FIATALLIS

FL 9

crawler loader

Service manual

Section 1 - General
Section 2 - Engine

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AVOID ACCIDENTS

Most accidents, whether they occur in industry, on the farm, at home or on the highway, are caused by the failure of some individual to follow simple and fundamental safety rules or precautions. For this reason **MOST ACCIDENTS CAN BE PREVENTED** by recognizing the real cause and doing something about it before the accident occurs.

Regardless of the care used in the design and construction of any type of equipment there are many conditions that cannot be completely safeguarded against without interfering with reasonable accessibility and efficient operation.

A careful operator is the best insurance against an accident. The complete observance of one simple rule would prevent many thousand serious injuries each year.
That rule is:

Never attempt to clean, oil or adjust a machine while it is in motion.

WARNING

On machines having hydraulically, mechanically, and/or cable controlled equipment (such as shovels, loaders, dozers, scrapers, etc.) be certain the equipment is lowered to the ground before servicing, adjusting and/or repairing. If it is necessary to have the hydraulically, mechanically, and/or cable controlled equipment partially or fully raised to gain access to certain items, be sure the equipment is suitably supported by means other than the hydraulic lift cylinders, cable and/or mechanical devices used for controlling the equipment.

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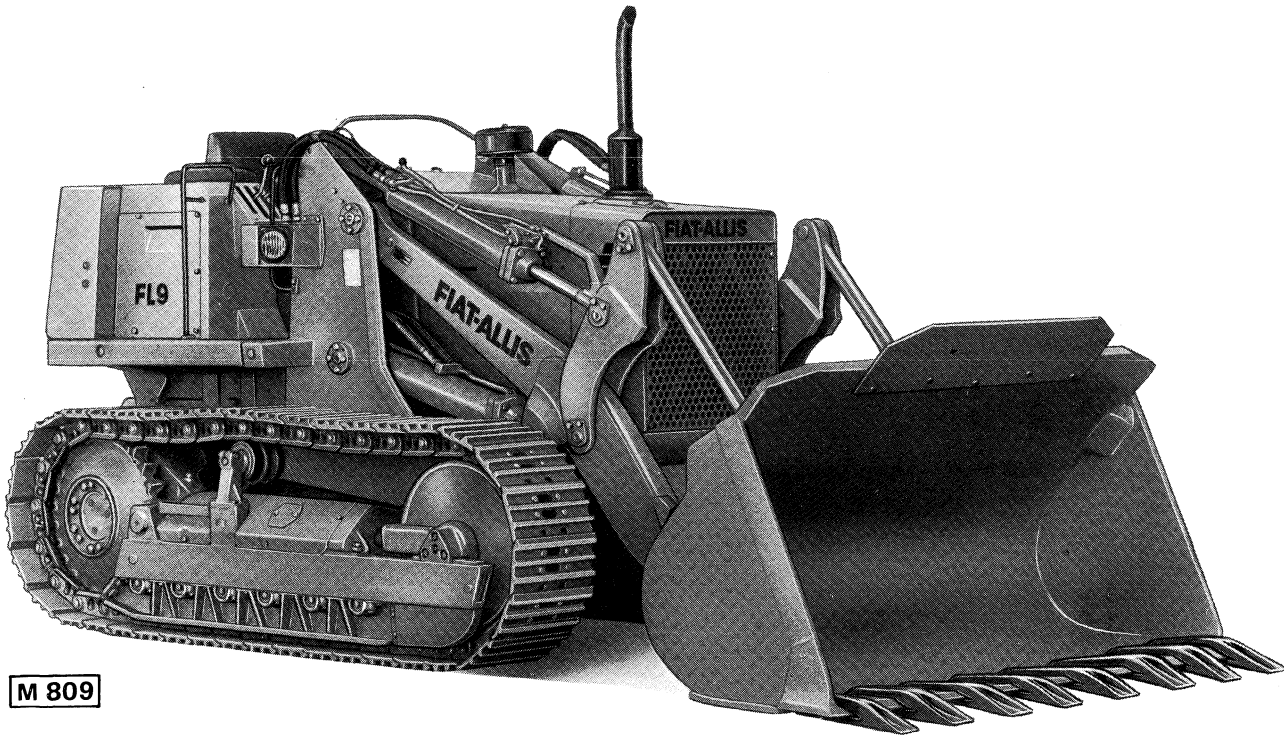


Section 1 - GENERAL

CONTENTS

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.

No unauthorized personnel should be allowed to service or maintain this machine. Do not perform any work on equipment that is not authorized. Follow the Maintenance and Service procedures.

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, safety glasses or goggles, heavy gloves, reflector vests, ear protectors, 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.

Never attempt to operate the machine or its tools from any position other 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 per OSHA 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 the exposed portion between uncontrolled or unguarded scissor points of machine without first providing secure blocking.

Never service or adjust a machine with the engine running, except as called for in the Operation and maintenance Instruction Manuals.

When servicing or maintenance requires access to areas that cannot be reached from the ground, use a ladder or step platform that meets OSHA 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 OSHA requirements.

Disconnect batteries and TAG all controls according to OSHA requirements to warn that work is in progress. Block the machine and all attachments that must be raised per OSHA 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 finger 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

General (Continued)

people in the vicinity

Never place gasoline or diesel fuel in an open pan

Never use gasoline or diesel fuel or other flammable fluid for cleaning parts. Use authorized commercial, non-flammable, non-toxic solvents.

When using compressed air for cleaning parts use safety glasses with side shields or goggles. Limit the pressure to 30 psi according to OSHA requirements.

Do not operate machine in closed area without proper ventilation to remove deadly gases

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

Shut off engine and disengage the Power Take-Off lever before attempting adjustments or service

Do not perform any work on equipment that is not authorized Follow the Maintenance or Service Manual Procedures.

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 thru 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 of 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 with engine running.

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 welders 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 authorized blocking as a safety measure before proceeding with service or maintenance per OSHA requirements.

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

Never use makeshift jacks when adjusting track tension. Follow the Undercarriage Service Manual.

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.

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 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/

Keep engine exhaust system and exhaust manifolds clear of combustible material Equip machine with screens and guards when working under conditions of flying combustible material

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 screens 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 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 battery 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.

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 internal pressure is relieved before removing panels, housing 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 per OSHA 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 of machine and attachments such as power control units, winches adjusted according to Operating and Maintenance Manuals of the manufacturers at all times.

Section 1 - GENERAL

1.1 SPECIFICATION

1.1.1 IDENTIFICATION DATA

Chassis type
- Engineering code 627.100
- Marketing code 8CA

Engine type FIAT/OM CO 3/130MT Mod. 1
Equipment type FL9

1.1.2 ENGINE

Cycle .....Diesel,naturally-aspirated
Number of strokes ..... Four
Injection ..... Direct
Number of cylinders ..... Four
Bore ..... 115 mm (4.5276 in)
Stroke ..... 130 mm (5.1181 in)
Capacity .....5401 cc
Compression ratio ..... 17.4 to 1
Main bearings ..... Five
Crankshaft rotation (as seen from fan side).....Clockwise
Maximum output speed ..... 2100 rpm
Maximum torque speed ..... 1300 rpm

Valve gear

Valves .....Pushrod-operated, OH
Tacho-hourmeter rating .....1400 rpm

Fuel system

Precleaner ..... Centrifugal
Air-cleaner ..Twin,paper element,in-line
Air-cleaner indicator .... Dash-mounted
Oil bath cleaner ..... Optional
Fuel filter ..... Twin,in-line, paper and cloth element, feed pump suction line mounted.
Injection pump ..... FIAT-BOSCH,in-line L.H. helix
Timing ..... 25° B.T.D.C.
Firing Order..... 1-3-4-2
Fuel injectors ...Four orifice, 145° spray angle.

Lubrication system

Type ..... Forced feed
Oil pump ..... Gear
Relief valve ..... Pump mounted
Oil filter .....Full-flow, paper cartridge, bypass valve
Pump drive ratio .....1.45 to 1

Cooling system

Type .....Water
Pump ..... Centrifugal
Thermostat ..... Wax
Water pump drive ratio ..... 1.34 to 1
Radiator ..... 5-deep vertical tube
Fan ..... Blower type, 6-bladed

1.1.3 TORQUE CONVERTER

Type .....13in, hydraulic,single-stage,single-phase
Torque multiplication ratio ... 3.1 to 1

1.1.4 TRANSMISSION

Type ..... Power shift, five hydraulically controlled constant-mesh, spur gearing,oil-bath multiplate clutches.
Number of gears ..... 3 forward and 3 reverse.
Control ... Lever to left of operator

Forward speeds
- First ..... Up to 3.4 kph (2.1 mph)
- Second ..... Up to 5.3 kph (3.3 mph)
- Third ..... Up to 9.2 kph (5.7 mph)

Reverse speeds
- First ..... Up to 4.1 kph (2.5 mph)
- Second ..... Up to 6.2 kph (3.9 mph)
- Third ..... Up to 10.5 kph(6.5 mph)

Power take-off

Position ..... Reverse clutch shaft
Shaft ..... Splined
Shaft speed ..... Uo to 1575 rpm
Direction of rotation (as seen from rear of machine)..... Clockwise

1.1.5 CONVERTER/TRANSMISSION HYDRAULIC SYSTEM

Hydraulic pump .... Double,gear,driven through flywheel
- Pump drive ratio .....1.154 to 1
- Feed pump rated output 39 litres/min (8.5 Imp.galls/min or 10 U.S.galls/min)
- Scavenge pump rated output 70 Litres/min (15 Imp.galls/min or 18.5 U.S. galls/min)

Oil filter (feed pump)
- Suction .... Metal cartridge and magnetic rod.
- Outlet ..... Metal cartridge

Oil filter (scavenge pump)
- Suction .....Gauze

Valve block

Transmission relief valve
- Pressure setting .....14.5 to 15 kg/cm^2 (206 to 213 psi)

Retarder valves
-Pressure setting ...1.65 to 1.95 kg/cm^2 (23.5 to 27.7 psi)

Torque converter relief valve
- Pressure setting ....0.8 to 1.2 kg/cm^2 (11.4 to 17.1 psi)

Torque converter safety valve
- Pressure setting .....6.7 to 8.3 kg/cm^2 (95.3 to 118.1 psi)

Lubricating oil pressure relief valve
- Pressure setting ...2 kg/cm^2(28.4 psi)

Oil cooler ..... Shell and tube, branched off the engine cooling system.

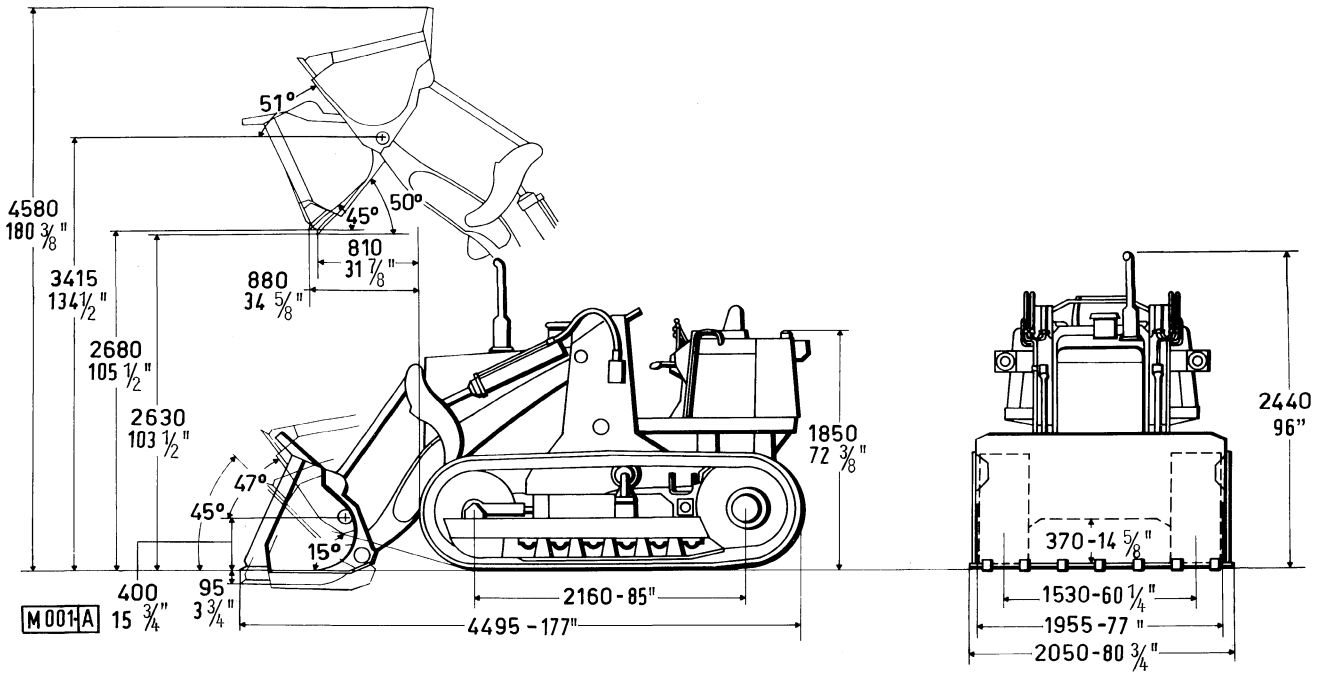


Fig. 1-1 Overall dimensions, FL9 Loader

1.1.6 BEVEL DRIVE

Type ..... Spiral,centrally mounted, bolted-on ring gear
- Reduction ratio (13/43)... 3.308 to 1

1.1.7 STEERING CLUTCHES

Type ..... Oil bath,multiplate,hydraulic
- Number of plates (each) 10

Control ..... Separate pedals
-Half stroke ..... Clutch actuation
-Full stroke .....Brake application

1.1.8 BRAKES

- Service
  Type ..... Oil bath, band, acting on outer steering clutch drums
  Operation ..... Mechanical
  Control ..... Central pedal
  Drum diameter ..... 340 mm (13 in)
  Brake band width ..... 60 mm (2.4 in)
- Parking
  Operation ..... Mechanical
  Control ..... Pedal, acting on service brakes

1.1.9 STEERING CLUTCH HYDRAULIC SISTEM

Hydraulic pump ..... Gear
Pump drive ..... From Flywheel
- Pump drive ratio ..... 1.154 to 1
- Rated pump output at maximum speed..... 36 litres/min (7.9 Imp. galls/min or 9.5 U.S. galls/min).
- Rated maximum operating pressure..... 29 kg/cm^2 (412 psi)

Oil filter
- Suction .... Steel gauze and magnetic rod.
- Return ..... Paper cartridge

Valve block ...Two spool, controlled by steering clutch pedals.

Steering clutch control valve setting.....19.5 to 20.5 kg/cm^2 (277 to 292 psi)

1.1.10 FINAL DRIVES

Type .....Straight toothing, double reduction
- Reduction ratio .....9.949 to 1

1.1.11 SPROCKETS

Ring gear ..... Integral
Number of teeth 27
Pitch circle diameter ... 737 mm (29 in)
Face width ..... 61 to 62 mm (2.40 in to 2.44 in)

1.1.12 UNDERCARRIAGE

Track frames .... Boxed, anchored at front and rear
Number of shoes to each chain 39
Shoe width ..... 360 mm(14.2 in)
Ground contact area ..... 15550 cm^2 (2410 in^2)
Specific ground pressure 0.68 kg/cm^2 (9.7 psi)
Number of track rollers .... 6 per chain
Number of carrier rollers .. 1 per chain
Track tension assemblv ...Recoil spring, hydraulic adjustment
- Overload valve setting 1100 to 1150 kg/cm^2 (15645 to 16356 psi)

Idlers and rollers Lubricated for life, equipped with long-life floating ring seals.

1.1.13 SUSPENSION

Front
- Cross beam .....Rigid, resting on track frames.

Rear ..... Two bars attached to track frames anchored to rear transmission case and final drive casing.

1.1.14 HYDRAULIC SYSTEM

Hydraulic pump .....Double gear pump
Pump drive .....From flywheel
Pump drive ratio .....0.9231 to 1
Rated pump output ..... 146 litres/min (32 Imp.galls/min 05 38.5 U.S. galls/min)
Maximum operating pressure 155 kg/cm^2 (2204 psi)
Oil filters
- Suction ..... Full-flow, steel gauze element and magnetic rod
- Return ... Paper element, full-flow

Hydraulic valve block.....3 spool
- Relief valve pressure setting 153 to 157 kg/cm^2 (2176 to 2233 psi)
- Reverse flow and safety valve pressure setting for bucket withrawal 178 to 182 kg/cm^2 (2532 to 2588 psi)
- Reverse flow and safety valve pressure setting for bucket dumping 68 to 72 kg/cm^2 (967 to 1024 psi)

Arm cylinders ..... Two, double-acting
- Bore and stroke .... 120 x 686 mm (4.75 in x 27 in)

Bucket cylinders.....Two, double acting
- Bore and stroke ..... 110 x 636 mm (4.25 x 25 in)

Bucket positioner ..... Automatic
Ripper cylinders (SC9 or SL9) optional ..... One, double acting
- Bore and stroke ..... 120 x 280 mm (4.75 x 11 in)

1.1.15 ELECTRICAL SYSTEM (24V)

Batteries ..... Two, series
- Capacity (20 hour rate).....77 Ah
Alternator..... 3-phase,self-rectifying
- Type ..... FIAT A12M 124/24/26B
- Maximum rating ..... 32 A Approx

Voltage regulator
- FIAT RC 2/24 ..... Electromechanical
- MARELLI RTT 110 CT ..... Electronic

Alternator warnig relay
-SIPEA ..... T 5240
-WEPOO 90003

Starter ..... Sliding armature, clutch
-Type .....MARELLI MT 43 P
- Rated output ..... 4HP (2.9 kw)

1.1.16 WEIGHTS

Dry engine (without lubricant, coolant and air cleaner) .....650 kg (1433 lb)

Standard machine (fully operational) 9100 kg (20,066 lb)

1.2 SPARE PARTS

When ordering spare parts please state
- Tractor model (marketing code) and frame number.
- Engine type and number
- Spare part number (see the Spare Parts Catalogue).

N.B. For machine identification data see the Operators Manual

1.3 CAPACITIES

DESCRIPTION	Litres(x)	US Gals	TYPE OF FLUID FIAT DESIGNATION
Engine oil Air cleaner (oil bath,opt.)	12 2	3 1/4 4 pints	Oliofiat AGERTER (1)
Converter/Transmission oil	20	5 1/4	(Above freezing) oliofiat AGERTER 30 (SAE 30)
Rear transmission oil (bevel, steering clutches)	15.5	4	(Below freezing) oliofiat AGERTER 10 (SAE 10 W)
Final drive oil (each)	14.5	3 3/4	Oliofiat AW 90/M
Loader oil	45.5	12	(Above freezing) oliofiat AP 51
Ripper oil (supplement)	5.5	1 1/2	(Below freezing) oliofiat AP 31
Coolant	25	6 1/2	Water or anti-freeze
Fuel	190	50 Gals	Diesel oil
Track tension grease	--	----	Grassofiat G9
Drive shaft and general purpose lubricating grease (2 nipples)	--	----	Grassofiat G9

(*) These quantities are only applicable for normal maintenance. In the case of a refit these quantities can be considerably different.

(1) FIAT AGERTER oil viscosity grade (SAE) in relation to atmospheric temperature:

AGERTER 10 W (SAE 10W)	Below - 15° C 5°F	
AGERTER 20 W (SAE 20W)	Below - 15° C to 0° C 5°F - 32°F	
AGERTER 30 (SAE 30)	Up to 35° C 95°F	Minimum above 0° C
AGERTER 40 (SAE 40)	Above 35° C	

RECOMMENDED LUBRICANT SPECIFICATION

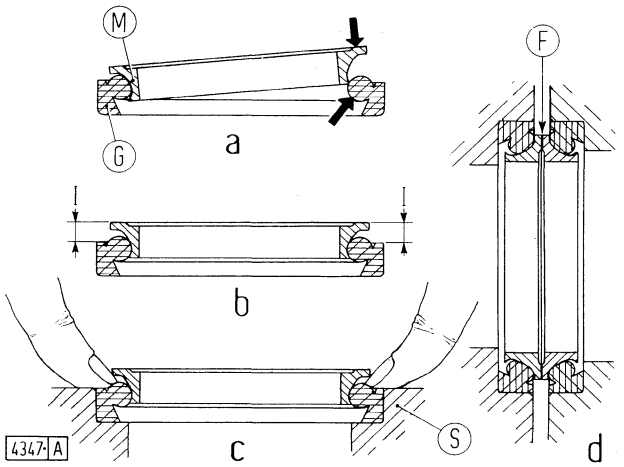
DESCRIPTION	FIAT PRODUCT	
	FIAT DESIGNATION	INTERNATIONAL DESIGNATION
ENGINE - TRANSMISSION - BEVEL - STEERING CLUTCH	AGERTER (1)	MIL-L-2104 C; Service API-CD
ROLLERS - IDLERS	AGERTER 30	As above SAE 30
FINAL DRIVES	AW 90/M	SAE 80W/90 EP MIL-L-2105 C
HYDRAULIC SYSTEM	AP 31	Hydraulic oil containing lubricity, wear control, and rust preventing additives - SAE 10W
	AP 51	As above - SAE 20W
LUBRICATORS	G9	Lithium-calcium mineral grease, water, load and heat resistant N.L.G.I. 2

1.4

1.4 GENERAL FITTING NOTES

1.4.1 FLOATING RING SEALS

Carefully examine the metal rings (M) ensuring that their sealing surfaces are free from score marks, dents or wear due to misalignment or flatness errors. Both metal rings (M) and rubber seals (G) should be renewed together, even if only one is found to be defective.



Do not pair new and worn metal rings together, nor used rings of different pairs.
To fit a seal proceed as fallows:

- Remove all sharp corners and burrs, and carefully clean the rubber seal housings.
- Thoroughly clean the rubber seals.
- Couple each metal ring (M) to the associated rubber seal (G) as shown in (a) pushing and pressing as indicated by the arrows.
- Ensure that each metal ring is correctly seated: dimension I (see detail b) should be equal all round.
- Place each seal assembly in position by depressing the rubber ring as shown in detail (c).
- Before pairing the seal assemblies (see detail d) clean sealing faces (F) using a lint-free cloth and smear a light coat of thin oil over the contact surfaces.

1.4.2 ROTARY SHAFT SEALS

To fit the rotary shaft seals proceed as follows:

- Prior to fitting soak the seals for at least half an hour in the fluid to be retained.
- Carefully clean the shaft and ensure that the contact surface is free from damage.
- Turn the end of the sealing lip towards the fluid to be retained; if it is the thrower lip type, turn the grooves so that during shaft rotation the fluid tends to be thrown back.
- Smear the sealing lip with a very thin coat of lubricant (oil is better than grease) and pack the space between the sealing lip and dust shield with grease (applicable to double lip seals).
- Fit the seals into their housing using a flat-ended tool or ram. Under no circumstances fit with a drift or hammer.
- Avoid entry of seal into the recess in

a tilted position. Exert a firm and uniform pressure squarely on it and ensure that the seal is pressed fully home.

- To prevent sealing lip damage during fitting use some form of protection before sliding over the shaft.

1.4.3 O-RINGS

Lubricate each ring prior to fitting and , on reassembly, slide over the part but do not twist, otherwise leakage will result.

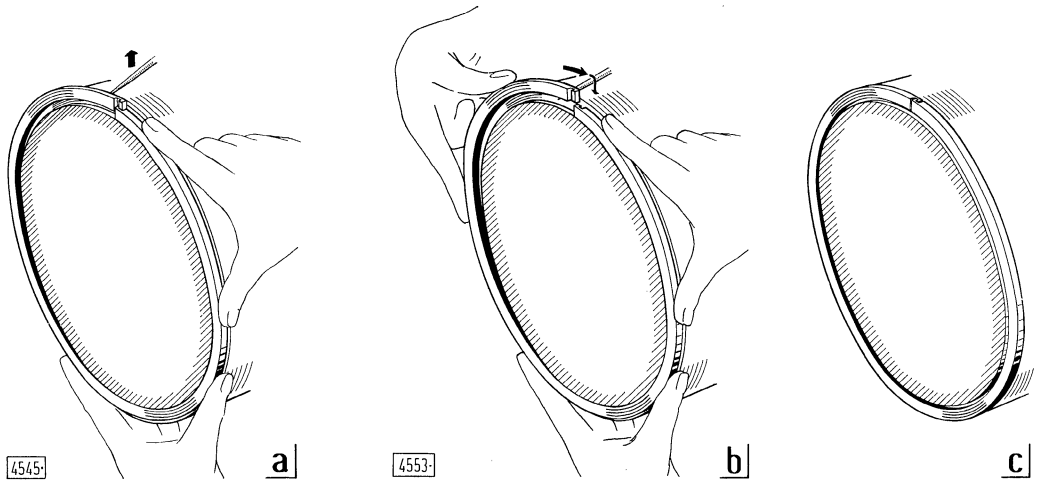
1.4.4 FACE SEALING RINGS

To remove proceed as fallows:

- Depress one end of the ring (see a)
- Hold in position and insert a scriber point beneath the other end to separate the interlocking ends as shown.

To refit adopt the following procedure:

- Re-position the seal and depress one end of the ring (see b)
- Hold in position and lift the free end (see b) until the two ends lock together correctly (see c).



1.5 HYDRAULIC PRESSURE CHECK POINTS

To diagnose the sources of possible machine hydraulic system trouble use the pressure checkpoints provided on each hydraulic circuit prior to dismantling any component.
The table overleaf indicates:

- Identification code of pressure tapping derived from Fig. 1-2
- Pressure point thread size
- Normal pressure rating at 2100 engine rpm and oil at normal operating temperature (other operating conditions are indicated in the footnotes).

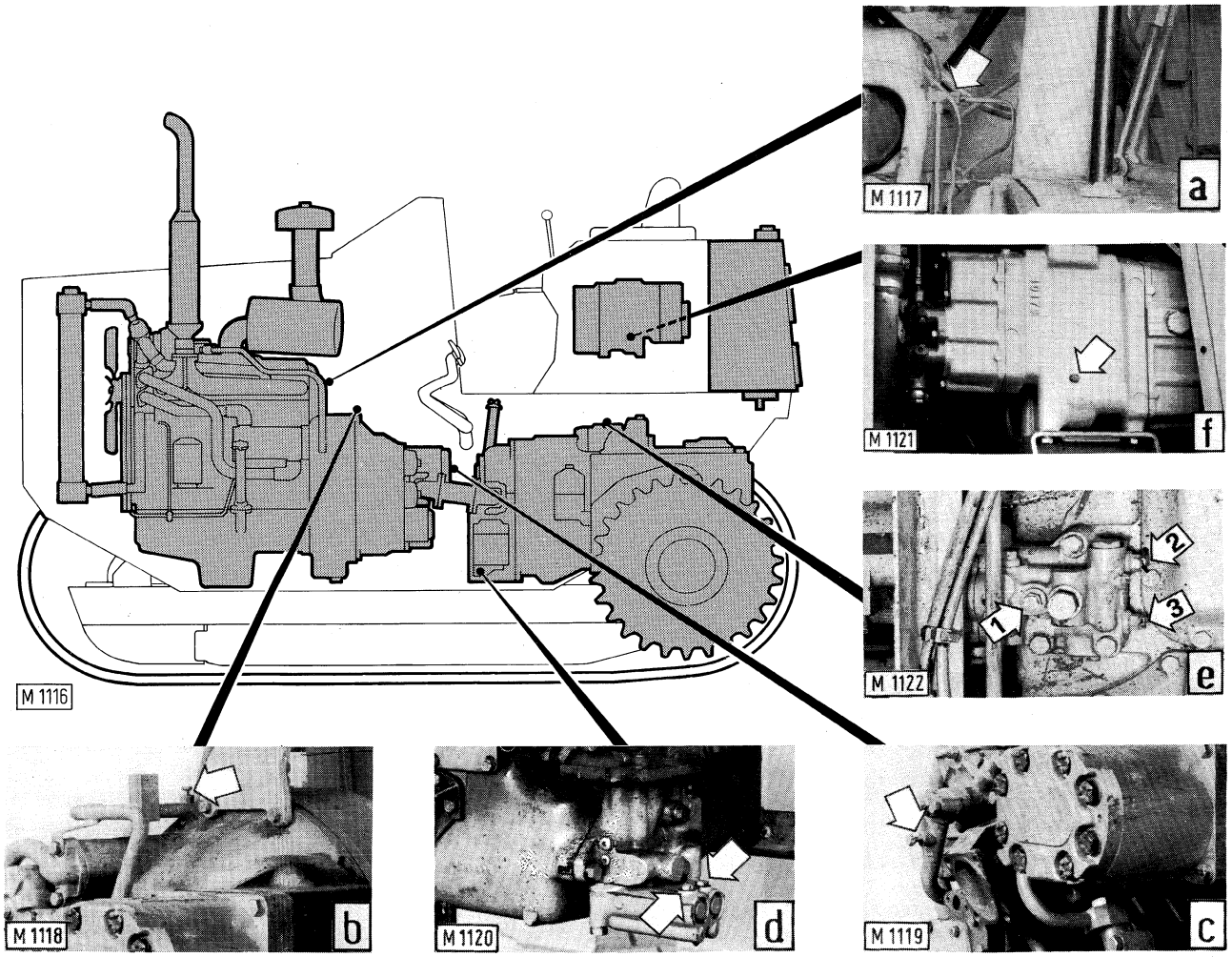


Fig.1-2 - Position of Pressure Checkpoints

Reference (Fig.1-2)	Pressure checkpoint	Normal pressure		
		kg/cm^2	bar	psi
a	Engine lubrication	4 to 5	3.9 to 4.9	57 to 71
b	Converter oil	0.8 to 1.2	.078 to 1.17	11 to 17
c	Transmission	14.5 to 15	14.2 to 14.7	206 to 213
d	Retarder valves for forward and reverse	14.5 to 15	14.2 to 14.7	206 to 213
e	Steering clutches			
	- 1. Servovalve	19.5 to 20.5(1)	19.1 to 20.1(1)	277 to 286
	- 2. R.H.steering clutch	19.5 to 20.5(2)	19.1 to 20.1(2)	277 to 286
	- 3. L.H.steering clutch	19.5 to 20.5(2)	19.1 to 20.1(2)	287 to 286
f	Hydraulic System control	153 to 157	150 to 154	2176 to 2233

(1) After withdrawal of either R.H. or L.H. steering clutch.

(2) After withdrawal of corresponding steering clutch.

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Section 2 - ENGINE

CONTENTS

Study SAFETY RULES, pages I thru III, thoroughly for the protection of personal and machine safety.

2. ENGINE

2.1 GENERAL

2.1.1 DESCRIPTION

The FIAT-OM engine (Fig.2-1) fitted to the loader is a high-speed naturally-aspirated Diesel power unit of the 4-stroke four-in-line cylinder type.
The engine block is an iron casting incorporating cylinder bores, crankshaft bearing housings and tappet bores.
The cylinder liners are wet iron sleeves.
The cylinder head is an iron casting with integral valve seats.
The crankshaft runs on five bearings.
The light alloy pistons incorporate three rings, namely two compression and one oil-scraper.
Valve timing gears are helical, valves being pushrod operated fitted overhead with guides pressed in the head.
Air is admitted through a dry filter composed of two paper cartridges.
Fuel injection is direct into high-turbulence combustion chambers in the piston crowns, through in-line injection pump and four-orifice fuel injectors.
The forced feed lubrication system incorporates a gear pump and features a relief valve.
The water cooling system includes a centrifugal water pump, radiator and six-bladed fan.
A thermostat controls the temperature.
Engine starting is through a 24V solenoid operated electric motor.

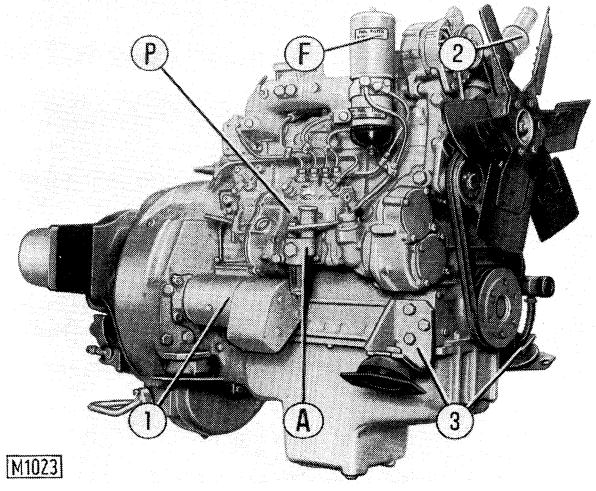

Fig. 2-1 Front R.H. view of engine.
A. Fuel feed pump - F. Fuel filters - P. Injection pump - 1. Starter - 2. Thermostat - 3. Front engine mounting -bracket with pad.

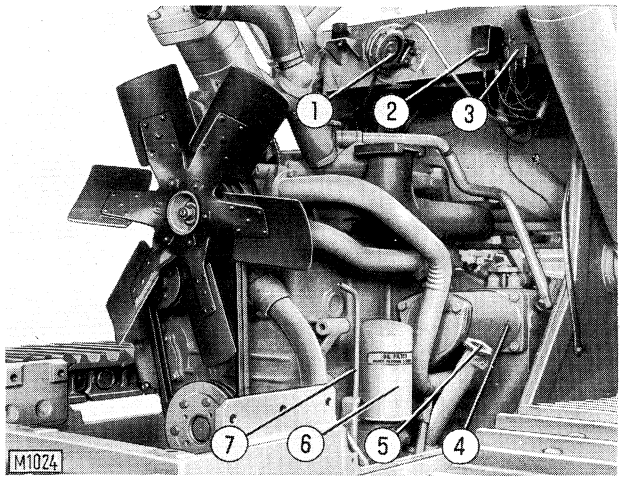

Fig. 2-2 Side L.H. view of the engine in position on the machine
1. Silencer - 2. Voltage regulator - 3. Generator warning relay - 4. Converter/Transmission oil cooler - 5. Oil filter plug with dipstick - 6. Oil filter - 7. Engine block drain cock.

2.1.2 ENGINE REMOVAL

- Raise the bucket and fit the spacer to arm cylinders; remove side engine covers, lower engine and transmission cover and foot boards.
- Drain coolant and oil from the converter/transmission, rear transmission case and hydraulic reservoir.
- Remove the operators seat, close the fuel cock and insulate the ground wire.
- Remove the hood, radiator grille and air cleaner.
- Detach the radiator hoses and remove the radiator and cowl.
- Disconnect all pipes, leads and links connecting the engine to the instrument panel, the fuel tank and the throttle.
- Disconnect all pipes connecting the hydraulic pump/converter assembly to other transmission units and the drive shaft joint.
- Attach brackets 293202-293203-293204- to the intake manifold, the exhaust manifold and the converter cover respectively. Use lift hook 290740 and tension the hoist, free the mounting pads from the machine frame, raise the engine and converter, taking care to turn through 180° to lift clear.

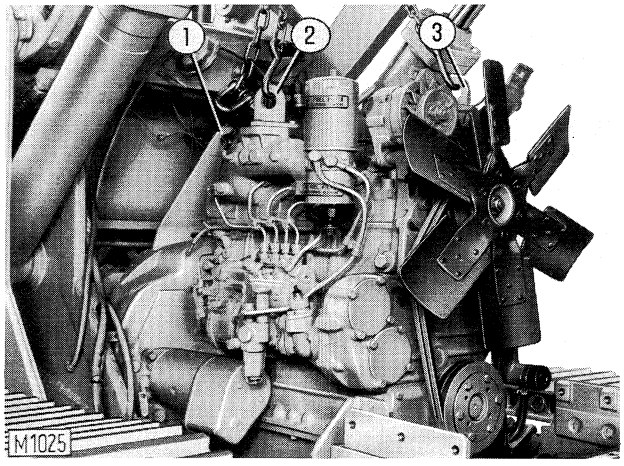

Fig. 2-3 Removal (installation) of engine using lift hook 290740.
1. Converter cover bracket 293204 - 2. Intake manifold converter bracket 293202 - 3. Exhaust manifold bracket 293203.

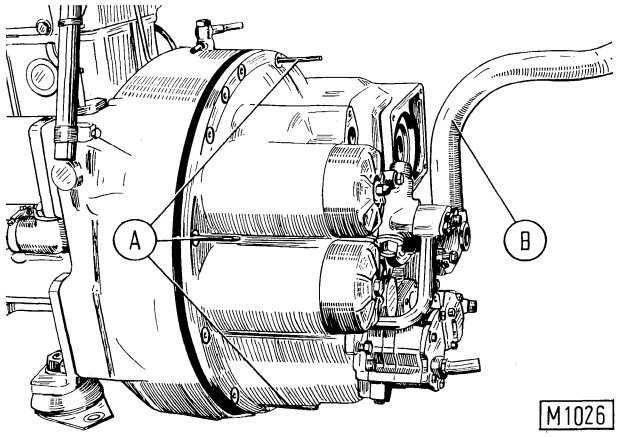

Fig. 2-4 Removal (installation) of converter assembly
A. Guide pins 291525 - B. Lift hook 291359 with bracket 291516

2.1.3 ENGINE OVERHAUL

Place the engine on rotary overhaul stand 290090 using two front brackets 293205 and two rear brackets 293206 and adhere to instructions given under the appropriate headings (fig. 2-5).

2.1.4 ENGINE INSTALLATION

Reverse the removal procedure and note the following:

- Attach the support brackets with pads to the engine use lift hook 290740 and place the engine on the machine (fig. 2-3).

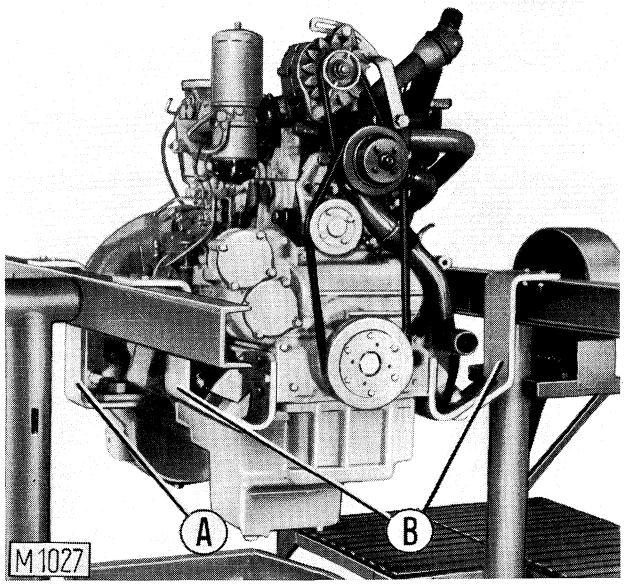

Fig. 2-5 Engine in position on Rotary stand 290090
A. - Rear brackets 293206 - B. Front brackets 293205.

2.1.5 ENGINE COMPRESSION TEST

If engine performance is found to be unsatisfactory, check the injection system and the compression in each cylinder using tester 291310 as follows:

- Remove the injectors
- Fit dummy injector 292634 in place of injector of the cylinder under test.
- Hold the injection pump at shut-off and take the necessary readings driving the engine through the starter.

In normal operating conditions, compression should be 26 to 28 kg/cm^2 or 370. to 398 psi as recorded at 40° C sump oil temperature, 760 mm Hg (sea level) and 200 to 220 rpm.
The minimum compression which is acceptable for a worn engine is 22 kg/cm^2 or 313 psi.
It should be noted that every 100 meters or 328 ft altitude increase above sea level results in a 1% decrease in compression.
The maximum variation in compression between cylinders is 3kg/cm^2 or 43 psi. Insufficient compression may be due to faulty valves and seats, pistons and associated rings, cylinder liners or cylinder head gasket.

2.1.6 PERFORMANCE TEST DATA

Bench Test Conditions

- Engine on bench with fan, air cleaner and exhaust silencer removed.
- Atmospheric pressure 740 ± 5 mm Hg
- Ambient temperature 20° ± 3° C
- Relative humidity 70% ± 5%
- Fuel density 830 ± 10 gram/litre
- Injection timing 25° ± 30 min B.T.D.C., cylinder No. 1 on compression stroke.

Throttle	rpm	Engine H.P.		Time required to burn 500cc of fuel (seconds)
		2 hour run-in	50 hour run-in	
Maximum (full load)	2100	91.5 (min)	92 (min)	45.6 to 46.6
Maximum (full torque)	1000	46 (min)	46.5 (min)	92.8 to 95.8
Maximum (no-load)	2300 max.	--	--	--
Minimum (idle)(.)	650 to 680	--	--	--
		--	--	--

(.) Adjust throttle "minimum" stop.

2.2 ENGINE BLOCK

Ensure that the block is free from damage. Check the studs for score-marks and strains resulting from excessive tightening. Renew as necessary.
Stud height above engine block top should be as shown in Fig. 2-6. Prior to fitting head and sump gaskets ensure that the associated block faces are clean.

2.2.1 CYLINDER SLEEVES

To inspect the sleeves for wear proceed as follows:

- Check the bore over the working length (H, fig. 2-7) swept by the piston rings
- The diameter reading should be taken in both the upper and lower part of the working length in plane (e) parallel to the crankshaft and in plane (f) at right angles to it.
- Compare the readings to establish the amount of sleeve out-of-roundness and taper.

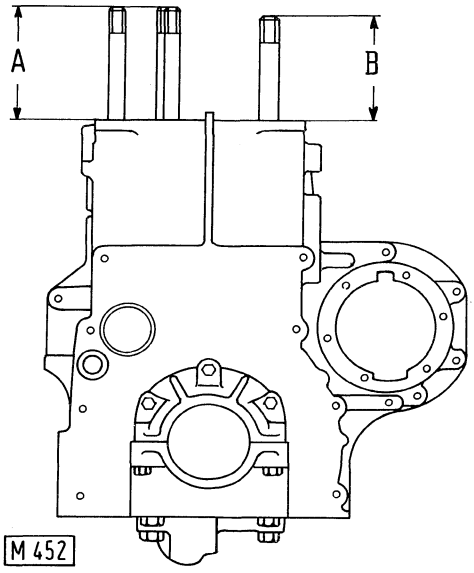

Fig. 2-6 Stud height above engine block top
A. 117 mm or 4.606 in, valve gear and stud height above block - B. 104 mm or 4.094 in, injection pump and stud height above block

To assess the piston working clearance check the sleeve bore diameter in lower part (L) in plane (f) only if out-of-roundness or taper in excess of .15 mm or.006" in is detected, re-bore to .60 mm or.024" IN OVERSIZE (see data table).
If the sleeves have already been re-bored, renew without hesitation.
After re-boring, check the bore diameter by means of a suitable dial gauge.
To do this zero the gauge and take c and d readings (fig. 2-7) at points 1,2 and 3 respectively. Out-of round should not exceed .01 mm or .0004 in over X length and .03 mm or .0012 in over Y length.
To adjust replacement liner protrusion proceed as follows:

- Insert one sleeve with its shim pack (S, fig. 2-7) of unspecified thickness and press fully home.
- Place spacers 290955/1 and 290956 over two diametrically opposed studs and tighten the nuts to 1 kgm or 7.2 lb ft.
- Position straightedge 291174 over the liner at right angles to the spacer centreline and, using a feeler gauge check the gap between block and straightedge at both end. The clearance should be .15 to .18 mm or .0059 to .0071 in.

To adjust, alter shim thickness as necessary. Adopt the same procedure on the other cylinders ensuring that the sleeve which has already been checked is removed together with its shim prior to dealing with the next cylinder.
The sleeve protrusion check should also be carried out when refitting the original sleeves.
Liner top misalignment should not exceed .03 or .0012 in

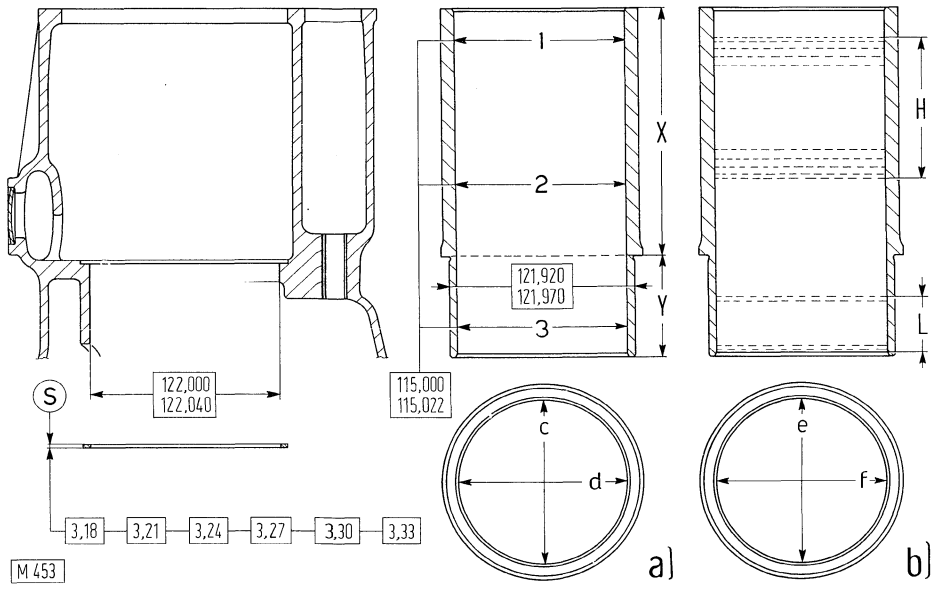

Fig. 2-7 Sleeve and Block dimensions and wear Data
a. Sleeve and block dimensions - b. Wear data - H. Sleeve wear inspection length; readings to be taken in planes (e) and (f) - L. Inspection length for assessment of piston fit; reading to be taken in plane (f) - S. Liner protrusion shim thickness - X. 167 mm or 6.575 in - Y. 68 mm or 2.677 in , new or re-bored liner out-of-round inspection length (see text) - 1-2-3 - New or re-bored sleeve bore dimensional check points; readings to be taken in planes (c) and (d)

2.3 CYLINDER HEAD

Check head flatness by placing the cylinder head on a surface plate smeared with carbon black and re-dress as necessary by scraping, or by grinding if distortion is in excess of .15 mm or .006 in.
When grinding the maximum amount of material which can be removed should not exceed .5 mm or .020 in.
After fitting the fuel injectors and the valves, ensure that injection protrusion and valve fitted depth are as prescribed in the data table.
Injector sleeve leakage can often be obviated by means of punch 291350.
To obtain a good seal between injector and sleeve bottom, dress the taper seat using cutter 291467.
To renew the fuel injector sleeves, use the set of taps A. 90424/1 (290687) for tapping and puller A. 42110 (290633) to remove from the head.
* Install the new injector sleeves using a hand press and expand their top end using punch 291350.
When refitting the cylinder head note the following points:

- Wipe the engine block top using solvent and carefully clean the cylinder head.
- Fit the gasket with the mark "BASSO" on the steel liner facing towards the block top.
- Position the cylinder head over the dowels and tighten the hold-down nuts in three stages according to the sequence shown in fig. 2-8.

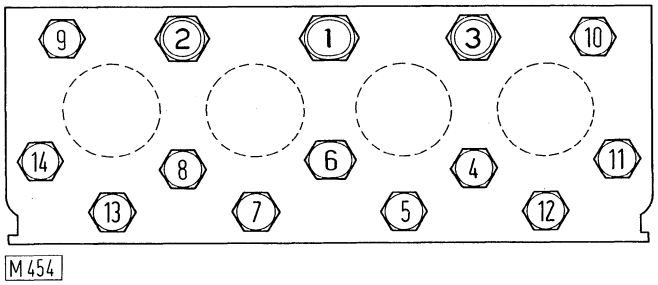

Fig. 2-8 Cylinder Head Tightening Diagram
Note: The prescribed tightening torque should be reached in at least three successive stages.

Note:

Once the engine has been run-in on the test bench or in the machine itself, tighten the three 18 mm dia. or 0.709 in hold down nuts by a 1/4 of a turn to 29-31 kgm (28-30 da N.m).
This is necessary due to the gasket slumping on its first exposure to heat.

2.3.1 VALVE SEAT DRESSING AND SEAT INSERTS

Use tool 291113 to rest the cylinder head on, and support 291112 to position the valves.
For valve seat re-cutting using universal lathe A.60419 (292913) proceed as follows:

- Remove all deposits and carefully clean the valve guide bore prior to inserting the cutter pilot.
- Attach the tool to the associated support and place in position.
- Zero the cutter on the valve seat centreline.
- Take .1 to .2 mm or .04 to .08 in cuts until a complete new seat is formed.
- Take a .5 mm or .02 in finish cut.

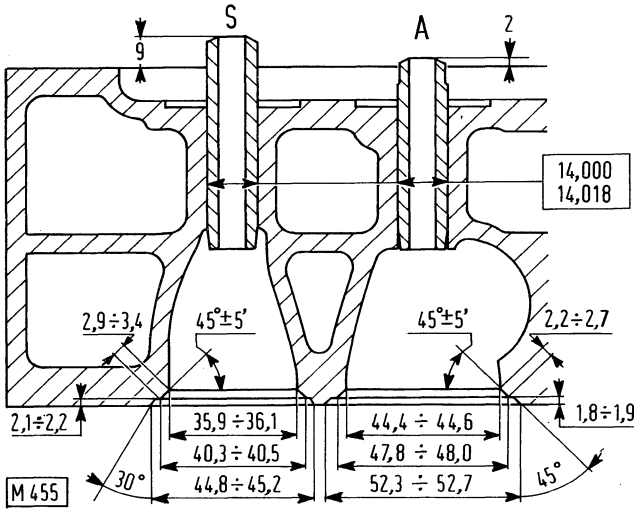

Fig. 2-9 Valve seat, Guide Housing Bore and Guide Protrusion Details.
A. Intake valve guide - B. Exhaust valve guide.

Proper use of the tools supplied together with the universal lathe enables the seat width to be reduced so as to obtain the dimensions prescribed Fig.2-9. Should the universal lathe not be available, satisfactory results may be obtained by means of hand cutter kit 292264, noting the following points:

- Universal cutter machined seats do not require grinding-in of new valves
- Hand cutter machined seats must be ground-in together with the valves.

After the seats have been re-cut several times, when valve depth below the cylinder head face exceeds the prescribed allowance, the cylinder head may be reconditioned by skimming the face or adopting valve seat inserts. (Fig.2-10)

2.4 VALVE GEAR

2.4.1 CAMSHAFT

Check for shaft distortion by placing the camshaft over V-blocks and resting the stylus of a dial gauge over the centre journal. Maximum eccentricity should not exceed .15 mm or .006 in in over one full revolution. If distortion is in excess of the stated value, renew the camshaft without hesitation.

Note that:

- The camshaft is available with attached drive gear, whilst the drive gear is available individually.
- Prior to fitting a replacement drive gear heat to 220° - 250° C.

2.4.2 VALVES AND GUIDES

To remove the valves take off the cylinder head, compress the valve springs using compressor 291050 and withdraw the spring cones.
The valve stem face may be re-ground removing as little material as possible. In this connection, note that the depth of the hard case in this area is 2 to 3 mm or .08 to .12 in.
Check valve stems and valve guides for size using a micrometer and kit A.95723 (292867) respectively. If the clearance recorded is excessive, renew the valves in question. If following valve replacement the clearance still exceeds the specified value, also remove the valve guides using driver 291046.

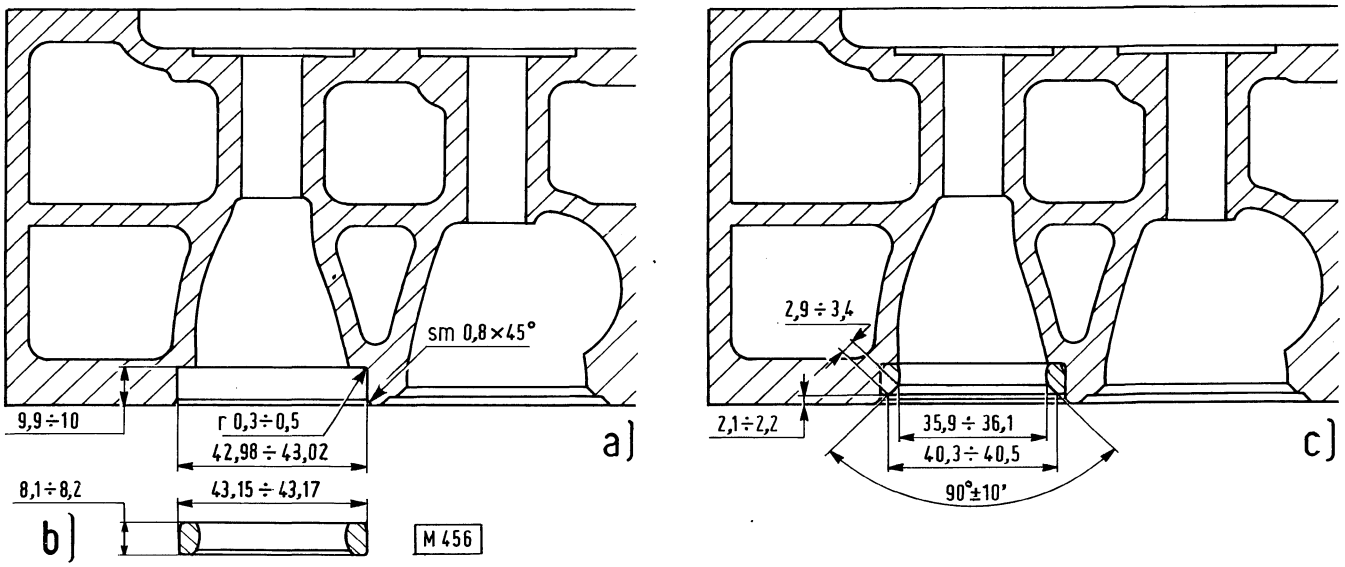

Fig. 2-10 Exhaust valve seat-insert details - a. Valve seat insert housing - b. Seat insert - c. Valve seats on insert.

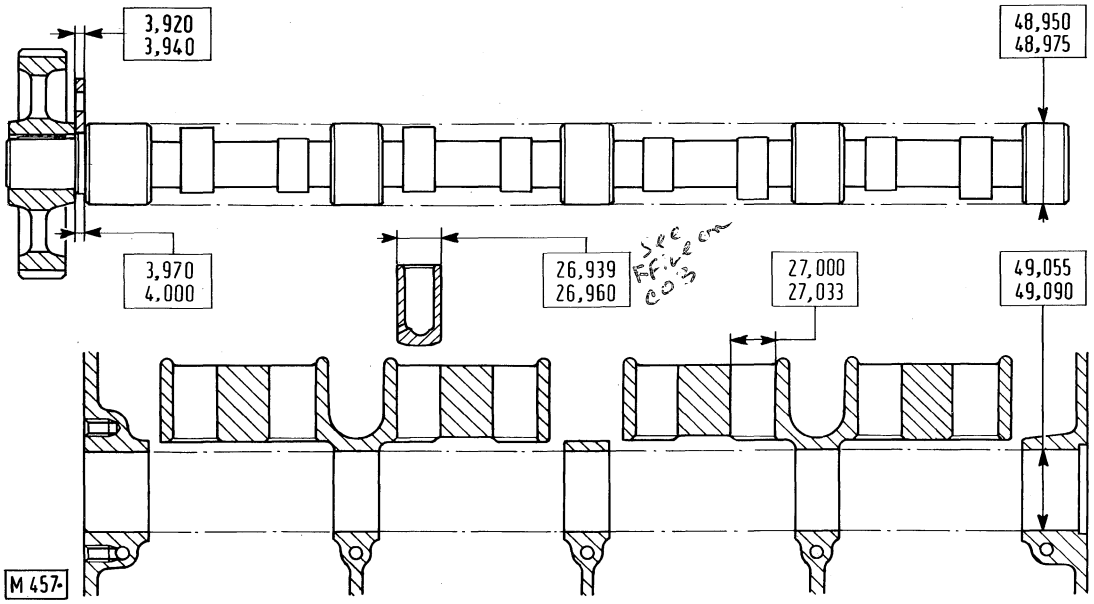

Fig. 2-11 - Camshaft, Thrust Plate and Tappet Details

When checking the guides note the following points:
- Guides should be tight in their seats in the heads; if not fit oversize guides (see data table).
- When in position, the guides should protrude from the cylinder head as prescribed in Fig. 2-9.
- After assembly, the guides should be reamed using reamer 290944.

The exhaust guides are 7 mm or .28 in longer than the intake valve guides.

- Check the working clearance. If greater than .15 mm or .006 in, renew using oversize tappets and open out the associated housing bores in the engine block (see data table).

Remove the rocker shaft and brackets and check the shafts and rockers for wear (Fig. 2-13). If the clearance exceeds .10 mm or .004 in renew one or both parts as necessary.
Inspect the rocker toes. When re-grinding becomes necessary, take care to remove as little material as possible.

2.4.3 VALVE CLEARANCE ADJUSTMENT

The correct clearance is .30 mm or .012 in for inlet valves and .50 mm or .020 in for exhaust valves.
Cylinder matching for valve clearance adjustment is 1-4 and 2-3. Bring the valves of the first cylinder of each pair in a condition of balance to adjust the valves of the second cylinder of the same pair and vice-versa.

2.4.4 TAPPETS AND ROCKERS

To remove the tappets take off the cylinder head and use tool 290947. For tappet inspection proceed as fallows:
- Check that the surface in contact with the cam is in good condition. Any score marks may be removed using a very fine abrasive stone.

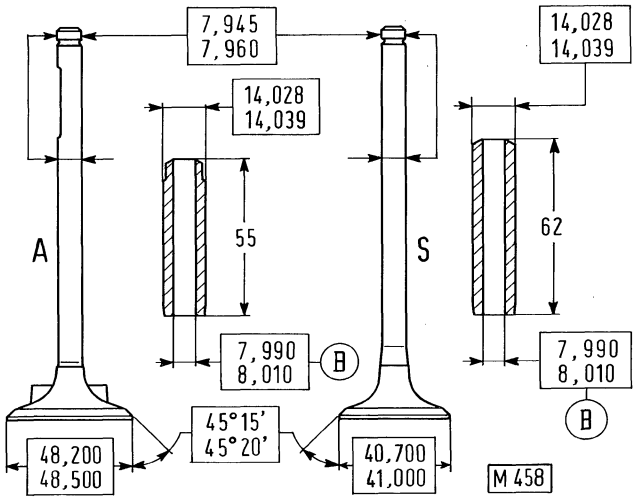

Fig. 2-12 Valve and guide details
A. Intake valve - S. Exhaust valve - B. Fitted bore dimension after reaming

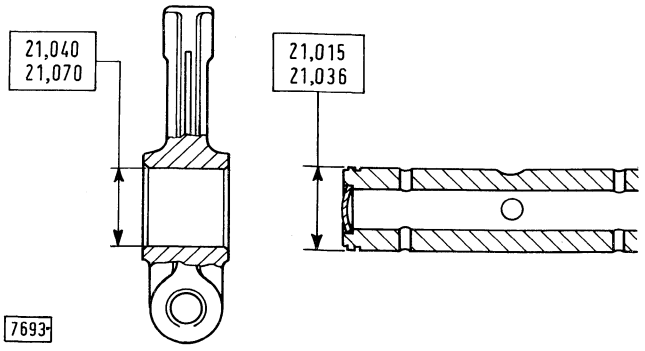

Fig. 2-13 Rocker and shaft details.

2.5 CRANK GEAR

2.4.5 VALVE TIMING

Refit the valve gear as follows:

- Slacken the fuel injectors and rotate the crankshaft until reference mark P.M.S. 1-4 (stamped on flywheel periphery) lines up with the associated fixed timing pointer (Fig.2-15), checking that cylinder No. 1 is on firing stroke (to this end turn the crankshaft a few degrees in opposite directions to ensure that the valves of cylinder No. 1 are closed and those of cylinder No. 4 are in a condition of balance)
- Position the intermediate gear flange 6 so that the slot for washer 7 lies as shown in detail (a)
- Position gears 1 and 5 so that the associated reference marks (Fig. 2-15) are in register and insert intermediate gear 4.
- Refit the injection pump gear 3 and auxiliary pump gear 2 lining up reference marks (T) and retighten screws.

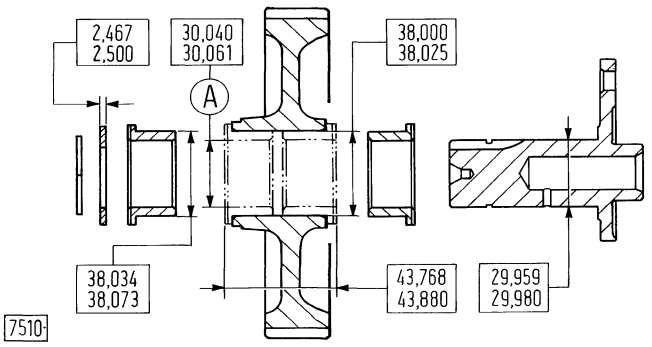

Fig.2-14 Idler gear, Bush and Jackshaft details - A. Bush fitted bore diameter

2.4.6 TACHO-HOURMETER

The tacho-hourmeter is valve gear driven
- Engine/drive ratio 2 to 1
- Tacho-hourmeter rating

2.5.1 CRANKSHAFT

To remove the crankshaft, proceed as follows:
- Withdraw the engine from the tractor (para 2.1.2) and position on rotary stand (Fig. 2-5).
- Remove the oil sump.
- Remove the cylinder head.
- Replace the front and rear rotary stand mounting brackets with brackets 291508/1 and 291509/1.
- Remove the valve block cover and the rear engine support.
- Remove the crankshaft.

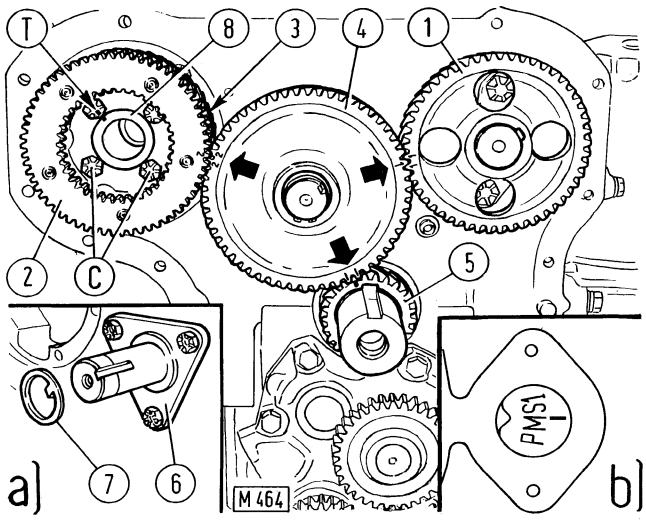

Fig. 2-15 Valve timing

a. Detail showing correct position of idler jackshaft flange - b. Timing mark on flywheel - C. Auxiliary pump screws (2) - T. Injection pump gear reference marks - 1. Camshaft gear - 2. Auxiliary pump gear - 3. Injection pump gear - 4. Intermediate gear. 5. Crankshaft pinion - 6. Intermediate gear support flange - 7. Washer - 8. Injection pump drive bush.

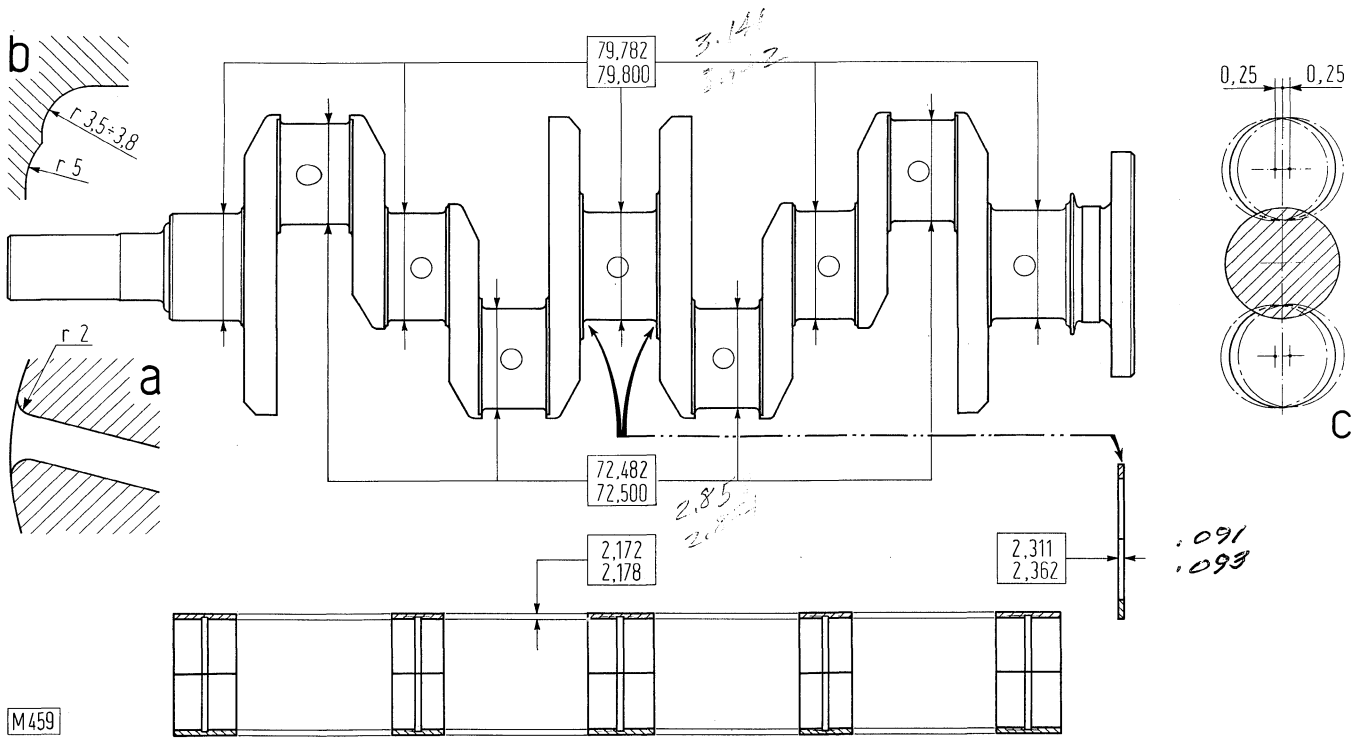

Fig. 2-16 Crankshaft journal, bearing and thrust washer details
a. Lubricating hole detail - b. Crankshaft journal fillet blending - c. Crankpin misalignment allowance.

Note:

Tighten setscrews of brackets 291508/1 and 291509/1 only after slackening setscrews of previous brackets.

Check both crankpins and main journal remembering the following:
- Scratch and slight pick-up marks may be eliminated using O-grade emery cloth.
- Score marks and ovality or taper in excess of .05 mm or .002 in call for grinding to the nearest undersize dimension (see data table).

After grinding, blend in the fillets and chamfer the lubricating holes as shown in Fig. 2-16.
Moreover, check the following:
- Journal ovality should not exceed .01 mm or .0004 in.
- Journal taper should be lower than .01 mm or .0004 in.
- With the shaft over V-blocks maximum misalignment should be .05 mm or .002 in (D, Fig. 2-17).
- Maximum crankpin misalignment should not exceed ± .25 mm or .01 in when measured as shown (c, Fig. 2-16).
- Crankpin periphery-to-shaft centreline should not exceed ± .10 mm or .004 in (Fig. 2-17)
- Crankshaft flange run-out (A)on periphery should not exceed .025 mm or.001 in; flange eccentricity (B) should not exceed .03 mm or .0012 in.

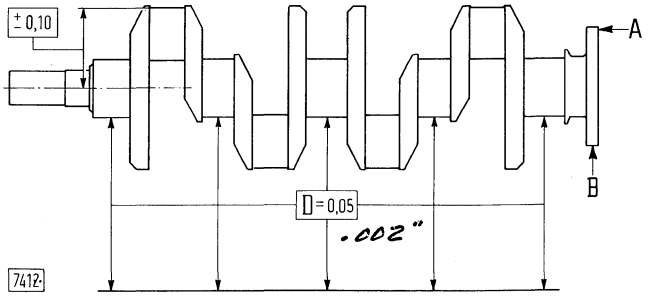

Fig. 2-17 Crankshaft alignment details.
A. Crankshaft flange run-out test point - B. Crankshaft flange eccentricity test point- D. Main journal misalignment allowance.

2.5.2 CRANKSHAFT BEARINGS

Check the bearing clearance as follows:
- Carefully clean the journal, the bearings, and the bearing housings using gasoline.
- Place a length of "Perfect Circle Plastigage" calibrated wire over the bearing at approximately 6 mm or .25 in from the centreline.
- Fit the bearing cap complete with calibrated wire and tighten to the prescribed torque.
- Remove the cap and compare the width of the compressed calibrated wire with the reference scale printed on the wire container.

In the course of this measurement, remember the following:
- The reading represents the amount of clearance.
- Uneven wire width is evidence of journal taper, the amount of which may be assessed by taking a measurement at either end of the wire and subtracting the lower value from the other.
- Place the bearing halves over the housings and caps ensuring that the lubrication ports are in register.
- Position the thrust washers on centre bearing housing and cap ensuring that the lubricating grooves are facing towards the centre journal shoulders.
- The reference numbers stamped on main bearing caps should lie on the side of the engine block which carries the identification numbers of the associated housings.
- Press the end bearing cap seal sections (four to each side) using drift 291222.
- Prior to refitting the connecting rods, check the crankshaft end float at the centre main bearing. If excessive play is detected, fit oversize thrust washers (see data table).

2.5.3 PISTONS AND RINGS

Asses liner and piston wear as shown in Fig 2-7 and at right angles to gudgeon pin 35 mm or 1.4 in from the lower end of the skirt (Fig. 2-18).
Maximum clearance is .30 mm or .012 in.
Check the ring side clearance and the gap. For the latter, place the ring in question in a sleeve which has previously been inspected. If the gap is found to be lower than specified, re-dress the ends as necessary; if in excess of the prescribed limit, renew the rings without hesitation.
Remedy gudgeon pin bore ovality or play by re-reaming the position using an expansion blade reamer to open out to the nearest oversize diameter (see data table). Subsequently, select oversize pins so that, when fitted at 20°C, the working clearance is as prescribed. If sleeve wear is such as to require re-grinding, renew the pistons and rings noting the following points:
- Select replacement pistons whose weight difference is not in excess of ± 5 grams or ± .18 oz.

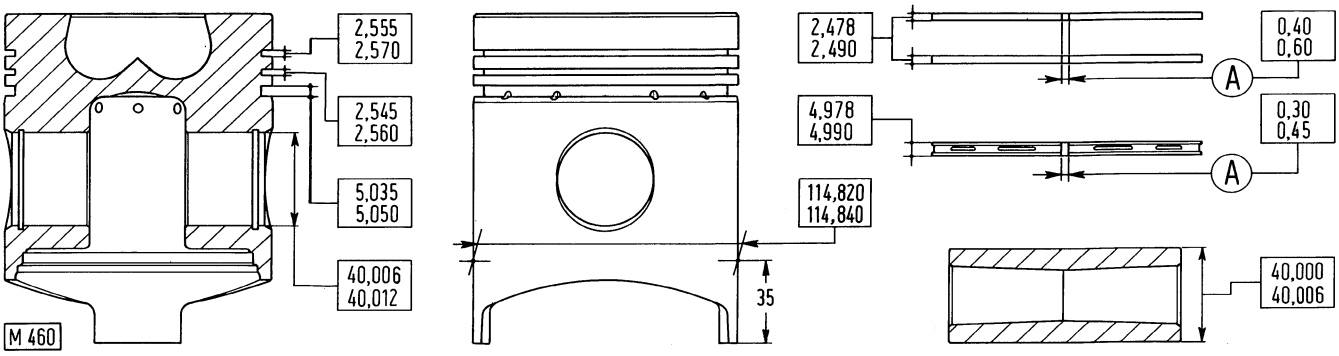

Fig. 2-18 Piston, Pin and Ring details. A. Fitted gap.

within 20 grams - piston & rod
" 15 grams - rods.

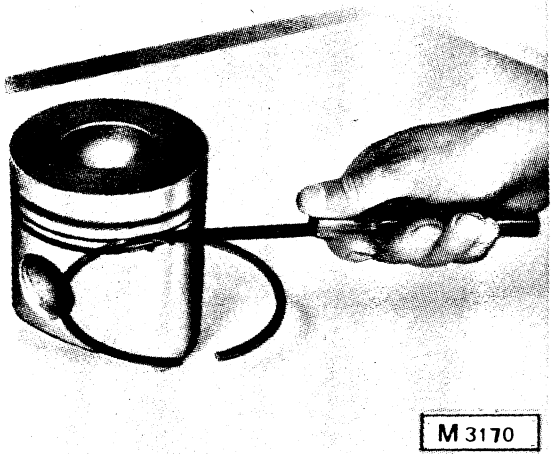

Fig. 34 - Checking ring-to-groove clearance with a feeler gauge.

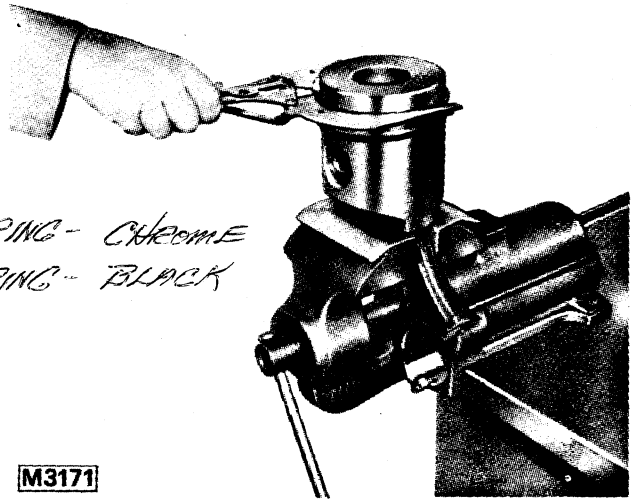

Fig. 35 - Installing piston rings with tool 75291160.

If gap is smaller than specified (A,fig. 32) grind ring end to achieve correct gap.

If gap is too wide renew rings.

4.3.4 INSTALLING PISTON RINGS (fig.35)

The top ring should be installed with the internal chamfer and the word "TOP" (fig.33) facing up.

The intermediate ring can be fitted either way, and the bottom ring (oil scraper ring) must be installed with inner spring gap 180° from ring gap.

NOTE - Ring gaps must be staggered 180° from each other.

4.3.5 PISTON PIN

Removal and installation of the piston pin must be done as shown in fig. 36 by means of special drift punch.

Any out-of-roundness or play between pin and piston must be corrected refacing the pin seats on the piston with an expansion type honing tool to bring them to the nearest spare oversize (see table "Specifications").

After refacing, select oversized pins so that, at a temperature of 20°C(68°F) there is a slight interference between pins and pistons.

4.4 CONNECTING RODS AND BUSHINGS

4.4.1 CHECKING CONNECTING ROD SQUARENESS

Connecting rod squareness should be checked on tool 75292172 (fig. 37) after installing pins on the small ends.

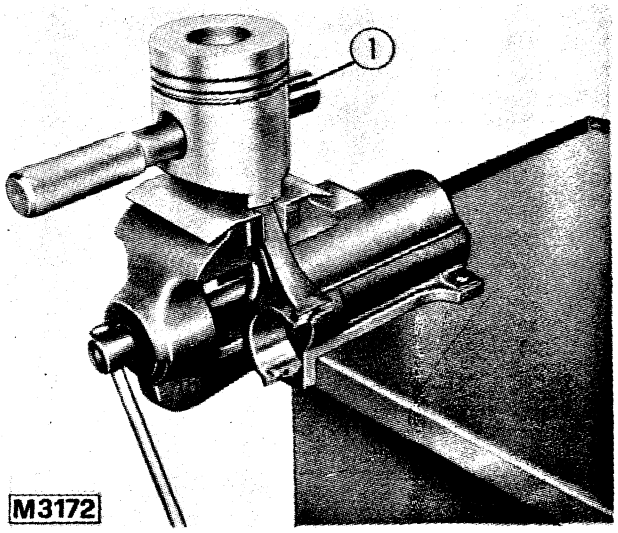

Fig. 36 - Removing pin (1) from piston with special drift punch.