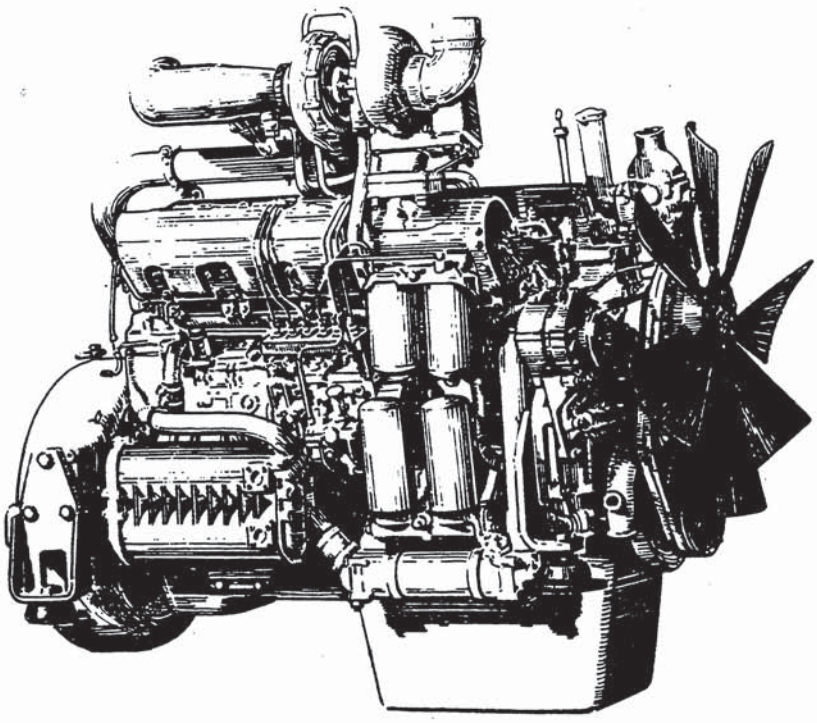
FIATALLIS

8205
Engine

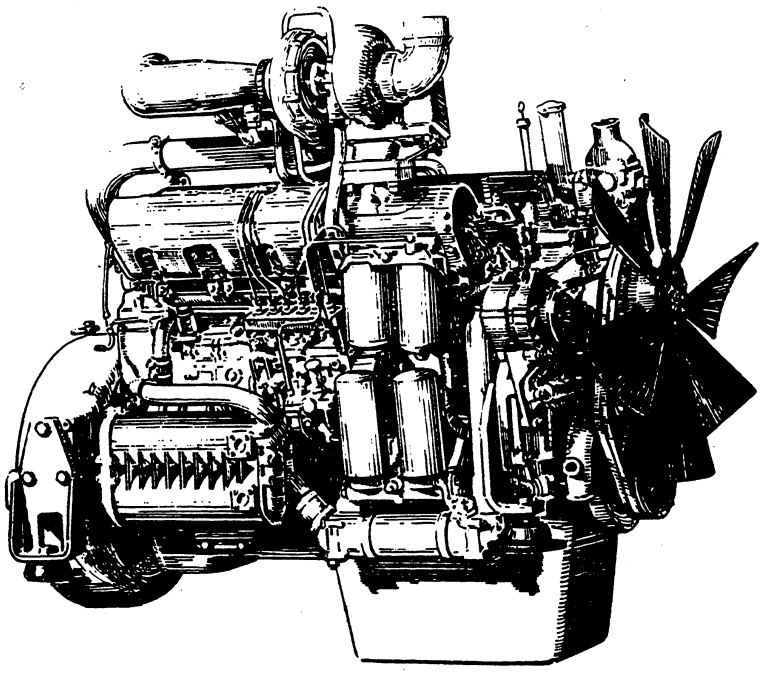
Service manual



Form 604.06.243 - English

8205
Engine

Service manual



Form 604.06.243 - English

8205 Engine

service manual

Form 604.06.243 - English

NOTE – This III print includes supplement No. 1 regarding specification of 8205.03 engines.

⚠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.

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 contains service instructions for parts common to class 8205 engines listed below.

Engine type	Application
8205.02.520	FL 14-C crawler loader
8205.02.531	14-C crawler dozer (Full Power Shift)
8205.02.533	14-C crawler dozer (Clutch and Power Shift)
8205.02.575	S15B crawler excavator
* 8205.03.531	FL14D/FD14 crawler loader/dozer
8205.03.531	FP 40 pipelayer

Service and overhaul procedures described herein are valid for all engine applications shown above. Any differences are indicated by the specific engine type number concerned.

See Section 1.1.1 for engine type number interpretation.

Capacities of the crankcase, cooling system, etc. vary depending upon the unit in which the engine is used, and may be found in the Operation and Maintenance Instruction Manual furnished with the unit.

The following topics are not covered herein, as they differ from machine to machine:

- Starter.
- Alternator.
- Engine removal and installation.

For these topics, see the Service Manual for the unit concerned.

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.

CONTENTS

1. GENERAL

1.1 ENGINE IDENTIFICATION

Each engine is identified by means of two numbers, the engine type number and the serial number, stamped on left side of cylinder block.
The engine type and serial numbers should always be quoted when ordering spare parts.

1.1.1 ENGINE TYPE

All engines installed on a given type of machine carry the same engine type number, which is to be interpreted as follows:
1st digit: 8 = "engine"
2nd and 3rd digits: identify engines of substantially similar design.
4th digit: 5 — indicates that it is installed on earth moving machinery;
5th digit: indicates a design feature of engine through code below.
0 = naturally aspirated engine
2 = turbo-charged engine;
6th digit: identifies series to which engine belongs within the same project;
7th, 8th, 9th digits: indicate engine variant.

1.1.2 ENGINE SERIAL NUMBER

Engine serial is a progressive number given to each engine during production.

1.2 DIESEL ENGINE OPERATION

1.2.1 GENERAL

In diesel engines, fuel and air is mixed directly in the combustion chamber. As a result of the high pressure to which the air is subjected, its temperature increases to the point where the air/fuel mixture ignites spontaneously.

In fact, when the air is brought rapidly to a pressure of 30 bar or 435 psi its temperature reaches 700°C (1290°F), sufficient to cause spontaneous combustion. During the intake stroke, only air enters the cylinder. Naturally, an effective air cleaner must be placed at the end of the intake manifold to prevent dust and impurities from entering the cylinder, thus causing irrepairable damage to engine components.

Air entering the cylinder may be drawn directly from the outside atmosphere during piston downstroke, as occurs in naturally aspirated engines, or it may be pre-compressed by an exhaust gas activated turbocharger, as in supercharged engines. After being drawn into the cylinder, the air is compressed, and, as a result, heated to a temperature high enough to ignite the fuel spontaneously.

Fuel is introduced directly into the cylinder (direct injection) towards the end of the compression stroke, and slightly before piston top dead center.

At the start of injection, atomized fuel is sprayed from the injector nozzle at high pressure (approximately 200 bar, 2900 psi), and penetrates the compressed air in the combustion chamber. Part of the fuel then begins to burn rapidly as a result of the high air temperature.

This part of the fuel burns so rapidly that it can be considered to explode.

The resulting great increase of temperature in the combustion chamber, together with the rapid swirling motion imparted to the air, combine to permit complete ignition of the fuel which continues to enter the combustion chamber from the injector.

The operating cycle is completed by the power and exhaust strokes, and is repeated every two revolutions of the crankshaft.

The operating cycle is completed by the power and exhaust strokes, and is repeated every two revolutions of the crankshaft.

1.2.2 FUEL INJECTION REQUIREMENTS

Correct fuel injection, and hence optimum engine performance, depend on:

a) Injection timing. — For proper functioning, injection should always take place at the same point of the operating cycle.
This point may, if necessary, be modified in accordance with engine speed by means of an automatic advance device.

b) Amount of fuel injected. — In order for the engine to develop the required power, the amount of fuel injected must remain constant and be the same for all cylinders. This amount of fuel must be determined in accordance with the engine requirements and, obviously, must be able to vary with the load applied to the engine.

c) Method of injection. — The fuel spray must:
- — Be sufficiently atomized to permit immediate combustion;
- — Fully penetrate the compressed air;
- — Spread in all directions so that the greatest possible amount of air in the cylinder can be used in combustion.

The fuel injection system, and in particular the pump and injectors, perform all these functions.
When adjusting fuel injection pump timing, care should be taken that injection advance is as prescribed to avoid causing irrepairable damage to engine and fuel injection system. Care should also be taken when adjusting fuel injection pump calibration to ensure that the maximum limit is not exceeded. Never try to increase engine power by increasing pump output, as this would cause permanent damage to the engine.

Also check injector calibration and spray characteristics.

1.3 SPECIFICATION, ENGINE 8205

1.3.1 TYPE

6 cylinder in-line vertical diesel engine.

Engine internal structure and characteristics are shown in figure 73.

Cycle.....Diesel
Aspiration.....natural
Number of strokes.....4
Injection.....direct
Number of cylinders.....6
Bore..... 122 mm or 4.8 in
Stroke..... 140 mm or 5.51 in
Total displacement.....9820 cm^3 or 599.2 in^3
Compression ratio.....16.7 to 1
Number of main bearings.....7
Crankshaft rotation (viewed from fan end) clockwise
Maximum speed, full load.....2000 rpm
Maximum torque speed.....1400 rpm
Maximum speed, no-load.....2200 rpm
Minimum speed, no-load..... 500 to 550 rpm
Engine weight (without fluids) approx. 960 kg or 2112 lb.

Valves
Type.....overhead, 2 per cylinder, pushrod operated
Valves open:
— intake..... 18° BTDC
— exhaust..... 54° BBDC
Valves close:
— intake.....54° ABDC
— exhaust..... 18° ATDC

Fuel system:
Fuel filters..... 2, series mounted, cloth and replaceable paper elements.

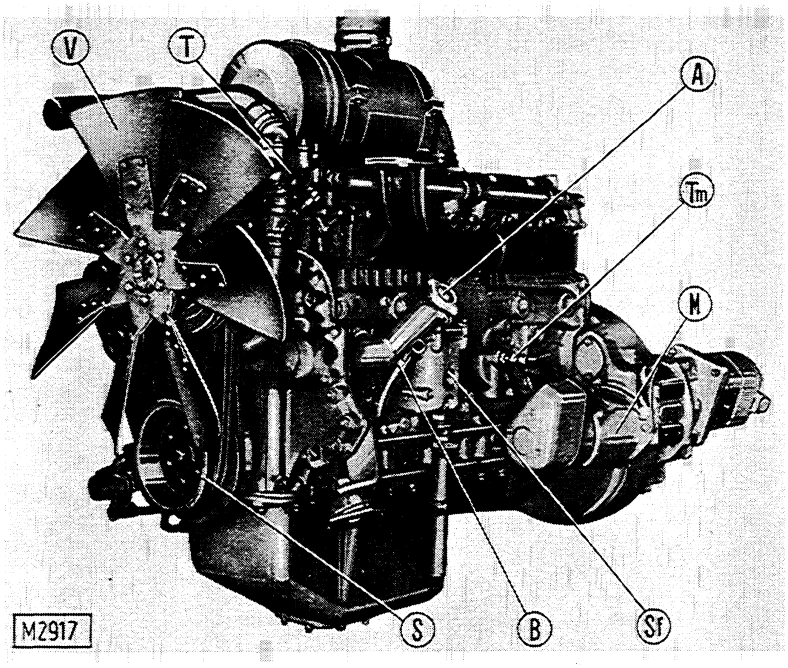


Fig. 1 - Left side view of engine 8205.02.531

A. Oil filler cap. - **B.** Dipstick. - **M.** Starter. - **S.** Crankshaft vibration damper. - **Sf.** Vent. - **T.** Thermostats. - **Tm.** Hourmeter sending unit. - **V.** Fan.

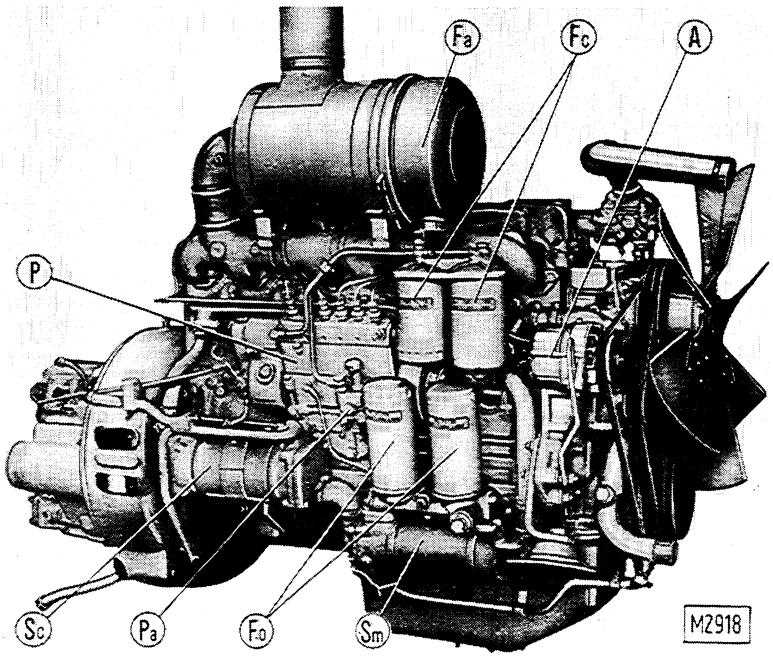


Fig. 2 - Right side view of engine 8205.02.531.

A. Alternator. - **Fa.** Air cleaner. - **Fc.** Fuel filters. - **Fo.** Oil filters. - **P.** Fuel injection pump. - **Pa.** Fuel pump. - **Sc.** Converter oil cooler. - **Sm.** Engine oil cooler.

Fuel injection:

- Plunger-type fuel pump with sediment bowl filter
- Injection pump with full range governor
- Automatic advance.

Firing order..... 1-5-3-6-2-4

Air cleaner

Dry type with integral automatic dust ejection pre-cleaner and secondary elements.

Lubrication

Forced feed type, with double gear pump, feed and scavenging.

Oil filter

- Suction..... gauze
- Outline.....twin, paper elements

Oil is cooled by an oil-to-water heat exchanger connected to the engine cooling system.

Cooling system

Type..... water
Pump..... centrifugal
Thermostats.....2, side by side

2. CYLINDER BLOCK AND CYLINDER HEADS

2.1 CYLINDER BLOCK AND SLEEVES

The cylinder block is a one-piece casting made of alloy cast iron.
The main oil gallery extends lengthwise through the left side of the cylinder block. Oil passages direct oil from main oil gallery to main bearings, camshaft bearings and cylinder heads.
The cylinder block is bored to receive cylinder sleeves, main bearings, camshaft bearings and valve lifters.
The pre-finished cylinder sleeves are heat treated before being pressed into the block. After installation, sleeves are classified into grades **A** and **B** (Figure 3) and require no futher machining.
The grade identification letters are stamped in the top of the block adjacent to the sleeves.

2.1.1 CYLINDER SLEEVE REPLACEMENT

Inspect the sleeves for wear as follows:
- Check sleeve I.D. over the working length (**X**, fig. 3) swept by the piston rings.
- The diameter reading should be taken in both the upper and lower part of the working length in plane (**c**) parallel to the crankshaft and in plane (**d**) at right angles to it.
- Compare the readings to establish the amount of sleeve out-of-round and taper.

To assess the piston working clearance, check the inner diameter of each sleeve along the length (**Z**) in plane (**d**) perpendicular to crankshaft.
If out-of round or taper in exces of 0.15 mm or 0.006 in is detected, new cylinder sleeves should be installed, as oversize pistons are not available.
To replace sleeves, engine must be removed from machine, all parts connected to the cylinder block disassembled, and a hydraulic press used.

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 vicinity.

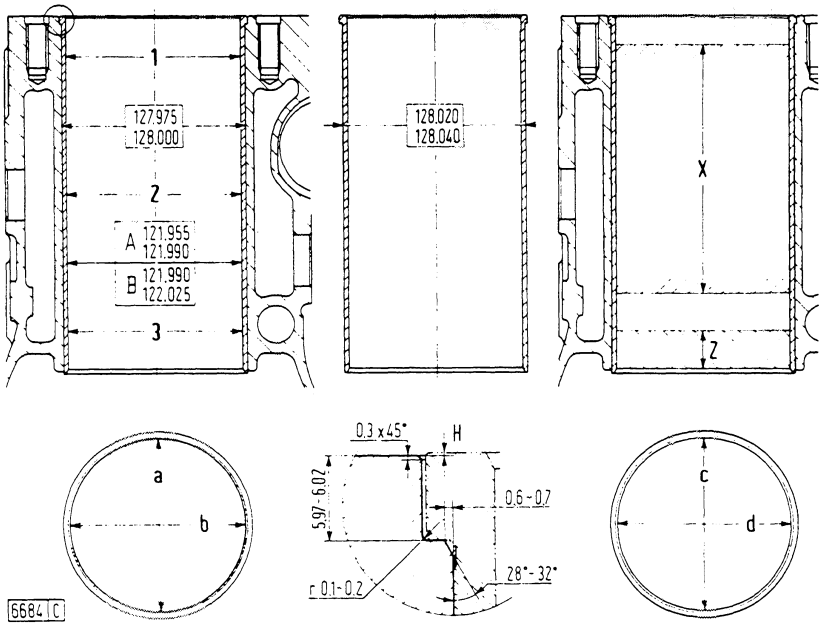


Fig. 3 - Cylinder sleeve and seat standard dimensions and wear data.

A and **B.** New sleeve grades, installed in block. - **H.** = 0.020 to 0.055 mm (0.0007 to 0.002 in). Sleeve stand-in or stand-out, installed. - **Z.** Inspection length for assessment of piston working clearance; reading to be taken in plane (d). - **X.** Sleeve wear inspection length (corresponding to the swept area); readings to be taken in planes (c) and (d). - **1, 2** and **3.** New sleeve I.D. check point; reading to be taken in planes (a) and (b).

Withdraw the cylinder sleeves from the bottom of the crankcase using plate **75291510**.
When installing replacement sleeves proceed as follows:

- Thoroughly clean both the sleeves and the block bores.

- Apply a coat of oil to block bore and the outer surface of sleeve.

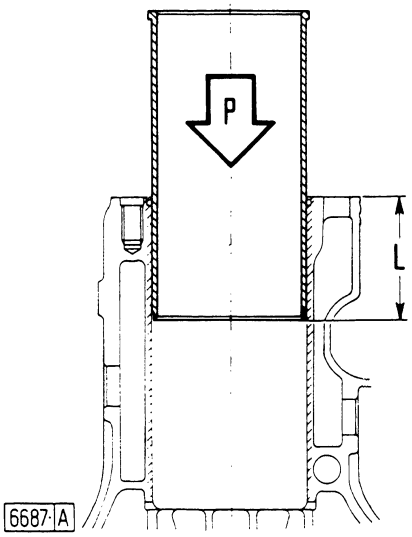
⚠ WARNING

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

- Install each sleeve in block from cold using a suitable press and plate **75291501**;

- When the sleeve is 100 mm or 4 inches in (see **L**, fig. 4) the load (**P**) required to press the sleeves fully home should be between 340 to 3400 daN or 764 to 7643 lb;

- A load lower than 340 daN or 764 lb indicates in sufficient interference, while a load higher than 3400 daN or 7643 lb means excessive interference. Replace sleeves so that load (**P**) is within the stated range.



NOTE

If it is impossible to obtain the correct fit owing to a block bore diameter in excess of nominal value (max. allowance is .05 mm or .002 in) install oversize cylinder sleeves.

- After installation, check sleeve I.D. by means of a suitable dial gauge. Zero the gauge and take readings in planes **a** and **b** (fig. 3) at points **1**, **2** and **3**.

- Check that cylinder sleeve stand-in or stand-out from block deck (**H**) is — 0.020 to 0.055 mm or — 0.008 to 0.0022 in.

- Where necessary, stamp the grade identification letters to which pistons must be matched (see para. 4.3) on the cylinder block (see fig. 3).

If in the course of overhaul block bore out-of-round is found to be in excess of 0.1 mm or 0.004 in, the bores should be opened out by 0.25 mm or 0.010 in (see data table, section 11). After opening out the block, recut the lead-in chamfer to conform with the dimensions given in fig. 3.

If the block top needs grinding (which should be done with the sleeves removed), also machine sleeve counterbore and lead-in chamfer to the dimensions shown in insert, fig. 3. Dimensions (**H**) will thus be maintained within tolerances when sleeves are installed.

Fig. 4 - Installing sleeves in block.
L = 100 mm (4 in). Lead-in depth prior to application of load (P). - **P.** = 340 to 3400 daN or 764 to 7643 lb, sleeve installation load.

⚠ WARNING

Wear proper safety equipment such as hard hat, safety shoes, heavy gloves, safety glasses or goggles where particles might fly.

NOTE
The sleeve bore is surface-hardened and must under no circumstances be ground or honed after installation. Owing to their low interference, the sleeves can be removed and re-installed several times without any adverse effect.

2.2 OIL PAN

With the engine on the machine, oil pan removal procedures differ from unit to unit as described in the following paragraphs 2.2.1, 2.2.2, 2.2.3.

2.2.1 FL 14-C CRAWLER LOADER

To remove the oil pan with the engine on the machine, remove the front lower cover, drain engine lube oil, and remove bolts securing main frame to front crossmember (**1**, fig. 5) and to rear track frame support.

⚠ 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.

Using a suitable hoist, raise main frame sufficiently to free oil pan. Support main frame on wooden blocks as shown in fig. 5, remove oil pan retaining screws and detach oil pan.

To install the oil pan proceed as follows:

- Always replace the complete gasket.
- Thoroughly clean gasket mating surfaces.

⚠ WARNING

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

- Cement the gasket assembly to the pan, making sure that the holes are correctly aligned. After the adhesive has dried, check that the rear end of the gasket overlaps the flange by 0.5 to 1.5 mm or 0.02 to 0.06 in. Cut off any excess material.
- Coat gasket seams (**A**, fig. 7), gasket ends (**B**), and threads of screws (**3**) with jointing compound.
- Place the oil pan in position and start retaining screws (**2**).
- Fully tighten screws (**1**) and turn screws (**3** and **4**) to approximately 3/4 of their full depth.
- Slightly loosen screws (**1**) and fully tighten screws (**3** and **4**).

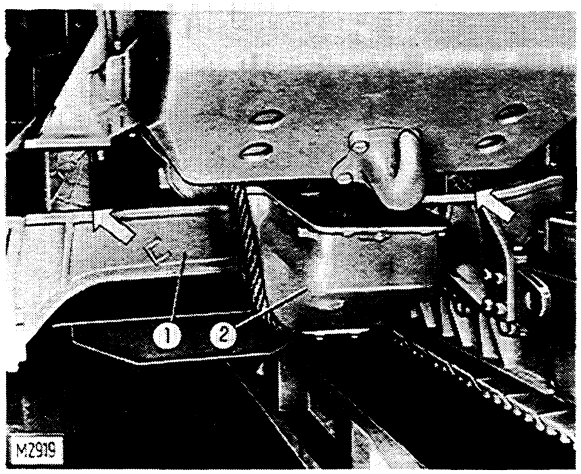


Fig. 5 - Removing or installing oil pan with engine on FL 14-C crawler loader.
Note - Arrows indicate wooden blocks.
1. Front crossmember. - **2.** Oil pan.

2.2.2 14-C DOZER

For 14-C dozers, the oil pan cannot be removed with the engine on the machine. Remove engine from machine in order to remove oil pan.

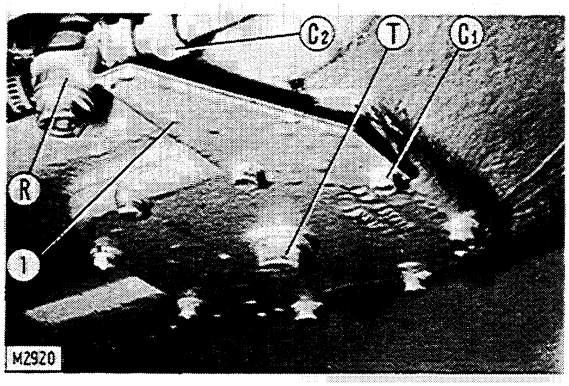


Fig. 6 - Bottom view of oil pan on S15B excavator.
C_1. Capscrews. - C_2. Connector nut. - **R.** Coolant drain tap. - **T.** Engine oil drain plug. - **1.** Drain tap bracket.

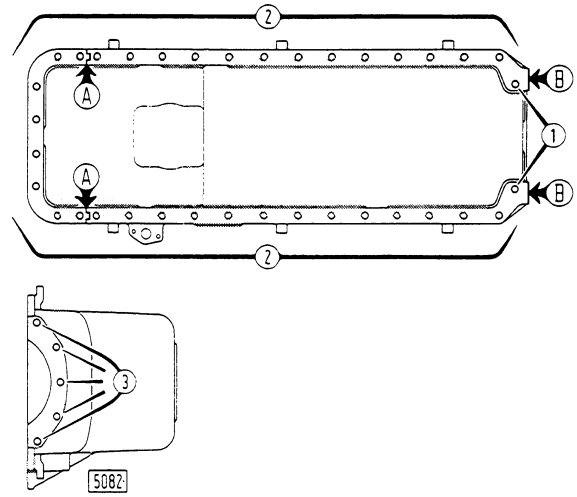


Fig. 7 - Engine oil pan tightening diagram (See instructions in para. 2.2.1).

2.2.3 S15B EXCAVATOR

Remove oil pan as follows:

- Rotate superstructure 90° with respect to direction of forward travel.
- Remove screws (C_1) and detach drain tap bracket (**1**, fig. 6).
- Loosen nut (C_2) and hose clip.
- Turn bracket to free oil pan.
- Loosen all screws securing oil pan to engine block and remove pan.

To install oil pan follow the procedure described for FL 14-C crawler loader (paragraph 2.2.1).

2.3 CYLINDER HEADS

2.3.1 CYLINDER HEAD REMOVAL

Do not remove cylinder heads when the engine is warm, as this could cause warping. To remove, proceed as follows:

- Remove exhaust manifold.
- Disconnect and remove engine temperature gauge tube from rear of water outlet manifold.
- Remove screws securing intake manifold to cylinder heads and remove manifold.
- Disconnect and remove radiator upper hose. Remove capscrews and lockwashers securing water outlet manifold to cylinder heads and remove manifold and thermostat housing.
- Remove capscrews securing valve rocker covers to cylinder heads and remove covers.
- Disconnect and remove fuel leak-off lines. Disconnect lines from injection pump and nozzle holders.
- Cover all fuel openings to prevent entrance of dirt. Remove nozzle holder assemblies from cylinder heads to prevent possible damage to nozzles after head is removed.
- Drain cooling system.
- Remove or disconnect all components and/or assemblies necessary for access to the cylinder heads, such as engine hood, air cleaner, exhaust system, etc.

- Remove nuts and lockwashers securing rocker shaft brackets to cylinder heads and remove brackets, shafts, and rocker arms as an assembly from each cylinder head.

- Withdraw pushrods from cylinder heads and block.

- Remove self-locking cylinder head capscrews.

2.3.2 CYLINDER HEAD INSPECTION

Check head flatness by placing each cylinder head on a surface plate smeared with carbon black. Recondition as necessary by scraping, or by grinding if distortion is in excess of 0.15 mm or 0.006 in.

When grinding, the maximum amount of material which can be removed should not exceed 0.5 mm or 0.02 in.

⚠ WARNING

Always wear safety glasses with side shields when machining or grinding metal, or performing any task where particles might fly.

Remember that new cylinder head thickness should be 124.750 to 125.000 mm or 4.91 to 4.92 in.
After installing valves and injectors, check that:

- Injector nozzle stand-out (**L**) from cylinder head is as indicated in fig. 9.

- Valve stand-in (**H**) from cylinder head is as indicated in fig. 8.

- If injector nozzle stand-out is less than prescribed, grind the taper seat in the sleeve using cutter **75291339.** If stand-out is excessive, install a new fuel injector sleeve. When removing the fuel injector sleeves, extract using set of taps **75290687** and puller **75290633**.

Install the new fuel injector sleeves using a hand press and expand their top end using burnisher **75291350**.

Check for leaking pipe plugs and fuel injector sleeves. In case of doubt, replace all suspect parts. Injector sleeve leakage can often be eliminated by means of burnisher **75291350**.

To obtain a good seal between injector and sleeve bottom, dress the taper seat using cutter **75291339**. Check that restricted passages (**1**, fig. 12) in rocker arm shaft brackets are not clogged.

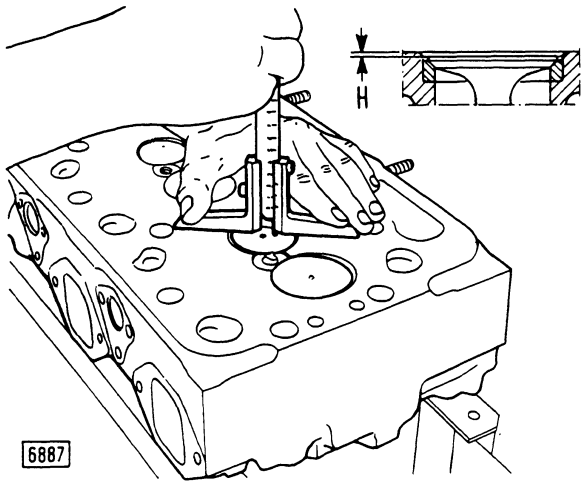


Fig. 8 - Checking valve stand-in from cylinder head.
L = 1 to 1.6 mm or 0.039 to 0.063 in. valve stand-in.

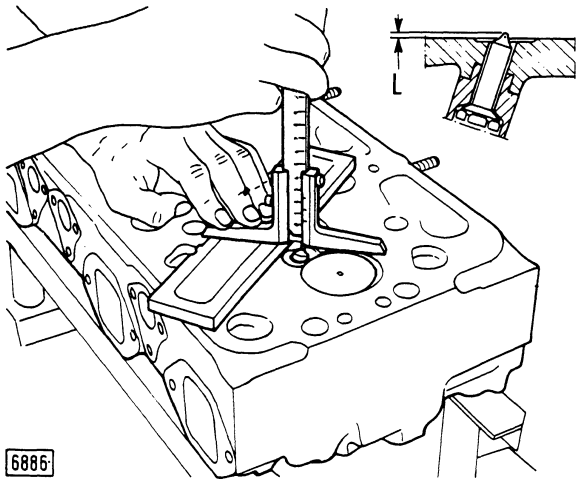


Fig. 9 - Checking injector nozzle stand-out from cylinder head.
L = 5 to 6 mm or 0.197 to 0.236 in. nozzle stand-out.

2.3.3 VALVE SEAT GRINDING

Rest the cylinder heads on tool **75291113**, and position valves on support **75291112**.

For valve seat grinding use the following:

Multi-purpose hand grinder **75292913**.

To determine seat contact on valve face, wipe a thin film of Prussian blue on valve face and bounce valve once on seat.

Do not revolve valve while checking seal.
A continuous pencil-thin line must be evident on valve face, otherwise further grinding is required.

⚠ WARNING

Wear welders' protective equipment such as dark safety glasses, helmets, protective clothing, gloves and safety shoes when welding. Wear dark safety glasses where welding. DO NOT LOOK AT THE ARC WITHOUT PROPER EYE PROTECTION.

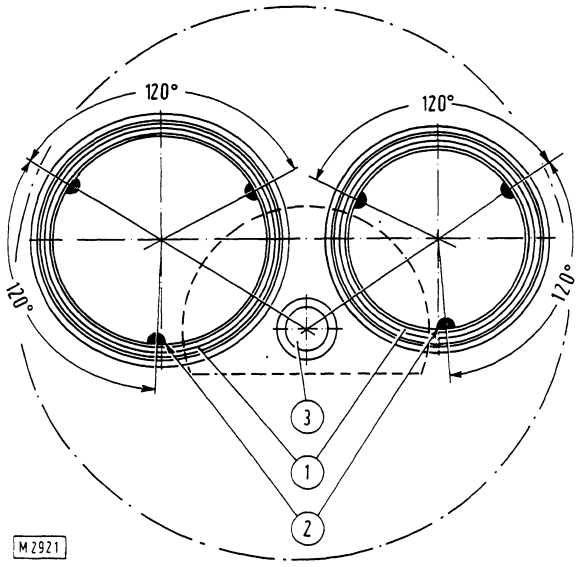
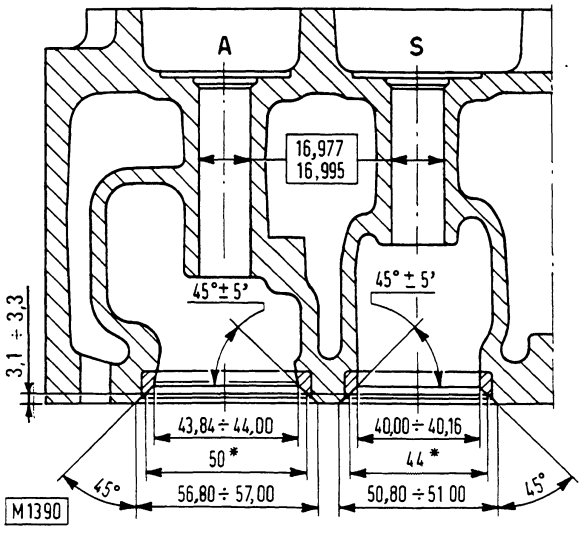


Fig. 10 - Location of weld beads for valve seat insert removal.
1. Valve seat inserts. - **2.** Weld beads. - **3.** Injector sleeve housing.
Note - Weld beads should never be located within area defined by dashed line.

2.3.4 VALVE SEAT INSERT REPLACEMENT

Inspect valve seat inserts. If loose, cracked, or pitted, new inserts must be installed.

Valve seat inserts may be removed from head by using valves to be replaced as a means of extraction by welding them to the inserts as shown in fig. 10.



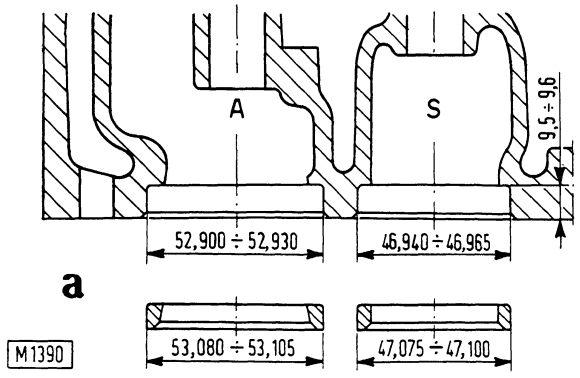


Fig. 11 - Valve seat and guide housing dimensions.
a. Valve seat insert details. - **A.** Intake. - **S.** Exhaust.
Note - Valve seat insert oversize on outside diameter is 0.2 mm or 0.008 in (see data table, section 11).

NOTE

Protect machined surfaces of cylinder head from splatter when welding.

If it becomes necessary to replace valve seat inserts, it is imperative that the original press fit be maintained between new inserts and insert bores in the cylinder heads (see dimensions, fig. 11). If insert bores in cylinder heads are damaged or worn to the degree that the recommended press fit cannot be attained when installing new standard size valve seat inserts, the bores must be opened out and 0.2 mm or 0.008 in oversize valve seat inserts installed.

2.3.5 CYLINDER HEAD INSTALLATION

Make certain that machined surfaces of cylinder block and cylinder heads are thoroughly clean.

WARNING

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

New cylinder head gaskets must be used when installing cylinder heads.

Install cylinder heads as follows:

- Check cylinder sleeve stand-out above top deck of cylinder block (see paragraph 2.1.1).
- Install the cylinder head gaskets, making sure that the side marked ALTO faces up.

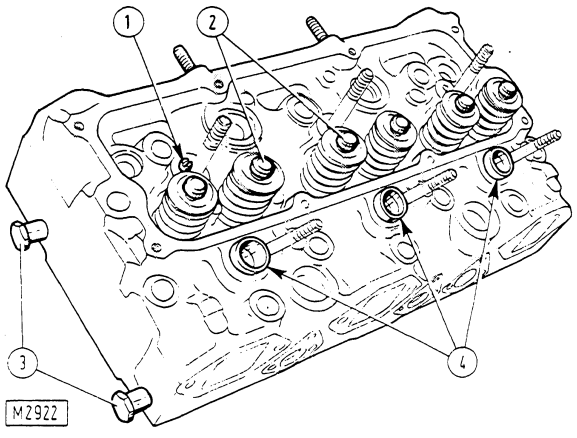


Fig. 12 - View of rear cylinder head.

1. Restricted passage for rocker arm shaft lubrication. - 2. Valve stem tip cups. - 3. Rear lifting pins. - 4. Injector sleeves.

NOTE

It is not necessary to apply jointing compound or lubricant to gaskets.

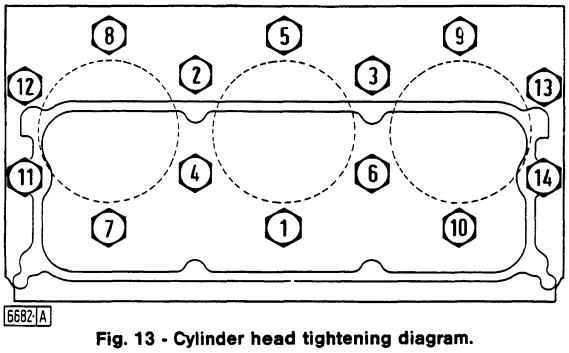


Fig. 13 - Cylinder head tightening diagram.

Note - The specified tightening torque should be reached in at least three successive stages, adopting the sequence indicated above.

NOTE

- The two cylinder heads are not interchangeable, as rocker lubricating oil port position and number and position of lifting pins are different.
- Before final tightening (see fig. 13), make sure that exhaust manifold mating surfaces line up.

NOTE

The specified tightening torque should be reached in at least three successive stages, adopting the sequence indicated in fig. 13.

3. VALVE OPERATING MECHANISM

3.1 GEAR TRAIN

The valves are driven by a gear train located at the front of the engine.
The gear train can be serviced with the engine installed on the machine for FL 14-C and 14-C models.
For S15B excavators, engine must be removed from machine.

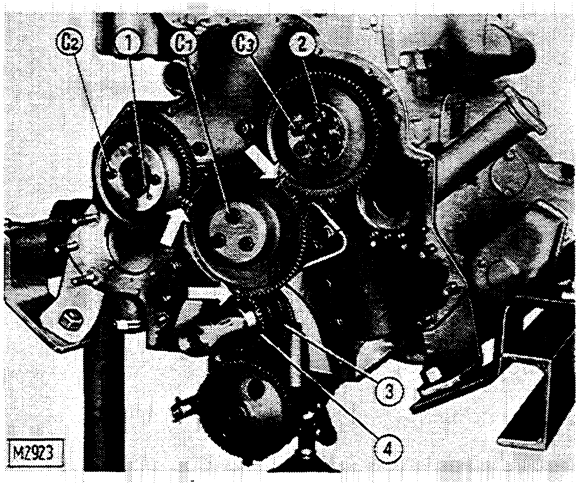


Fig. 14 - Gear train assembly.

Note - Arrows indicate valve timing reference marks 1-1, 2-2, 3-3. **C_1**. Self-locking idler gear capscrews. - **C_2**. Self-locking fuel injection pump drive gear capscrews. - **C_3**. Self-locking camshaft gear capscrews. - **1**. Injection pump gear alignment dowel. - **2**. Camshaft gear alignment dowel. - **3**. Engine oil pump driving gear. - **4**. Crankshaft gear.

3.1.1 GEAR TRAIN REMOVAL AND INSTALLATION

- Remove water pump assembly, crankshaft vibration damper and pulley, fan belt tightener pulley and alternator support.
- Remove timing gear housing cover (fig. 14).

Camshaft gear.

- Remove capscrews (**C_3**, fig. 14) and withdraw camshaft gear.
- Remove the three thrust collar capscrews.
- Examine the thrust collar for signs of wear and replace if necessary. Thrust collar thickness should be 7.978 to 8.0 mm or 0.3144 to 0.3149 in.
- To install camshaft gear, reverse removal procedure.
- Make sure that alignment dowel (**2**) is inserted in the associated seat on gear.
- Torque tighten capscrews (**C_3**).

Idler gear

- Remove capscrews (**C_1**, fig. 14) and withdraw idler gear.
- Dismantle idler gear components and check dimensions (fig. 15). Maximum wear clearance between bushing and shaft installed in gear is 0.20 mm or 0.007 in.
- Should it become necessary to replace bushing, check that the new bushing is centered in the gear bore.
- Install the gear/shaft/thrust ring assembly, and tighten the three capscrews to the specified torque.

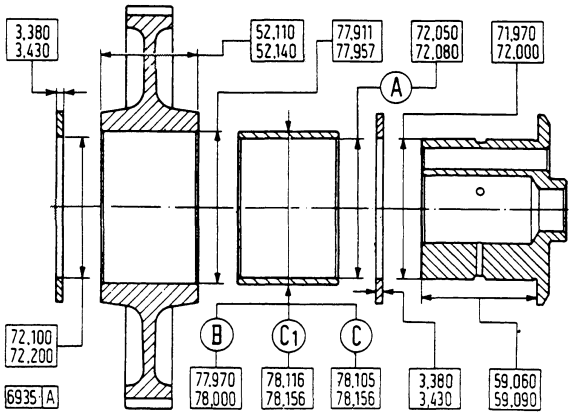


Fig. 15 - Idler gear and shaft dimensions.

A. Bushing installed diameter. - **B.** Bronze bushing. - **C.** Babbitt metal-lined steel shell (Vandervell type). - **C_1**. Babbitt metal-lined steel shell (Clevite type).

Engine oil pump drive gear (**3**, fig. 14) and crankshaft gear (**4**, fig. 14):

- Withdraw both gears using a multi-purpose puller with the three claws applied at the back of the engine oil pump drive gear.

- Inspect the front seal. If the outer face is worn, install a new seal.

- Heat gears in oil to 180° - 200°C or 356° - 392°F and assemble, reversing removal procedure.

Fuel injection pump drive gear.

See paragraph 5.4.6.

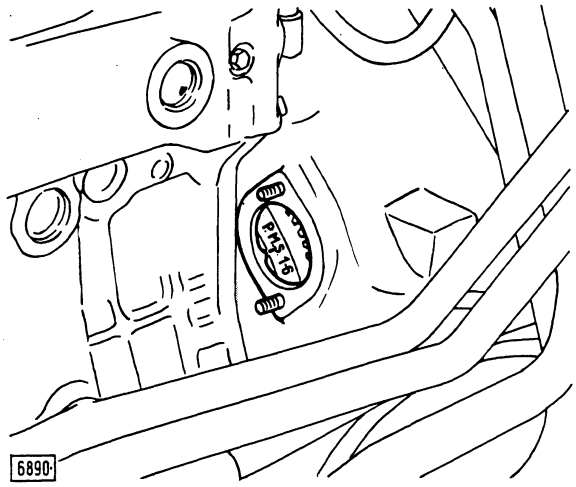


Fig. 16 - T.D.C. timing mark on flywheel.

3.1.2 TIMING THE GEAR TRAIN

Provisionally adjust valve lash (intake and exhaust) on No. 1 and No. 6 cylinders to 0.5 mm or 0.02 in.

- Loosen the fuel injectors and rotate the crankshaft until the PMS 1-6 (T.D.C. 1-6) mark stamped on flywheel periphery lines up with the timing pointer (fig. 16).

- Install the gears to the associated shafts, ensuring that the timing marks are matched (1-1, 2-2, 3-3, fig. 14). Install the idler gear last, after gears (1 and 2) are properly meshed.

- Tighten capscrews (C_1, C_2, and C_3).

- Rotate the crankshaft a few degrees in each direction to ensure that cylinder No. 1 is on the combustion stroke, with both valves closed, and that valves of cylinder No. 6 are open. The rocker arms should also be at the prescribed angles.

Service of valve mechanism

Some parts of the valve mechanism can be serviced with the engine installed on the machine. For other parts, the cylinder heads or the engine itself must first be removed from the machine.
Operations which can be carried out with the engine installed on the machine are:

- Gear train overhaul.
- Valve adjustment.
- Rocker arm or rocker arm shaft replacement.
- Pushrod replacement.
- Valve lifter replacement.
- Valve spring replacement.

Operations which can be carried out with the engine installed on the machine but which require that the cylinder heads be removed are:

- Valve grinding, reseating or replacement.
- Valve guide replacement.
- Valve seat insert replacement.
- Camshaft replacement (not including S15B excavators).

3.1.3 CAMSHAFT

The camshaft (**1**, fig. 18) is supported in the cylinder block by 4 Babbitt metal-lined steel bushings. A thrust collar (**2**, fig. 18) is provided at the front.

Camshaft removal

NOTE
On FL 14-C and 14-C units the camshaft may be removed with the engine installed on the machine by removing the radiator, cylinder heads, timing gear housing cover and oil pan.
However, it to advisable to remove the engine, as otherwise the camshaft bearings cannot be removed.
For S15B excavators, the camshaft cannot be removed without removing the engine.

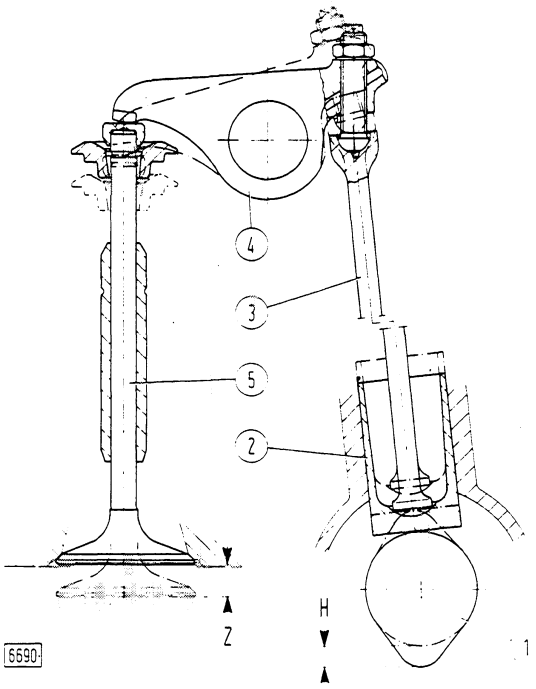


Fig. 17 - Valve operating mechanism.

H. = 7.621 mm or 0.30 in. Cam lift (effective lift = 7.3 mm or 0.28 in). - **Z.** = 12.2 mm or 0.48 in max valve lift. - **1.** Cam. - **2.** Valve lifter. - **3.** Pushrod. - **4.** Rocker arm. - **5.** Valve.

- Remove water pump assembly, fan belt tightener, crankshaft vibration damper and alternator support.
- Remove nuts and bolts (C_2 and C_3, fig. 18) and detach timing gear housing cover.
- Remove the pushrods and valve lifters.
- Remove camshaft gear capscrews (C_3, fig. 14).
- Remove camshaft thrust collar capscrews (C_{10}, fig. 18).
- Withdraw the camshaft, using care to prevent the cams from damaging the bearings.

Camshaft inspection

Measure clearance between camshaft bearings and journals using a suitable inside micrometer. For specified dimensions, see fig. 19 and section 11.

Check that cams are smooth and free from scratches. Minor scratches can sometimes be remedied using a very fine abrasive stone; otherwise, scrap and replace camshaft.

Check the camshaft gear flange for run-out as follows:

- Place the camshaft with two end journals over vee blocks and rest the stylus of a dial gauge on the flange face at approximately 37 mm or 1.5 in from the centerline (**C**, fig. 19).
- Rotate the shaft and check that over revolution the run-out does not exceed 0.01 mm or 0.0004 in.

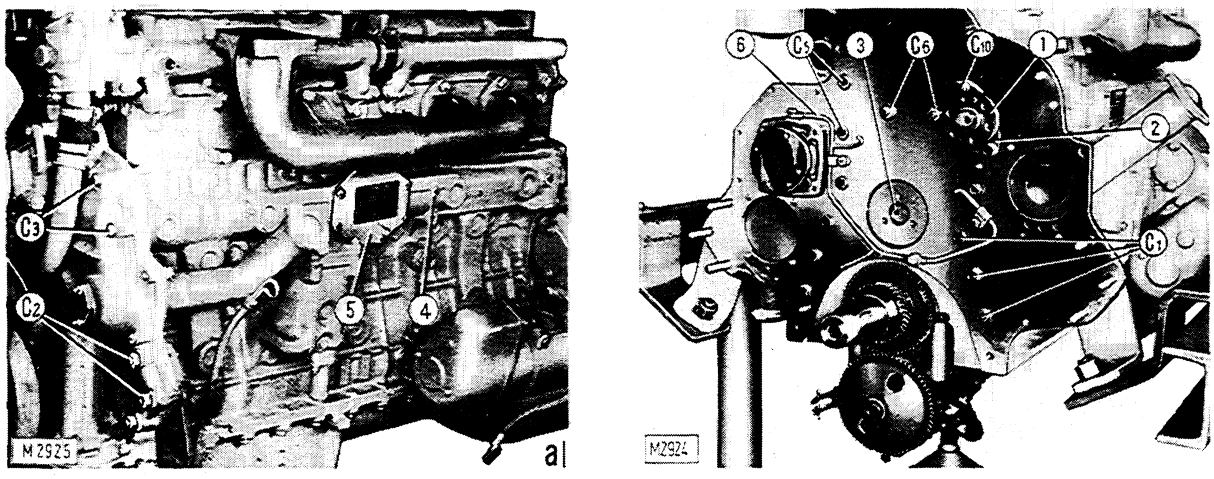


Fig. 18 - Camshaft installation.

a. Left side view of cylinder block. - C_1. and C_5. Plate retaining screws. - C_2. and C_3. Front plate retaining bolts and self-locking nuts. - C_6. Plate self-locking retaining nuts. - C_{10}. Camshaft thrust collar capscrews. - **1.** Camshaft. - **2.** Camshaft thrust collar. - **3.** Idler gear shaft oil port. - **4.** Camshaft bearing retaining screws. - **5.** Camshaft housing side cover. - **6.** Gear train lube oil lines.

– Place the stylus over spigot surface (**D**) and check that over one full revolution the amount of out-of-round does not exceed 0.01 mm or 0.004 in.

Also check for shaft distortion by placing the stylus of the dial gauge over the two intermediate bearing journals. Eccentricity should not exceed 0.10 mm or 0.004 in over one revolution. If necessary, straighten the camshaft using a suitable press.

Camshaft installation

Install the camshaft by a direct reversal of removal procedure. After servicing camshaft or overhauling engine, always lubricate camshaft by introducing 1 kg (13/4 pint) of oil in each cylinder before starting engine.

Camshaft bearing removal

The camshaft bearings are pressed into the cylinder block and secured by means of capscrews (**4**, fig. 18). To remove, proceed as follows:

– Remove the engine.

– Remove camshaft (see paragraph 3.1.3).

– Remove rear (flywheel end) cover and associated gasket.

– Remove side cover (**5**, fig. 18);

– Remove bearing retaining screws (**4**, fig. 18).

– Remove rear engine mounting and withdraw front and rear bearings using multi-purpose puller **75292909**.

– Withdraw intermediate bearings using remover **75292797**. Recover bearings through side cover (**5**, fig. 18).

Camshaft bearing inspection

Inspect bearings for signs of scratching, flaking, rust or overheating, replacing as necessary.
Check that oil holes are not obstructed.
Check bearing dimensions (see fig. 19).

Camshaft bearing installation

Install camshaft bearings as follows:

– Position bearings so that retaining screws (**4**, fig. 18) are lined up with the associated passage holes, and that oil holes (**b** and **g**, fig. 19) line up with the corresponding oil supply holes (**B** and **G**) in the cylinder block.

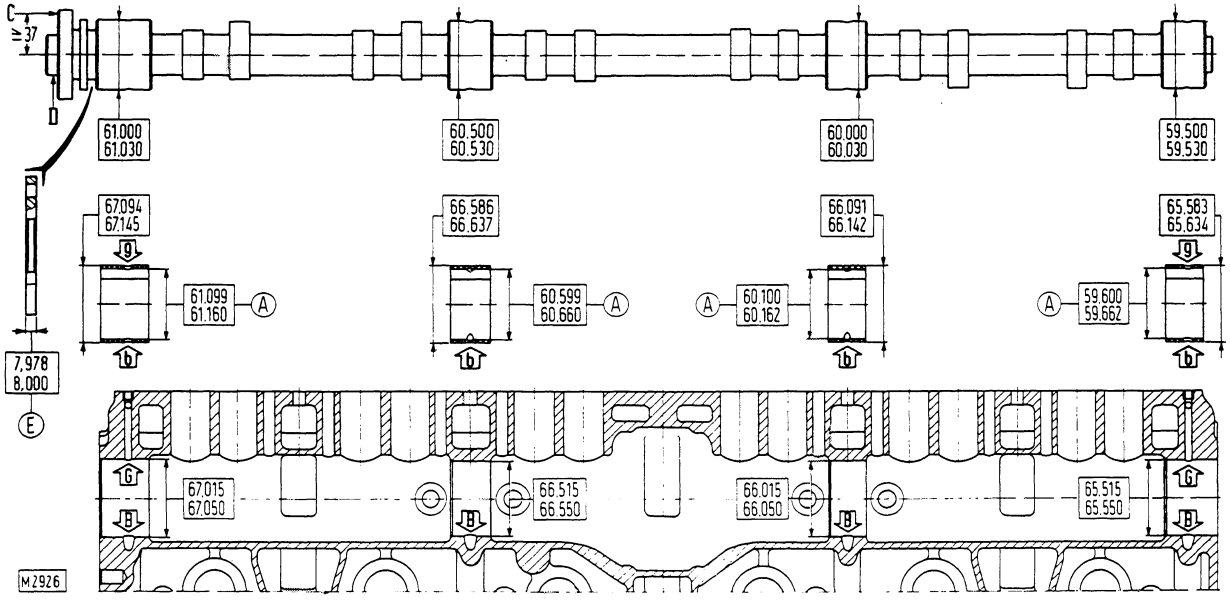


Fig. 19 - Camshaft, bearing and housing dimensions.

A. Bearing installed I.D. - **C/D.** Flange run-out stylus positions. - **b/g.** and **B/G.** Oil passages and holes for camshaft journals and bearings. - **E.** Camshaft thrust collar.

- Working from the front of the engine, install the two intermediate bearings using installer **75292797**.
- Install front and rear bearings using installer **75292796**.
- The camshaft bearings are pre-finished and do not require reaming after installation.

NOTE
No I.D. undersize is available for spare bearings. Should bearing to crankshaft clearance exceed 0.2 mm or 0.007 in, replace the camshaft.

3.2 VALVES AND VALVE GUIDES

To service valves and valve guides, remove cylinder heads and proceed as follows:

- Compress springs using tool (**E**, fig. 20) and remove valve spring retainer locks (**2**).
- Remove valves.
- Remove all carbon from the valve head, face and stem.
- Grind and polish valves and seats, subsequently removing all traces of abrasive material.

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

- Check valves and guides for size, and check stem-to-guide clearance by resting the dial gauge stylus on the valve face (**C**, fig. 21).
  Maximum clearance is 0.20 mm or 0.007 in, while maximum out-of-round is 0.04 mm or 0.0015 in.
- Use kit **7592867** to carry out measurements. If tolerances are exceeded, scrap and replace the parts involved.
- Install valves in cylinder heads, ensuring that valve stand-in is as indicated in fig. 8.

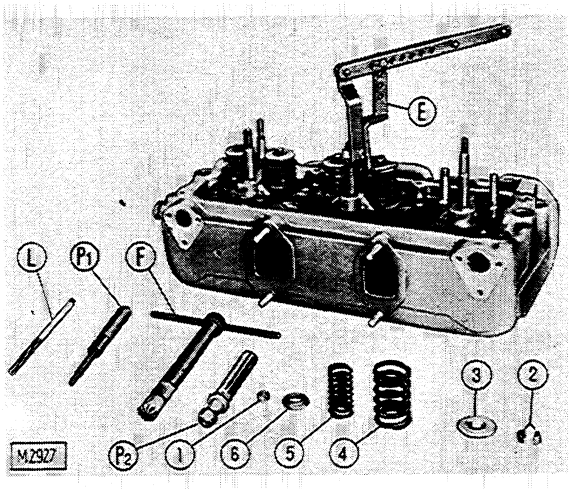


Fig. 20 - Removing or installing valves.
E. Spring compressor **75291050**. - **F.** Injector sleeve cutter **75291339**. - **L.** Valve guide reamer **75291499**. - **P.** Valve guide installer/remover **75291496**. - **P_2.** Injector sleeve burnisher **75291350**. - **1.** Valve stem tip cups. - **2.** Valve spring retainer locks. - **3.** Upper valve spring retainer. - **4.** Outer spring. - **5.** Inner spring. - **6.** Lower valve spring retainer.

3.2.1 VALVE GUIDES

When replacing valve guides, use installer/remover **75291496** (**P_1**, fig. 20), together with a suitable press.

Work from the underside of the cylinder heads to remove and from the top to install.
Inspect the valve guides, noting that:

- Guide bores should be smooth, and free from scratches, signs of scuffing or carbon deposits.
- Each guide should have a retaining ring;
- Guides should be tight in their seats in the heads; otherwise, install oversize guides (see data table).
- After they are pressed into the cylinder heads, valve guides should be reamed using reamer **75291499** (**L**, fig. 20).

Exhaust valve guides are 10 mm or 0.394 in shorter than the intake valve guides.

NOTE
If only valve springs need servicing, cylinder heads need not be removed. Remember to position the piston associated with the springs being serviced in the T.D.C. position.

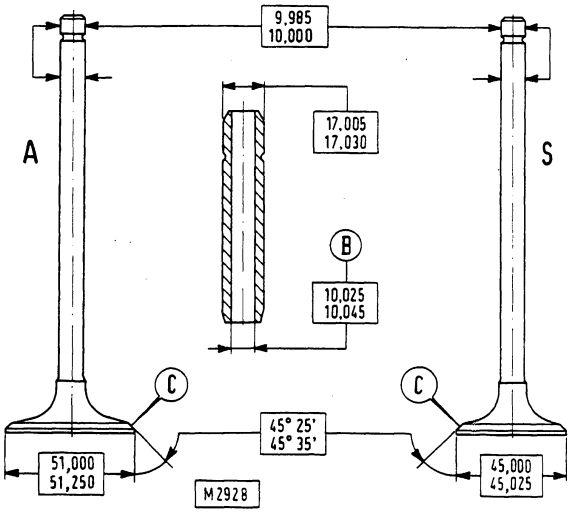


Fig. 21 - Standard valve and valve guide dimensions.
A. Intake valve. - **D.** Bore dimension after reaming. - **C.** Valve face. - **S.** Exhaust valve.

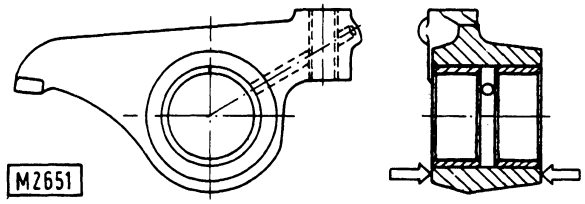


Fig. 23 - Bushing position on rocker arms.
Note - Bushings must be flush with arrowed planes on rocker arms.

3.3 ROCKER ARMS AND VALVE LIFTERS

3.3.1 ROCKER ARMS

Rocker arm removal
Rocker arms may be removed with the engine on the machine. Proceed as follows:

- Remove rocker cover.
- Remove nuts from rocker shaft bracket studs.
- Detach rocker arm shaft assembly, remove snap rings and dismantle assembly.

Rocker arm inspection
Check rocker arm shafts and rocker arm bushings for wear and play.

When necessary install new bushings, noting the following points:

- Only bronze bushings (**B**, fig. 24) are available as spares, whereas the bushings originally fitted in production may consist of babbitt metal-lined steel shells (**C**).

- After installation, the bushings should lie flush with the rocker arm sides as shown in fig. 23.

- After installation, the bushings should be reamed by means of expanding blade reamer **75290001**.

Inspect rocker arm tips. When reconditioning becomes necessary, remember that the depth of case (hardened layer) is 1.2 — 2 mm or 0.047 — 0.079 in at the center of the rocker arm tip.

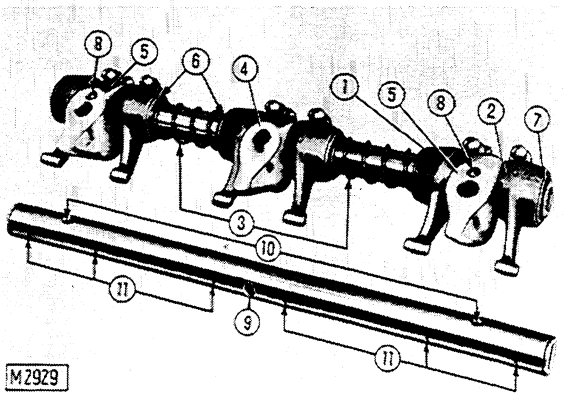


Fig. 22 - Rocker shaft assembly.
1. Exhaust valve rocker arm. - **2.** Intake valve rocker arm. - **3.** Spacer springs. - **4.** Rocker shaft center bracket. - **5.** Rocker shaft end brackets. - **6.** Spring plates. - **7.** End washers. - **8.** Oil holes. - **9.** Reference mark. - **10.** and **11.** Oil holes.

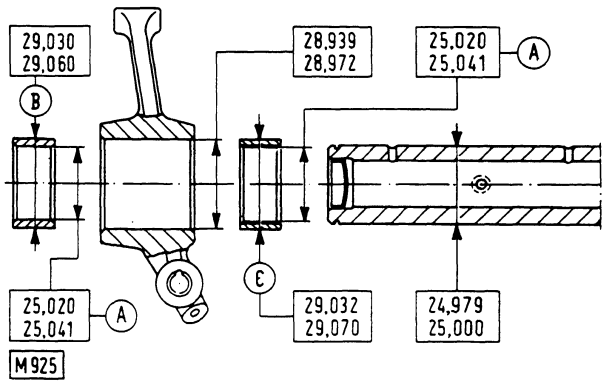


Fig. 24 - Rocker arm, bushing and shaft dimensions.
A. Installed dimension after reaming. - **B.** Bronze bushing. - **C.** Babbitt metal-lined steel shell.

WARNING

Always wear safety glasses with side shield when machining or grinding metal, or performing any task where particles might fly.

Rocker arm installation

Assemble rocker arm shaft components as shown in fig. 22, noting the points below:

- Ensure that oil holes and passages (**8**, **10** and **11**) are clean.
- Position rocker arm shafts so that reference mark (**9**) machined in shaft lines up with the stud hole drilled in center bracket (**4**) to ensure correct alignment of oil holes (**10** and **11**).
- Thickness of spring plates (**6**) should be 1.5 mm or 0.059 in.
- End washers (**7**) are available in three different thicknesses, namely 1.5 mm, 2 mm and 2.5 mm (0.06 in, 0.081 and 0.1 in). Use the most suitable thickness to reduce end float of the end rocker arms to a minimum.

3.3.2 VALVE LIFTERS

Valve lifters may be removed with the engine on the machine and cylinder heads removed.

Check that surface in contact with cam is in good condition. Any score marks may be remedied using a very fine abrasive stone.

Check working clearance. If clearance exceeds 0.2 mm or 0.007 in, install new oversize valve lifters and open out associated housing bores in cylinder block (see data table, section 11).

Lubricate valve lifters with clean oil before installing.

3.4 VALVE LASH ADJUSTMENT

For valve lash adjustment, use wrench **75290886** (**M**, fig. 26) and a suitable feeler gauge (**R**). The correct clearance is 0.30 mm or 0.012 in for intake valves and 0.40 mm or 0.016 in for exhaust valves.

Cylinder matching for valve lash adjustment is 1-6, 2-5 and 3-4.

Bring the valves of the first cylinder of each pair to a condition of balance to adjust the valves of the second cylinder of the same pair and vice versa.

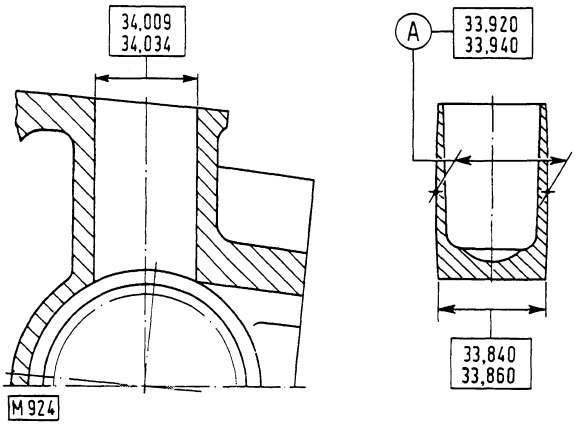


Fig. 25 - Standard valve lifter and seat dimensions.
A. Maximum O.D., measured at valve lifter centerline.

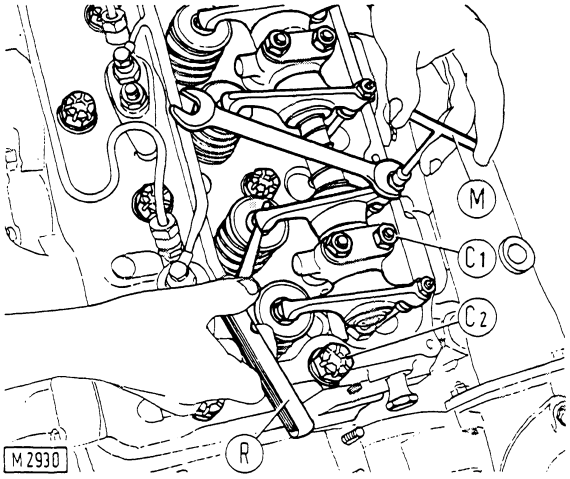


Fig. 26 - Checking and adjusting valve lash.
C_1. Rocker shaft bracket nut. - **C_2.** Self-locking cylinder head capscrews. - **M.** Wrench **75290886**. - **R.** Feeler gauge.

4. CRANKSHAFT AND PISTON ASSEMBLY

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 remove the crankshaft, remove the engine from the machine and proceed as follows:

- Remove flywheel and flywheel housing.
- Drain engine oil and remove oil pan.
- Working from the front end of the engine, remove water pump, drive pulley, fan and alternator .
- Remove crankshaft vibration damper and withdraw hub as shown in fig. 27.
- Remove connecting rod bearing caps and connecting rod bearing shells. Remove main bearing caps and lower main bearing shells. Remove the crankshaft.

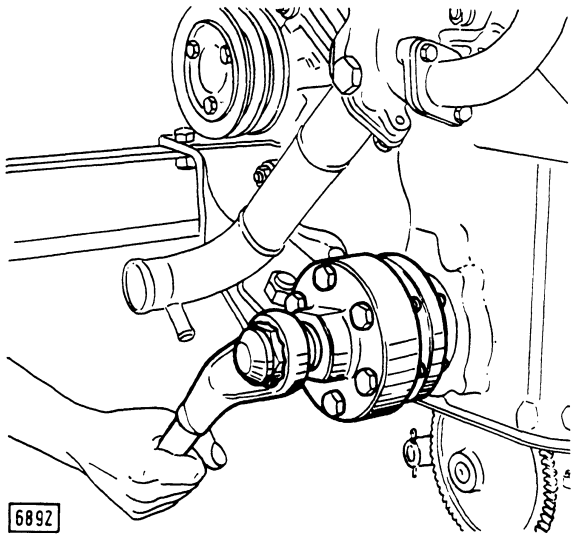


Fig. 27 - Removing crankshaft vibration damper using puller 75291504.

Crankshaft inspection

Clean crankshaft and inspect carefully. Any signs of cracks will necessitate replacement.

⚠ WARNING

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

Check condition of main and connecting rod journals. Slight pick-up marks and scratches may be remedied using zero grade emery cloth.

If more serious scratches or journals out-of-round or taper exceeding 0.05 mm or 0.002 in are detected, regrind journals to the nearest undersize (see data table, section 11).

⚠ WARNING

Always wear safety glasses with side shields when machining or grinding metal, or performing any task where particles might fly.

After regrinding, blend and polish crankshaft journal fillet radii. Also blend and polish oil hole opening radii as shown in fig. 28, and check that:

- Journal out-of-round does not exceed 0.008 mm or 0.00031 in.
- Taper of each journal is lower than 0.012 mm or 0.0004 in .
- With the shaft over vee blocks and cranks 1-6 at the top, maximum misalignment is 0.05 mm or 0.002 in (**D**, fig. 29).
- Maximum misalignment of main journals to connecting rod journals does not exceed ± 0.25 mm or 0.01 in when measured as shown in fig. 30.
- Connecting rod journal periphery-to-shaft centerline should not exceed ± 0.10 mm or 0.004 in (fig. 29).
- Crankshaft flange run-out (**A**) on periphery should not exceed 0.02 mm or 0.0008 in; flange eccentricity (**B**) should not exceed 0.04 mm or 0.001 in.