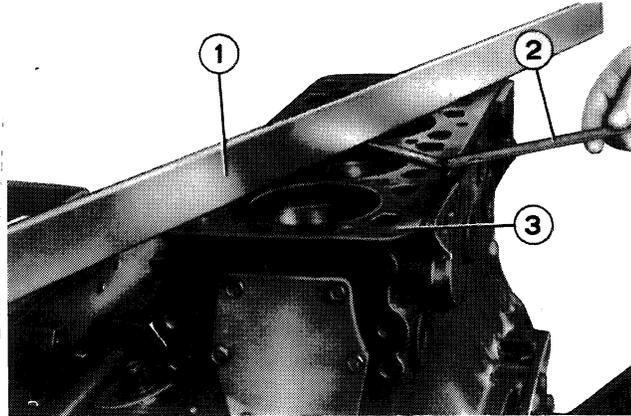
LINERS MUST BE CHAMFERED AS SHOWN AFTER RECONDITIONING

The removal and installation of cylinder liners in engine block is carried out using a hydraulic press and holder plates.

Upon press fitting in cylinder barrels, mind the following:

- Check that liner O.D is 106.970 to 106.940 mm, and that barrel bore in crankcase is 106.850 to 106.900 mm.
- Wet mating surfaces with engine oil.
- Start introduction of liner in barrel and begin press-fitting.
- With liner fitted 70 to 90 mm deep in barrel, check that applied load is over 2300N and less than 5000N

- Continue pushing in the liner and at a distance of 10 mm before bottoming, check that the load is included between 10000 and 40000N.
- After bottoming, bed in the liner by keeping a load of at least 5000N applied for about 2 minutes.
- Tap lightly and check flushness of liner lip to crankcase contact.



5592

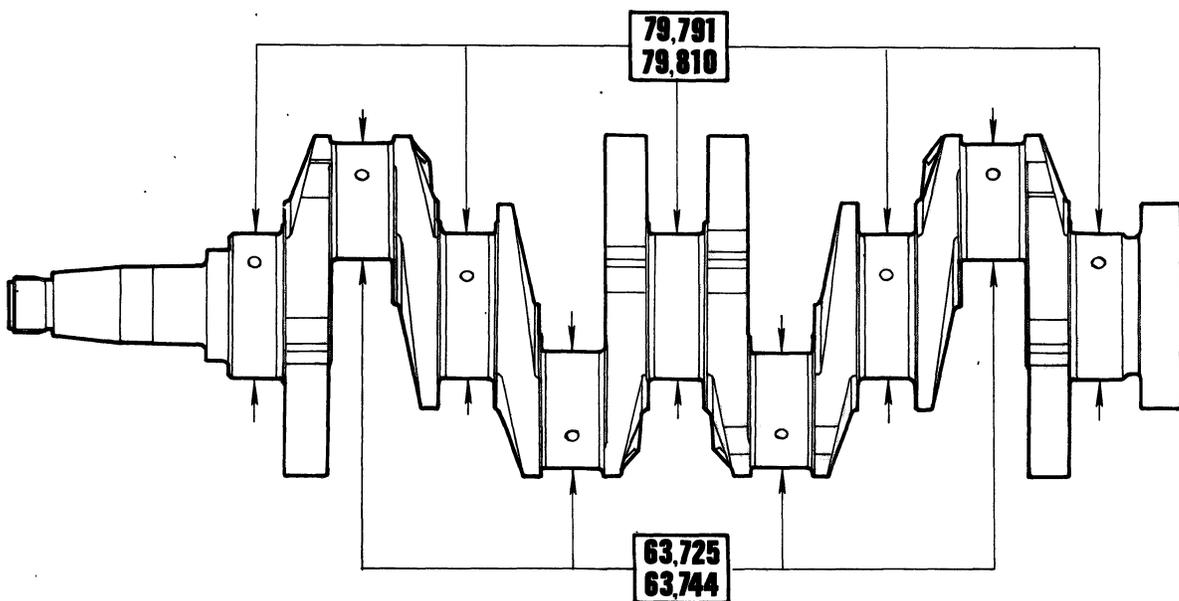
DIMENSIONS

Checking the flatness (planarity) of engine block top face (3) using a straight edge (1) and feeler gauge (2). Any distorted areas may be reconditioned using a grinder and removing the least possible amount of stock from top face.

NOTE - Remove the centering dowel only if top face needs reconditioning.

CRANKSHAFT

Check cylinder block Welsh plugs for good condition : if rusty or when lack of tightness is suspected replace.



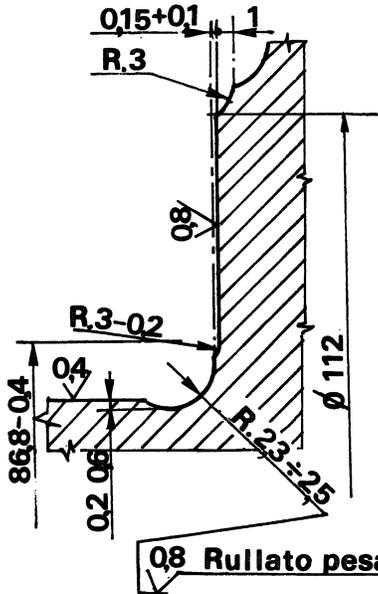
21175

CRANKSHAFT JOURNAL AND CRANKPIN MAIN

JOURNAL AND CRANKPIN CHECKS AND RE-CONDITIONING

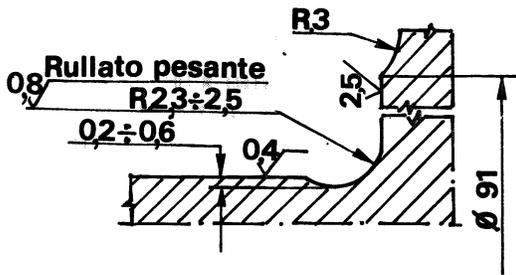
When traces of seizure, excessive scoring or ovality of journals and crankpins are found, these must be reconditioned by grinding.

Before grinding, however, measure journals and crankpins with a micrometer gauge to establish the final diameters - based on bearing undersizes - to be obtained after machining.



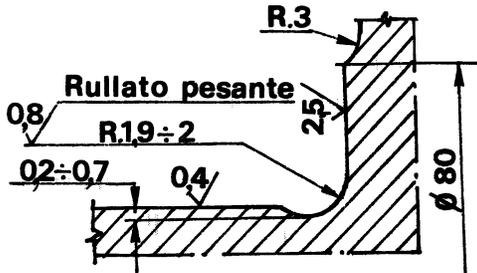
21176

DETAIL OF CRANK SHOULDER FILLET RADIUSING DATA (Rullato pesante=Heavy rolling)



21177

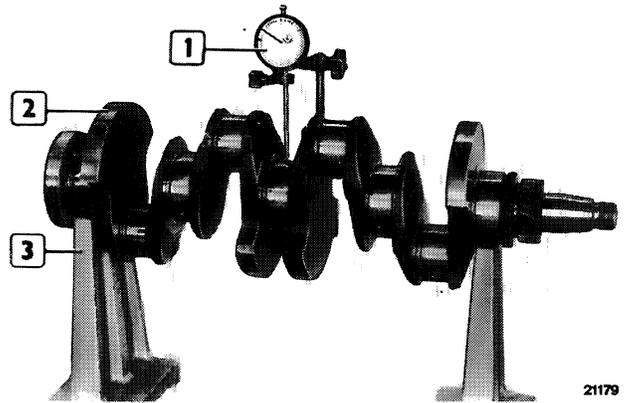
DETAIL OF JOURNAL FILLET RADIUSING DATA (Rullato pesante=Heavy rolling)



DETAIL OF CRANKPIN FILLET RADIUSING DATA (Rullato pesante=Heavy rolling)

During crankshaft regrinding pay great attention to the blending curvature (radiusing) of journal/crankpin fillets and crank shoulder fillets: check, and if other than indicated, restore specified fillet radii (see illustrations above).

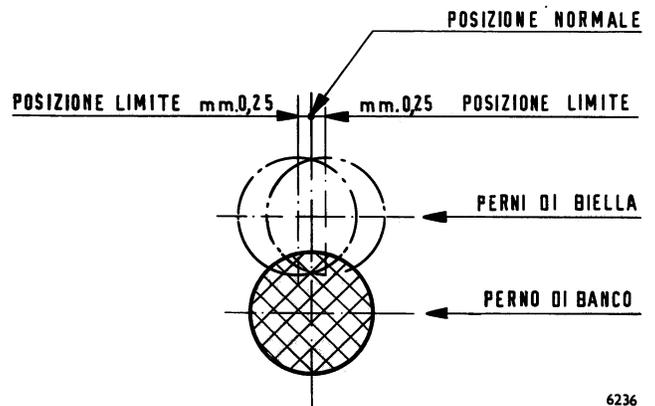
JOURNAL/CRANKPIN ALIGNMENT CHECKS



21179

After possible re-grinding of journals and crankpins, place crankshaft (2) on a pair of Vee-blocks (3) and then proceed with the following checks, using a centesimal dial gauge (1):

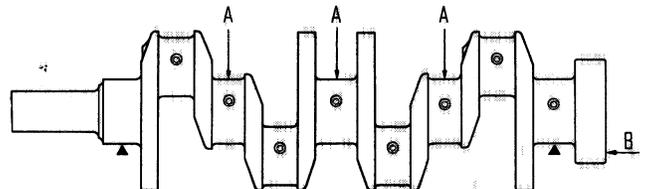
Alignment of journals - Max misalignment allowed to be not more than 0.10 mm TIR.



6236

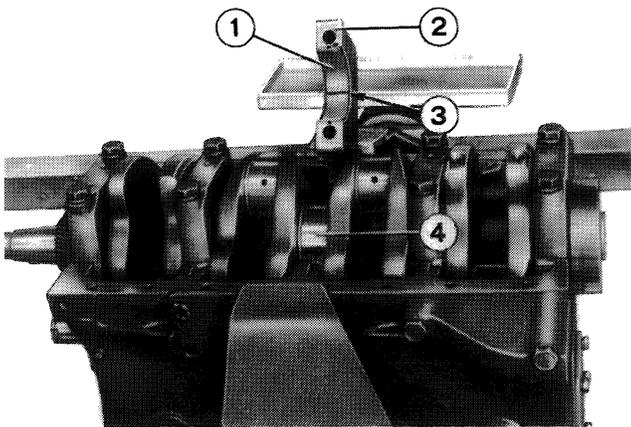
(posizione normale=normal position)
 (posizione limite=limit position)
 (perni di biella=crankpins)
 (perno di banco=journal)

Alignment of crankpins - The centerline of each pair of crankpins and the centerline of journals must lie in the same plane: max. allowed misalignment measured at right angles to said plane is 0.25 mm.



6237

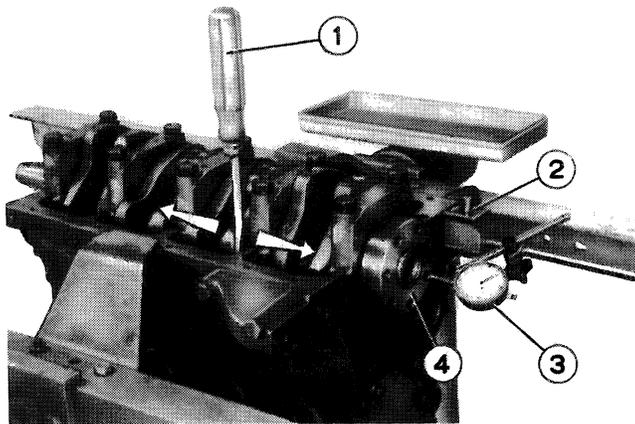
Crankshaft rotation axis relative to crankpin outer faces: max. offset tolerance 0.10 mm. Check rifled hole plugs for proper oil tightness under an internal pressure of 15 bar: if not tight replace, using a suitable drift for removal.



5607

To check the main bearing to journal clearances, use a calibrated wire plastigage and proceed as follows:

- Accurately clean and remove any trace of oil from the parts involved.
- Place the bearing halves in their housings, on journals.
- Install the crankshaft.
- On journals (4) apply a piece of calibrated wire (3) in a position parallel to crankshaft longitudinal centerline.
- Fit the caps (2) complete with bearing shells, on the associated journals.
- Insert the cap screws and tighten to the specified torque; screws must first be wetted with lube oil.
- Remove the caps from journals; determine the running clearance by comparing the flattened out width of the calibrated wire (3) - in the area where compression was greatest - with the graduated scale on the packing.



5610

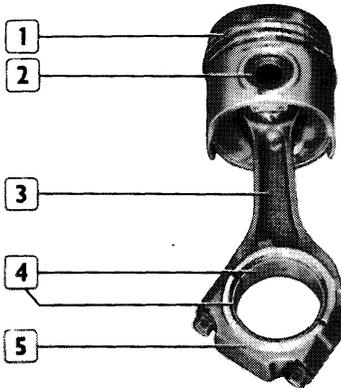
Next, check the crankshaft (4) end float using a dial gauge (3): end float is normal when it ranges between 0.082 and 0.034 mm. If found to be greater, discard the old thrust washers and fit new standard size or oversize replacement washers.

FLYWHEEL RING GEAR REPLACEMENT

This ring gear will need replacement whenever it is found to be markedly damaged or deteriorated, particularly the teeth.

Before installation, heat new ring gear to 80 C.

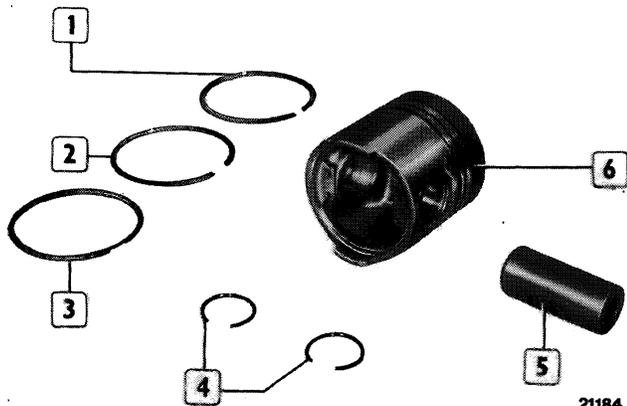
PISTON/CONNECTING ROD SETS



21183

PISTON/CONNECTING ROD SET

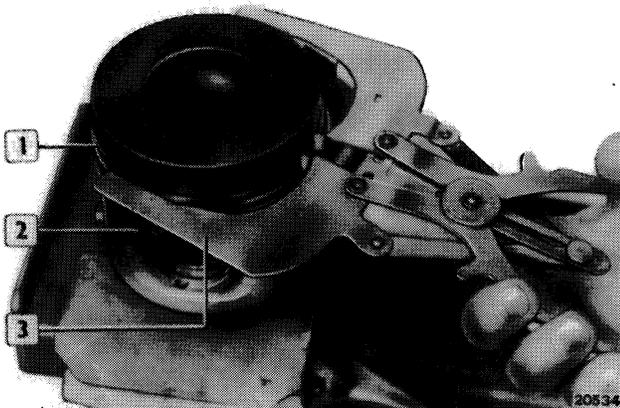
1. Piston - 2. Piston pin - 3. Connecting rod - 4. Big end bearings - 5. Big end cap.



21184

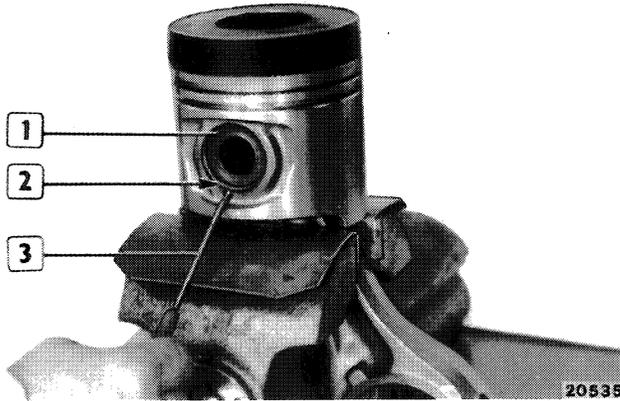
PISTON ASSEMBLY

1. Compression ring - 2. Oilscraper ring - 3. Milled oilscraper ring - 4. Retaining rings - 5. Piston pin - 6. Piston.

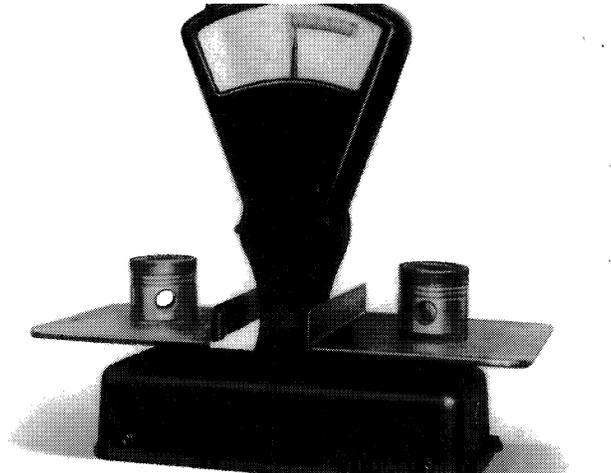


20534

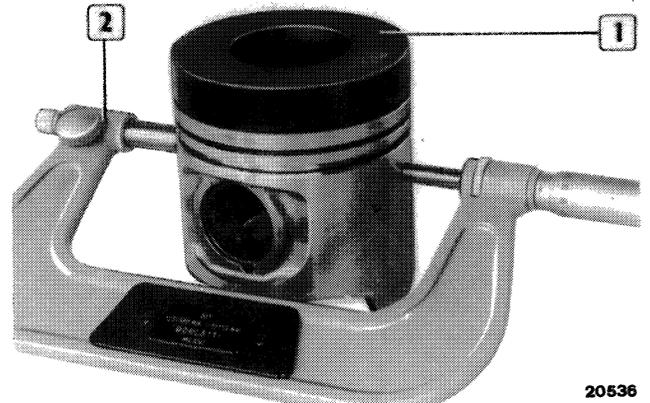
Fitting/removing compression rings (1) on piston (2) using special installer tool 99360183 (3).



For removal of piston pin (1) retaining rings (2) use the tip of a scribe (3) as shown.

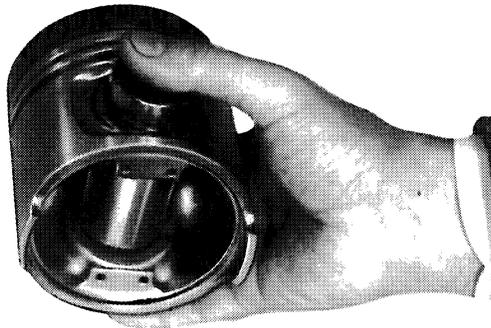


Piston weight tolerance checks: max. allowance is 20 g.



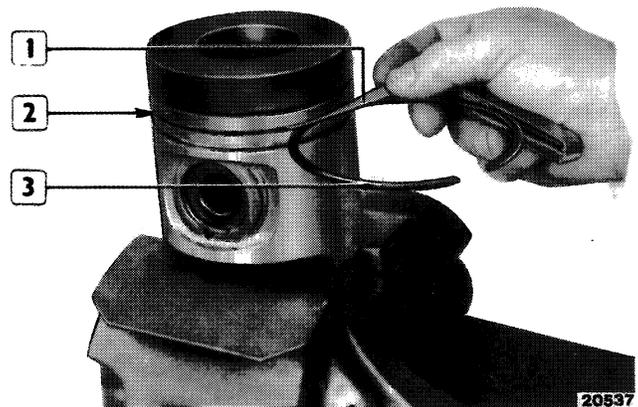
Measuring the diameter of piston (1) using a micrometer gauge (2) for fit clearance determination.

NOTE - This diameter shall be measured at 57 mm from skirt bottom edge.

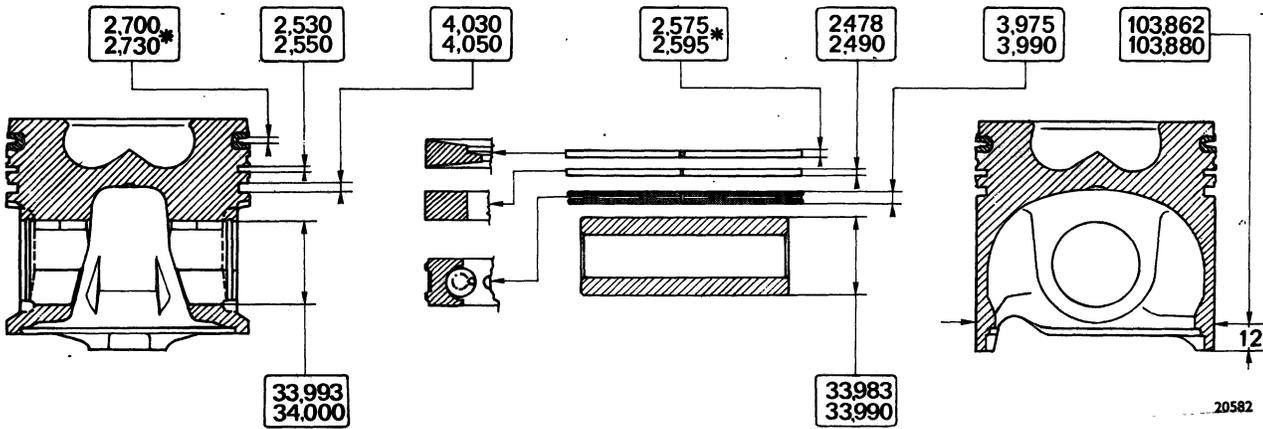


Piston pins are installed with a fit clearance relative to both the connecting rod small end and piston skirt boss. Upon fitting new pins, check proper mating with skirt boss as follows:

- Lubricate the pin and boss bore with engine oil.
- Insert pin through piston bosses.
- Holding the piston with pin vertical check that pin will not slip out unless it is pushed out by thumb pressure.

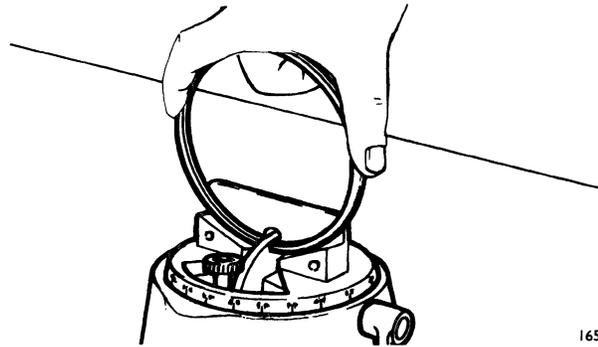
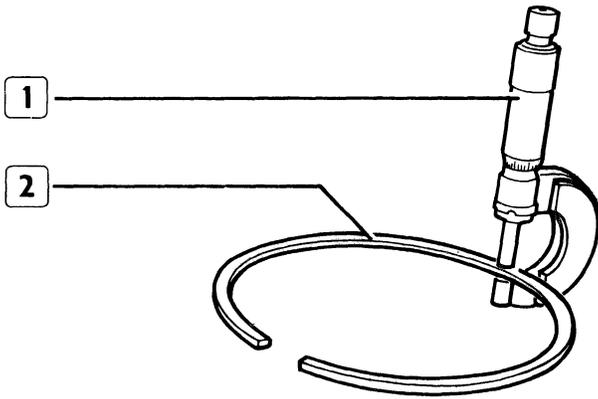


Check the side clearance between rings (3) and groove lands (2) using a feeler gauge (1).



PISTON, PIN AND RING DATA

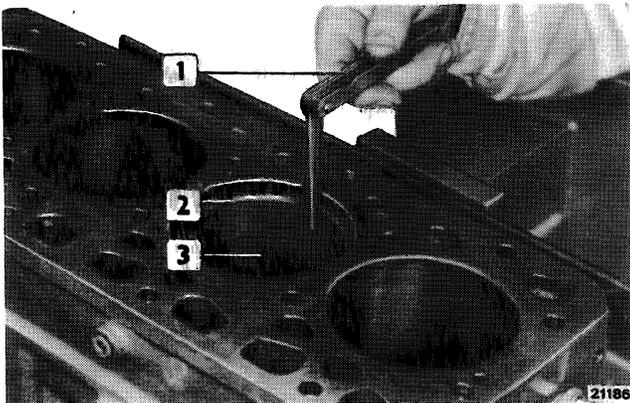
(*) this dimension is measured on the 101 mm diameter size.



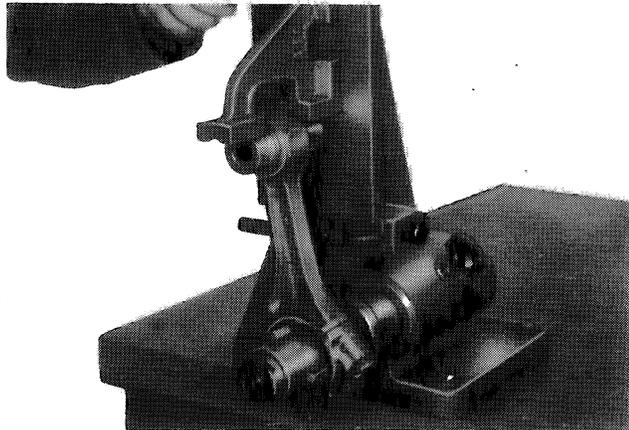
Checking the thickness of ring (2) using a micrometer gauge (1).

When ring gap is less than specified, recondition the ring ends using manual grinder 99360188; if gap is more than specified, replace the ring.

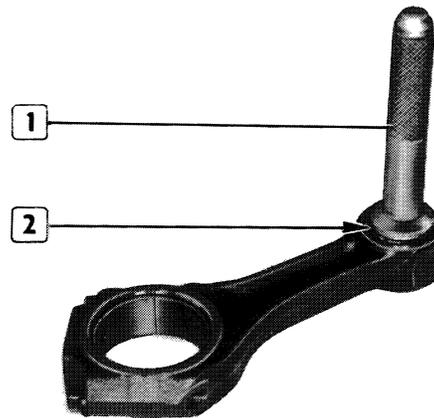
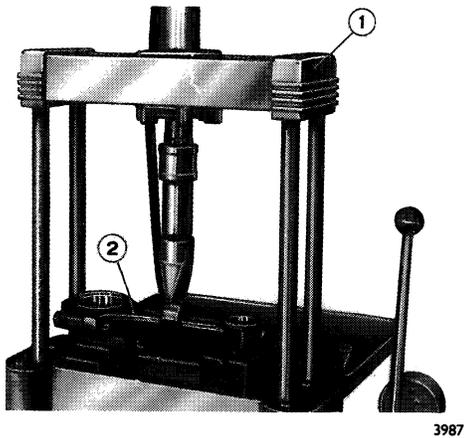
CONNECTING RODS



Measuring the ring end gap with rings (2) fitted in liner (3) and using a feeler gauge (1)

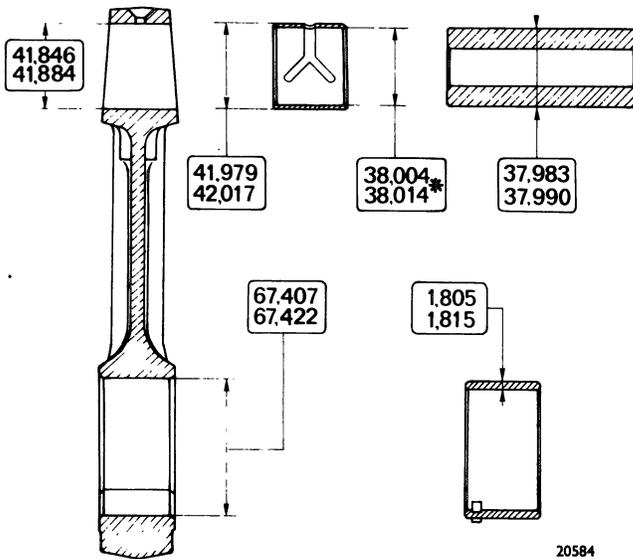


Check the parallelism of connecting rod big and small end axes. Tolerance allowed is 0.07 mm measured at 125 mm from connecting rod longitudinal centerline



Straightening the connecting rod stem (2) on a press (1)

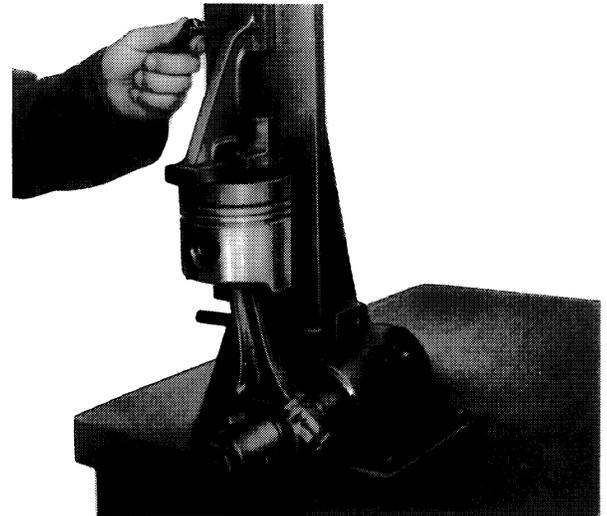
Installing the small end bushing (2) with driver 99374267 (1).



NOTE - Each connecting rod is stamped on both body and cap with a number corresponding to the associated cylinder. In case of replacements, stamp the new connecting rod(s) with the same number as found on the discarded connecting rod.

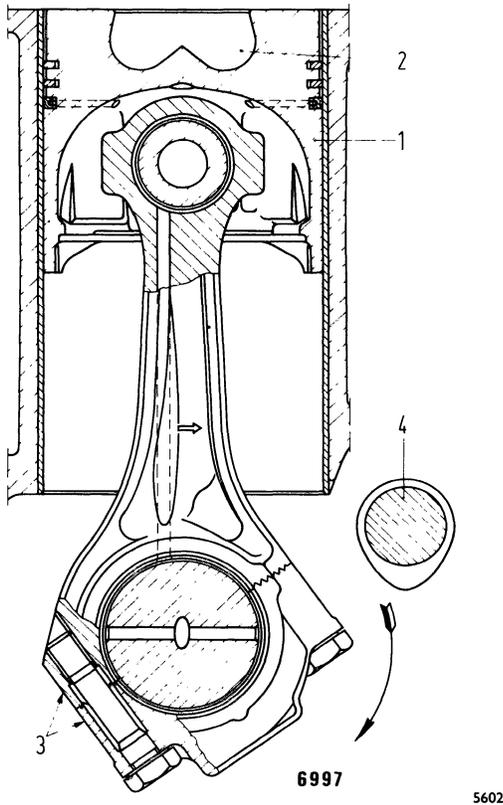
CONNECTING ROD, SMALL END BUSHING, BIG END BEARING, AND PISTON PIN FIT DATA.

(*) Dimensions obtained with press fitted bushing.



NOTE - After press fitting in con rod small end, possible bushing lateral protrusion shall be dressed flush with boss and the new bush bores reamed out to obtain the specified diameters.

NOTE - Before installing the piston/con rod sets in engine check them for proper squareness which must be perfect; if not, find the cause and replace parts as required.



When installing piston/con rod sets into their associated cylinder check that:

- Connecting rod number is same as the number of the cylinder in which it is fitted.

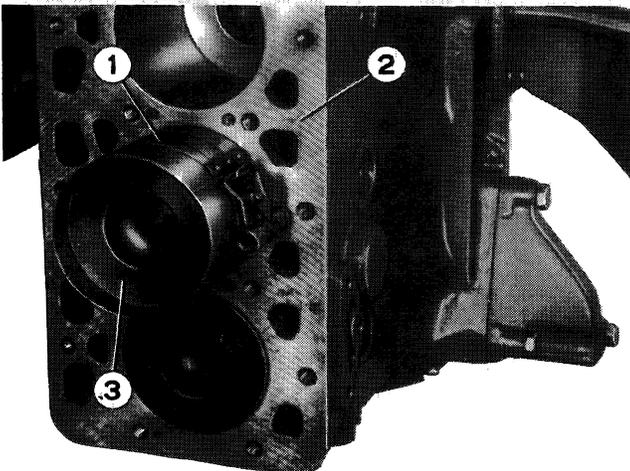


- Wording "LATO PUNTERIE" (tappet side) on piston top faces the camshaft.
 - Numbers stamped on connecting rods are located on side opposite the camshaft.
 - Piston ring gaps are positioned offset and 120 apart.
- Before insertion, lubricate the pistons, rings and liner bores.

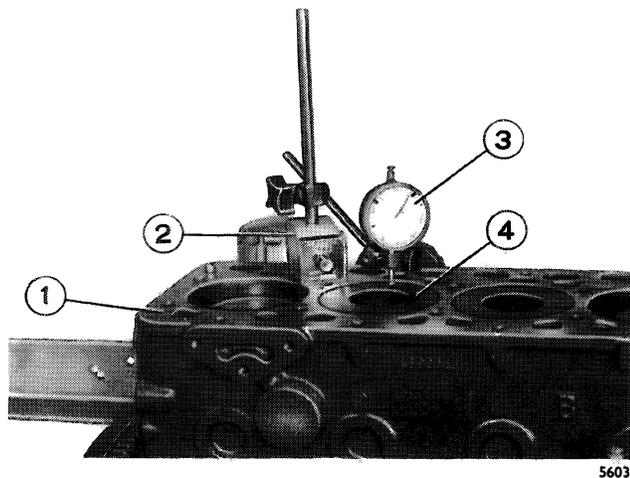
PISTON AND CONNECTING ROD SET ASSEMBLY DATA

1. Piston - 2. Combustion chamber - 3. Corresponding cylinder number stamping area - 4. Camshaft

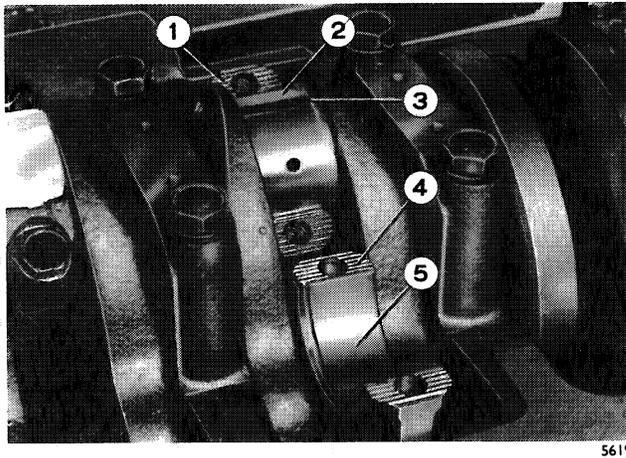
NOTE - The con rod cap screws may be re-used as long as their thread diameter measured between 19 and 35 mm from thread start is not less than 10.5 mm.



Fitting the piston/connecting rod assemblies (3) into cylinders using special ring compressor 99360605 (1).



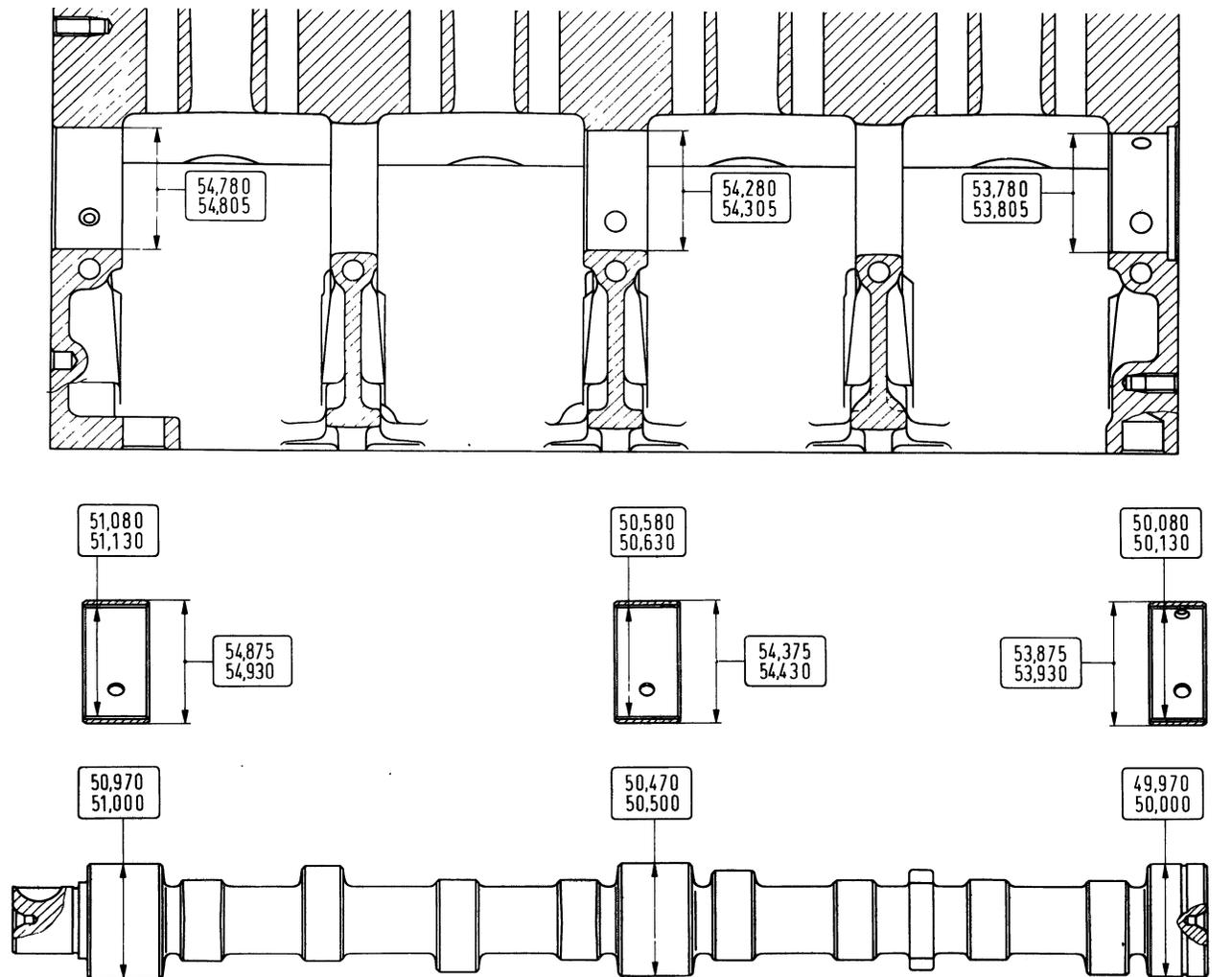
At end of assembly check the TDC position of pistons (4) relative to engine block top face using a magnetic base dial gauge (3).
Piston top standout over face (1) shall be 0.46 to 0.79 mm max.



- Proceed with the clearance check as follows:
- Clean components accurately, eliminating any trace of oil.
 - On crankpins (2) apply a piece of calibrated wire (3).
 - Fit caps (4) and tighten the screws to the specified torque; screws must be lubricated with oil.
 - Remove the cap and determine the running clearance by comparing the flattened out width of the calibrated wire (3) with the graduated scale on the plastigage packing.

Application of calibrated wire gauge (3) for crankpin fit clearance checks.

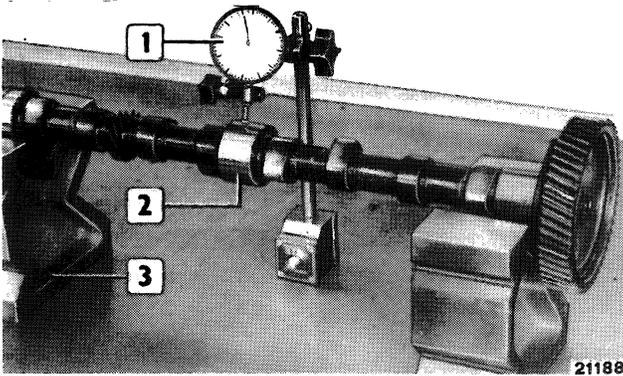
CAMSHAFT - BUSHINGS - TAPPETS



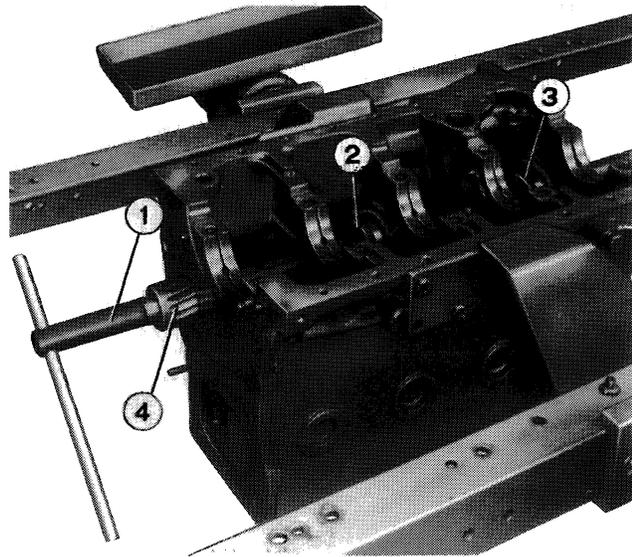
CAMSHAFT, BUSHING AND HOUSING DATA

The journal and cam surfaces must be mirror like and in good condition.

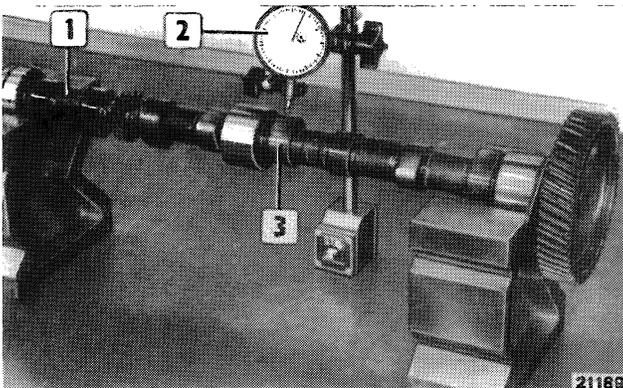
If signs of seizure or scoring marks are present, replacement of the camshaft and bushings is recommended.



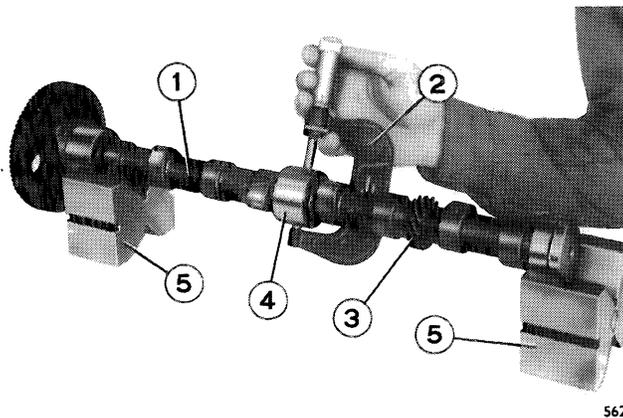
Place the camshaft on two Vee-blocks (3) and check by centesimal dial gauge (1) the proper alignment of journals (2): misalignment shall in no case exceed 0.020 mm. If greater, camshaft shall be straightened on a press.



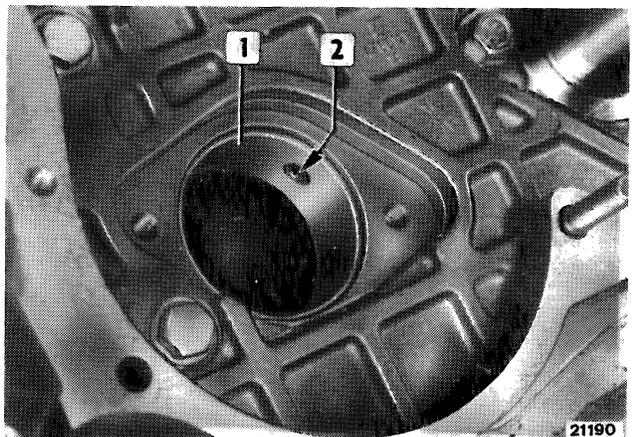
For bushing removal/installation use drift 9960383; for reaming, use spindle with cutters 99390363 (1-2-3-4).



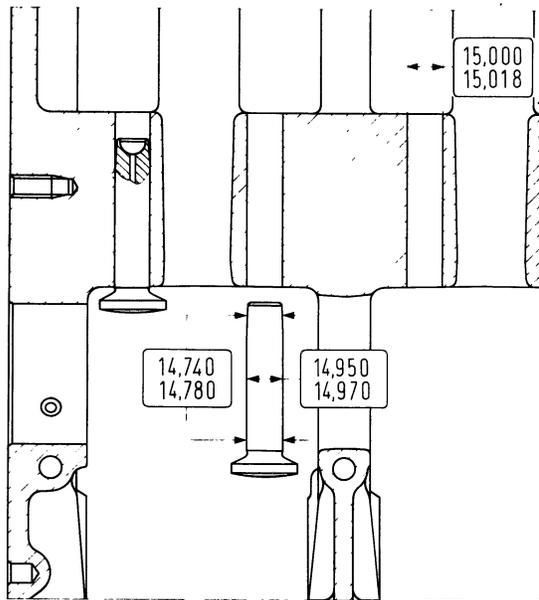
Still with camshaft (1) on the Vee-blocks, check cams (3) for proper lift using a centesimal dial gauge (2). Specified values are:
 5.955 mm for intake valve cams.
 6.027 mm for exhaust valve cams.



Measure the I.D of bushings and the O.D. of journals (4) on camshaft (1): the difference between the values found is the actual running clearance. If greater than 0.160 mm replace the bushings or, if necessary, also the camshaft.



NOTE - Upon installation of bushings (1) ensure proper alignment of riflings (2) with the lube oil passage holes in engine block.



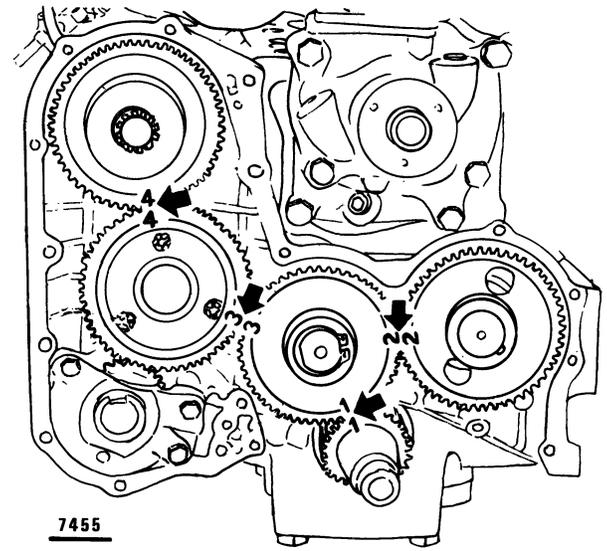
20399

TAPPETS AND HOUSINGS MAIN DATA

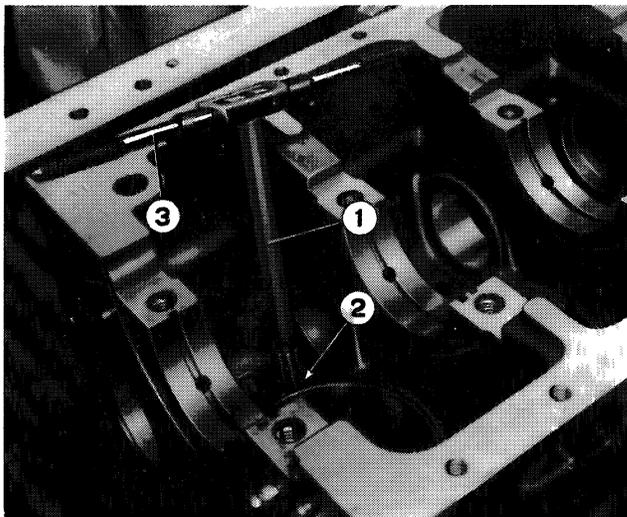
VALVE TIMING GEARS

Check that gear teeth are in no way damaged or excessively worn. Otherwise, replace gears without hesitation.

Before installation, the new gears must be heated in oven at 150 C for about 10 minutes. Next, press fit on crankshaft and camshaft interposing the retaining keys.

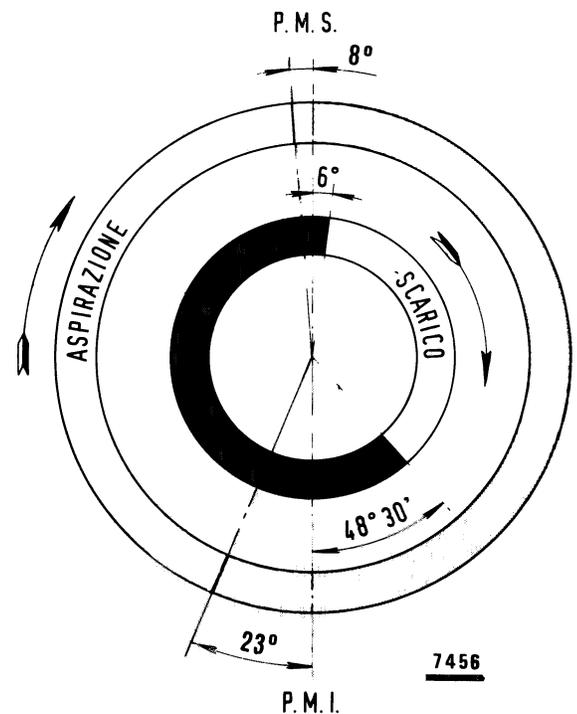


7455



5941

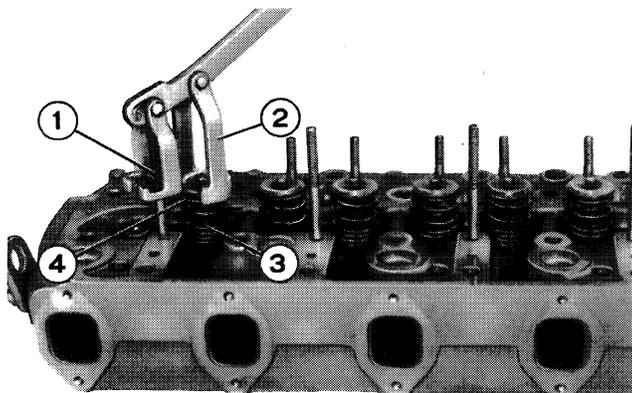
The replacement of tappets on account of their excessive clearance in housings calls for the installation of oversize tappets and the reconditioning of housings (2) by reamer (1). Spare tappets are available in standard size and in 0.10 - 0.20 - 0.30 mm oversizes.



7456

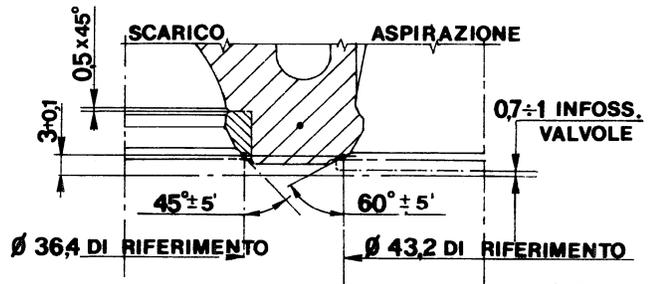
For valve gear timing checks proceed as follows:
 Adjust valve tappet clearance provisionally to 0.45 mm and check with a graduated quadrant that the advance and retard angles, both for intake and exhaust, are as indicated in the diagram above.

CYLINDER HEAD



5612

For valve removal and installation use compressor 99360357 (2).



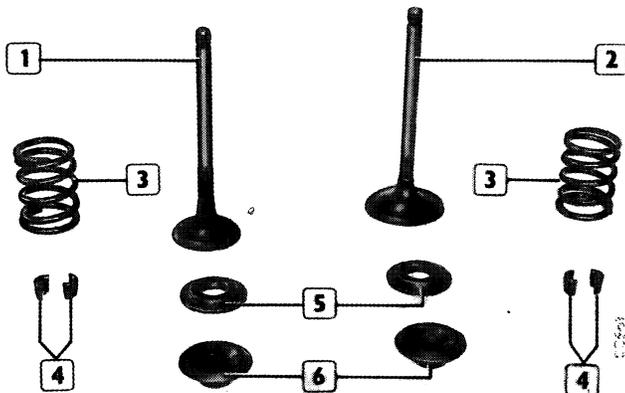
20585

(SCARICO=EXHAUST)
 (ASPIRAZIONE=INTAKE)
 (INFOSS. VALVOLE=VALVES SINKING)
 (RIFERIMENTO=REFERENCE)

VALVE SEAT MAIN DATA (mm)

Test cylinder head hydraulic tightness: no leaks shall be present under a water pressure of abt. 5 bar. Check the proper centering and clearance of valve stem in its seat.

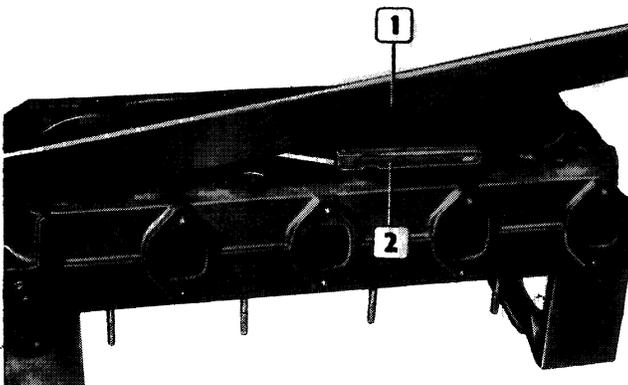
If clearance is found to be excessive, replace the valve and, if necessary, also the valve guide.



20541

VALVE ASSEMBLY COMPONENTS

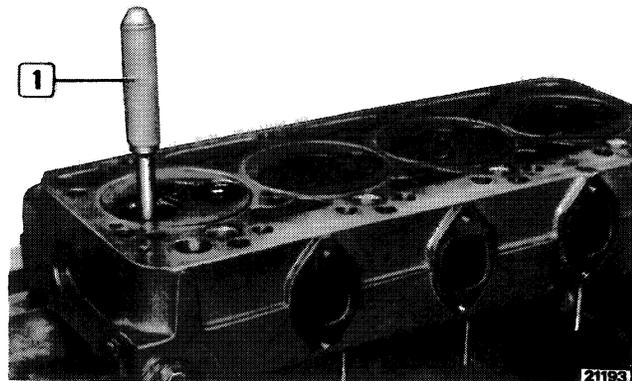
1. Exhaust valve - 2. Intake valve - 3. Springs - 5. Lower cups - 6. Upper cups.



21192

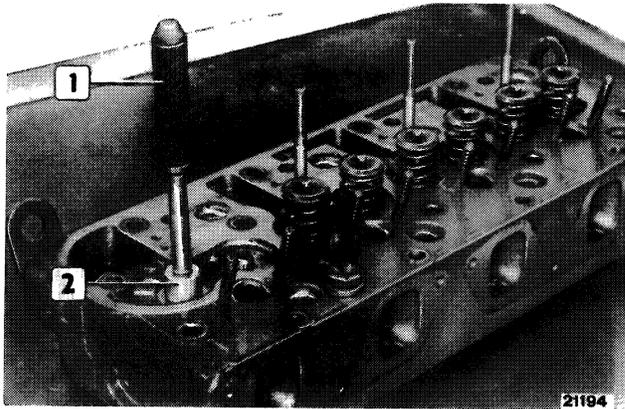
The cylinder head to engine block faying surface flatness check is carried out using a steel straight edge (1) and a feeler gauge (2).

If across the full length of this surface out of flatness values greater than 0.15 mm are found, proceed with a lapping operation on a surface grinder.

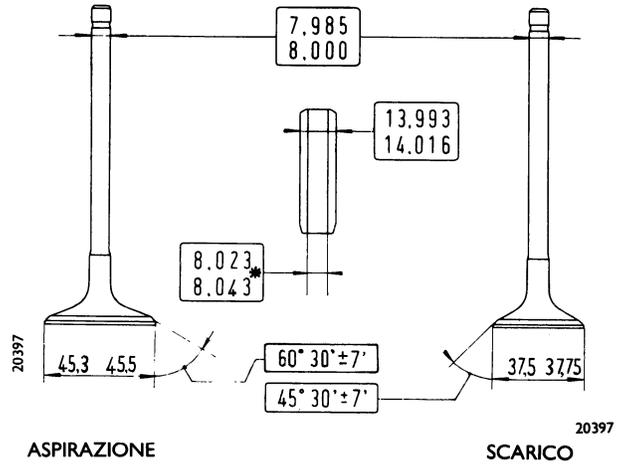


21193

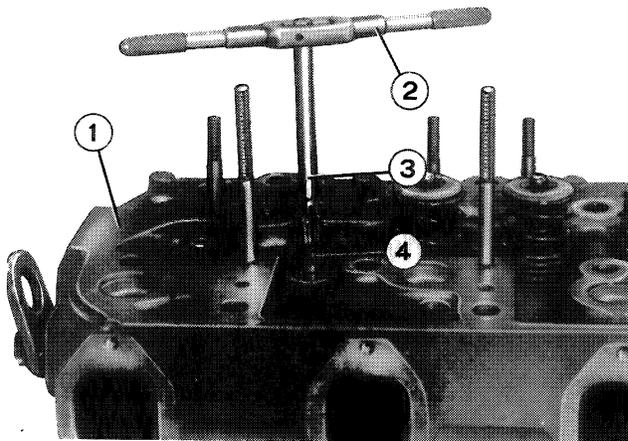
Removal of valve guides using a suitable drift 99360288 (1).



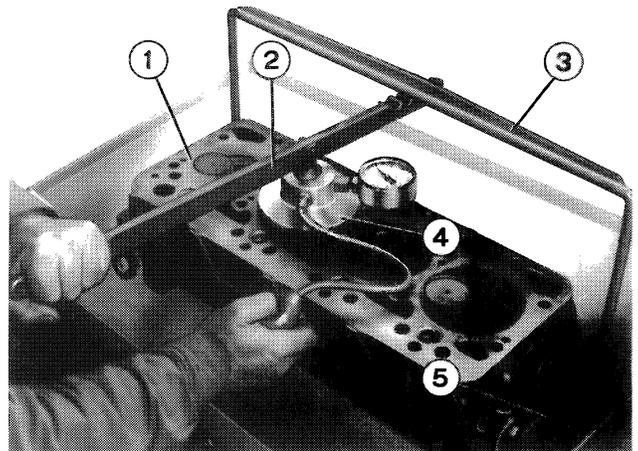
Installation of valve guides using drift 99360288 (1) and driver 99360293 (2)



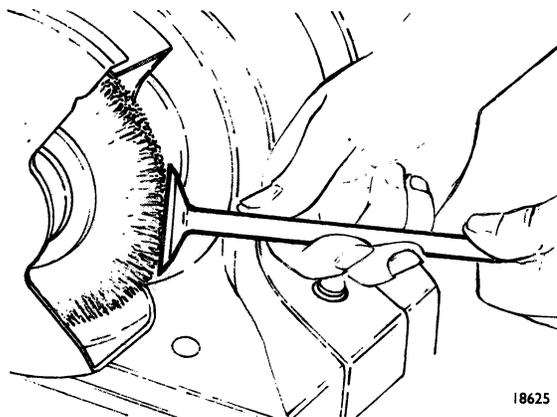
(SCARICO=EXHAUST) (ASPIRAZIONE=INTAKE)
VALVES AND VALVE GUIDES MAIN DATA (mm).
(*)To be obtained after valve guide press fitting.



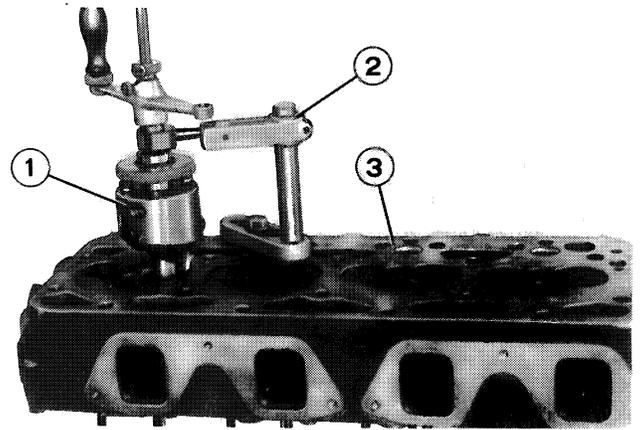
After press-fitting, ream the bore of valve guides (4) using reamer 99390310 (3)



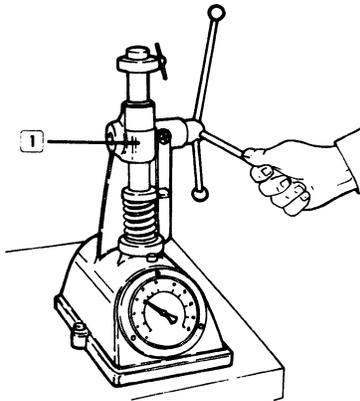
Valve leak tightness must be tested using specially designed equipment (items 2-3-4-5).



Clean valves with a wire brush and check for signs of seizure, cracks or excessive wear. If necessary, re-grind the seat-ing faces on valve heads using grinder 99301014 removing the least possible amount of stock metal.

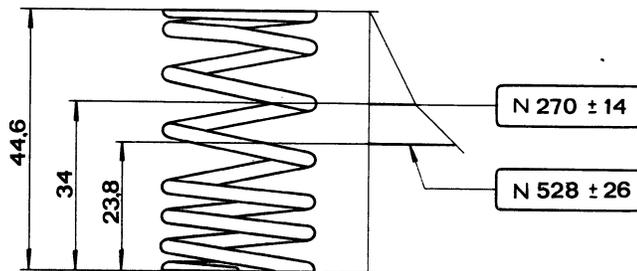


Cylinder head valve seats reconditioning by HUNGER universal grinder 99360419 (1) to restore the specified compression tightness.



16587

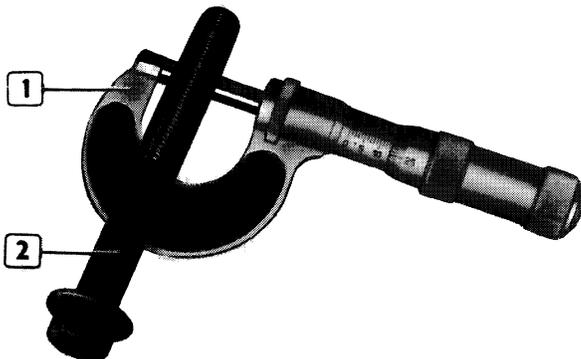
Valve spring rate must be checked using load tester 99305049: compare results with spring load and flexibility data given in figure below.



20398

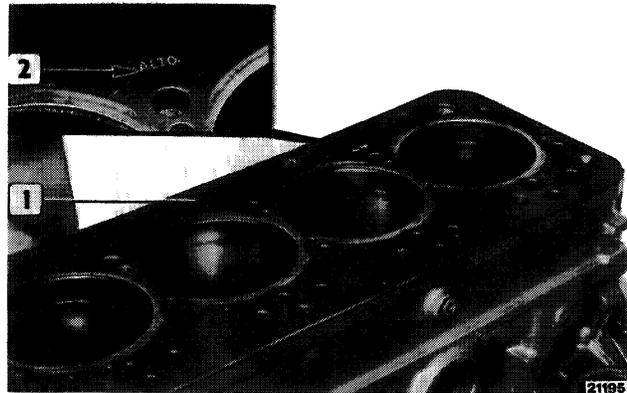
VALVE SPRING TEST DATA

CYLINDER HEAD ASSEMBLY



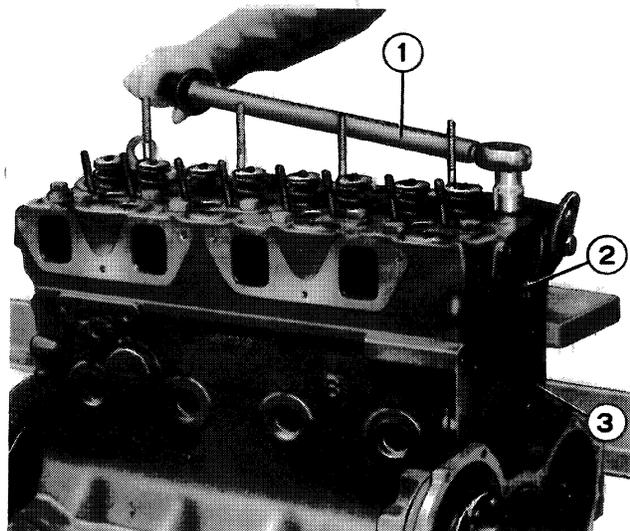
21196

Before cylinder head hold-down screws re-use, measure their thread diameter using a micrometer (1): diameter shall not be less than 11.5 mm in any point, otherwise replace the screws.



For cylinder head reassembly and tightening proceed as follows:

- Position the head gasket (1) with mark ALTO (TOP) (2) uppermost (facing serviceman).

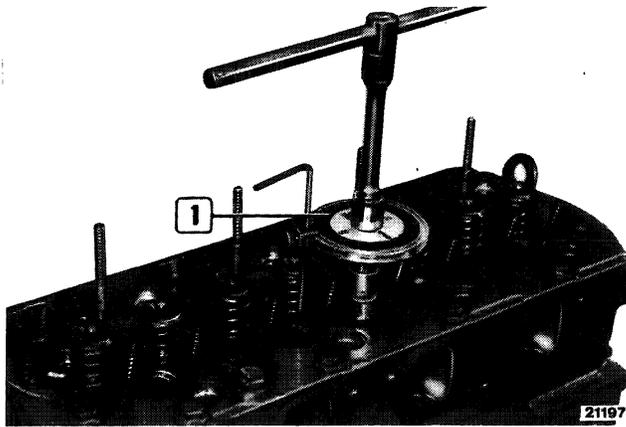


5616

- Position head (2) on engine block, wet hold down screws with oil and thread into their seats, then tighten as instructed on next page.

Tighten in step sequence:

- 1st step - Using a torque wrench, tighten initially to 60 Nm.
- 2nd step - Re-tighten all screws to a final torque of 60 Nm.



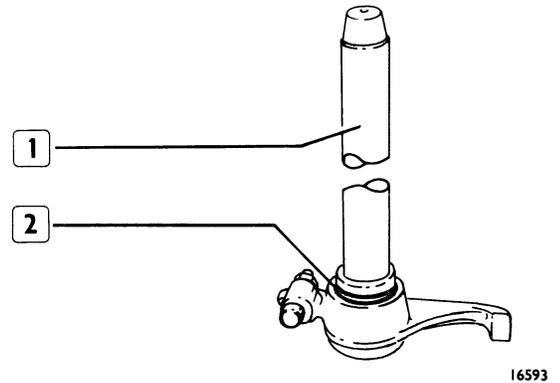
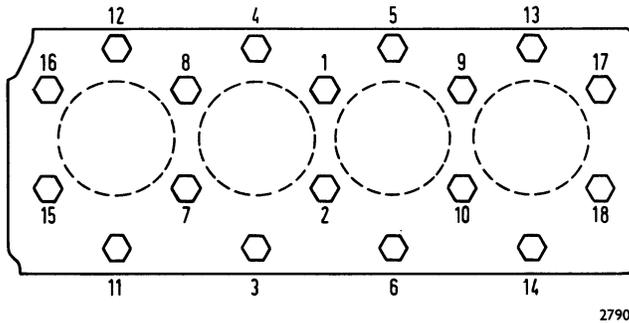
ROCKER SHAFT - PUSHRODS

Check that all contact faces show n sign of scoring or seizure marks: if present, replace parts as required.

Check bushing-to-rocker shaft and support-to-rocker shaft clearances which shall be 0.016 to 0.052 mm and 0 to 0.061 mm respectively. Change any parts causing specified running clearance increases.

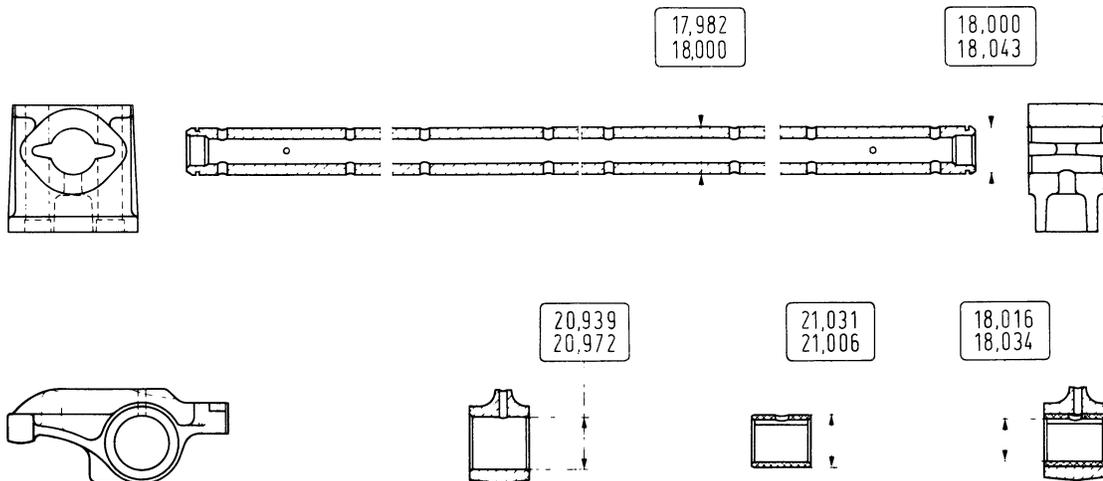
Check pushrod ends for perfect tightness.

- 3rd step - Fit socket wrench with special fixture (1) and tighten to angle-torque of 90
- 4th step - Tighten again through other 90 angle torque.

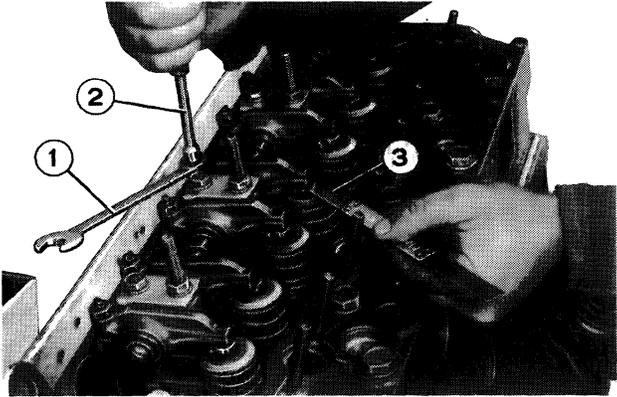


CYLINDER HEAD HOLD-DOWN SCREWS TIGHTENING SEQUENCE SCHEMATICS

Press fit bushings (2) in rockers using a suitable drift (1).
On installing new bushings make sure they do not stand out of rocker bore edges.



LUBRICATION SYSTEM



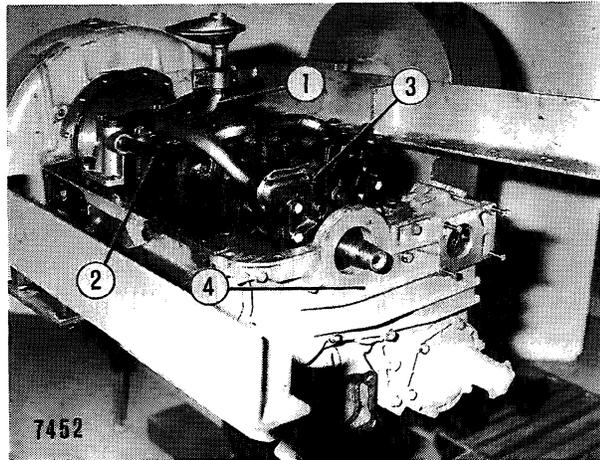
5627

Valve to rocker clearance adjustment using wrench 99350108 (2), socket wrench (1) and feeler gauge (3).

This clearance must be re-set scrupulously in order not to introduce any change in valve timing diagram specifications as would occur if clearance is higher or lower than normal.

Specified operation clearance is 0.25 mm for intake and 0.35 mm for exhaust valves. Crank engine and check that the cylinder involved is in the "explosion" stage, that is, with its valves both closed; the valves of its symmetrically paired cylinder must be in the 'balanced' condition.

For clearance adjustment purposes, the design pairing of cylinders is: 1 and 4, 2 and 3.

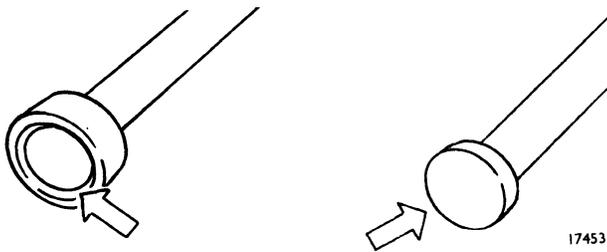


LUBRICATION SYSTEM DETAILS
1. Suction line and intake screen - 2. Delivery line - 3. Oil pump - 4. Cover.



6956

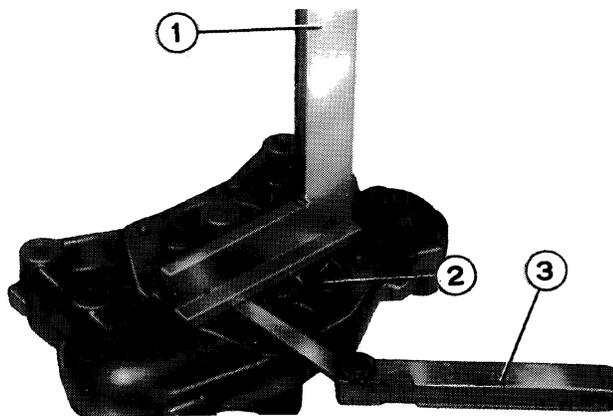
Oil pump complete with pressure relief valve.



17453

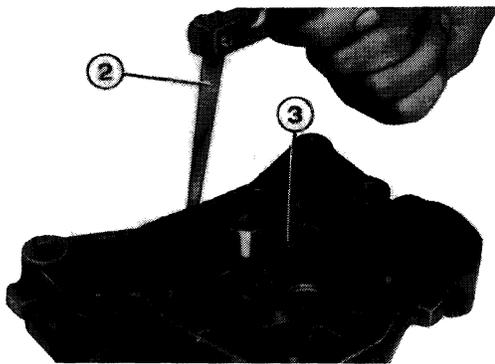
The pushrods shall be free from distortion and their spherical seating contact with the rocker should show no sign of pick-up or roughness whatever (white arrows in figure). In case of inefficiency, renew without hesitation.

The intake/exhaust valve pushrods are identical and therefore perfectly interchangeable.



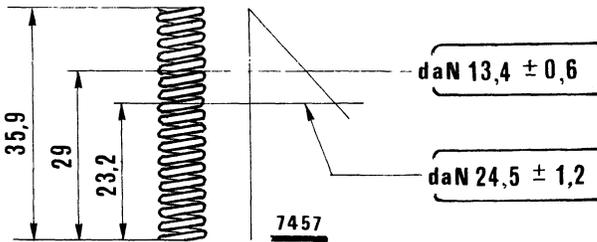
6957

During service, check with a square (1) and feeler gauge (3) that the clearance between gears (2) and pump cover abutment plane falls between 0.016 and 0.107 mm or, in any case, is not greater than 0.15 mm.



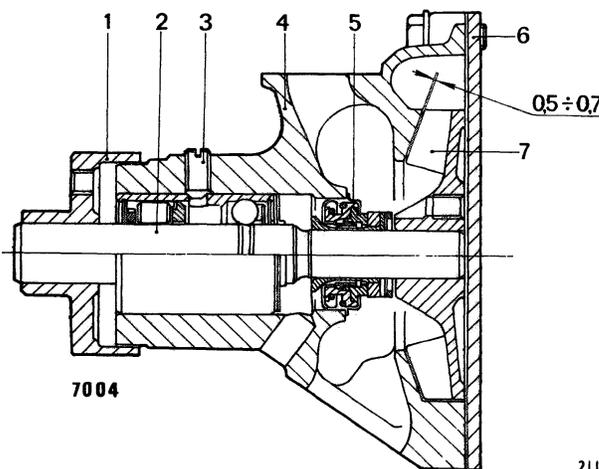
6959

Check the clearance between gears (3) and housing walls in pump body which shall be 0.030 to 0.134 mm; if not, replace any worn parts.



PRESSURE RELIEF VALVE SPRING DATA

COOLING SYSTEM



21199

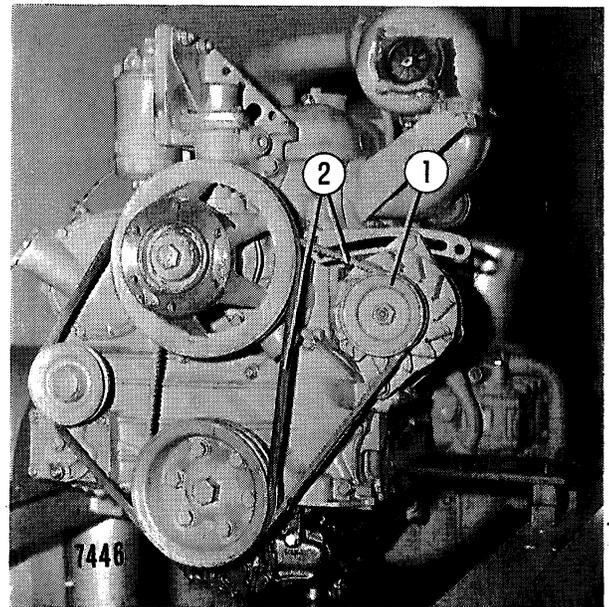
Water pump section
 1. Hub - 2. Bearing shaft - 3. Screw - 4. Pump body
 - 5. Seal - 6. Cover - 7. Impeller.

WATER PUMP

The water pump is of the centrifugal, vane type. The pump bearing is in one piece with the vaned impeller shaft and is located in a carrier housing. Water tightness between pump body (4) and shaft (2) is ensured by a seal (5). This seal is press fitted in the body of pump (4) so that the water in pump cannot seep across its contact face in housing. The other seal - fitted on impeller - has a function complementary to seal (5). The bearing lock screw (3) must be retained in its seat by some LOCTITE 242 sealant.

NOTE - The fan pulley impeller and hub (7 and 1) are press fitted on bearing shaft without the intermediary of lock pins.

At assembly, make sure the impeller (7) is flush with the end of shaft (2).



ALTERNATOR/WATER PUMP DRIVE BELT TENSION ADJUSTMENT

- To increase belt tension, proceed as follows:
- Slacken alternator pivot pin nuts (1 and 3)
 - Slacken nut (2) locking alternator on tensioner.
 - Shift alternator outwards and lock all nuts fully; normal sag of belt shall be 1 to 1.5 cm under a hand load of 12 daN.
- Do not overtighten belt or abnormal load on bearings may result.
 Drive belt tension shall be checked periodically.