INDEX
10C DOZER
SERVICE MANUAL SET
FORM NO. 73158153

Service manual set is arranged in the following order		Individual manuals are also available in translation in form numbers listed below			
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The following additional Service Manuals, in English, are not included in the Manual Set, but may be ordered from a Fiatallis dealer:

Cut along the dotted lines and insert in spline of binder

10C DOZER SERVICE MANUAL SET FORM 73158153

FIATALLIS®

Index card 73158176

8365
ENGINE

SERVICE MANUAL

FORM 604.06.293
7/90

8365 Engine

Service manual

Form 604.06.293 - English

⚠WARNING

STUDY THE OPERATION AND MAINTENANCE. INSTRUCTION MANUAL THROUGH BEFORE STARTING. OPERATING, MAINTAINING, FUELING OR SERVICING THIS MACHINE.

⚠ The Operation and Maintenance Instruction Manual provides the instructions and procedures for starting, operating, maintaining, fueling, shutdown and servicing that are necessary for properly conducting the procedures for overhaul of the related components outlined in this Service Manual.

⚠ This symbol is your safety alert sign. It MEANS ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED.

⚠ Read and heed all safety instructions carrying the signal words WARNING and DANGER.

⚠ Machine mounted safety signs have been color coded yellow with black border and lettering for WARNING and red with white border and lettering for DANGER points.

IMPORTANT

The information in this manual was current at the time of publication. It is our policy to constantly improve our product and to make available additional optional items. These changes may affect procedures outlined in this manual. If variances are observed, verify the information through your Dealer.

NOTE

Additional plublications pertaining to this model and to all other Fiat-Allis products are available through Fiat-Allis dealers. Publications are generally available in several languages. Refer to Service Publications Index for all such publications; this index is available free from Fiat-Allis.

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 adjust 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 (CO_2) 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

FOREWORD

This manual gives instructions for repairs on common parts of **8365** engines.
Procedures for repair or overhaul given in this book are valid for all applications on the different machines; any differences are clearly indicated and variant and engine type number are given. For composition of the engine type number see paragraph 1 1 1
Units not dealt with in this manual are specific for the machines fitting class **8365** engines; for these units refer to the "Engine related components" manuals of the specific machines.

NOTE

For what concerns fuel and fluid capacities refer to the "Operation and Maintenance Instruction Manual" of your particular machine.

IMPORTANT

The information in this manual was current at the time of publication It is our policy to constantly improve our product and to make available additional optional items These changes may affect procedures outlined in this manual If variances are observed, verify the information through your Dealer

NOTE

Additional publications pertaining to this model and to all other Fiat-Allis products are available through Fiat-Allis dealers Publications are generally available in several languages. Refer to Service Publications Index for all such publications; this index is available free from Fiat-Allis.

8365 Engine

SUBJECT INDEX

1. GENERAL

1.1 ENGINE IDENTIFICATION

Each engine carries two identification numbers (engine type and serial number) on the left-hand side of the cylinder block (see fig. 1).

The engine type indicates the composition of the engine and must always be indicated together with the serial number (fig.1) when requesting spare parts.

1.1.1 ENGINE TYPE

1st digit: 8 indicates "engine".

2nd and 3rd digits: indicate engines of basically similar design.

4th digit : 5 indicates adoption of the engine on earth moving machines.

5th digit : indicates engine type according to the following code :
0 = aspirated engine
2 = turbocharged engine.

6th digit : indicates a series of engines based on the same design.

7th, 8th, 9th digits : indicate the variant number of the engine.

1.1.2 SERIAL NUMBER

It is the progressive engine number assigned by production.

Fig. 1 - Position of engine type and serial number plate.

1.2 PRINCIPLES OF DIESEL ENGINE OPERATION

1.2.1 GENERAL

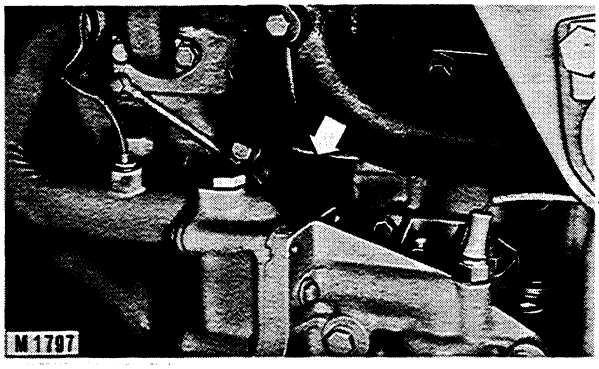
In the diesel engine the air-fuel mixture is formed in the combustion chamber and ignition is spontaneous as the aspirated air is brought to a very high temperature by the compression. In fact, when air is brought rapidly to a pressure of 30 bar (426.7 psi) its temperature reaches 700°C (1292°F) which is enough to ignite the fuel mixture.

In the intake stroke air only enters the cylinder; of course a filter must be fitted on the air intake to prevent foreign matters getting into the cylinder and damaging the engine components.

The air drawn into the cylinder may be aspirated directly from the outside in the downward stroke (naturally aspirated engines) or be first compressed by a turbocharger operated by the exhaust gas (turbocharged engines).

The air is then compressed and consequently its temperature rises and allows the spontaneous ignition of the fuel.

Injection of the fuel into the cylinder (direct injection) occurs at the end of the compression stroke,a few



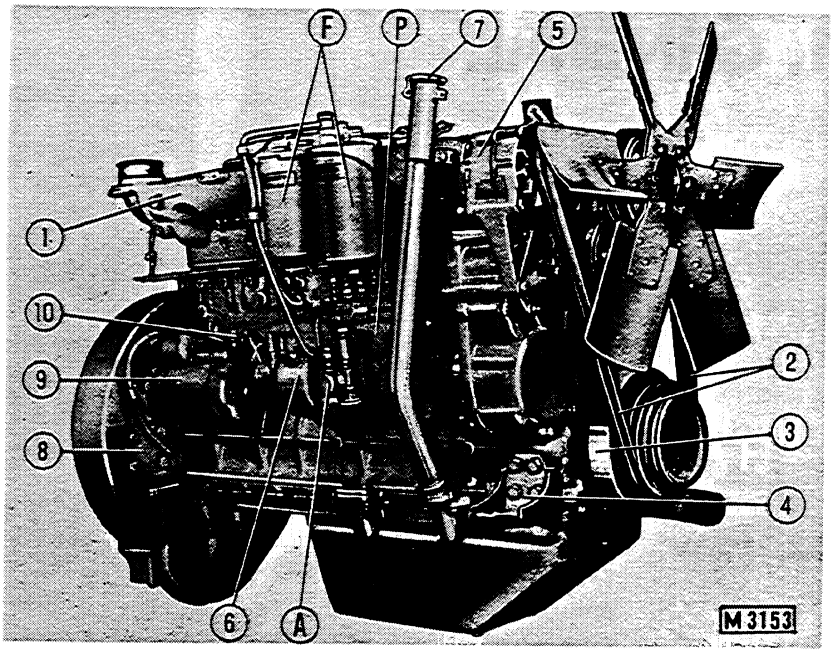


Fig. 2 - R.H. Side view of engine 8365.05.560 (fitted on crawler loader FL10-C.)

A. Fuel supply pump - F. Fuel filters - P. Injection pump - 1. Intake manifold 2. Alternator, water pump, and fan belts - 3. Damper - 4 and 8. Engine mounting brackets - 5. Alternator - 6. Speed regulator - 7. Oil filler and dipstick - 9. Starter motor - 10. Cylinder block water drain cock.

degrees before the piston reaches T.D.C.

When the finely atomized fuel is injected under extremely high pressure(about 200 bar - 2844 psi) into the combustion chamber, it immediately starts a partial ignition, owing to the very high air temperature.

The ignition of this part of fuel might be better considered an explosion. The sharp rise in temperature that follows and the movements of the air not yet involved in the combustion lead to a complete burning of the fuel which is still being injected into the combustion chamber.

Power and exhaust strokes follow.
So the operation cycle closes, which is achieved every two complete revolutions of the crankshaft.

1.2.2 REQUIREMENTS FOR INJECTION

According to what said above, we may sum up the requirements for a correct injection that will ensure top performance of the engine as follows :

a) Timing of the injection - Injection must always start at the same stage of the cycle, chosen to be as close as possible to the ideal engine operating cycle. It must be possible to adjust this timing according to the engine speed (automatic advance adjustment).

b) Quantity of fuel injected. Injection into each cylinder and for each cycle of the same quantity of fuel required to provide the sufficient output.
Of course it must be possible to adjust this quantity to the variations of the torque applied to the engine.

c) Way in which injection is achieved. The jet must have enough :

- atomization, so that it immediately ignites ;
- penetration through the compressed air;
- diffusion to all directions so that as much as possible of the air in the cylinder can be used for combustion.

This task is achieved by the injection system and by the pump and injectors in particular.

To prevent serious damage to the engine and injection system the utmost care should be taken when adjusting the pump flow to the engine to ensure a correct

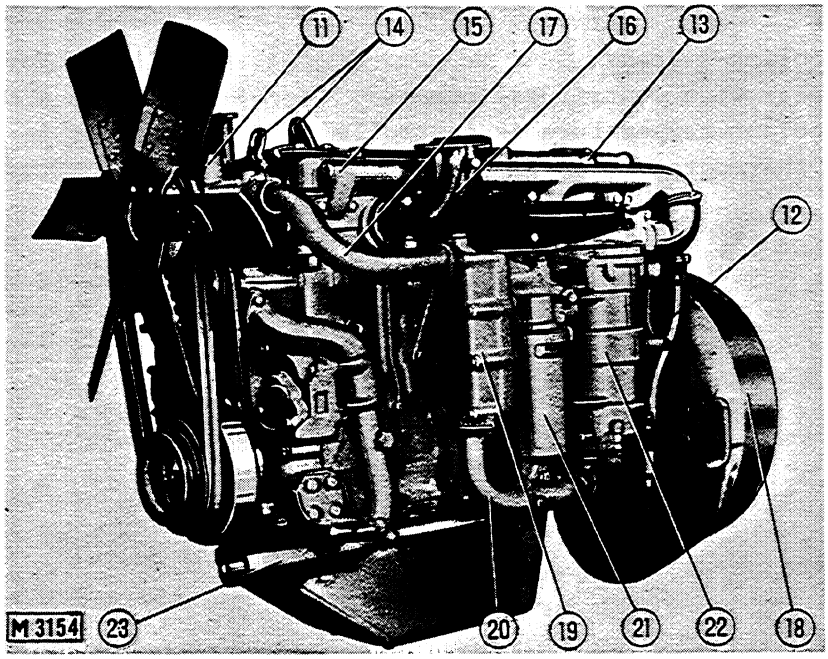


Fig. 3 - L.H. side view of engine 8365.05.560 (fitted on crawler loader FL 10-C).

11. Thermostat - 12. PCV breather pipe - 13. Cylinder head covers - 14. Hoist hooks to remove (install) engine - 15. Coolant header - 16. Exhaust manifold - 17. Oil cooler (19) - to-pump water return pipe - 18. Flywheel cover - 19. Engine oil cooler - 20. Oil cooler (22) -to-oil cooler (19) water return pipe - 21. Engine oil filter - 22. Transmission oil cooler - 23. Water pump suction pipe.

advance of the injection. Equal care must be taken when calibrating the pump in order that its delivery is not beyond the maximum allowed. Increasing the pump delivery to increase engine power would be a mistake, as this would very rapidly damage the engine beyond repair. Correct operation of the injectors must be checked, both for what concerns calibration and jet characteristics.

1.3 8365 ENGINE SPECIFICATION

Cycle	Diesel
Type	naturally aspirated
Strokes	4
Injection	direct
No.of cylinders	6
Bore	115 mm (4.52 in)
Stroke	130 mm (5.11 in)
Total capacity ..	8102cc (494.3 cu in)
Compression ratio	16 to 1
No.of main bearings	7
Crankshaft rotation (fan side view)	clockwise
Engine dry weight	about 960 kg (2116 lbs)

Timing system

Overhead valves with camshaft in the cylinder block.

Fuel system.

Air cleaner: dry type with centrifugal pre-cleaner and two in-series renewable paper elements.
Clogging indicator on instrument panel.

Fuel filter: twin filter with two fabric and paper renewable elements in-series on the fuel pump delivery. Injection system featuring six in-line pumping elements and normal L.H.helix pistons with recovery.

NOTE - Refer to the appropriate "Engine related components" manual for overhauling operations on the injection system of your particular machine.

Lubrication system.

Forced type with twin pump and supply and and recovery gears. Full flow oil filter on the delivery, renewable paper element cartridge with safety valve operating in case of filter clogging.

NOTE - Refer to the appropriate "Engine related components" manual for overhauling operations on the heat exchanger (when fitted)of your particular machine.

Cooling system.
Water with centrifugal pump.
Coolant temperature is controlled by a thermostat.

NOTE - For some applications of this engine a coolant corrosion inhibitor filter is fitted.

2. CYLINDER BLOCK AND CYLINDER HEAD

2.1 CYLINDER BLOCK AND SLEEVES

The cast-iron cylinder block carries the cylinder sleeve seats, the crankshaft main bearings, the camshaft bushing seats, and the valve lifter seats. The cylinder sleeves can be extracted from the top of the block and they are in contact with the coolant. When overhauling make sure the block is not damaged, wash with hot water and soda, then rinse with hot water; degrease all galleries with a suitable product and with compressed air.

⚠ WARNING

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

⚠ WARNING

Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce the danger of personal injury from flying particles. Limit the pressure to 2.1 bar (30 psi) according to local or national requirements.

Check condition of cylinder head fixing studs and renew them if deeply oxidized or stretched because of excessive tightening.

NOTE - On 8365 class engines studs of three different diameters are fitted. Depending on the diameter, the studs are color-keyed as follows.

	Diameter mm -(in)
Stud with blue stripe	15.005-15.045 (0.5907-0.5923)
Stud with no stripe..	15.053-15.116 (0.5926-0.5951)
Stud with red stripe.	15.124-15.164 (0.5954-0.5970)

In case one or more studs have to be replaced, before requesting the spares check stripe color and find the diameter by means of the table; then order the correct pieces referring to the "Spare Parts Catalogue".

Before fitting the cylinder head and oil pan gaskets be sure all surfaces are thoroughly clean.

2.1.1 CHECKING CYLINDER SLEEVE COUNTERBORES

Make sure cylinder sleeve counterbores are parallel to the top face of the

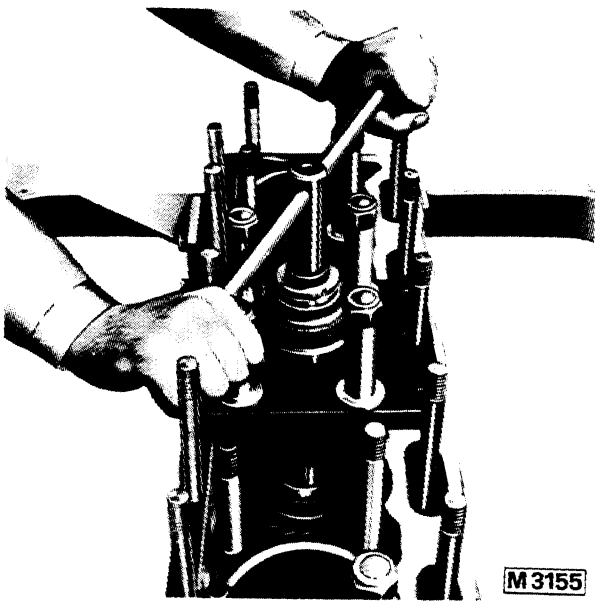


Fig. 4 - Refacing cylinder sleeve bores.

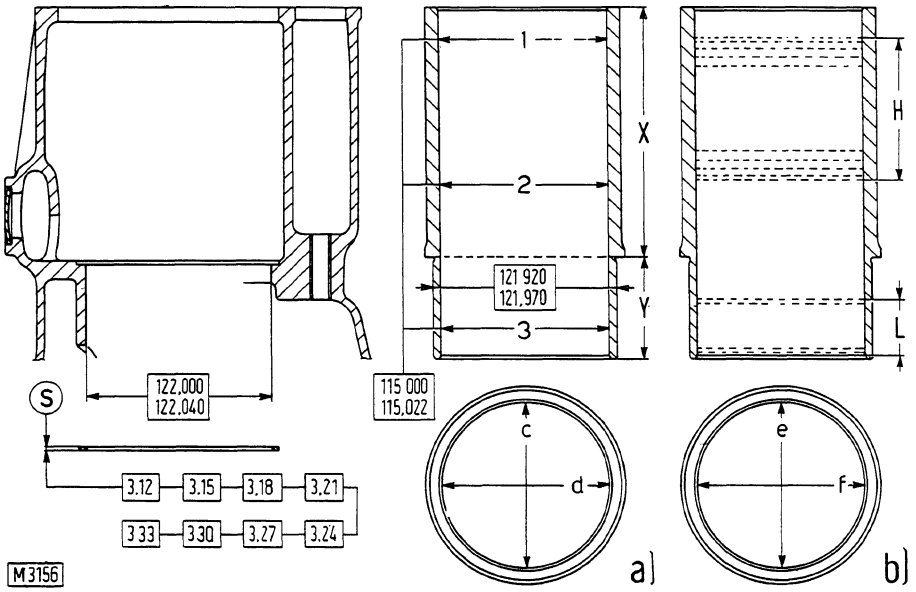


Fig. 5 - Standard dimensions of new cylinder sleeves and relevant bores in the block (a) and checking wear (b). H. Worn sleeve I.D. measuring area to check wear along axes (e-f) - L. Sleeve I.D. measuring area to determine sleeve-to-piston clearance along axis (f) - S. Shims to raise the sleeve - X = 167 mm (6.57 in), Y=68 mm(2.67in) Areas for check of out-of-roundness of new or refaced sleeves - 1,2 and 3. Measuring levels of new or refaced sleeve inner diameters along axes (c-d).

block. If not, parallelism must be obtained with mandrel 75295904, cutter 75295907, bushing 75295833, and expansion cone 75295909 (fig. 4).

To check measure sleeve protrusion at two diametrically opposed points and at 120 mm (4.72 in) from the cylinder axis, with a load of 700 daN (1574 lb) uniformly distributed over the sleeve top plane.

The difference between the two measurements should not exceed 0.040 mm (0.00157 in).

2.1.2 CHECKING AND MEASURING CYLINDER SLEEVES

Check cylinder sleeve surfaces for evidences of seizing, scoring, out-of-roundness, taper, or excessive wear.

Sleeve I.D. measurement to check extent of out-of-roundness, taper or wear should be made with a zeroed dial gauge proceeding as follows :

- measure I.D. of area swept by the piston rings (H, fig.5) ;

- measure this area along axis (e) parallel to the crankshaft and (f) perpendicular to the crankshaft. Take the measurement both at the top and at the bottom ;

- compare figures obtained to determine sleeve out-of-roundness and taper.

To check piston-to-sleeve clearance measure diameter of each sleeve at (L) only along axis (f) perpendicular to the crankshaft.

In case out-of-roundness or taper exceed 0.15 mm (0.006 in) it is necessary to increase the sleeve I.D. by boring 0.60 mm (0.023 in) (see table "Specifications"), or to replace the sleeves if they are already oversized.

Then check sleeve I.D. by placing the dial gauge (duly zeroed) along the perpendicular axes (c-d, fig. 5) and repeating the two measurements on three dif-

ferent planes (1,2 and 3). Moreover ensure that out-of-roundness does not exceed 0.01 mm(0.0004 in) in section (X) or 0.03 mm(0.011 in) in section (Y).

2.1.3 CHECKING SLEEVE FIT TO BLOCK BORE

Main data of cylinder sleeve are given in Fig 5.

Measurement of sleeve O.D must be made at a max. distance of 15 mm(0.59 in) from the resting surface.

Clearance should be 0.03-0.12 mm(0.0011-0 0047 in)

2.1.4 INSTALLING SLEEVES

On installation of serviced or new sleeves, check that the planarity and protrusion of sleeves relative to cylinder block top face is as follows :

- Remove old sleeves and shims (S, Fig.6); if applicable, for later relocation , mark each sleeve, shim and barrel set.
- If sleeves must be reused, clean them and their respective barrel,with chlorothene, to remove any trace of old bonding agent.
- Fit in barrel only one sleeve, complete with shim (S); on the fitted sleeve locate presser plate (**1**) of fixture 75296228.
- Rest plate (3) complete with its 4 dial gauges on a surface plate and zero the gauges
- Position plate (3) on crankcase through the two cylinder head studs (A) and make sure that gauge plunger rods are properly inserted through the slots in plate (1). Connect the plate with plate (3) by tightening screws (4).
- Introduce top plate (5) complete with screws (7) onto the four cylinder head studs (A, C) and secure to crankcase by the four knurled ring nuts (6)
- Tighten screw (7) to specified torque of 10.8 daNm and check on all four dial gauges that proudness of the sleeve is within 0.13 to 0.17 mm; if not, vary the thickness of shim pack (S) as required.
- Proceed in the same way with the remaining sleeves, after extracting the first sleeve already checked, with its shim Make sure that the top edges of all sleeves lie on the same plane; allowed tolerance is 0.04 mm ("0.0016")
- On accurately degreased sleeve locating area in crankcase, apply a thin coat of LOCTITE type HVX/PIPE SEALANT No. 576 for a width X of 3 to 4 mm; avoid dripping.
- Fit the sleeves in barrels, and relevant shims, ensuring proper location.
- Considering that 24 hours are needed for sealant curing, if the crankcase (with piston/rod set) must for some reason be turned during this period, the sleeves should first be secured to crankcase using spacers 75297628 inserted on cylinder head studs.

2.2 OIL PAN

To remove the oil pan without removing the engine refer to "Engine related components" of your particular machine.

Before reinstalling the oil pan on the block, wash the pan with hot water and soda and rinse with cold water Reinstall

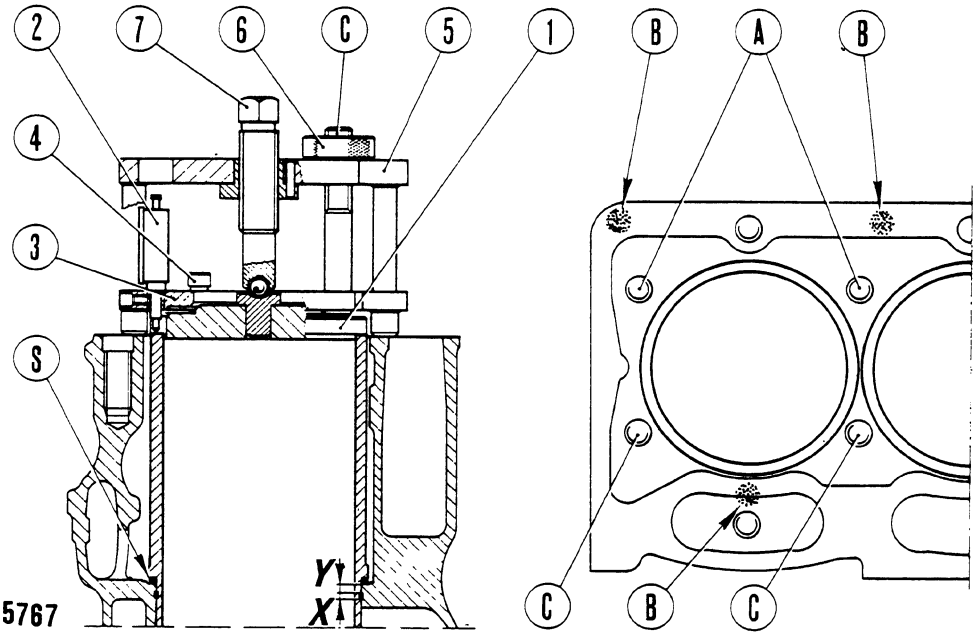


Fig. 6 - Checking cylinder sleeve proudness relative to crankcase top.

A. Cylinder head studs used for mounting plates (3) and (5) - B. Plate (3) contact spots on crankcase - C. Cylinder head studs used for mounting plate (5) - S Sleeve proudness adjustment shim - X = 3 to 4 mm,sealant coating width - Y. = 4 mm, sleeve abutment to shim distance - 1. Presser plate-- 2 Dial gauges - 3. Dial gauge carrier plate - 4. Screws securing plate (1) to plate (3) - 5 Top plate - 6. Ring nut - 7 Screw.

pan as follows:

- always renew the complete gasket(gasket may be in one piece or in three separate pieces) ;

- stick the gasket (or the gasket elements) to the pan with sealant making sure holes register with one another. When dry make sure the ends of the gasket are flush with the rear of flange surface, and trim off the excess material;

- smear sealant on the joint areas and on the thread of the three capscrews securing the pan to the rear engine mount ;

- install the pan and tighten the screws by alternate selection.

2.3 CYLINDER HEAD

Lift cylinder head clear of engine block by means of hoist as shown in fig. 7.

NOTE - Never remove cylinder head with engine hot to prevent any distortions.

Check head resting surface on a reference plane covered with soot and if necessary use a scraper to eliminate slight distortions or lap the surface on a surface grider for distortions greater than 0.15 mm (0.0059 in).

WARNING

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

In case grinding is made, max.thickness to be removed must not exceed 0.5 mm (0.0196 in).

Bear in mind that cylinder head height when new is 99.780-100.00 mm (3.928 - 3.937 in).

In either case, install injectors and valves and ensure that :

- nozzle protrusion (L) above the deck is as per fig. 8 ;

- valve inset (H) in the deck is as per fig. 9.

In case injector protrusion is below the min. value indicated, reface the

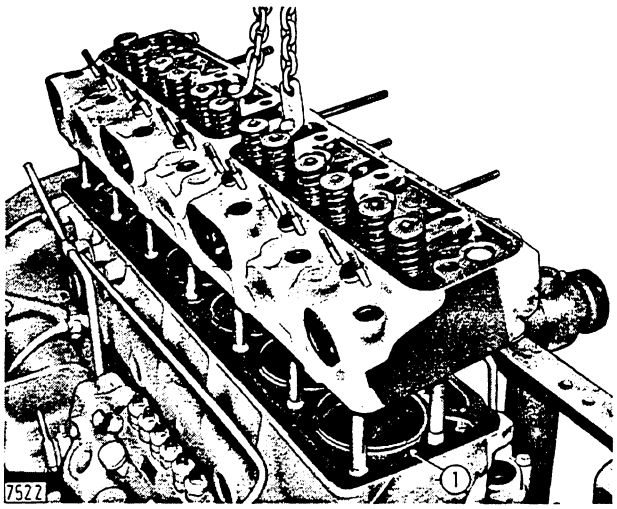


Fig. 7 - Removing (installing) cylinder head on roll-over type stand.
1. Locating dowel.

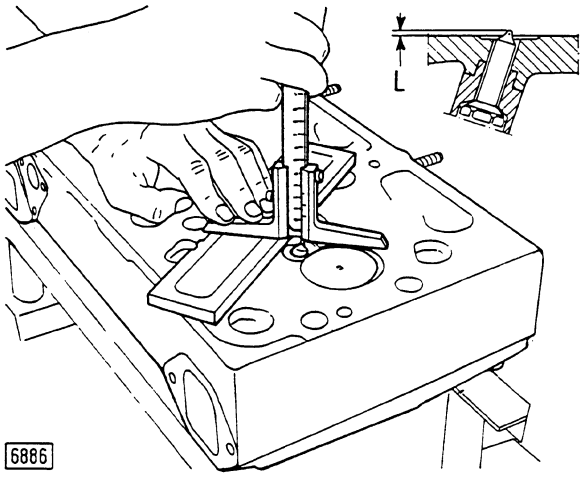


Fig. 8 - Checking injector protrusion on cylinder head deck.
L = 2.85-3.55 mm (0.112-0.139 in).

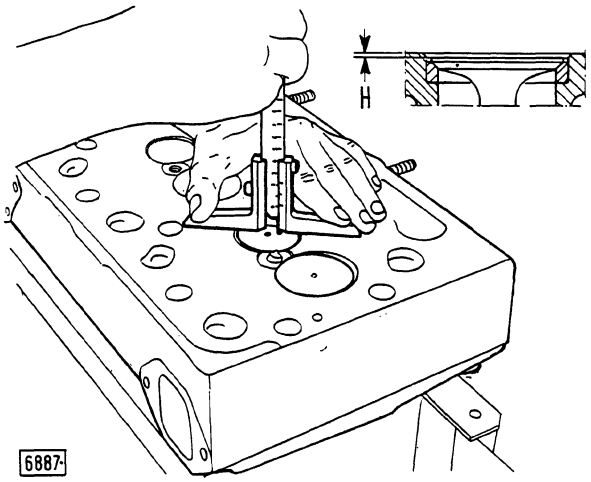


Fig. 9 - Checking valve inset in the cylinder head.
Intake valve H= 0.1-0.5 mm (0.0039-0.0196 in)
Exhaust valve H= 0.4-0.8 mm (0.0157-0.0314 in)

injector conical seat on the holder with miller cutter 75291339; if protrusion is greater than the max. value allowed renew holder.

To renew injector holders use: screw tap set 75290687 to thread them and puller 75290633 to remove them from the head.

Check head tightness at the injector holder expansion plugs; if in doubt renew suspect parts. Small leaks of the injector holders may be eliminated by using punch 75295632 (fig. 10).

Ensure injector tightness at the bottom of the holders by grinding the conical contact surface with end teeth miller cutter 75291339 (fig. 11).

Thoroughly wash the head after any operation to remove any abrasive matters.

WARNING

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

WARNING

Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce the danger of personal injury from flying particles. Limit the pressure to 2.1 bar (30 psi) according to local or national requirements.

When reinstalling cylinder head observe the following procedure :

- place cylinder head gasket on block with the word "ALTO" facing up ;

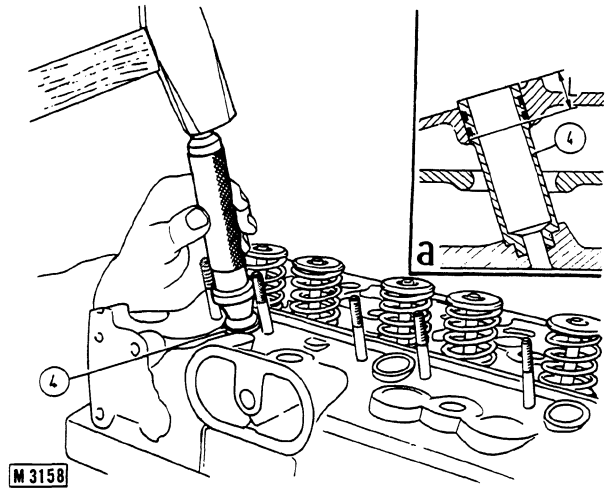


Fig. 10 - Swaging injector holders (4) with punch 75295632.
a. Section view of injector holder.
L = 20 mm (0.787 in). Max.depth of swaging allowed.

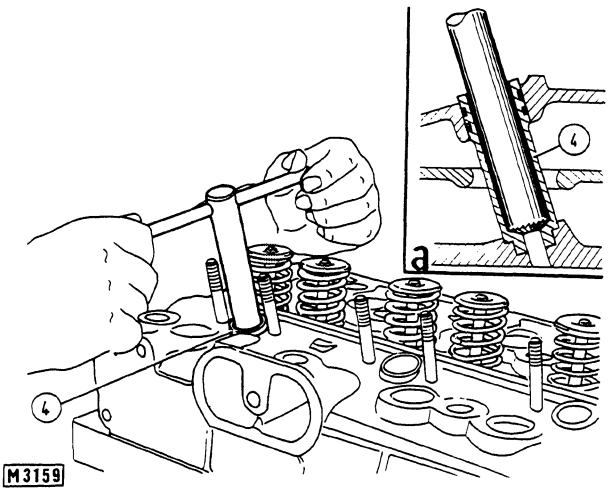


Fig. 11 - Refacing injector holder (4) with end teeth miller cutter 75291339.
a. Section view of injector holder and cutter working position.

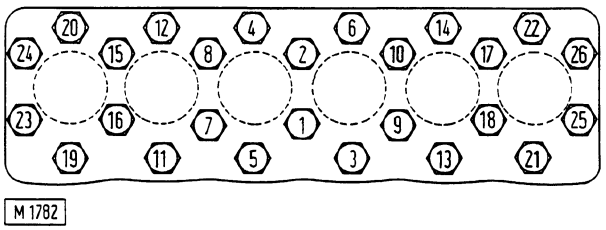


Fig. 12 - Cylinder head stud nuts tightening sequence.

Note - Prescribed tightening torque is to be achieved in at least three stages, following the sequence above.

- install cylinder head on engine block;

- tighten nuts following the sequence shown in fig. 12 in three different stages to the following torques :

- stage 1.....12 daNm (88.51 lb ft)
- stage 2.....17 daNm (125.3 lb ft)
- stage 3.....22 daNm (162.2 lb ft)

NOTE - Do not use sealant or lubricant on the cylinder head gasket.

2.3.1 VALVE SEAT GRINDING

Use tool 75291113 to rest cylinder head and support 75291112 to position the valves.

To grind valveseats use manual universal lathe 75292913 proceeding as follows :

- remove deposits in the passages and carefully clean the valve guide inside before mounting the tool pilot ;

- work with tool secured by means of special tilting support ;

- set tool to zero on the seat centerline ;

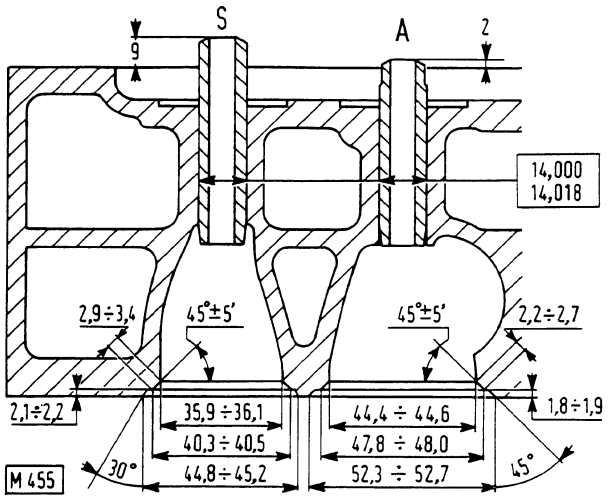


Fig. 13 - Valve seat and valve guide dimensions (Intake A-Exhaust S) on cylinder head and valve guide protrusion on head deck.
25.4 mm = 1 inch.

- make 0.1 mm (0.0039 in) deep cuts until the valve seat is completely refaced ;

- make a 0.05 mm (0.0019 in) finishing cut.

By suitably changing the lathe tools it is possible to reduce the seat width according to fig.13. If after repeated grindings the valve inset in the head exceeds the prescribed value(fig.9) it is possible to salvage the cylinder head by regrindingits contact surface on the block.

NOTE - To check seat contact on the valve head, smear head with Prussian blue and bounce the valve on the seat (never rotate the valve to check tightness). A thin continuous line should be noticed on the valve head; otherwise additional grinding is required.

3. TIMING SYSTEM

3.1 CAMSHAFT

The camshaft, located in the engine block, is supported by seven bushings coated with anti-friction material. The camshaft is held in place at the front by a thrust plate (1,fig. 14).

For camshaft removal proceed as follows:

- remove complete engine (see "Engine related components" manual of your machine) and place it on roll-over stand;
- remove oil pan ;
- dismantle cylinder head ;
- remove timing gear cover ;
- extract valve lifters with tool 75290633 ;
- remove screws C_1, securing camshaft thrust plate to engine block and withdraw camshaft.

When the camshaft bushings have to be removed, also the rear engine support casing and the crankshaft have to be removed.

Use puller/installer 75295455 with adaptor 75295457 to remove (and install) bushings from/to the block.

WARNING

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

3.1.1 CHECKING CAMSHAFT AND RELEVANT SEATS

Check camshaft journal and bushings for wear (fig.15) and check clearance between them (see table "Specifications").

The bushings are not supplied with undersized I.D. and when clearance exceeds 0.25 mm (0.0098 in), if replacement does not cure the problem, renew camshaft.

The bushings must have a tight fit on the block ; if gap exists, renew them.

Examine bores of the bushings : if seized or scored renew them.

WARNING

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

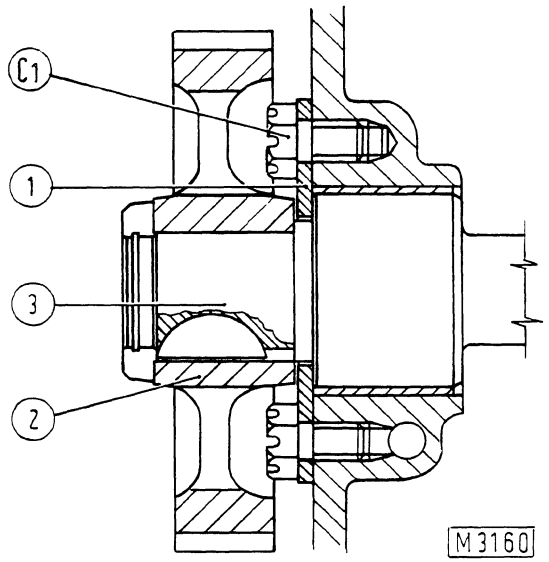


Fig. 14 - Camshaft front end section.
C_1. Plate (1) self locking screws - 1. Thrust plate - 2. Drive gear - 3. Camshaft.

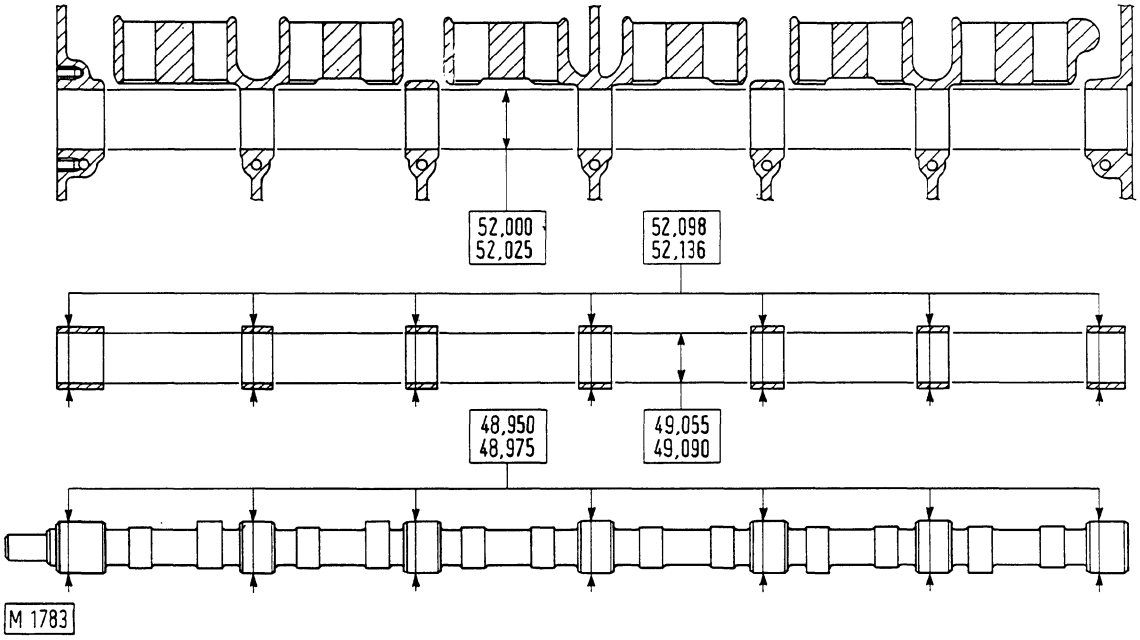


Fig. 15 - Dimensions of camshaft journals, bushings and relevant seats.
Note - Bushing inner diameter must be obtained by grinding after fitment.

If bushings are very slightly damaged , reface with a burnisher.

In case bushings are renewed, after fitment their bore should be reamed with mandril and milling cutters 75295830 to get an inner diameter of 49.055-49.090 mm (1.931-1.932 in).

Make sure camshaft journal and cam surfaces are smooth and bright. If they are seized or scored renew camshaft.

Only if damage is very slight, it can be eliminated with very fine grade emery cloth.

Moreover check camshaft for straightness: a micrometer gauge placed on the camshaft center journal should not indicate variations greater than 0.20 mm (0.008 in) ; if higher values are indicated the camshaft cannot be straightened with a press and it should be renewed.

NOTE - In case gear (2,fig.14) should be renewed, install thrust plate (1) on the camshaft and heat gear (2) in oven to obtain a difference in temperature between camshaft and gear of about 240°C (464°F).
Install gear on the shaft and check end play between gear and thrust plate to be 0.060-0.110 mm (0.0023-0.0043 in).
In case the camshaft has to be renewed, the spare comes complete with gear and thrust plate.

3.2 VALVES AND VALVE GUIDES

To dismantle the valves remove cylinder head, compress springs with tool 75291050 (fig.17) and remove split cone keepers (1).

Thoroughly clean valves and check that stem and seat are not cocked or show signs of seizing or scoring; if damaged renew valves.

If required, it is possible to grind the rocker arm at its point of contact with the valve stem. Remove as little material as possible as the thickness of the hardened material is 2-3 mm (0.08-0.12 in).

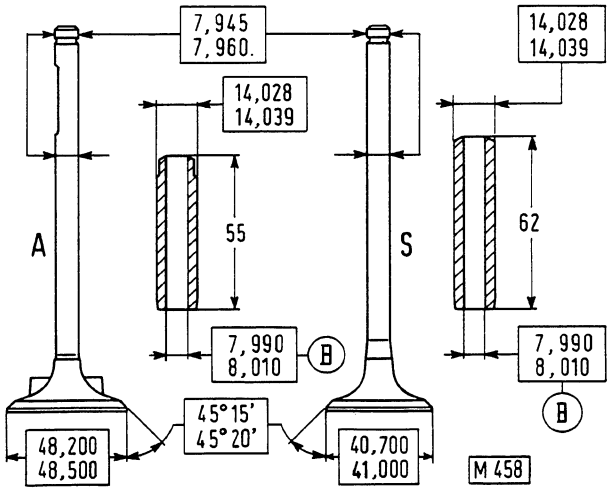


Fig. 16 - Main dimensions of intake valves (A) and exhaust valves (S) and relevant guides.
B. Value to be obtained after installation.
25.4 mm - 1 inch

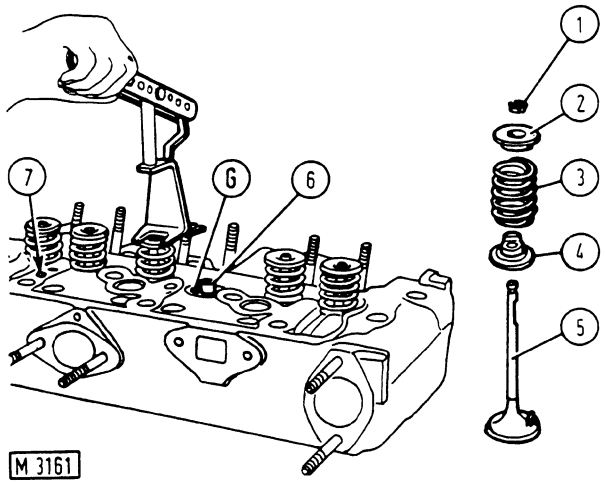


Fig. 17 - Dismantling (installing) valves and springs with tool 75291050.
G. Locating dowel for retaining cup (4) - 1. Split cone keeper for upper retaining cup (2) - 3. Spring - 4.Lower retaining cup - 5. Intake valve - 6. Valve guide - 7. Rocker arm lubrication gallery.

Valve springs must not be cracked or stressed; before installation check load and compression data of the springs (see table "Specifications").

If different figures are obtained discard springs.
Measure valve stems with a micrometer and guides with set 75292867.
If play exceeds value listed in table below, replace valves; if this is not enough to bring value back to normal replace valve guides as well.

Valve guide inner dia. mm (in)	Valve stem dia. mm (in)	Stem to guide clearance mm (in)
7.990-8.010 (0.314-0.315)	7.945-7.960 (0.312-0.313)	0.030-0.065 (0.002-0.0025)

Valve guides have have an interference fit in the cylinder head.

To remove (install) valve guides from/ to cylinder head, use installing tool 75291046 (fig.18).

Check valve guides bearing in mind that:

- bore surface of each guide must be smooth and without scoring, seizing,or scale ;

- guides must have an interference fit in the seats. If slack, oversized guides are available(see table "Specifications") ;

- guides installed must protrude above cylinder head as shown in fig. 13;

- after installation, guides must always be ground with reamer 75290944.

The exhaust valve guides are 7 mm (0.275 in) longer than the intake valve guides.

After installation make sure that :

- valves are below cylinder head deck as indicated in fig. 9 ;

- split cone retainers (1, fig. 17) are perfectly seated in their housings;renew them if in doubt.

3.2.1 ROCKER ARM-TO-VALVE CLEARANCE ADJUSTMENT

Rocker arm-to-valve clearance adjustment must be done with the utmost care.

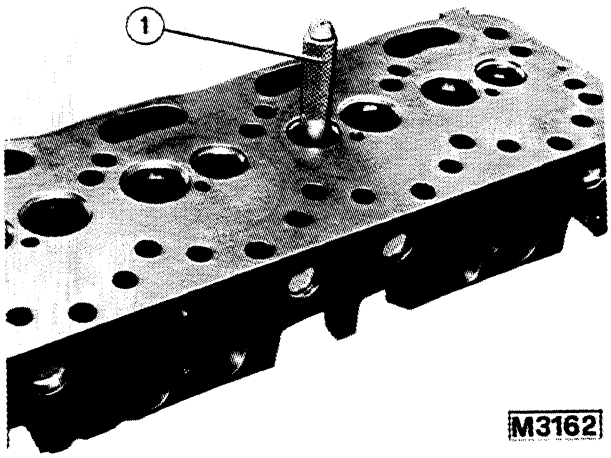


Fig. 18 - Dismantling valve guides.
1. Installing tool 75291046.

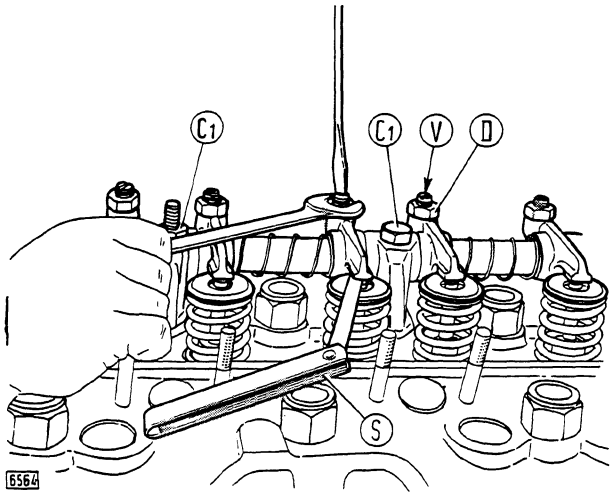


Fig. 19 - Adjusting rocker arm-to-valve clearance. C_1. Rocker arm shaft carrier capscrew - D. Screw (V) stop nut - S.Feeler gauge - V. Clearance adjusting screw.

Excessive clearance will cause noise, retard valve opening and advance closing, whereas too little clearance will produce opposite effects.

If no clearance exists the valves are always slightly open, which in time will damage valves and seats.

To adjust rocker arm-to-valve clearance proceed as follows :

- slowly rotate crankshaft to bring it to the power stroke of the cylinder on which rocker arm-to-valve clearance is to be adjusted.

The valves of this cylinder are closed when they balance the valves of the mated cylinder.
Cylinder mating for clearance adjustment is 1-6, 2-5, 3-4, hence it is possible, by balancing the valves of the first cylinder of each pair, to adjust the valves of the second and vice versa.

Keep adjusting screw locked and slacken stop nut; insert a feeler gauge blade (fig.19) between rocker arm and valve stem, then act on adjusting screw until the gauge slides with a slight friction between the two parts; at this point keep adjusting screw locked and tighten nut.

Operating clearance between valves and rocker amrs, with engine cold, should be :

- intake ..... 0.25 mm (0.0098 in)
- exhaust ..... 0.30 mm (0.0118 in)

After adjustment on one cylinder repeat operation on the others.

3.3 VALVE LIFTERS AND ROCKER ARMS

To dismantle valve lifters cylinder head must be removed and tool 75290947(fig.20) should be used.
Checks required are :

- check that lifter surface in contact with the cams is perfectly smooth and not dented ;

- check clearance with reference to the seats: if above 0.10 mm (0.0039 in) replace lifters with oversized ones and reface seats on the block (see table "Specifications").

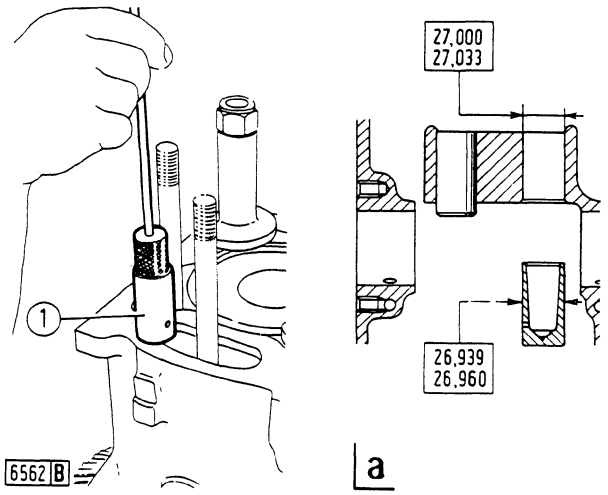


Fig. 20 - Removing(installing) lifters (1) with tool 75290947 and main dimensions of lifters and seats in the block (a).

Note - Lifter shown is a pre-modification type. Post-modification type differs from type shown only in the different external shape (convex). I.D. measurement must be made at 17.5 mm (0.688 in) from lifter top surface.

Max. diameter of post modification convex type lifters must be measured at 17.5 mm (0.688 in) from lifter top surface.

NOTE - Post-modification lifter is interchangeable even as a single item with pre-modification lifter, without having to replace the whole set.

When refitting lifters lubricate surfaces with engine oil.

Check that push rods are not bent and that rocker arm contact spherical seat is not seized or rough. If damaged renew them.

Rocker arms are hinged on two separate shafts. To remove end bearing (8,fig. 21) from shafts remove screw (V_1).

Make sure contact surfaces between shafts and rocker arms are not scored or seized, otherwise renew failed components.

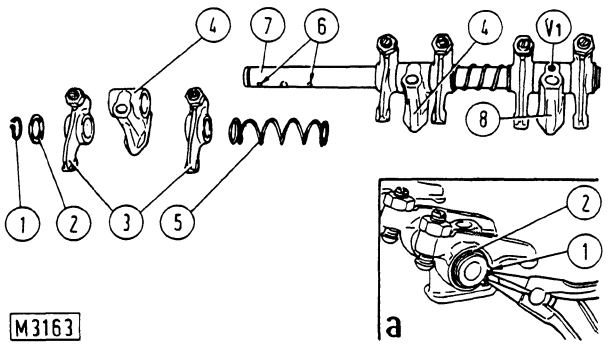


Fig. 21 - Removing (installing) retaining clip (a) and dismantled parts of a rocker arm shaft.
V_1. Support (8) fixing screw - 1. Retaining clip - 2. Washer - 3. Rocker arms - 4. Intermediate supports - 5. Spacer spring - 6. Lubrication holes - 7. Rocker arm shaft - 8. End support.

If damage is very slight it can be eliminated with a very fine grade abrasive stone.

Check clearance between rocker arm and shaft; with engine new or overhauled it should be 0.014-0.065 mm (0.0005-0.0025 in) and clearance between support and shaft should be 0.004-0.046 mm (0.00015-0.00181 in);discard components causing wider clearances.

Reinstall rocker arm shafts arranging components as shown in fig. 21 and considering the following :

⚠ WARNING

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

⚠ WARNING

Wear safety glasses with side shields or goggles when using compressed air for cleaning to reduce the danger of personal injury from flying particles Limit the pressure to 2 1 bar (30 psi) according to local or national requirements.

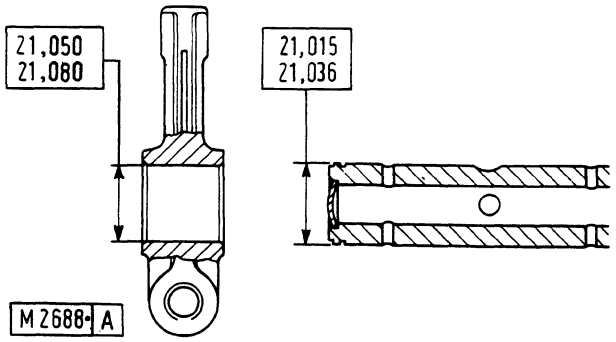


Fig. 22 - Rocker arm shaft and rocker arm bore dimensions.

- make sure holes (6, fig.21)and relevant oil galleries are not clogged ;

- orientate rocker arm shafts with milled face towards support capscrew holes;

- install supports (8) on the shaft ends and secure them by means of screws (V_1).

When refitting rocker arm assy make sure the end rocker arms rotate freely.

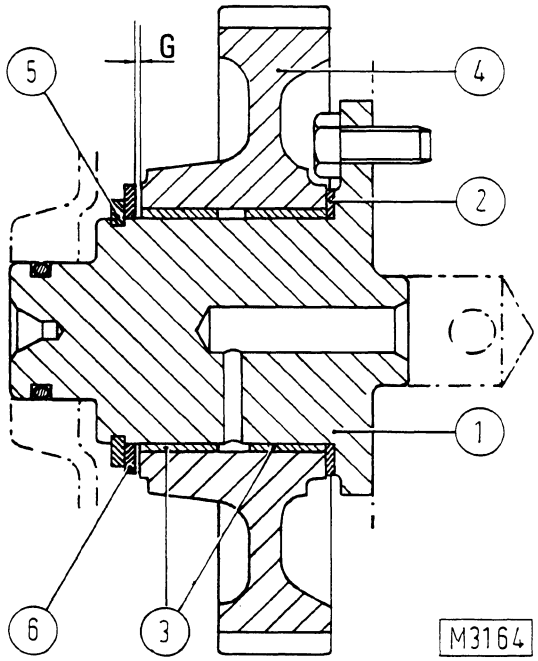
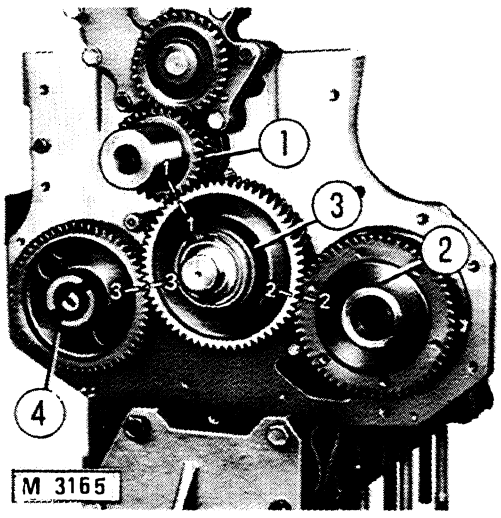


Fig. 23 - Section view of driven idle gear assy.
G = 0.05-0.308 mm (0.00196-0.01212 in): clearance between gear and thrust ring to be checked when assembled - 1. Hub - 2. Thrust ring - 3. Bushings - 4. Idler gear - 5. Gear (4) retaining clip - 6.Thrust ring.
Note - Bushings (3) must have a flush fit on gear(4) to allow a good lubrication.



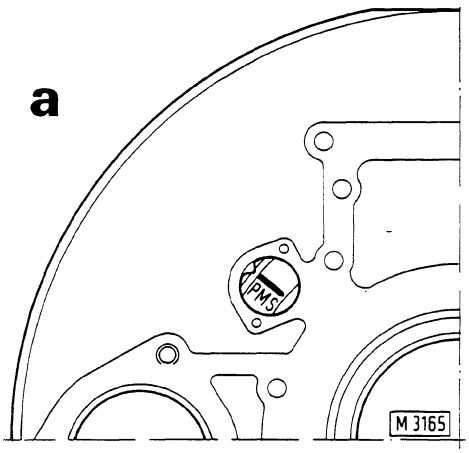


Fig. 24 - Timing gear alignment.
a. Mark on flywheel indicating T.D.C. of piston 1 and 6 - 1. Drive gear - 2. Injection pump drive gear - 3. Idle gear - 4. Camshaft driven gear.

3.4 TIMING GEAR ALIGNMENT

To align timing gear proceed as follows:

- preliminary set to 0.25 mm (0.0098in) clearance between valves (intake-exhaust) and rocker arms of cylinders 1 and 6 ;

- slacken injectors and rotate crankshaft until T.D.C. mark 1-6 (on front ring of flywheel) and fixed timing mark (fig.24) are aligned ;

- install timing gears (fig.24)keeping marks aligned ;

- rotate cranskahft some degrees in opposite directions and make sure cylinder No.1 is in the expansion stroke;consequently the two valves must be closed, whereas valves of cylinder 6 must be open and balance within angular values listed in table "Specifications".Otherwise remove gears,turn crankshaft 180° and repeat operation.

4. CRANK MECHANISM

4.1 CRANKSHAFT

WARNING

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

To dismantle crankshaft proceed as follows :

- remove engine (for this operation see corresponding "Engine related components" manual of your particular machine) ;

- remove oil pan and install engine on rotating stand (fig. 25) ;

- remove oil pump and cylinder head ;

- remove timing front cover and rear engine support housing ;

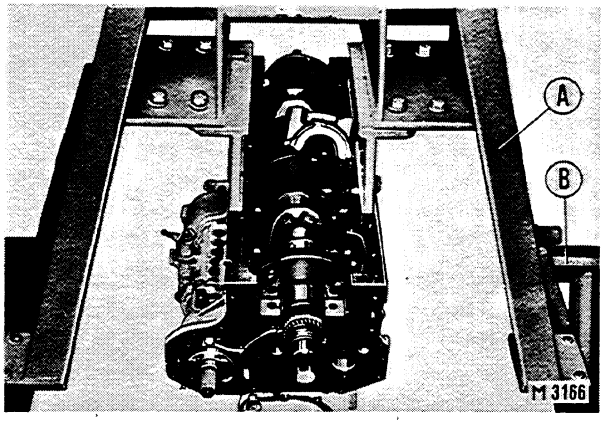


Fig. 25 - Crankshaft on the engine (connecting rod caps and main bearing caps removed).

A. Brackets 75293002 securing engine to rotati stand - B. Rotating stand 75290090.

- remove connecting rod caps and main bearing caps and lift crankshaft.

WARNING

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

Wash crankshaft and carefully examine it; if cracked even slightly renew it.

4.1.1 MAIN AND CONNECTING ROD JOURNAL REFACING

WARNING

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

If signs of seizing or scoring are noticed on main and connecting rod journals, they must be measured with a micrometer to establish on the basis of the bearing undersize scale (see table "Specifications") to what diameter they must be ground, bearing in mind that clearances are :

- between main journal and shell : 0.050-0.108 mm (0.00196-0.00425 in) ;

- between connecting rod journal and shell: 0.058-0.111 mm (0.0022-0.0043in).

When refacing crankshaft journals strictly observe the fillet radii.

After grinding suitably chamfer lubrication holes on journals (a and b,fig.26).

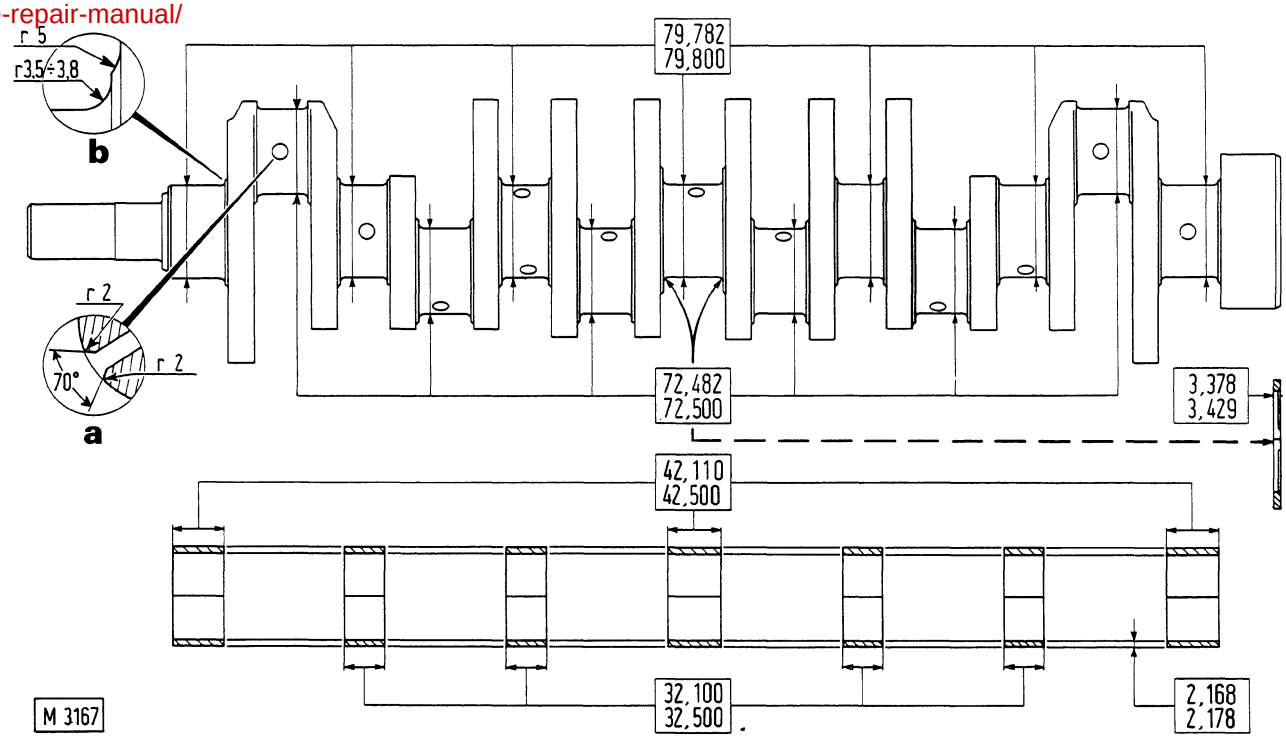


Fig. 26 - Standard dimensions of journals, main bearings and shells.
a. Detail of lubrication hole chamfer - b. Detail of main connecting rod journal fillets.
25.4 mm - 1 inch

4.1.2 CHECKING MAIN AND CONNECTING ROD JOURNAL ALIGNMENT

This check should be made after grinding the crankshaft journals by placing the crankshaft on V blocks and using a micrometer gauge.

Make sure that :

- journal out-of-roundness does not exceed 0.005 mm (0.00019 in) ;

- the axis of each pair of connecting rod journals and the axis of the main journals are on the same plane; max. tolerance perpendicular to this plane is ±0.25 mm (± 0.0098 in) (fig.27) ;

- taper of each journal is less than 0.01 mm (0.00039 in);

- max.tolerance on main journal alignment (total gauge reading) is 0.05 mm (0.00196 in) (fig. 27) ;

- distance between connecting rod journal outer surface and crankshaft axis of rotation is within ±0.10 mm (0.0039 in (fig. 27) ;

- a gauge placed in (A,fig.27), on a diameter of 119 mm (4.68 in)does not reveal perpendicularity variations higher than 0.025 mm (0.00098 in) and the same gauge placed on flywheel centering seat (B) does not indicate variations higher than 0.03 mm (0.00118 in).

4.1.3 CHECKING AND ADJUSTING CRANKSHAFT END PLAY

Check crankshaft end play (with crankshaft installed in the block) by using a magnetic mount gauge (fig. 28). Play should be 0.068-0.270 mm (0.0026-0.0106 in).

If a different figure is obtained, replace thrust half rings with others having a more suitable thickness.