Workshop Service Manual

EBRO

TRACTORS

350 AND 460 MODELS

CATION SP-1029-EXP-I

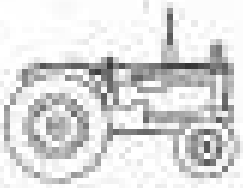
Motor Ibérica

DAVID McNEILL

SECTION 1:

GENERAL INFORMATION

CONTENTS



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IDENTIFICATION

The identification of the CKP-1 (50 and 48) tractors is provided by the unit serial number and the engine serial number.

Fig. 1 — Unit serial number

Unit Serial number (Fig. 1)

In both models it is stamped on the edge of the left side of the rear axle cover, adjacent to the hydr. cover.

8TXL97498

Engine Serial number (Fig. 2)

The SI 3.152 engine of Model 50 bears its unit serial number stamped directly in the cast iron body on the left side of the block.

152ME
2125ODL

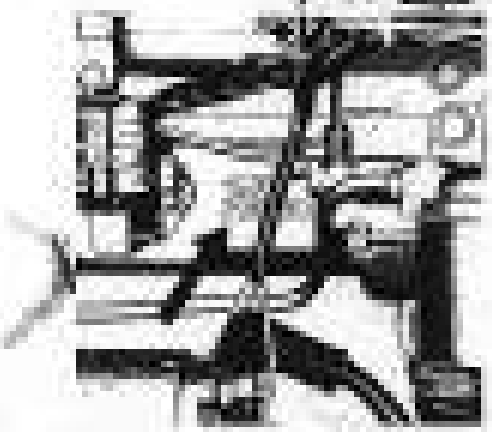

Fig. 2 — Engine serial number of Model 50

Engine Serial number (Fig. 3)

The 4.203 engine of the Model 48 bears its unit serial number in the upper rear part of the left cliff of the block.

Fig. 3 — Engine serial number on Model 48

NOTE. — When asking any supply, order or request for information with regard to either tractor model, always state the model, serial number and engine number.

Identification of the instruments and controls

In Figure 4 the different instruments and controls found on both models are shown.

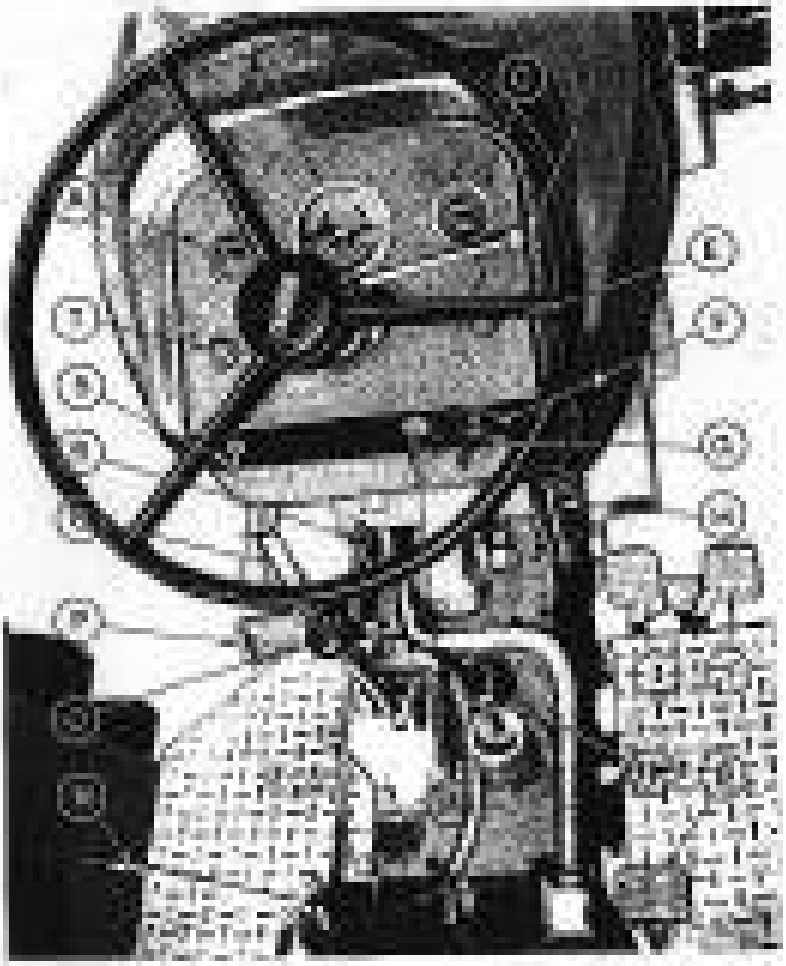

Fig. 4 — Instruments and controls

A — Temperature gauge
B — Tachometer
C — Fuel gauge
D — Throttle control lever
E — Battery charge control light
F — Light switch
G — Horn button
H — Ignition key-lock switch
I — Right brake pedal
J — Left brake pedal
K — Parking brake lever
L — Differential locking pedal
M — Ignition switch
N — Auxiliary hydraulic control lever
O — Gear shift lever
P — Clutch pedal
Q — Choking index lever
R — Engine throttle control
S — Hydraulic lifting control
T — Oil pressure warning light

SPECIFICATIONS

The specifications of the different versions, which have not been included in their corresponding groups, are set out below:

Rear axle

— Bevel pinion

1st $\frac{10}{32} \times \frac{18}{39} \times \frac{17}{30} = 5{,}26 : 1$

2nd $\frac{10}{32} \times \frac{18}{39} \times \frac{17}{30} = 5{,}10 : 1$

3rd $\frac{10}{32} \times \frac{18}{39} \times \frac{22}{21} = 3{,}63 : 1$

4th $\frac{10}{32} \times \frac{18}{39} \times \frac{25}{16} = 3{,}04 : 1$

5th $\frac{16}{32} = 2{,}00 : 1$

6th $\frac{17}{32} = 1{,}53 : 1$

7th $\frac{22}{32} = 1{,}00 : 1$

8th $\frac{25}{32} = 0{,}78 : 1$

Low reverse $\frac{10}{32} \times \frac{18}{39} \times \frac{15}{30} = 2{,}88 : 1$

High reverse $\frac{10}{32} = 2{,}13 : 1$

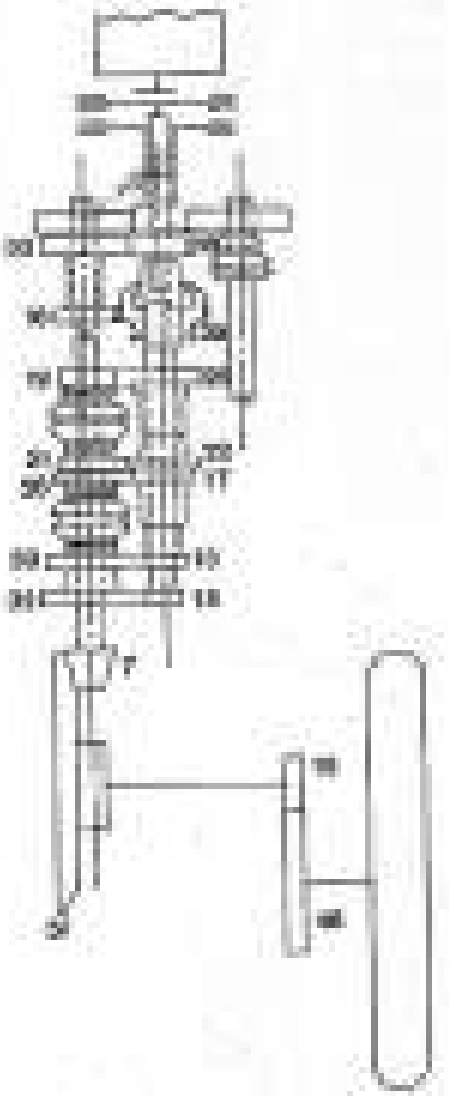

Fig. 6 — Transmission diagram

Rear axle

— Differential reduction 4,6 : 1 (10 pinion teeth — 46 crown teeth)

— Pinion-to-gear wheel reduction 1,22 : 1 (11 pinion teeth — 27 gear wheel teeth)

— Total rear axle reduction 5,61 : 1

Power take-off

— Position: Rear
— Dimensions: 34.8 mm in diameter
— Number of splines: 6 (according to ISO recommendation)
— Height above the ground:
Model 350: 695 mm
Model 450: 748 mm
— Distance to the tractor's vertical rear symmetry plane: 0 mm
— Direction of revolution: To the right
— Reduction: $\frac{34}{41} \times \frac{20}{28} = 0.71 : 1$
— Speed: 540 r.p.m. at 2038 r.p.m. of the engine

Weights of the tractor in operating conditions (without the driver and with fuel tank full)

— Without ballasting
Model 350:
Over the front axle: 720 kg
Over the rear axle: 1,220 kg
Total weight: 1,950 kg
Model 450:
Over the front axle: 760 kg
Over the rear axle: 1,360 kg
Total weight: 2,110 kg
— With liquid ballasting and counterweights
Model 350:
Over the front axle: 1,000 kg
Over the rear axle: 1,400 kg
Total weight: 2,400 kg
Model 450:
Over the front axle: 1,010 kg
Over the rear axle: 2,030 kg
Total weight: 3,040 kg

[illegible]

Model (20)

A — [illegible]	[illegible]
B — [illegible]	[illegible]
C — [illegible]	[illegible]
D — [illegible]	[illegible]
E — [illegible]	[illegible]
F — [illegible]	[illegible]
G — [illegible]	[illegible]
H — [illegible]	[illegible]

Model (20)

A — [illegible]	[illegible]
B — [illegible]	[illegible]
C — [illegible]	[illegible]
D — [illegible]	[illegible]
E — [illegible]	[illegible]
F — [illegible]	[illegible]
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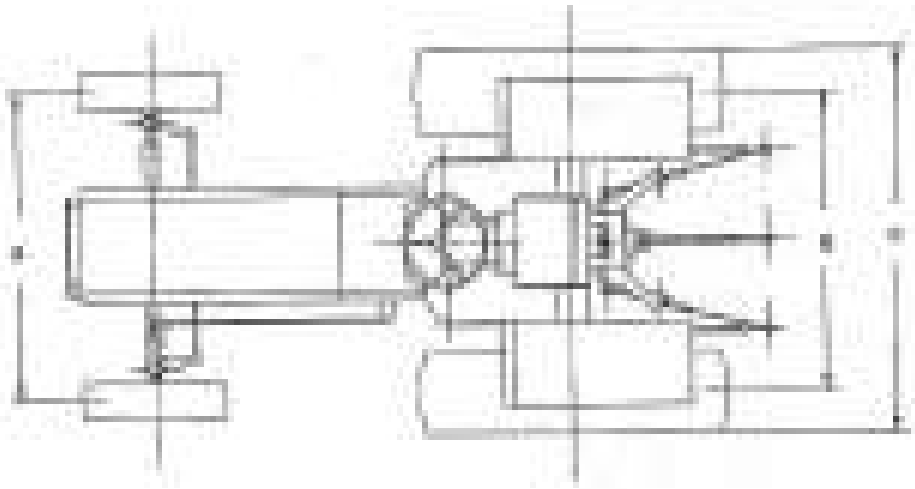

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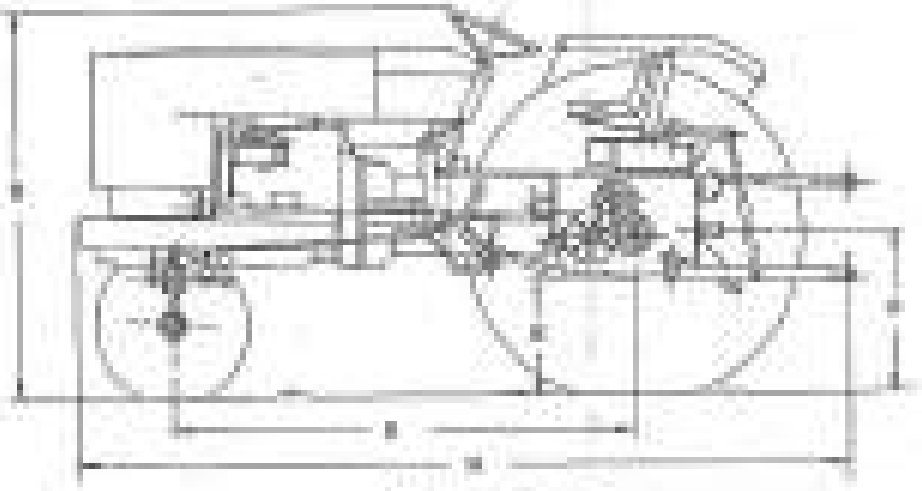


Fig. 2 — [illegible]

Capacities

Fuel tank	90.0 litres
Crankcase	
Model 360	4.0 litres
Model 460	5.25 litres
Oil filter	0.4 litres
Engine cooling system	
Model 360	10.5 litres
Model 460	12.0 litres
Air cleaner	1.0 litres
Steering box	1.0 litres
Gear box, rear axle and hydraulic lift	36.0 litres

LUBRICATION

The quality of the lubricant to be used for each part is indicated in the lubrication schedules. By using only good quality lubricants, the tractor will be maintained in perfect working order.

APPROVED LUBRICANTS - ALL TERRITORIES

*Tenderfoot and Grease

PRE-DELIVERY INSPECTION

Before delivering the tractor to the customer, the pre-delivery operations described as follows shall be carried out:

- Check engine oil level.
- Check oil level of the gear box, rear axle and hydraulic lift.
- Check steering box oil level.
- Check radiator water level (add anti-freeze if necessary).
- Check oil cleaner oil level and fan/alt belt assembly.
- Check tension of the fan/alternator belt.
- Check electrolyte level of the battery.
- Check operation of the engine cut-out control and cold-starting.
- Check operation of the controls and instrument panel.
- Check idle and full throttle r.p.m. without engine load.
- Check operation of the clutch free travel and maximum disengagement travel.
- Check operation of the power take-off.
- Check the travel of the brake and parking brake pedals.
- Place draft bars and three point linkage in working position.
- Check electrical connections and condition of wiring.
- Tighten up nuts and bolts in general.
- Check operation of the hydraulic lift.
- Check tightness of wheel nuts and air pressure of the tires.
- Start up tractor and observe its behaviour, checking the following:
  a) Operation of the gear box.
  b) Operation of the clutch.
  c) Operation of the brakes and uniformity of braking.
  d) Operation of differential blocking.
  e) Operation of the steering.

MAINTENANCE

The good running of the tractor depends on its maintenance. In this chapter all the necessary information is given for performing the maintenance operations on the different components at the proper time.

MAINTENANCE SCHEDULE

Several times a day:

- Close the centrifugal purifier of the oil cleaner.

Every 10 hours or daily

- Check engine crankcase oil level.
- Check radiator water level.
- Check transparent cup of the fuel filter.
- Clean the air cleaner (in dusty conditions).
- Check the bolt nuts after changing a wheel.

Every 50 hours or weekly

- Clean the air cleaner (in normal conditions).
- Check oil level of the gear box, rear axle and hydraulic lift.
- Check electrolyte level of the battery.
- Remove impurities from the fuel sediment cup.
- Grease lubrication to the following points:
  - a) Front axle pivot pin.
  - b) Brake and clutch pedal shaft.
  - c) King pin bolts.
  - d) Drag link.
  - e) Ball joints of the steering track rod to the steering arms.
  - f) Levelling box.

Every 100 hours or monthly

- Test brake efficiency and free travel of the pedals.
- Test clutch pedal free travel.
- Check or adjust alternator belt tension.
- Check tightness of wheel nuts.
- Check or clean and grease front wheel side ball bearings.
- Clean and oil accelerator and cut-out linkage control linkage.

Every 250 hours

- Change crankcase oil and engine filter.
- Check steering box oil level.
- Clean the screens of the radiator honeycomb.
- Clean the fuel filter.
- Tighten up wire and bolts in general.

Every 500 hours

- Change fuel filter.
- Clean and test injectors.
- Tighten up cylinder head and manifolds.
- Test and adjust the valves' play and clean the engine air refreshing lube.
- Clean the sealing gasket's rubber rolls.
- Clean the rear axle breather.
- Test the adjustment of the steering linkage.

Every 1000 hours

— Change the hydraulic filt, gearbox and rear axle oil.

— Clean the hydraulic system filters.

The maintenance operations that the tractor requires,

BELT, SHEET METAL AND BODY (Section 9)

— Always keep body parts clean and repaint them as soon as they become warped or weakened to

FRONT AXLE AND STEERING (Section 4)

— Grease the axle pivot pin (Fig. 7).

— Grease king pin bolt (Fig. 8).

— Grease the king links.

— Grease ball joints of steering track rod to steering arms (Fig. 9).

which are grouped together in each section, are as follows:

— Empty and clean the fuel tank.

— Check the thermostat and starter motor.

avoid rust and maintain the good appearance of the tractor.

— Check or clean and grease the wheel spindle bearings (Fig. 8).

— Test the adjustment of steering linkage.

— Check steering box oil level (Fig. 10).

Fig. 7

Fig. 8

Fig. 9

Fig. 10

ENGINE (Section 4)

– Check crankcase oil level (fig. 13).

– Change overdose oil (fig. 12 Arrow) (fig. 14 Ref.) and the engine filter.

– Retighten cylinder head and manifold.

– Check and adjust the rocker arm bolt (fig. 14).

The adjustment of the rocker arm bolt which does with a cold engine, is 0.30 mm for both valves. With the engine warm is to 0.25 mm for both intake and exhaust.

– Clean the engine air intercooling tube.

Fig. 11

Fig. 14

Fig. 12

Fig. 15

FUEL FEED SYSTEM (Section 5)

– Close the air cleaner profiles (fig. 16).

– Check the fuel filter sediment cup (fig. 16).

– Close the air cleaner.

– Remove impurities from the fuel filter sediment cup.

– Clean and oil the accelerator and cab roll (angle control linkage (fig. 17).

– Change the fuel filter cleaner.

– Clean and test the injectors.

– Drain and clean the fuel tank.

Fig. 16

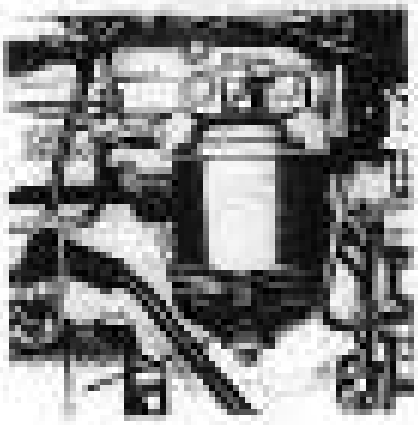


Fig. 17

COOLING SYSTEM (Service 4)

— Check radiator water level.

— Clean the outside of the radiator grills (Fig. 18).

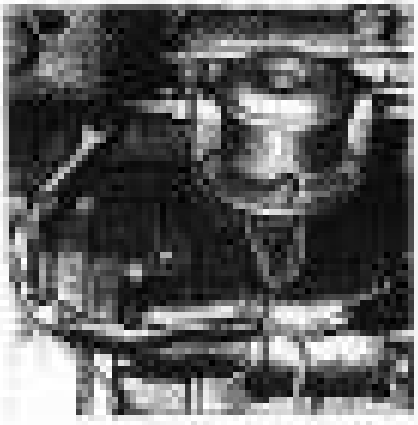


Fig. 18

Fig. 19

Fig. 19

— Flush out the cooling system (Fig. 19 blank stem plug) on the Model 48 the plug is located behind the starter motor (Fig. 20 rubber drain plug).

Fig. 20

CLUTCH (Section 7)

– Grease hoist and clutch pedal shaft (fig. 29).

– Test clutch pedal free travel.

GEARBOX (Section 9)

– Check the oil level of the gearbox, rear axle and PTO (fig. 21). The oil should come up to the level of the plug hole situated on the right side face of the gearbox, behind the fuel tank.

– Change the gearbox, rear axle and PTO oil (fig. 23 drawing-out) (fig. 22 filling hole).

Fig. 21

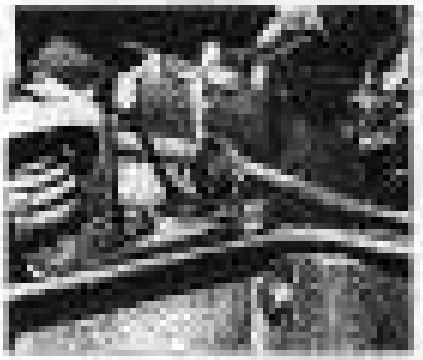


Fig. 22

Fig. 23

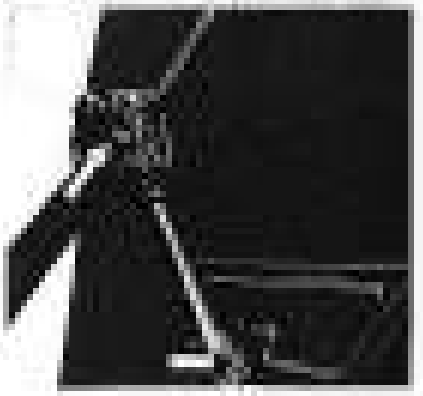


Fig. 24

HYDRAULIC SYSTEM (Section 9)

– Check the oil level of the PTO, rear axle and gearbox (fig. 21).

– Change PTO, rear axle and gearbox oil (figs. 22 and 23).

– Grease the levelling bars (fig. 24).

– Grease lift rods, right and left (figs. 24 and 25).

– Clean the two PTO filters (figs. 26 and 27). These two filters are to be cleaned with clean gas oil and dried with air.

Fig. 36

Fig. 37

Fig. 38

Fig. 39

REAR AXLE (Section 10)

— Check oil level of the rear axle, gearbox and lift (fig. 31).

— Clean rear axle breather located above the lift cover.

— Change the rear axle, gearbox and lift oil (figs. 32 and 33).

BRAKES (Section 11)

— Grease the brake cross shaft (fig. 39).

— Test brake efficiency and pedal travel.

WHEELS AND TYRES (Section 12)

— After a wheel change, test the wheel bolt nuts.

— Check the tightness of the wheel nuts.

— Test the tire pressure.

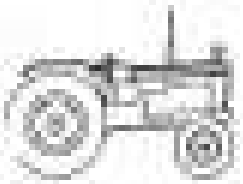
ELECTRICAL EQUIPMENT AND INSTRUMENTS
(Section 18

- Check battery electrolyte level.
- Check or adjust alternator drive belt tension (Fig. 20).
- Inspect alternator and starter brush.

Fig. 18

SECTION 2: SEAT SHEET METAL AND BODY

CONTENTS



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SEAT

SPECIFICATIONS

Type of seat	EAGLE 3000 H
Suspension	By helical springs.
Type of shock absorber	Controlled by shock absorber

DESCRIPTION Figs. 1 and 2)

The seat is designed to prevent accident and reduce fatigue of the operator, thereby increasing his work performance. The seat cushioning is of plastic foam. The height of the seat back can be adjusted by the wing nuts (A). Control (B) enables the amount of the springs to be regulated (C), in accordance with the driver's weight and the irregularities of the ground. The shock absorber (D) softens the return of the springs (C), eliminating any kickback and harshness of the suspension. In order for the operator to have the pedals and other controls at a distance most in keeping with his own personal stature, the seat is also adjustable horizontally. For this purpose the holes (E) of the seat bottom attached to the lift cover are elongated. Loosen and tighten the set screws once the seat has been set in the most convenient position.

Fig. 1 — Seat

Fig. 2 — Securing of the seat

TO REMOVE AND INSTALL THE SEAT

To remove the frame seat, proceed as follows:

- Loosen the two screws and the lock nut (F, Fig. 2) and slide the seat forwards (in this way the head of the set screw is exposed).
- Withdraw the two screws and the nut and lift the seat (Fig. 2).

To install the seat, carry out the above operations in reverse.

Fig. 4 — Removal of the seat

DISASSEMBLY AND ASSEMBLY OF THE SEAT (fig. 4)

The seat does not require maintenance. If however, for any reason, it is necessary to disassemble it, proceed as follows:

Disassemble the following:

— the seat back (A) by taking off the safety nuts (B);

— the seat back (C) by loosening its set screws;

— the safety bolt (D) of the springs (E) and check elasticity (F);

— the side levers (G);

— the lock support (H) of the springs (E);

— the inverter adjustment nut (I) and the guide clip (J) of the upper fixture of the check sheets at (K).

— the set screws (O) of the seat (L);

— the link bolt (M) and its safety plate (N);

— the link bolt (O).

Once the seat has been taken apart, check the condition of the plastic bushings, rubber strips and other parts, replacing any component found to be defective or which does not offer complete security.

To assemble the seat, carry out the above-described procedure in reverse.

Note. — Lubricate the sling nuts (B) with oil or graphite grease.

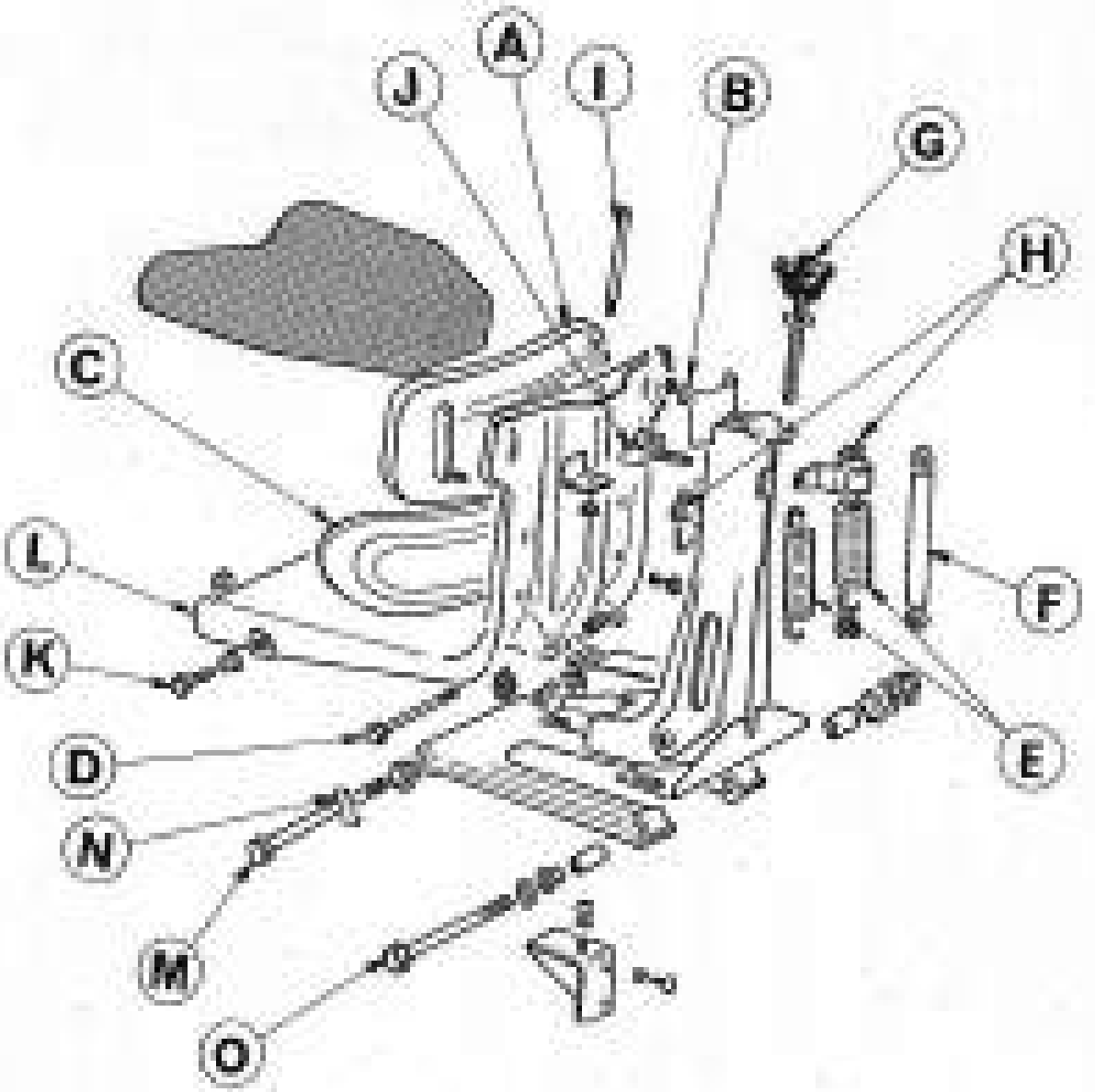


Fig. 4 — Exploded view of the seat

RIDDER MOUNTED SEAT (Fig. 3)

The fender mounted seat consists of a suitably designed metal rail attached to the left fender. To remove or install the seat, it is only necessary to loosen or tighten the nuts which secure it to the flat upper surface of the fender from the inside.

Fig. 3 — [illegible]

SHEET METAL AND BODYWORK

SPECIFICATIONS

Type of bodywork	Metal with flat fenders and footwells

DESCRIPTION (Fig. 8)

The cars shows the assembly of the hood (A), front grille (B), front sheeting (C), instrument panel (D) and the rear fenders (E) which are equipped with a bolt on.

These parts, which can be very easily removed and installed in a short time, afford protection to both the operator and the mechanic. Under no circumstances should the fenders be used without their parts in place. Always keep them clean and repair them as soon as they are scratched or scraped to prevent rust and maintain the good appearance of the motor.

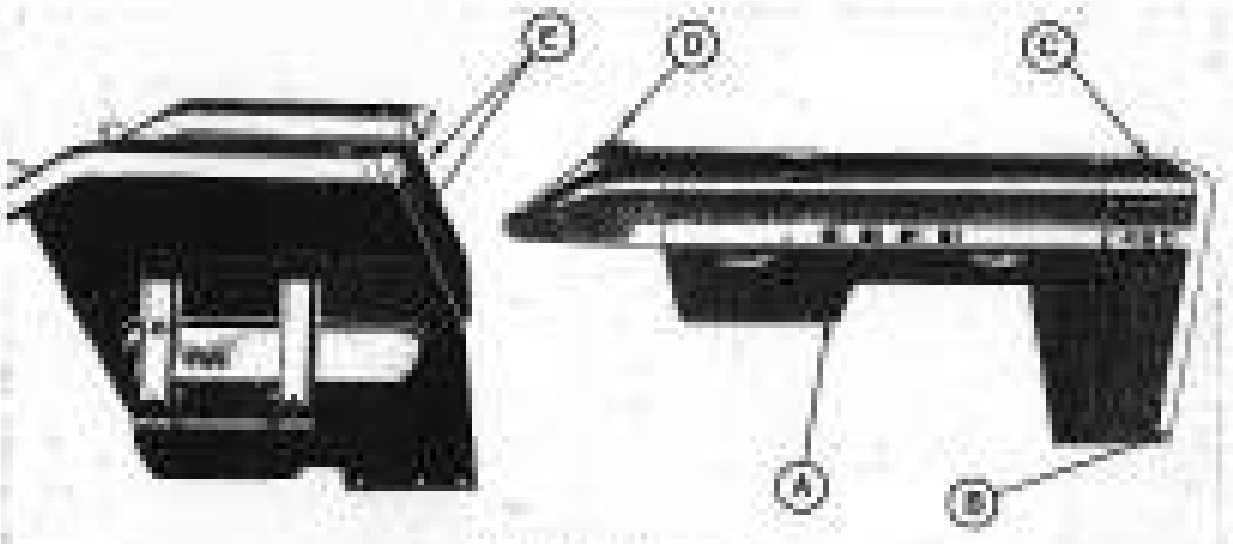


Fig. 8 — Fenders bodywork

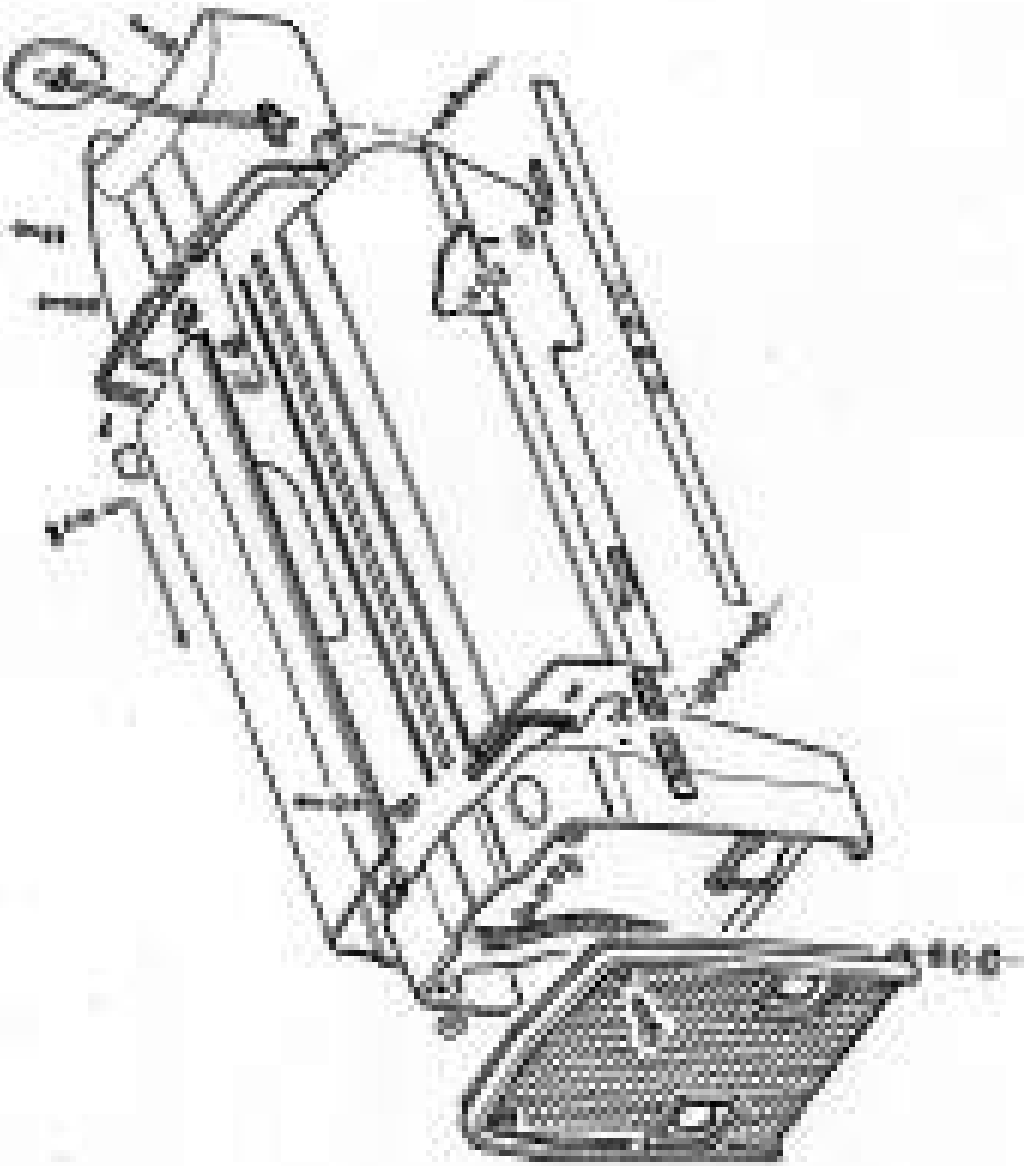


Fig. 2 — Exploded view of the front seat assembly

TO REMOVE AND INSTALL THE FRONT GRILLE (Fig. 8)

To remove the front grille, proceed as follows:

— Remove the two screws (A).

— Pull the front grille (A) forwards and upwards to separate the two guides (C) from their housing in the cross member.

To install the front grille, reverse the above operations.

Fig. 8 — Removing the front grille

TO REMOVE AND INSTALL THE HOOD

To remove the hood, proceed as follows:

— Raise the right-hand side of the hood.

— Remove the four retaining nuts from the guides.

— Remove the hood assembly. To install hood, reverse the above procedure.

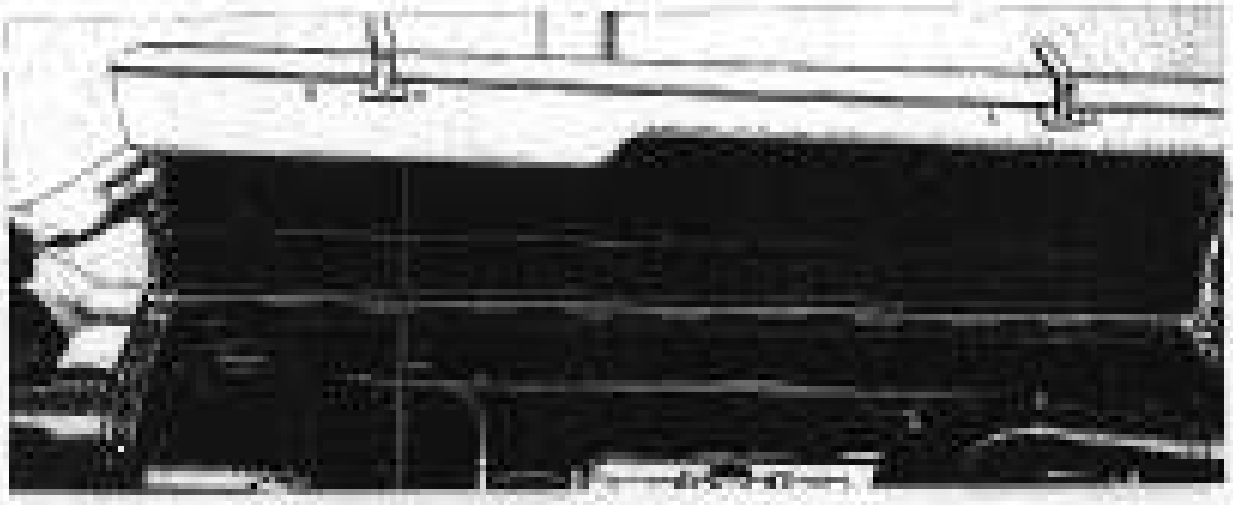


Fig. 9 — Hood attachment screws and guides

Fig. 10 — Removal of the hood

TO REMOVE AND INSTALL THE FRONT COWLING

To remove the front cowling, proceed as follows:

— Remove the front grille.

— Remove the hood.

— Disconnect the air cleaner to intake hose (A, fig. 12).

— Disconnect electrical connections of the following:

a) the regulator

b) the horns, as well as the earth wire

c) the front right headlight

— Remove the air pre-filter (fig. 11).

— Remove the cleaner intake elbow (fig. 11).

— Remove the two side sound-no-vibration set screws (fig. 12) (be careful with the two rubbers, which act as shock absorbers).

— Remove the four cowl to-chassis set screws (fig. 13).

— Partially loosen the two radiator set screws.

— Pull the cowl forwards, disengaging it from the radiator (fig. 14).

Once the cowling has been separated from the chassis, remove the following:

a) the regulator

b) the air cleaner

c) the horn

d) the right and left headlights and the front brackets.

To install the front cowling, carry out the above procedure in reverse order. Do not forget to tighten the radiator set screws and to place the two rubber washers in the side sub-panels between cowl and radiator.

Fig. 11 — Removal of bonnet stay rod (or prop rod)

Fig. 12 — Removing or fitting bonnet hinge set screws

Fig. 13 — Removal or refitting bonnet lock striker

Fig. 14 — Taking off the front panel

TO REMOVE AND INSTALL THE INSTRUMENT PANEL

To remove the instrument panel, proceed as follows:

— Remove the hood.

— Loosen the steering control lever.

— Remove the instrument panel and board set screws (Fig. 16).

— Pull the panel towards cable casing A out (Fig. 16).

To install the panel, carry out the above procedure in reverse order.

Fig. 15 — Disassembly of the panel

Fig. 16 — Removal of panel

TO REMOVE AND INSTALL THE FENDERS

To remove the fenders, proceed as follows:

— Disconnect the wiring of the lights in the connection box (Fig. 17), located on the left side of the rear axle.

— Remove the fenders-to-bumper set screws (Fig. 18).

— Remove the two set screws of each fender, located inside of the tail-lights (Fig. 19).

— Take off the fenders (Fig. 20).

To install the fenders, carry out the above procedure in reverse.

Fig. 17 — Connection box

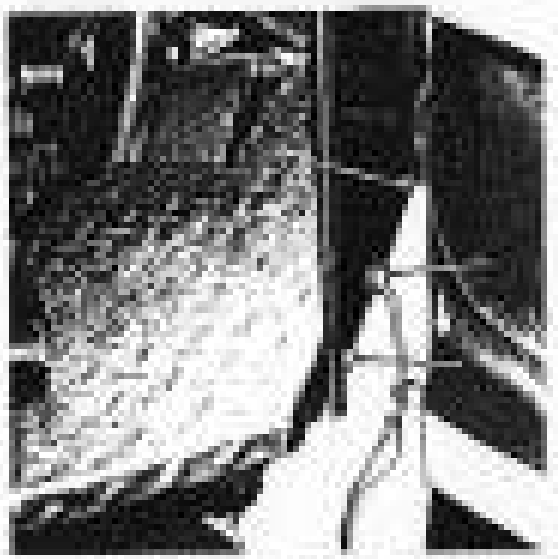


Fig. 38 — Fender to rear plate and screws

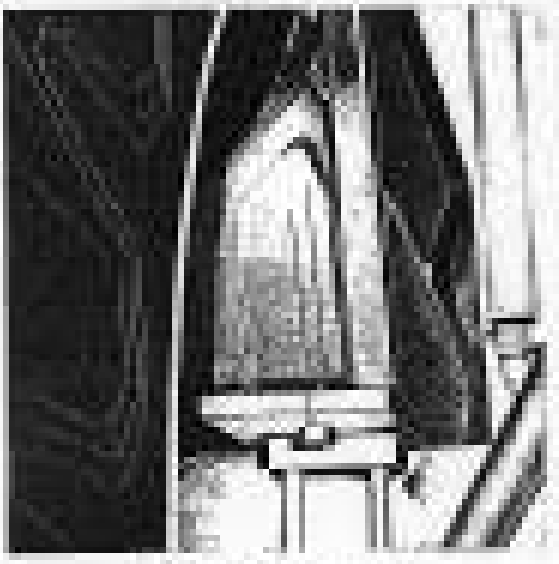


Fig. 39 — Fender and screws

Fig. 40 — Taking off the fender

TO REMOVE AND REFIT THE STEP PLATES

To remove the step plates, carry out the following procedure:

— Remove the step plate-to-fender set screws (Fig. 39).

— Remove the step plate-to-mudguard set screws.

— Remove the step plates.

To refit the step plates, carry out the above procedure in reverse order.

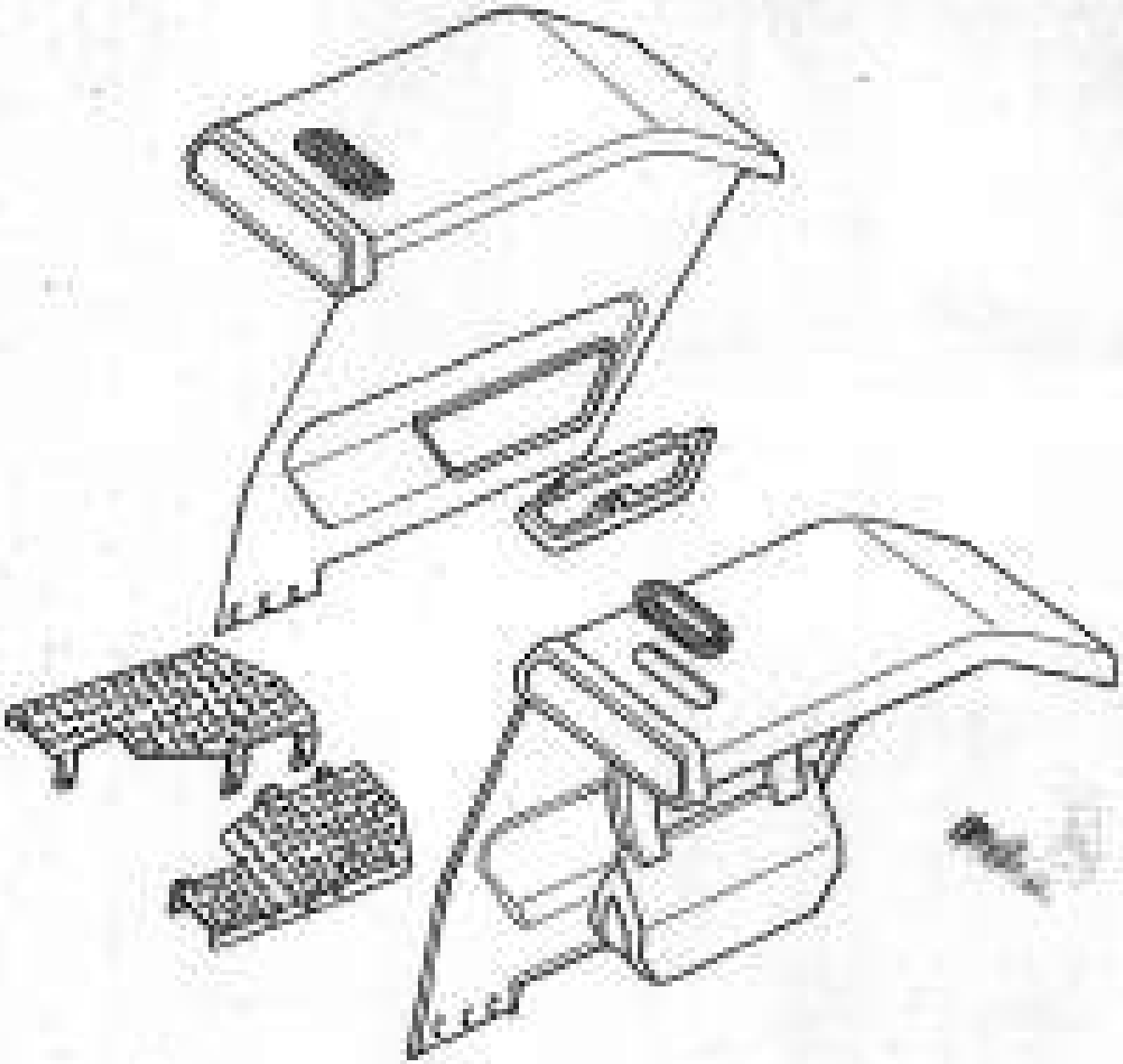
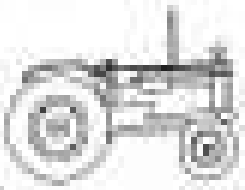


Fig.21 — Fenders and step plates

SECTION 3:

FRONT AXLE AND STEERING

CONTENTS



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FRONT AXLE

SPECIFICATIONS

Caster angle	0°
Camber angle	30' 30'
Kingpin inclination angle	11°
Toe-in	0 to 5,25 mm
Kingpin diameter	31,80 to 31,90 mm
Kingpin bushing bore diameter	32,00 to 32,05 mm
Diameter of center pivot pin	47,55 to 47,65 mm
Center pivot pin bushing bore diameter	47,65 to 47,85 mm

DESCRIPTION

The front axle is of the floating type and is mounted over the cross member with a pivot pin.

The cross member is joined to the rear side rails and is mounted on the engine main bolt bolts in each rail and six bolts in the cross member itself.

The front axle is made up of a strong center beam of quadrangular cross-section and individual side extensions, joined on the housings of the kingpins. The side extensions can be locked to the center beam in different positions, thus making it possible to obtain different track widths.

ADJUSTMENT OF THE FRONT TRACK
(Figs. 1 and 2)

The side side extensions can be moved in gradual fitting of 61 mm per side, which provide the following seven track widths: 1,29 m, 1,35 m, 1,40 m, 1,46 m, 1,51 m, 1,71 m and 1,87 m.

To adjust the front track proceed as follows:

— Raise the front part of the tractor.

— Loosen the two clamps (2) which secure the ends of the track rods (1) to the tank forks (3) of the drag links (4). These clamps have a bolt, a counterbolt nut and a safety screw pin.

— Take out the bolts which, screwed into their respective nuts (A), secure each extension (B) to the center beam (C).

— Place the new extensions at the desired track spacing at the same time as the necessary adjustments are made on the track rods. For this purpose, the fork ends have machined grooves

for the different tread dimensions. These grooves fit into the clamp bolts and provide for safe assembly of the track rods.

Fig. 1 — Front wheel adjustment

— Once the toed adjustment has been carried out, firmly tighten all nuts and bolts and lower the tractor to the ground.

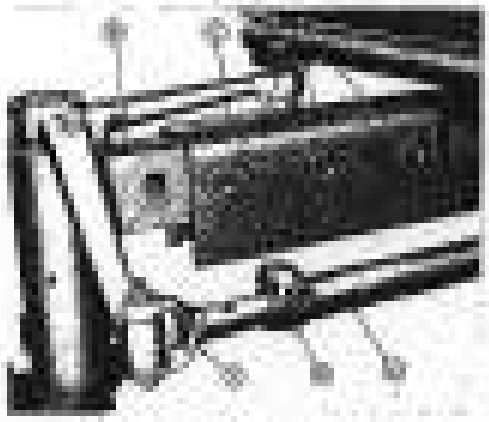


Fig. 2 — Front wheel adjustment

TOE-IN

The toe-in of the front wheels on the LRPS 200 and 400 tractors, complies with a permanent pre-established production standard, according to the design characteristics of both axles. No specific value is known to be given. An idea can be gathered from the foregoing, the toe-in is set ahead by the different wheel adjustments since there is a different track rod length for each model setting.

TO REMOVE AND INSTALL THE FRONT AXLE CROSS MEMBER ASSEMBLY
(Figs. 3 and 4)

The operations involved in removing and installing the front axle-cross member assembly should be carried out in the following order:

— Place a chock under the tractor engine.

— Place a wedge between the front axle central beam and the sill on both sides.

— Remove the bonnet.

— Disconnect the steering shaft at its connection with the idler link.

— Drain water from engine and radiator.

— Remove upper and lower radiator-to-engine hoses.

— Remove air cleaner-to-engine intake manifold hose.

— Take the front grille off the tractor.

— Disconnect the battery terminals.

— Take out the eight bolts that secure the two rails to the engine.

— Take out the six bolts that secure the cross member to the engine.

— Pull the front axle-cross member assembly forwards to disengage it from the engine.

— Check up the assembly adequately and remove

c) The radiator.
d) The battery, previously moving the front hold-down bracket backwards.
e) The radiator cowl, air cleaner and horn assembly.

To install the front axle-case member assembly, follow the above procedure in reverse order.

Fig. 3 — To remove the front axle-case member assembly

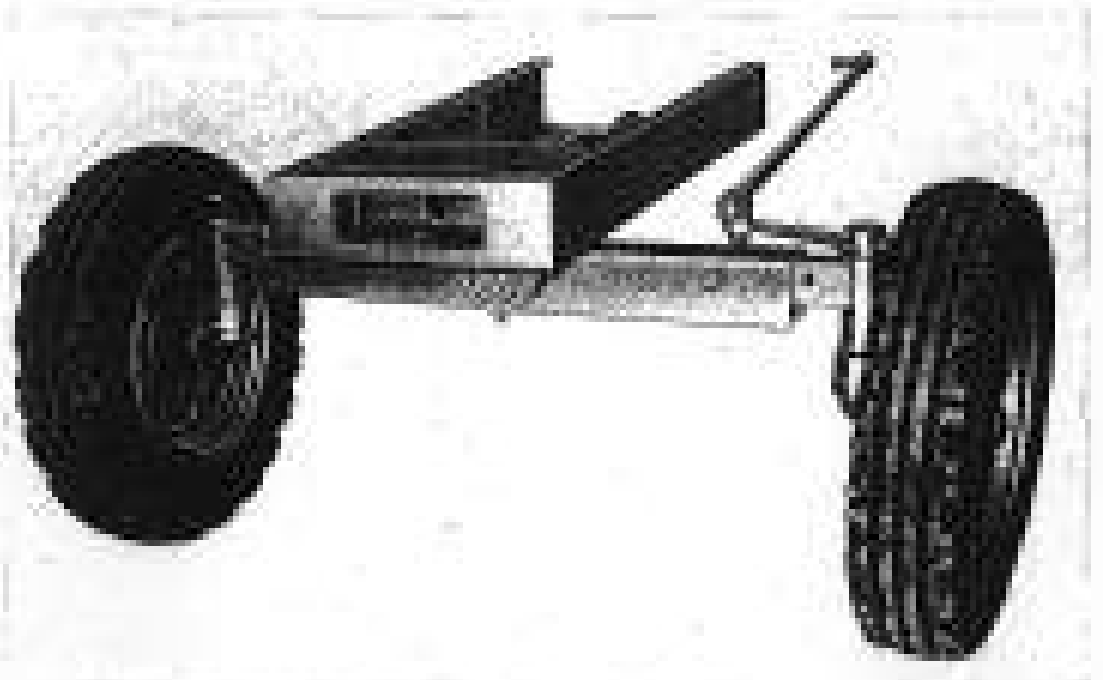


Fig. 4 — Front axle-case member assembly

DISASSEMBLY OF THE FRONT WHEEL HUB ASSEMBLY (Fig. 6)

To carry out this operation, proceed as follows:

- Raise the front of the tractor and remove the wheel from its hub.
- Remove the hub cap (A).
- Pull out the cotter pin (B).
- Remove the castellated nut (C) and the washer (D).
- Disassemble the following from steering swivel: The hub (F), together with the bearings (E) and (G) and the retainer (J).
- Remove the following from the hub: the ball races (H) and (I) of both bearings.

Fig. 6 — Front hub assembly

ASSEMBLY OF THE FRONT WHEEL HUB ASSEMBLY

- Place the ball races in the hub.
- Set the inner bearing to place (G).
- Introduce the retainer (J) with the flat face towards the inside of the hub, fitting it onto the step located inside of it.
- Partly fill the hub with grease and mount it on the steering swivel.
- Assemble the outer bearing (E), the washer (D) and the castellated nut (C). Tighten the castellated nut to 8.3 kgs and then loosen it approximately half a turn so that the hub has an axial play of 0 to 0.25 mm.
- Insert a new cotter pin (B).
- Fill the hub cap with grease, set it in place and mount the wheel.

TO REMOVE AND INSTALL A SIDE EXTENSION OF THE FRONT AXLE (Figs. 6, 7 and 8)

The same procedure must be followed when removing a side extension only, also for the purpose of changing a steering swivel.

The procedure is as follows:

– Raise the front of the tractor and remove the wheel.

The following applies when changing a steering swivel (Fig. 6):

– Remove the hub assembly as described on page 4.

– Put chocks under the steering swivel or steering swivel hub assembly to prevent them from falling to the ground while carrying out the following operation.

– Remove the nut and bolt (A) which secure the drag link (B) to the knuckle and disengage both parts.

– Take out the king pin retainer (C).

– Remove the chocks from under the steering swivel or steering swivel-hub assembly and their own weight will cause them to slide out of their housing in the side extension. Take out the bearing (D).

At this point the steering swivel is left free. To install it, carry out the above procedure in reverse order.

When removing the side extension, the trouble of separating the bore from the steering swivel can be avoided by disengaging them together and proceeding as follows:

– Remove the three bolts (E) which secure the beam side extension.
– Take out the side extension.

NOTE: – Before mounting a side extension, make sure the inside bushings of the king pin housing and the grease cup are in good condition, replacing them if necessary. To install the side extension, reverse the procedure described above.

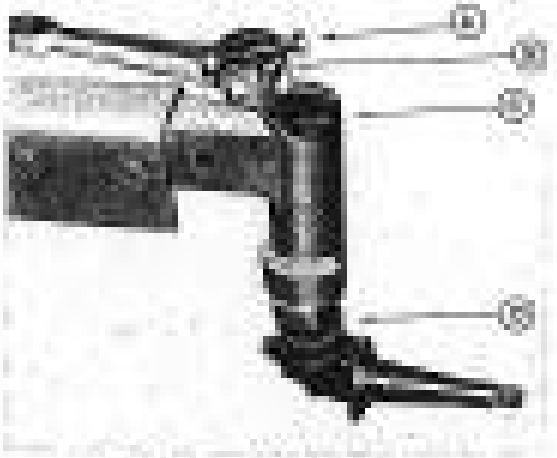


Fig. 6 – Removing a steering swivel

Fig. 7 – Removing a steering swivel-hub assembly

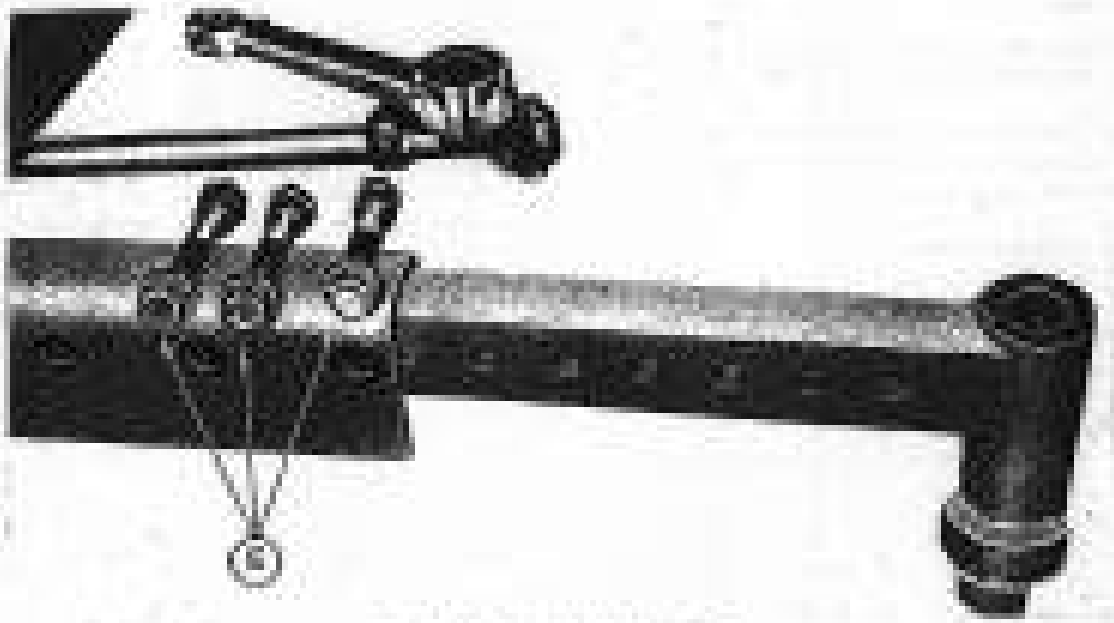
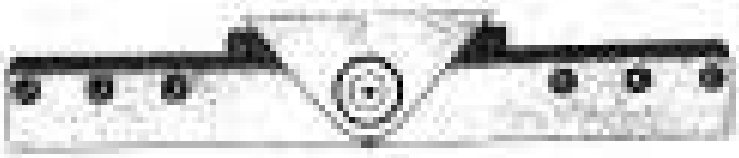


Fig. 5 — Measuring caster inclination

TO REMOVE AND INSTALL THE FRONT AXLE CENTER BEAM (Fig. 6)

To remove and install the center beam of the front axle, proceed as follows:

— Raise the front part of the tractor and check up the center beam's stellar bolt wheels bits.



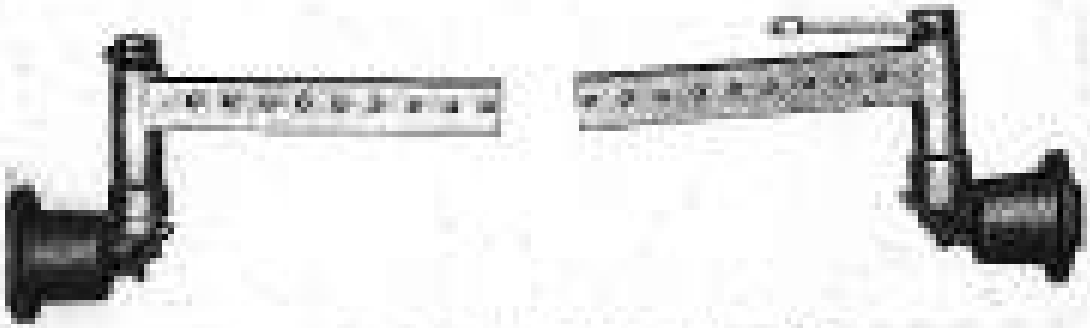


Fig. 6 — Removing and installing the front axle center beam

— Disconnect the steering arm in the drag link.

— Disconnect the track rod at both ends.

— Remove both wheels.

— Take out the six side retaining set screws.

— Remove both of the side extensions together with dust sealing gaskets and halfs.

— Loosen the nut and set screw of the center beam pivot pin.

— Withdraw the pivot pin. Bearing periodically demand the center beam out (Paragraph K).

NOTE. — Before assembling the center beam, check the pivot pin bearing, bushing and the grease cup, replacing them if necessary.

To install the center beam, follow the above procedure in reverse order.

NOTE. — When installing the pivot pin (fig. 8 bis), have a clearance in (A) of 0.079 to 0.354 mm. Tighten the nut (B) to a torque of 2.7 to 3.6 kg. The thread of the screw (C) must be completely free of grease and be given a coating of «Loctite» before assembly, applying a torque of 3 to 4 kg.

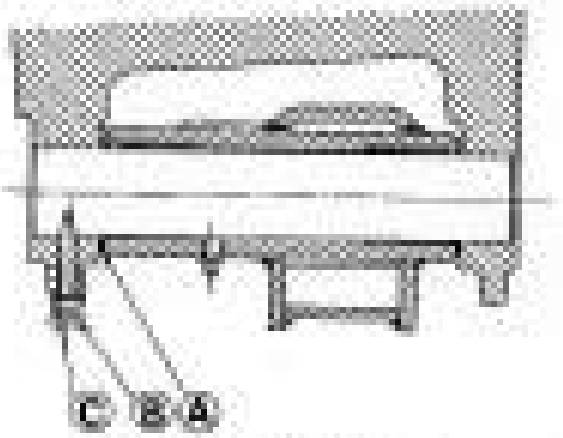


Fig. 8 bis — Mounting of pivot pin

STEERING

SPECIFICATIONS

Type	Worm and nut recirculating ball system
Center	22.1 : 1
Oil capacity	1 lit.
Lubricant	SAE 80 E.P.
Worm matching	Right-hand thread
Worm bearings	Two radial ball bearings
Number of upper worm bearing balls	19 (6.35 mm (1/4"))
Number of lower worm bearing balls	19 (6.35 mm (1/4"))
Number of male worm nut balls	34 (7.93 mm (5/16"))
Worm adjusting washers	Steel of 0.1, 0.18 and 0.25 mm
Worm rest travel	30°
Worm maximum turn	39°
Steering column gaiters	Rigid of 0.1 mm
Steering wheel turns from lock to lock	4.8

DESCRIPTION (Fig. 10)

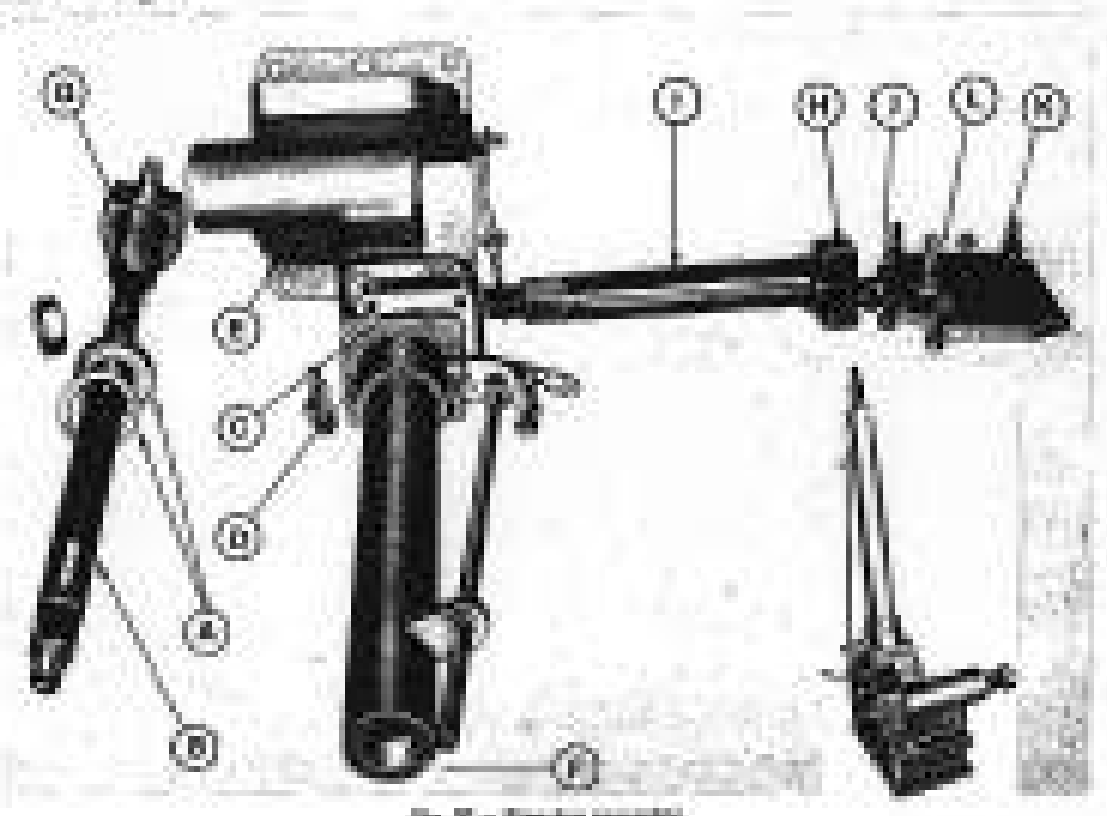


Fig. 10 – Steering assembly

The steering mechanism is of the high performance recirculating ball type and required very little attention aside from normal maintenance.

Two ball bearings (A) receive the thrust. They are located at the upper and lower ends of the worm shaft (B). The adjustment of these bearings is by means of shims (C), located between the steering column flange (D) and the cover (E). At the upper end of the steering column a bushing (F) is fitted, and acts as bearing race for the worm shaft.

The worm shaft drags the steering nut (G), which consists of the nut itself and the transfer tube, held together by the transfer tube lock. The helicoidal grooves in the steering nut and worm come together to form a guide. The ends of the guide are connected by means of the transfer tube, providing a continuous duct in which sixty four balls circulate.

When the worm shaft turns the balls in the guide are diverted by its movement, passing through the transfer tube and entering the other end of the guide. Only the balls are in contact with the worm.

The fork (H) of the sector (I) is coupled to the conical end of the steering nut. The vertical end, which stands out from the sector fork, embodies the roller (J) which revolves longitudinally along the groove in the lower face of the side cover (K).

The function of the roller is to ensure that the steering nut rotates incorporating rollers in a straight line, parallel to the worm shaft, and for the effect of increasing the steering ratio when the steering nut moves away from the position in which the wheels are parallel to the tracks.

The meshing of the sector with the steering nut is regulated by means of the adjusting screw (L), located on the outside of the steering box side cover.

TO REMOVE AND REFIT ALL THE TRACTOR STEERING BOX

To remove the steering box, proceed as follows:

Remove:

- The hood.
- The throttle lever.
- The steering wheel, after first marking its position.
- The radiator cowl and instrument panel, disconnecting the electrical connections and the hydraulic tube.
- The fuel tank.
- The throttle linkage.
- The steering arm (see fold AF-P 10/11).
- The steering box.

To install the steering box in the tractor, carry out the above procedure in reverse order.

DISASSEMBLING THE STEERING BOX

Once the steering box has been placed on the bench and its oil has been drained, disassemble as follows:

Remove:

- The side cover and its gasket (fig. 11).
- The steering sector pin after removing the split cotter locking it.
- The steering sector and roller through the side cover housing (fig. 12).
- The steering column and its gasket (fig. 13) in case excessive play is found. They will be checked when installing the steering box again.
- The worm shaft, raising it high enough to be able

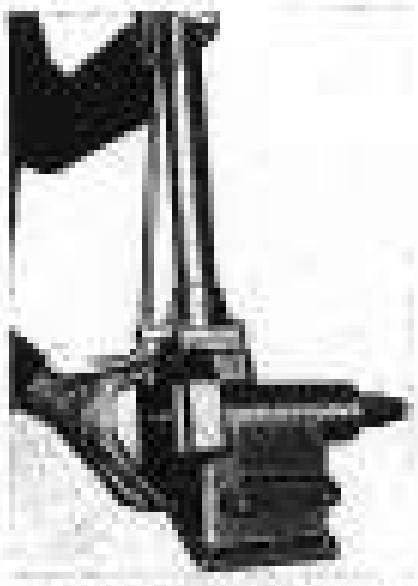


Fig. 12 – Removing the side cover

Fig. 13 – Removing the column

to remove the thrust washer, the upper bearing race and the ten balls. Withdraw the worm shaft through the side cover housing (fig. 14) together with the steering nut and the ten balls of the lower bearing.

— The worm shaft steering nut (fig. 15), bearings is completely. Be careful with the thirty balls housed in the guide and transfer tube.

Once the steering box has been disassembled, check the plastic bushing in the upper part of the steering column, the bushing in the worm shaft housing, the retainer on the lever side and the other components of the assembly. Replace all parts which are defective or worn with new ones.

Fig. 14 — Removing the worm shaft

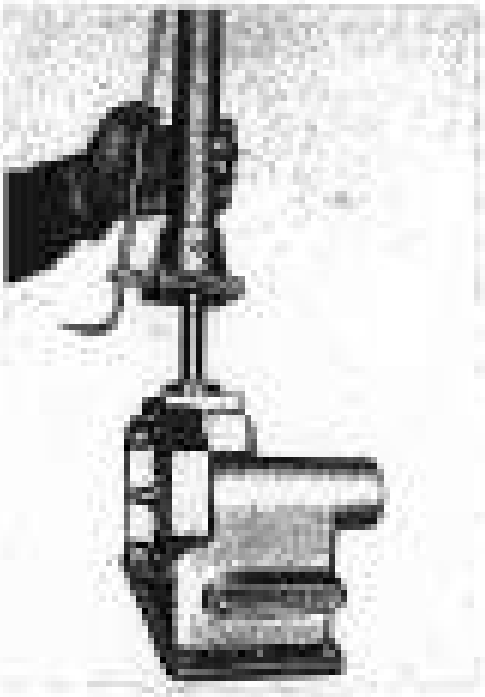


Fig. 15 — Removing the cylinder

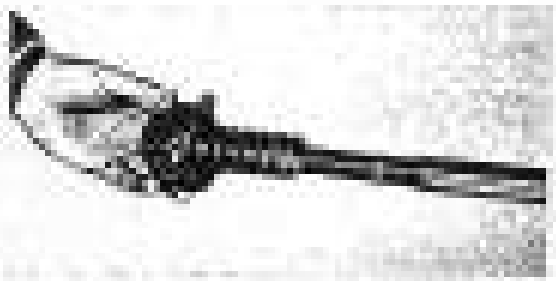


Fig. 16 — Removing the steering nut

ASSEMBLY OF THE STEERING BOX

Once all parts of the assembly have been inspected and cleaned, the steering box should be assembled as follows:

– Fit the steering nut on the worm, interposing the balls into the guide and ball tube (fig. 16).

Fig. 16 – Fitting the steering nut on the worm

– Place the balls in the bearing seat. A thin coating of clean grease will help to maintain the balls in the correct position.

– Insert the worm shaft with the steering nut through the side cover housing, setting it in such a way that the lower end of the worm shaft is placed between the balls of the lower bearing.

Taking care not to move the worm shaft so that the balls of the lower bearing will not displace, proceed as follows:

– Set the upper ball race onto the worm shaft, with the ball guide downwards, until it is seat its bearing in the box. After first applying a thin coating of clean grease, place the balls in the race guide and insert it into the housing.

– Set the thrust washer on to the worm shaft until it rests on the upper ball race.

– Set the paper gasket on the worm shaft and assemble the adjustment shims and steering column, securing it to the box cover with its set screws.

While tightening the steering column set screws, turn the worm shaft by hand. If it is too stiff, cut in new adjustment shims. If, on the other hand, the worm shaft is too free, remove some adjustment shims.

When the steering column is fully tightened, the worm shaft should turn quite freely.

– Mount the sector on a 90° angle with respect to the worm, so that the center hole fits onto the conical end of the steering rod.

– Fit the collar on the conical edge of the steering rod, which secures rod from the sector fork.

– Assemble the side cover, ensuring that the roller fits into the longitudinal groove on the inside face of the cover.

Once the cover has been assembled, turn the worm shaft so that the sector is in a straight position, that is, in the middle of its travel. Check to see if there is any play in the sector shaft end. If there is any play, or else if it is too stiff, adjustment is necessary. The adjusting screw and its counter nut are located on the outside face of the side cover.

– Fill the steering box with the correct amount of oil of the recommended viscosity.

SECTION 3:

FRONT AXLE AND STEERING

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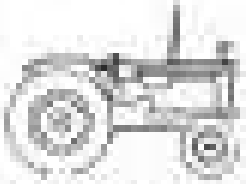

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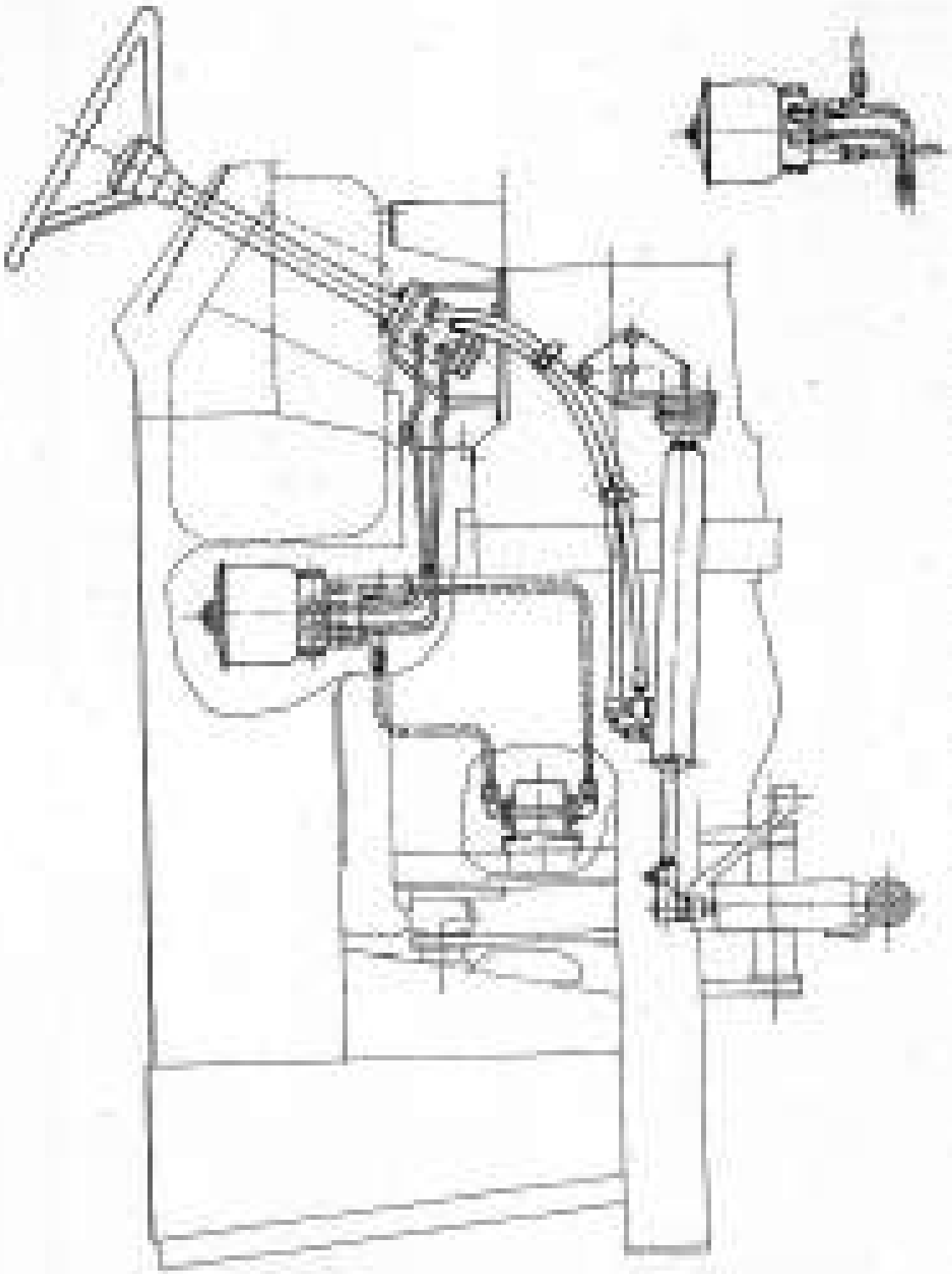
HYDROSTATIC STEERING SYSTEM

CONTENTS

HYDROSTATIC STEERING SYSTEM

SPECIFICATIONS

Hydraulic ram	
Outer cylinder length	476.5 mm
Bore	57 mm
Outer Diameter	80 mm
Inner cylinder length	376.5 mm
Bore	50 mm
Outer Diameter	70 mm
Outer overall length	941.5 mm
Stroke	328 mm
Diameter	35 mm
Front end ball joint threaded length	80 mm
Rear	33 mm
Piston diameter	40.1 (38.7)
Cylinder rear end anchoring ball joint	5/8" BSF
Piston rod to ram thread	5/8" BSF
Ram max. working pressure	100 kg/cm²
Steering column	
Overall length	476 mm
Diameter	36 mm
Hydrostatic unit	
Hydrostatic unit output (theoretical)	80 cm³/rev. (optional ram for 125 cm³ rev.)
Bolts fitted	5/16" W UNF
Lower cover screws (5) fitted	M 6x1 (DIN 965 5M)
Hydrostatic unit to steering column fastening	
screws (3)	5/8" - 18 UNC
Thread depth	15.7 mm (min.)
Steering wheel	
Diameter	380 mm
¼ of turns from stop to stop (fitted with 80 cm³/rev. unit)	5 towards the left 5 towards the right
¼ of turns from stop to stop (fitted with 125 cm³/rev. unit)	5 towards the left 3.5 towards the right
Hydraulic oil reservoir capacity	
350 Tractor	13 litres
550 Tractor	1.04 litres
Steering pump flow output	
350 Tractor	32 l per minute
450 Tractor	32 l per minute at 1,000 r.p.m.
Safety valve setting pressures	
350 Tractor	70 kg/cm²
450 Tractor	90 kg/cm²
Recommended hydraulic oils	
Brand	**Counterpart**
Hydraulic H.L.P. 46	B.P.
Tellus 37	SHELL
Castrol Hyspin AWH-M 46	CASTROL
DTE 25	MOBIL
Gear Compound EP 140	Genuine Fluid is the type of oil fitted to tractors on assembly line
Tightening torques	**Kgf m**
Flywheel securing nuts	7 to 8
Steering ram rear support bracket securing bolts	11.5 to 13.5
Hydrostatic unit to steering column screws	4.5 to 5.5
Hydrostatic unit to tractor frame securing screws	6.5 to 7
Hydraulic oil reservoir support bracket fastening screws	5 to 6



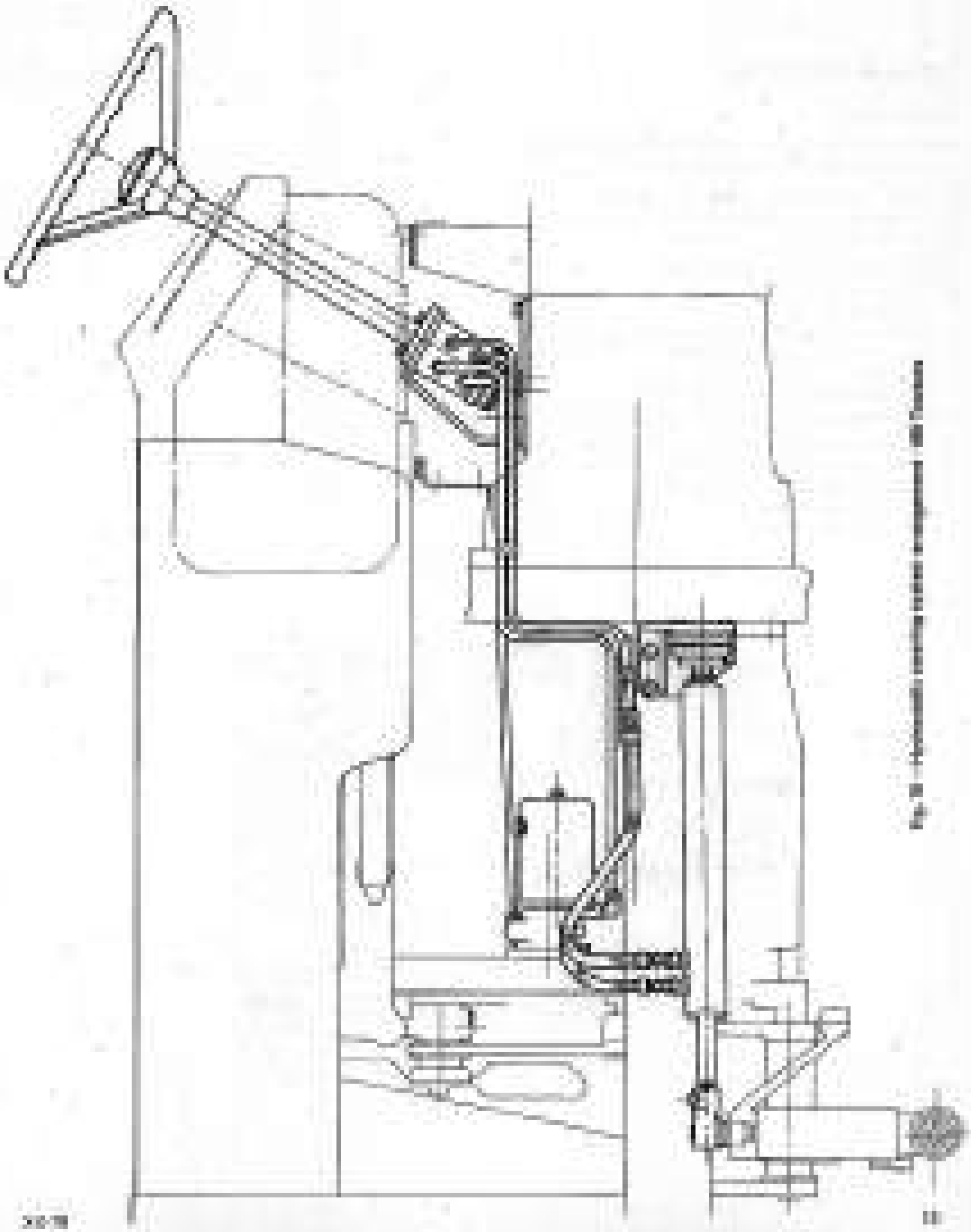


Fig. 3 — Hydraulic steering system components

GENERAL DESCRIPTION

350 Tractors

The hydrostatic steering system fitted to 350 model tractors comprises the following components:

1. Gear type hydraulic pump (A), located on the engine right hand side towards the front end. It is driven by a gear in the timing case.
2. Oil reservoir (B), containing the hydraulic oil for actuating ram in the steering circuit, incorporating a sump valve (E).
   This reservoir is fitted on the engine right hand side, towards the rear and top part, in front of the fuel tank.
   The oil filter is also located in this reservoir. The oil level dipstick is located in the oil filler cap (C).
3. Hydraulic unit (D) attached to the bottom end of the steering column and secured to the tractor body by means of a support bracket.
   The hydrostatic unit, the hydraulic pump and the steering ram are connected with hydraulic pipes.

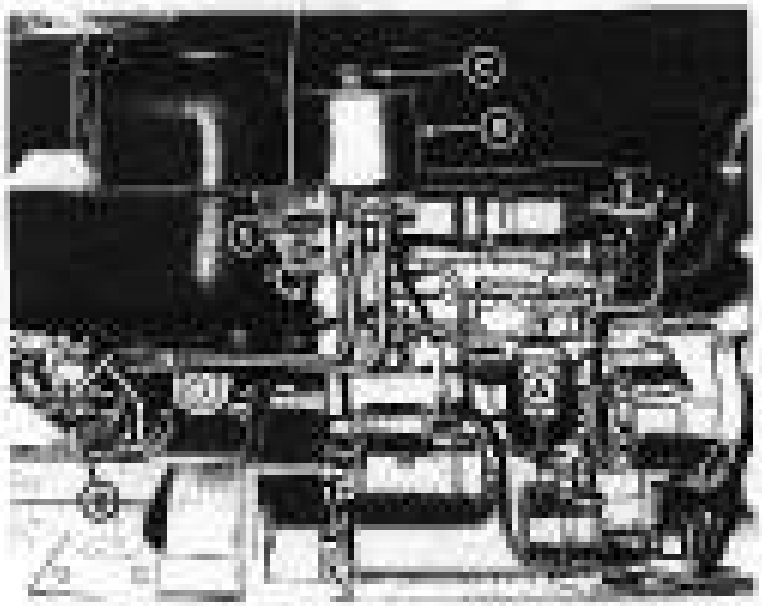


Fig. 30 – Hydrostatic unit arrangement - 350 Tractors

4. Dual action steering ram (P) with a single stem, fitted on the tractor L.H. side.
   The ram rear ball joint is attached to the gearbox housing by means of a bracket (Q). The front end ball joint is secured to the steering arm.
   The ram houses two oil inlet hydraulic pipe unions coming from the hydrostatic unit which will determine the steering towards either side.

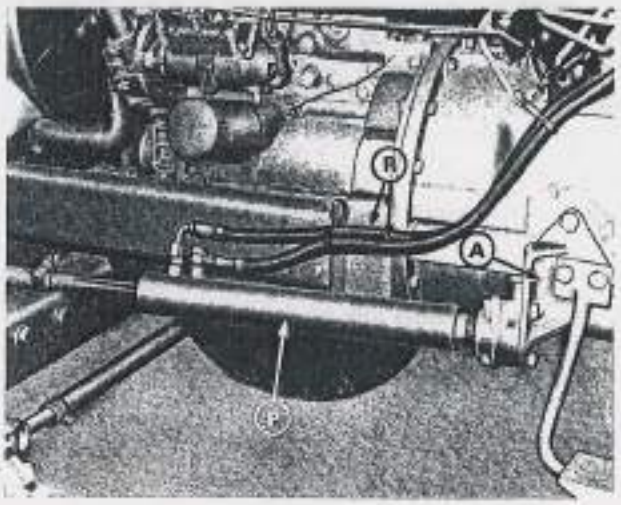


Fig. 20 — Location of the steering ram fitted to 350 Tractors

460-Tractors:

The hydrostatic steering system fitted to 460 tractors comprises the following components:

1. Gear type hydraulic pump (A), incorporating the hydraulic oil reservoir (B), located at the engine L.H. side front end. It is driven by a gear in the timing case.

2. The oil reservoir (B) incorporates an oil filter and a safety valve. The oil filler plug (C) is also used to check the oil level in the reservoir.

3. Hydrostatic unit (F), attached to the steering column bottom end and secured to the tractor frame by means of a bracket. Hydraulic pipes connect the hydraulic oil pump to the steering ram.

4. Dual action steering ram (D) with a single stem. Its rear end ball joint is attached to a bracket (E) and the front end ball joint is secured to the steering arm.

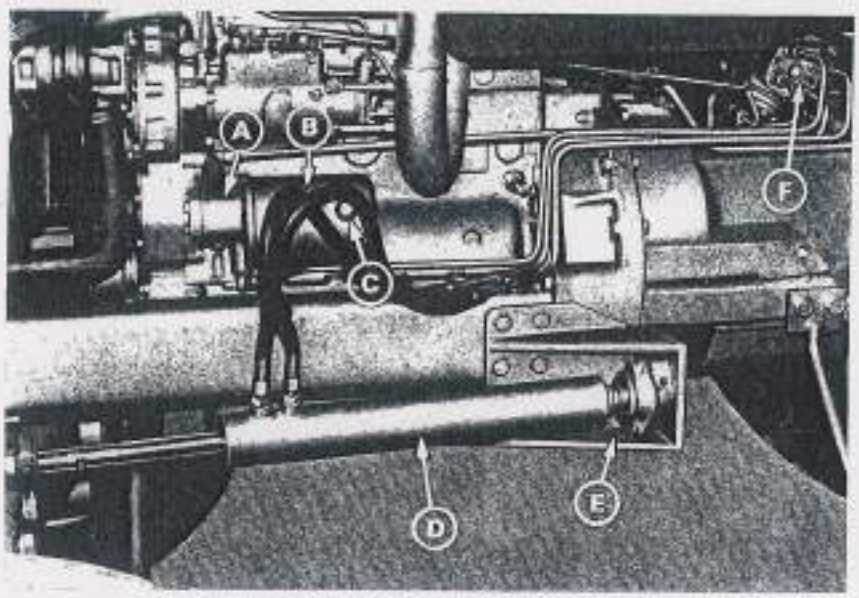


Fig. 21 — Hydrostatic unit arrangement - 460 Tractors

The steering hydrostatic steering unit is a set of parts the function of which is to provide a steering controller at least as the steering car's and, in the case of an emergency, it acts as a hand pump.
The unit consists of:

a) A rotary valve comprising a fixed outer ring (B) with inner holes, and an inner valve (K) with outer holes.

b) A two-element, four way rotary distributor valve the two elements of: an inner sleeve (D) and an outer sleeve (E). The inner sleeve is connected directly to the steering wheel.

c) A cardan shaft (F) that mechanically connects the valve (E) to the outer sleeve (E). It is providing internal synchronization.

d) A check valve (C) located between the return and pressure connections.

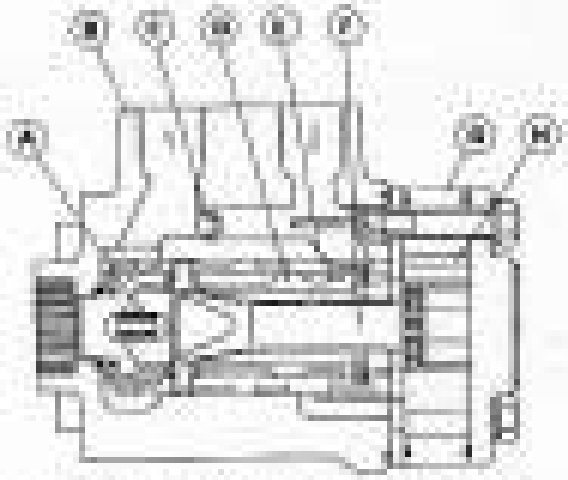
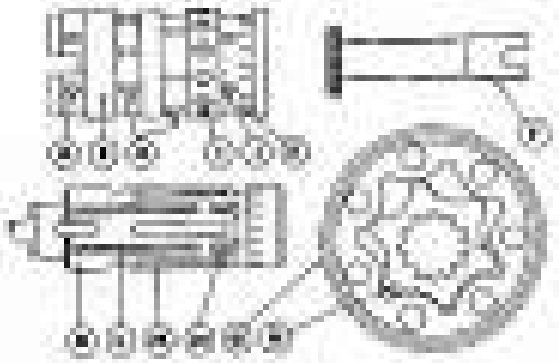


Fig. 22 — Cut-away view of hydrostatic steering unit

A — Cover plate
B — Hydrostatic unit body
C — Check valve
D — Rotary valve inner sleeve
E — Rotary valve body
F — Cardan shaft
G — Valve outer ring
H — Rotor

Fig. 23 — Hydrostatic steering unit components

A — Return holes
B — Holes to cylinder
C — Inner sleeve
D — Outer sleeve
E — Cardan shaft
F — Valve outer ring
G — Rotor
H — Hydraulic motor feed holes
I — Distributor valve feed holes
L — Spool cut-outs
M — Rotary groove
N — Control feed groove
O — Distributor valve lock hole



OPERATION

1. The (SFO) 88 and 108 tractors equipped with the hydrostatic Steering Unit have an independent hydraulic circuit fitted with an oil reservoir.
2. 400 (SFO) Tractors incorporate the hydraulic oil reservoir on the hydraulic pump.

   On 350 (SAE) Tractors, the hydraulic oil reservoir is located on the engine right hand side towards the rear top end. Connection from the reservoir to the pump is achieved through hydraulic pipes.
3. Safety valve setting pressure must be of 55 kg/cm² for both tractor models.
4. The pressurized oil supplied by the pump through the safety valve body goes to the hydrostatic unit by means of two metal pipes, i.e.: a return pipe and a pressure pipe.
5. When the steering wheel is inoperative and the rotary valve is in neutral position, the small radial holes on the inner sleeve coincide with the small holes on the outer sleeve, thus allowing a free circulation of oil through said holes, returning to the reservoir once again.

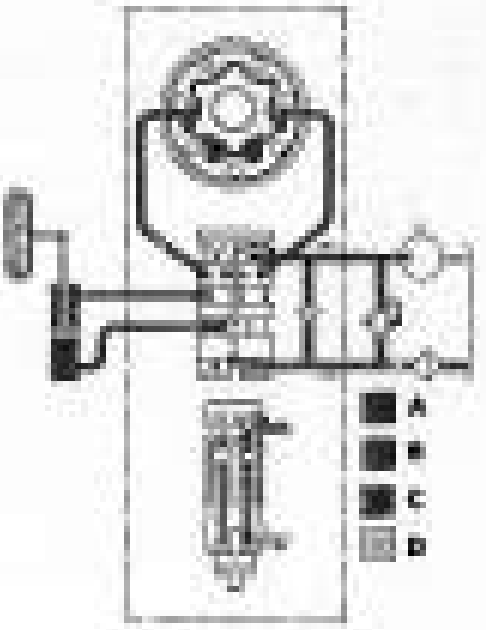


Fig. 24 — 400 circulation is reversed

A — [illegible] supply line
B — [illegible]
C — [illegible] return line
D — [illegible] suction line

b. When turning the steering wheel the valve outer and inner sleeves turn like one in respect of the valves. The passages leading to the cylinder ports progressively open for an approximate rotation of 12°. These passages are fully open for an approximate rotation of 9°.
After a rotation of approximately 8° the neutral ports are closed.

Oil circulation through gear with rotation.

a. Rotor gear rotation.

c) A flow volume every directly proportional to the steering wheel angular movement on the steering cylinder, to turn the front wheels in the desired direction.

d. The lever mechanical feed from the rotor gear to the valve outer sleeve is such that the rotary servo-valve ports of selector spool are closed when the angular movement of the rotary gear coincides with that of the steering wheel.

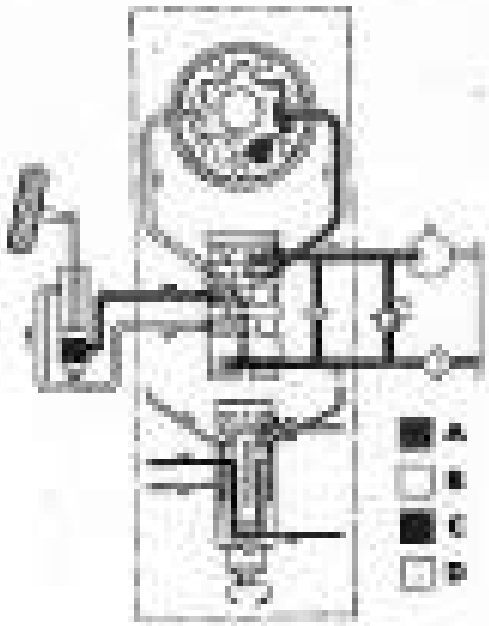


Fig. 30 – Hydraulic powered steering oil circulation
Right hand turn
A – Oil to hydraulic line to rams
B – Oil to pressure line to cylinders
C – Oil to return line
D – Oil to suction line

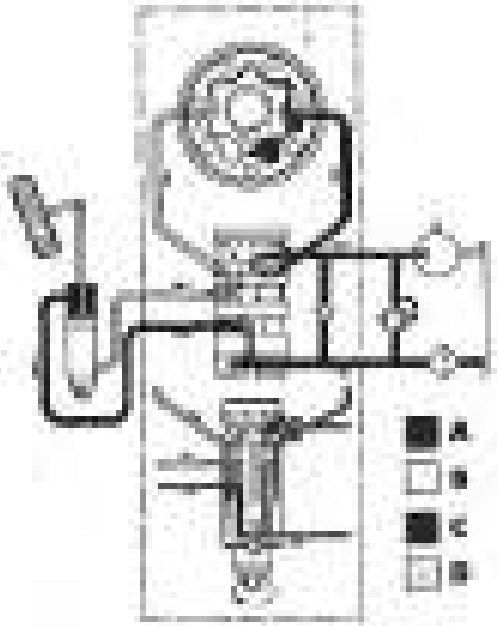


Fig. 31 – Hydraulically powered steering oil circulation
Left hand turn
A – Oil to hydraulic line to rams
B – Oil to pressure line to cylinders
C – Oil to return line
D – Oil to suction line

MAINTENANCE

BD Tractors

1. Every 10 hours of operation or daily, lubricate the rear axle ball joint with an easy-to-use multipurpose grease, through nipple (A).

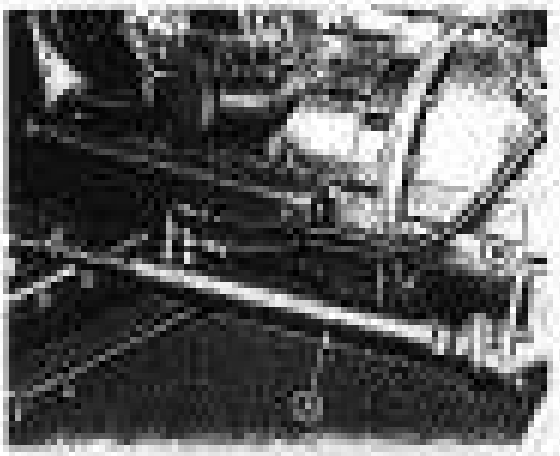


Fig. 27 – Hydraulic cylinder rear exchange – BD tractors

A – Cylinder body
B – Ball joint grease nipple

2. Every 200 hours of operation, check oil level in the steering oil reservoir. Whenever necessary, refill with good quality oil. See **Specifications** on Page 15.

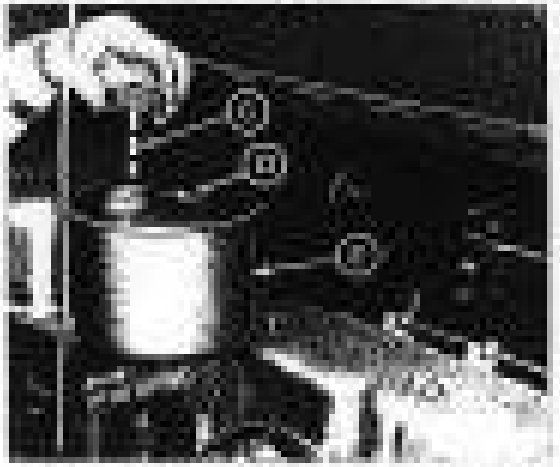


Fig. 28 – Checking oil level - BD tractors

C – Plastic
D – Cover end of the steering screw
E – Oil reservoir

3. Every 1,000 hours of operation or yearly (whichever first occurs), flush the entire steering circuit and refill with new oil.

Also change the end-cap filter (F) fitted inside the reservoir. The oil must be of an adequate quality (see SPECIFICATIONS on page 15).

NOTE: When adding oil to the reservoir or changing same, check oil and assemble circuit lines. Any dirt in the circuit would cause considerable damage.

Fig. 29 – Changing oil filter – BD Tractors

F – Reservoir lid
G – Filter housing
H – Element filter
I – Oil reservoir

MAINTENANCE

450 Tractors

1. Every 10 hours or daily, lubricate the steering ram rod end ball joint through nipple (D). Use multi-purpose grease.
2. Every 250 hours of operation, check the hydraulic pump oil reservoir (C) level, by following the procedure outlined below:
   - Start the engine and turn the steering wheel one turn towards the L.H. side.

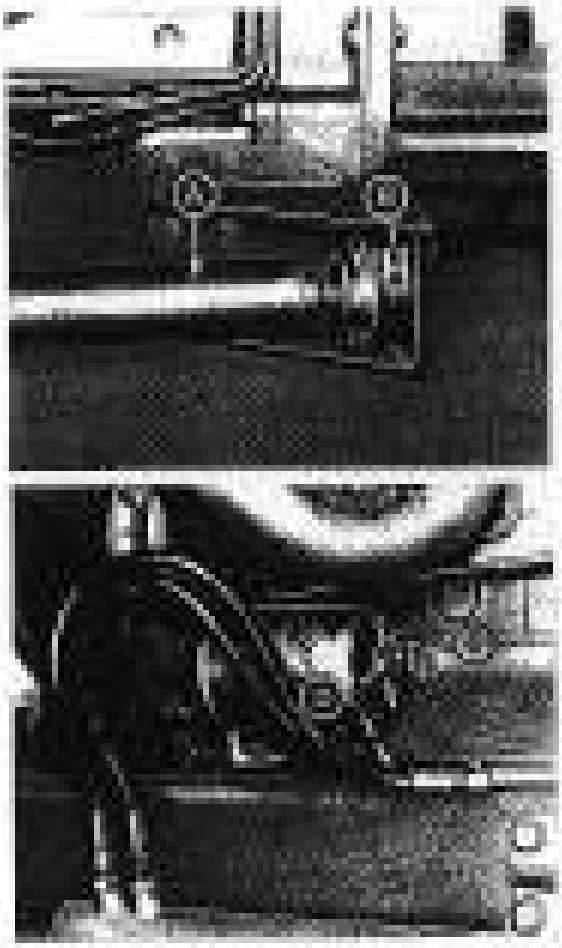
Fig. 31 — Hydraulic ram rear end anchorage
A - Cylinder body
B - Ram ball joint grease nipple

   - Keep the engine running for 30 seconds.
   - Remove the filler plug (D). The oil level must reach up to the filler mouth lower lobe. Top-up if and as required.
   - Refit the filler plug. Start the engine and keep it running the neutral three minutes.
   - Remove the filler plug again and check the oil level adding oil as required to reach the correct level.
   - Refit the filler plug once more and tighten to 1.5 kgf m torque.

Fig. 31 - Checking reading reservoir oil level
450 Tractors
C - Oil reservoir
D - Oil filler and level plug

3. Every 1,000 hours of operation, change the oil reservoir oil filter element as per the following instructions (Fig. 33).
   - Place suitable sized container under the reservoir.
   - Remove the nut (N).
   - Remove the reservoir (F).
   - Remove the washer (O).
   - Remove the rubber pin (H).
   - Remove the washer (L).
   - Remove the spring (K).
   - Remove the washer (G).
   - Remove the seal (M).
   - Remove the filtering element (N) and discard. Clean all components in paraffin and dry them.
   - Remove the "O" ring (E).

Assemble the elements by reversing the above procedure except for:
a) Fit a new "O" ring and a new filter element.
b) Reservoir nut must be tightened to 3 kgf m.
c) Fill the reservoir and check that level is correct.



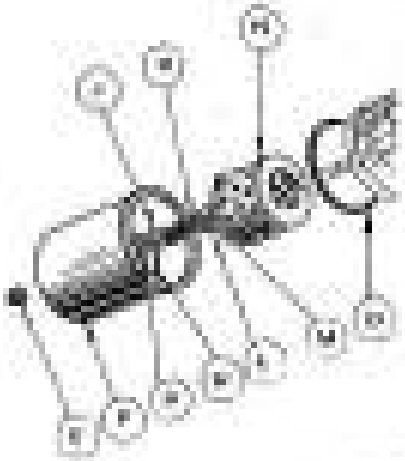


Fig. 33 — Exploded view of reservoir and oil filter

BLEEDING THE STEERING SYSTEM

400-Tractors

1. Remove the filler plug.
2. Fill the pump reservoir with fresh oil up to the filler hole lower hole.
3. Refit the filler plug and tighten to 1.8 kgf m.
4. Start the engine and keep it at 800 r.p.m. for 30 sec. approx.
5. Turn the steering wheel from stop to stop (with hand) left to right and from right to left.
6. Stop the engine and refill the reservoir.
7. Start the engine and keep it at 1200 r.p.m. approx.
8. Repeat operation 5 above.
9. Turn the steering wheel to the L.H. stop and keep it there for about 15 sec. Repeat the operation with the steering wheel turned to the R.H. side stop. (When the steering wheel is held against either stop, the safety valve can be heard while in operation).
10. Repeat the operation under 9. above, three times.
11. Stop the engine, check for leaks at all unions and repeat the sequence from 7 to 10.
12. Loosen the unions on the steering ram slightly to let out all air that might have built inside the ram. Turn the steering wheel from stop to stop while the engine is running and tighten the unions adequately.

500-Tractors

1. To bleed the steering system on 500 tractors follow the procedure outlined in item 12. above.

REMOVING AND REFITTING THE STEERING PUMP ON 500-TRACTORS

1. Loosen out the pressure outlet pipe unions (A).
2. Loosen out the suction pipe unions (C) letting the oil drip into an adequate container.
3. Unscrew the retaining screws (M) and pull out the pump assembly (B) from its housing in the timing case.
4. Refit the pump by reversing the above stated procedure and bleed the oil suction pipe and outlet pipe (delivery) so to change their original fitting positions.

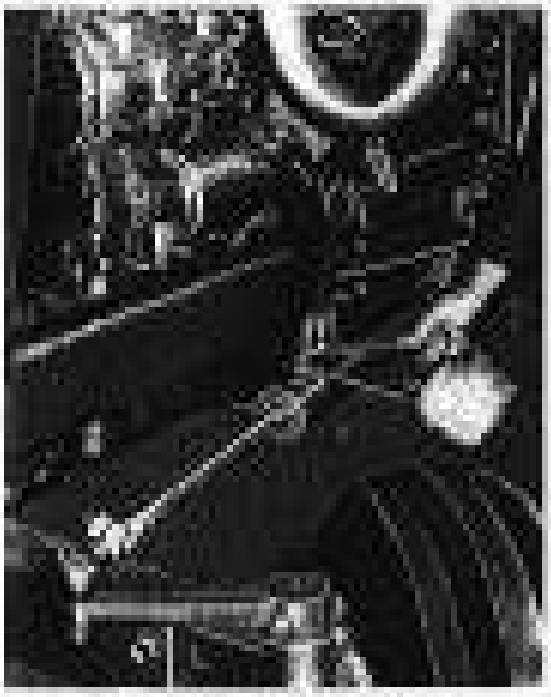


Fig. 33 — Bleeding the steering system

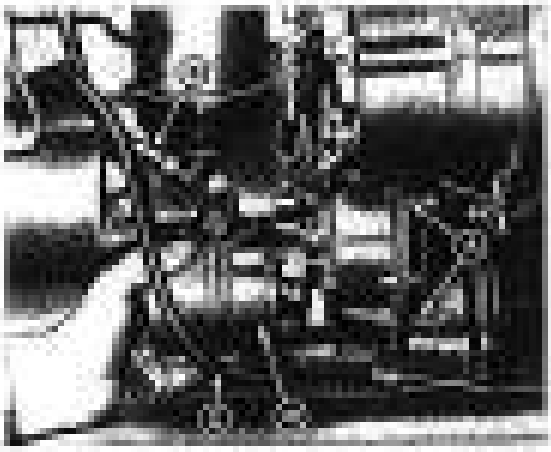


Fig. 34 — Removing the steering pump from 500 Tractor

DISMANTLING THE STEERING PUMP ON TO BENCH ACTION

1. Straighten the locking washer tabs and remove the nut (C) and locking washer (H) securing the helical gear (H) to the pump pressure driving gear shaft (B).
2. Detach the helical gear from the gear shaft. Tap the gear loose with a plastic hammer or use a suitable puller if required.
3. Remove the woodruff key (U) from the shaft.
4. Remove the eight socket-head set-screws (F) and washers securing the pump cover (M) to the pump body (A).
5. Separate the cover from the body. Where necessary the oil seal can be removed from the cover by carefully driving it out with a suitably sized bronze drift.
6. Extract the S-shaped 'O' ring (G) from its location in the pump body, and withdraw the rubber 'O' rings (L) and nylon thrust washers (K) from the front bronze bearing (D). Separate the bearing from the gears, taking care not to lose the small expander (bonar) (E).
7. Withdraw the pump gears (I) and (J) and the rear bronze bearings (K).
8. Examine the bearings for signs of seizure or scoring on the face or journals. Light scars resulting can be removed by careful lapping on a surface plate, using 'O' grade emery paper and carefully maintained.
9. Examine the body for wear in the gear running track. If the track is worn deeper than 0,1 mm on the inlet side, the body must be replaced.
10. Examine the gears for excessive wear or damage on journals, faces or teeth. Run out across the gear face to the tooth edge should not exceed 0,025 mm. The gear journals can, if required, be lightly polished with 'O' grade emery paper to remove wear marks. The gear faces may be polished by polishing the emery paper between the gear and a worn bearing and rotating the gear.
11. All rubber seals, nylon washers and 'O' rings should be replaced when overhauling the pump.

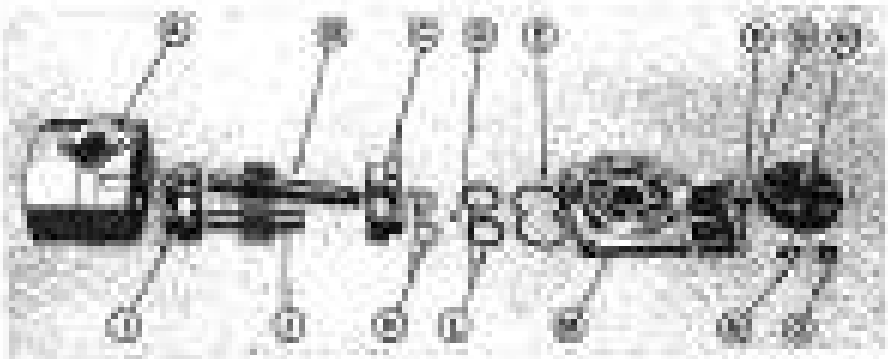


Fig.26 – Exploded view of steering gear driven hydraulic steering pump

A – Pump body
B – Pressure driving gear
C – Gear bearings
D – Expander (bonar)
E – Rubber 'O' ring
F – Set-screws and washers
G – Woodruff key
H – Helical gear
I – Gear bearings
J – Pressure driven gear
K – Nylon thrust washers
L – Thrust washer 'O' rings
M – Pump cover
N – Locking washer
O – Securing nut

ASSEMBLING THE STEERING PUMP 300 TRACTORS

The bevels meshing must be assembled in correct relationship to the gears and to the housing in the pump body or bodies. To this end, when dismantling the pump the components should be arranged on the work bench in accordance with their original mounting position (see fig. 36).

Carry out a thorough cleaning with kerosene or petrol (gasoline) when rebuilding the pump.

1. If the oil seal has been removed previously, insert a new double-lip oil seal in the pump cover. The oil seal can be driven in by using a suitable (60) bevel drift.

2. Fit the cam bearing (K) into the pump body (A). Care should be taken to distinguish these bearings from the front ones, which are identified by the small recess in the front edge of their face, intended to house the rubber expander thread (B).

3. Assemble the pressure driving gear (H) and driven gear (J) into their respective bearing in mesh with each other. Be careful not to lower the original mounting position of the above gear, so as to avoid change-over of tooth drive side.

4. Fit the front bearing (C) onto the gear journals and lower the rubber dowel (D) between them.

5. Fit new nylon thrust washers (R) and rubber rings (L) on the front bearings, ensuring that the rubber rings seat correctly around the washers.

6. Fit a new Scheerpak 'O' ring (E) into the groove in the pump body (A).

7. Assemble the pump cover (M) to the pump body (A) taking care not to damage the oil seal when passing the driving shaft (E) through. Fit the eight centering and washers (F) and tighten evenly to 2.8 mkg (19 lbs. ft.). An accurate torque wrench must be used for this operation, to ensure that this torque figure is not exceeded.

8. Position the woodruff key (S) in the shallow driving gear shaft and assemble the helical gear (H) to the shaft.

9. Place a locking washer (N) onto the shaft and bend the single tab into the keyway in the gear. Screw on the securing nut (K), tighten fully and lock the nut with the twin tabs of the locking washer.

REMOVING AND REFITTING THE STEERING PUMP (SF-505 EXP-I)

1. Place a suitably sized container beneath the tractor to collect the oil from the steering circuit.
2. Loosen out the nature and outlet pipe unions (B and C respectively).
3. Loosen out the 4 screws (A) securing the pump body to the timing case.

Fig. 36 – Removing the steering pump - 505 Diesel

A – Securing screws
B – Return pipe union
C – Pressure pipe union

4. Remove the pump (D) and roll-reservoir (E) assembly from the tractor.
5. Refit by reversing the removal procedure except that:
   - fit a new sealing gasket between pump flange and timing case cover.
   - refill the reservoir (E) with oil.
   - Bleed the system (see page 27).
   - Check the whole system for leak-proof working.

Fig. 37 – Removing the pump and oil reservoir assembly from 505 Diesel

CHECKING THE SAFETY VALVE SETTING PRESSURE. NO FRACTIONS

1. Start the engine and keep it running at 1,000 r.p.m. with the steering wheel turned applied to stop, until the oil temperature reaches 50° C. Stop the engine.
2. Unscrew the pressure outlet plug union off the pump and tighten a pressure gauge (like union to its housing.
3. Start the engine.
   The safety valve must relieve pressure and show a pressure reading of 90 kg/cm² on the gauge with the engine at 1,000 r.p.m. approx.
4. If the pressure reading is other than the specified check the system as follows:
   – Drain the system.
   – Remove the reservoir.
   – With a screwdriver drive the regulating screw in or out to increase or decrease the pressure, respectively.

Remark. – Internally the regulating screw is sealed by a welding spot to prevent pressure setting alterations.

– Refill the reservoir.

– Refill with oil brought in the pressure gauge union room.

– Start the engine and check that the pressure reading is 90 kg/cm².

Fig. 48 – Checking safety valve pressure setting

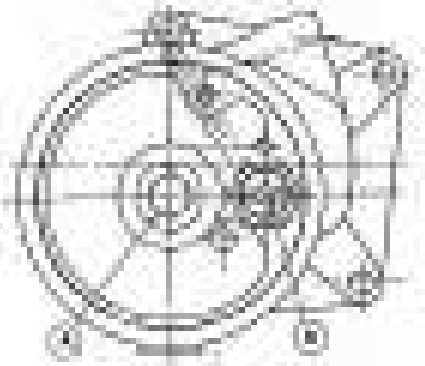


Fig. 49 – Safety valve pressure setting regulating screw

A – Oil-flow housing guide
B – Valve valve stop

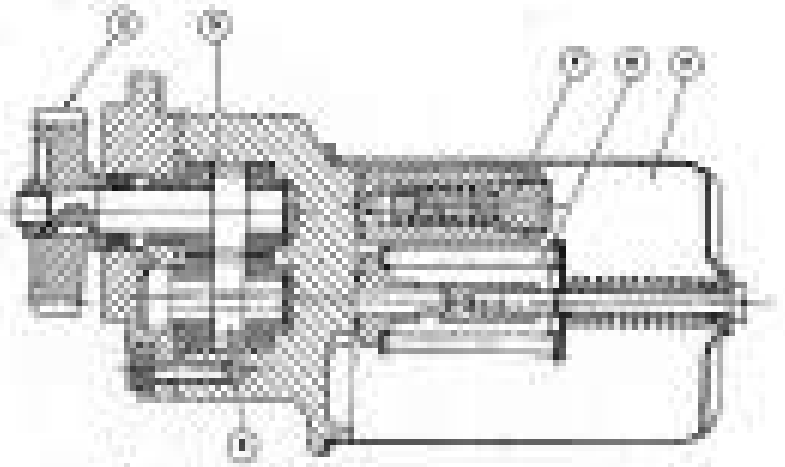


Fig. 46 – Cut-away view of the reservoir, safety valve and pump

1 – Intake filter pipe
2 – Filler port
3 – Drive gear
4 – Safety valve
5 – Oil filter
6 – Oil reservoir

DISASSEMBLY, INSPECTION AND REASSEMBLY OF STEERING PUMP, 480 TRACTORS

Disassembly

1. Remove the solenoid and filter assembly from the pump body (see item 3 on page 36) and place the pump body in a suitable vice.
2. Loosen out the safety valve plug (6) along with its sealing washer.
3. Loosen out the filter housing guide (2) along with its sealing washer.
4. Remove the "O" ring (C) sealing the pinion to solenoid assembly from the body (P).
5. Reverse the pump attaching position on the workbench vice.
6. Straighten out the washer tab (T) locking the nut (N).
7. Loosen out the nut (N) and remove along with washer (T).

   Remark. — Lock the gear in order to loosen the nut.
8. Remove the driven gear (H) with a standard gear puller.
9. Remove the gear (M) and the woodruff key (R).
10. Scribe a fitting mark on the pump body (P) and the end plate (E) to make the re-fitting operation easier.
11. Loosen out and remove the (6) "Allen" screws (U) and washers, securing the end plate (E) to the pump body (P).
12. Remove the long dog (M).

Fig. 36 — Steering pump components - 480 Tractor

A — Drive Pin
B — End plate
C — Pinion to pump sealing "O" ring
D — Filter housing stud
E — Safety valve plug
F — Pump body
G — "O" — shaped "O" ring
H — Sealing "O" rings
J — Wood washers
K — Expander sleeve
L — Filter and housing
M — Pinion and bearing
N — Driven gear
P — Drive gear
R — Woodruff key
S — Pump drive gear
T — Drive gear and drive nut
U — Screws

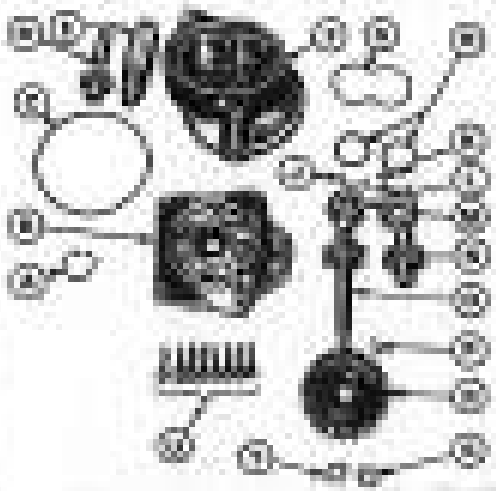
13. Remove the "O" rings (H) and the dowel washers (J).
14. Remove the expander sleeve (K).
15. Remove the bearing (L) from the drive gear shaft.
16. Remove the bearing (M) from the driven gear.
17. Remove bolts, the drive (G) and the driven (H) gears.
18. Remove the oil tip seal from the end plate (E) and fit a new one.

Checks

Check the bearing for wear. Carefully inspect the splined/key grooves and the axial location between the face of each helix. Any scoring or damage in this area has caused important leaks.

Usually on service rg, the bearings might be pulled out and replaced by new ones. However, if new bearings are not available, the existing ones may be re-used. Bearing body if these bearings are observed). Polish them as per the following instructions: Place grade "0" emery paper coated to parallel on a flat surface. Polish the surface by sliding the bearing in a circular pattern. Check that the bearings can move freely inside the pump housing. If so required, polish the bearing periphery surface.

After polishing, thoroughly clean the bearings in paraffin to remove filings.



visually check for wear, scorings or cracks in the pump body and end plate. Due to oil pressure, the gears normally cut a groove in the pump body inlet side. This groove should never exceed 0.1 mm. If it does the pump body must be changed.

The only repair that can be performed on the pump body is to carefully grind off any burrs at the groove edge with a very fine grit emery paper. Examine closely for damage as the gear teeth or gear shaft. If gear shaft wear or scoring are of minor importance, they can be eliminated with carefully worked grade '0' emery paper.

Gears bearing small scorings on the surfaces can be reconditioned with paraffin soaked grade '0' emery paper.

Check gear backlash, which cannot be greater than 0.08 mm. If gears cannot be polished since scorings are of greater importance, a new set must be used.

Gears are only supplied in sets of two, i.e.: drive and driven gear.

Inspect the reservoir, especially the bottom concave face where in may get scraped if the nut is over-tightened.

Also check the 'O' ring sealing surface for conditions.

Finally, examine the safety valve and seat for corrosion. If so required, slightly smear the stem and seat with adequate paste. Then, clean carefully.

Notice. — The groove in cut out by the oil under pressure forcing the gears on to the pump body wall. If the bearings are worn, this groove will be cut deeper.

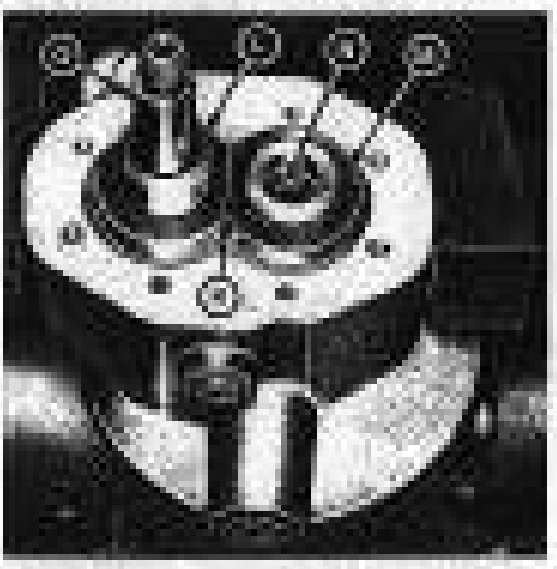


Fig. 42 — Rotating the bearings with the eccentric dowel removed from

Assembly

1. Fit the drive (2) and driven (4) gear shafts into the pump housing.
2. Fit the bearing 3, and 5 on to the corresponding shaft using due they have the corresponding fitting position.
3. Fit the eccentric dowel (6) between the eccentric dowel and drive the bearing on to their seats.
4. Place (at '0' ring (8) round the bearing surface with the corresponding thrust washer (7), as shown in fig. 43.
5. Place the "R" shaped 'O' ring (9).
6. Fit the end plate on to the pump body, using not to damage the oil tip seal when fitting it on to the drive shaft.
7. Secure the end plate by means of 8 screws. Tighten down diagonally.
8. Fit the snap ring (14).
9. Place the woodruff key (11) on to the drive shaft (2) keyway and press the pump helical drive gear (3).
10. Insert the nut washer (17) and tighten the nut. Then bend the tab on the washer on to the nut flats.
11. Insert the mounting position of the pump and fit the filler bracket/gusset screw (23) washer washer.
12. Drive the safety valve plug (5) into its housing.
13. Mount the reservoir 'O' ring and fitting.

Fig. 43 — Fitting the bearing washers and "O" ring

REMOVING THE OIL RESERVOIR FROM 308 TRACTORS AND DISASSEMBLING AND ASSEMBLING THE SAFETY VALVE

1. Flush the reservoir.
2. Remove the pipes from the four pipes (A, B, C and D).
3. Unscrew the reservoir to engine support bracket fastening screws.
4. Remove the reservoir and safety valve assembly from cooler.

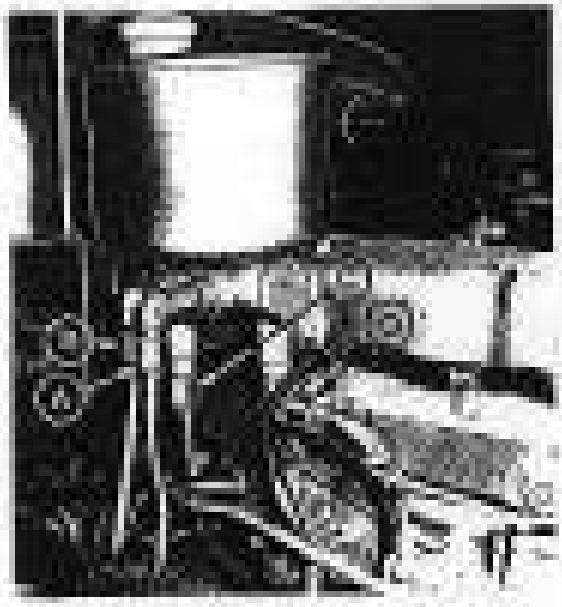


Fig. 10 – Removing the oil reservoir – 308 Tractors

A – Pressure pipe to hydraulic unit
B – Return pipe to reservoir
C – Reservoir to pump intake pipe
D – Pressure pipe from pump to hydraulic unit on the valve side.

Dismantling and assembling the safety valve

1. Place the reservoir and valve assembly on a work bench vice.

   NOTE: This valve can also be dismantled with reservoir fitted on tractor.

2. Loosen the screw (I) and remove along with the spring (H).
3. Loosen and remove the screw (B). Remove the spool (G).
4. Clean all components carefully. Check the spool (G) and sealing (A) for perfect condition.
5. Insert the spool (G) in its housing. The thinner part of the spool (G) must be on the side of the longest neck (H).
6. Tighten the screw (I) equipped with a sealing washer (F). On the other side, tighten the screw (I) equipped with the spring (H) and the sealing washer (E).
7. Fasten the assembly to the bracket by means of the screws. Apply a torque of 6 to 8 mkg.
8. Connect the pipes (A), (B), (C) and (D).
9. Fill the reservoir with good quality new oil, as indicated under SPECIFICATIONS.

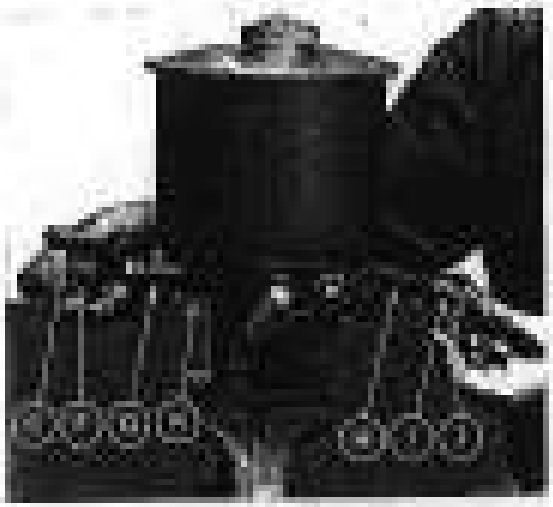


Fig. 11 – Dismantling the safety valve

A – Safety valve seat
B – Sealing washer
C – Safety valve seat
D – Safety valve spring
E – Valve spring guide screw
F – Sealing washer
G – Valve housing

REMOVING AND REFITTING THE HYDROSTATIC UNIT.

(55 and 66 Tractors)

Removal:

1. Remove the steering wheel (B) by means of a puller (A).

   Remark. — This tool is locally made.

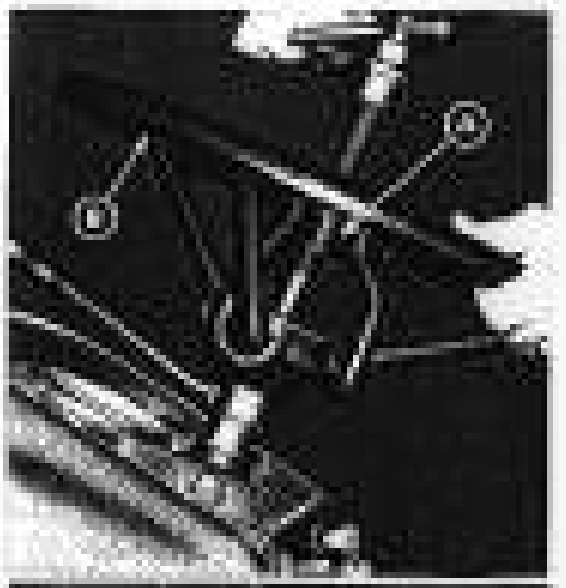


Fig. 46 — Removing the steering wheel

2. Remove the hand throttle lever (C).

   Remark. — Care not to lose the woodruff key securing the hand throttle lever (C) to the main linkage.

3. Pull out the dust cover (D).
4. Loosen and remove the six screws (O) securing the instrument panel on to the shield.

Fig. 47 — Removing the instrument panel and hand throttle lever

5. Unscrew the fourteen screws (F) out of the engine sump.

Fig. 48 — Fourteen screws

c) Remove the bolt and nut from the hand throttle lever (G).

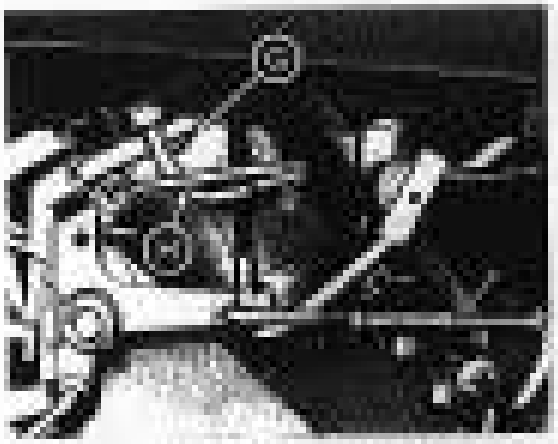


Fig. 48 - Removing the bolt and lever the hand throttle lever

3. Loosen out the four screws (J) from the hydrostatic (K).

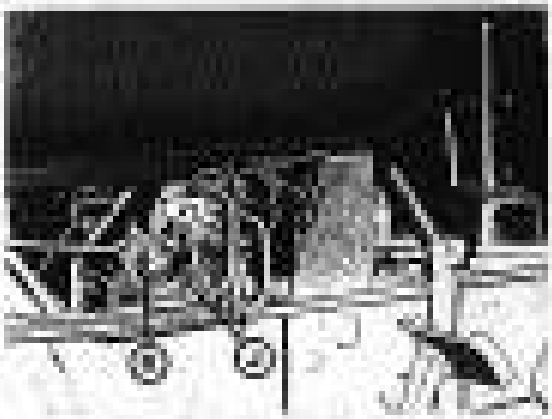


Fig. 50 - Removing the hydrostatic unit

4. Place the instrument panel (M) on the lower front.
5. Through the hole-space in the fuel tank, loosen out the four screws securing the steering column (O) to the hydrostatic unit. Use a box wrench with an extension arm (L).

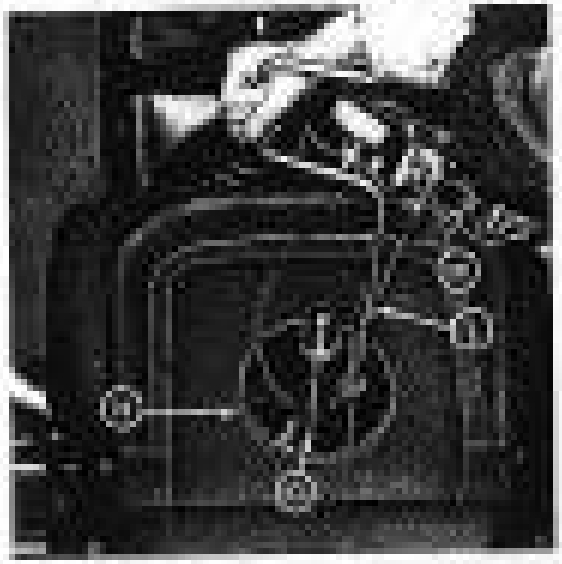


Fig. 51 - Removing the steering column and hydrostatic unit from tractor

10. Slide the steering column (P) away from its housing.

Fig. 54 – Removing the steering column through the bottom right-hand side of the front frame

11. Slightly push apart the two plastic lock circlips (Q) and remove the hydrostatic unit from the bracket on the frame.

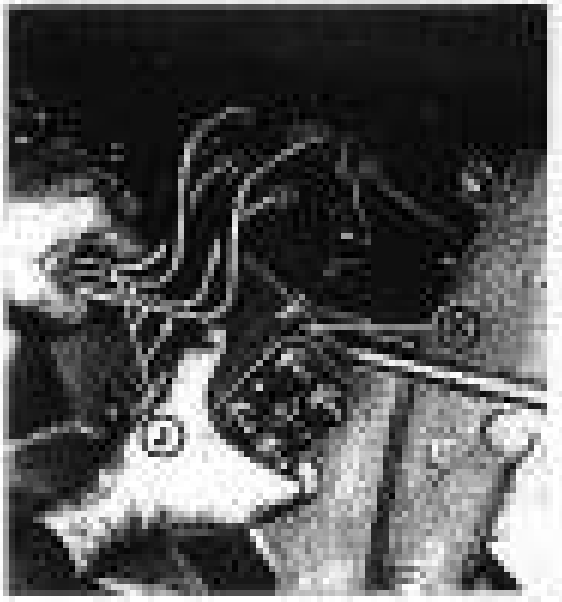


Fig. 55 – Removing the hydrostatic unit from the bracket

Refitting: Reverse the removal operations to refit the hydrostatic assembly back to the frame, bearing the following in mind:

- Steering column to hydrostatic unit support plate securing screws must be tightened to 4.5 to 6.5 kgf m.
- Tighten the steering wheel to column fastening nut to 1.5 to 2 kgf m.

DISMANTLING THE HYDRAULIC STEERING UNIT - 818 and 857 tractors

To dismantle the hydraulic steering unit, place same on a work bench vice with the T screw face upwards then proceed as follows:

1. Unscrew and remove the T screw (C) with their washers (B).
   NOTE. – One of the screws is equipped with the check valve stop (A).
2. Remove the cover (D) along with the O-ring (E).
3. Remove the valve take ring (G) along with the valve (H) and the O-ring (H).
4. Remove the spacer washer (I).
5. Remove the valve plate (J) and O-ring (K).
6. Remove the control shaft (L).
7. With the aid of an adequate screwdriver, loosen the check valve screw (M) in the hydrostatic unit.
8. Turn the hydrostatic unit and remove the ball (N), which will come out easily.
9. With a plastic mallet, tap the outer sleeve end (P) and it comes, out through the other end.
10. Remove the pin (Q) from the outer sleeve (P).
11. separate the outer sleeve (P) from the spacer (S).
12. Remove the following parts from the hydrostatic unit:
    a) Metal disc (R)
    b) Objet thrust flat washer (T).
    c) Roller bearing (U)
    d) Flat washer (V)
    e) O-ring (X)
    f) Carefully remove the rubber seal with the steel ring (Z).
13. With the aid of a screwdriver, apply pressure to the 6 pressure springs (W) and remaining same from spacer (S).

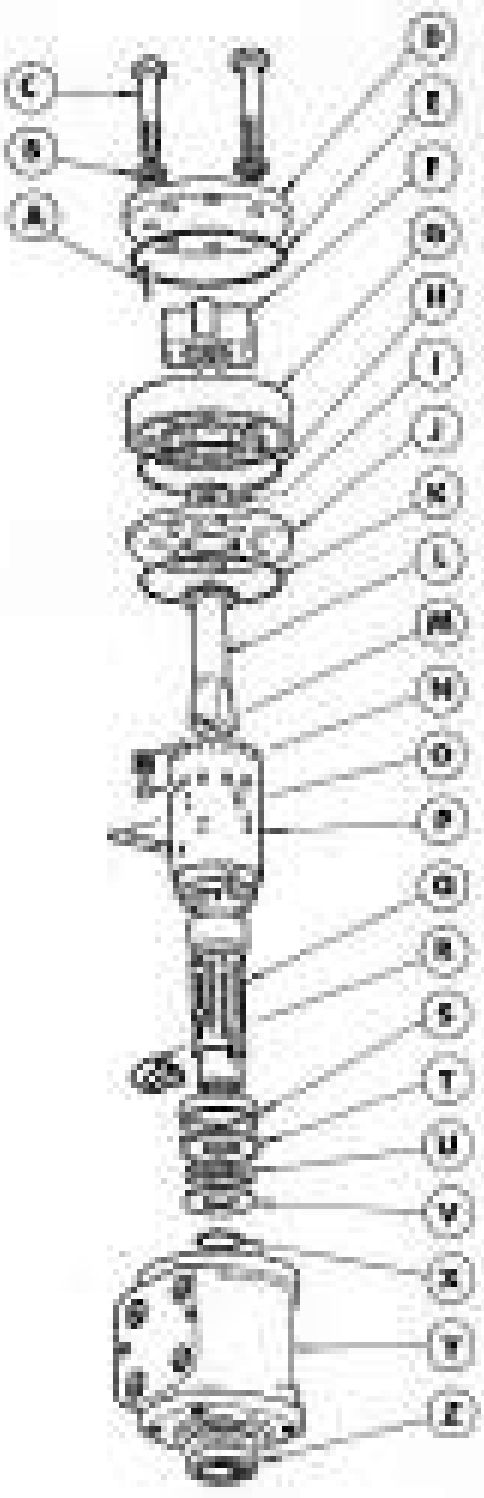


Fig. 66 – Exploded view of hydrostatic unit

A – Check valve stop
B – Flat washers
C – Hydrostatic unit screws
D – Unit cover
E – O-ring
F – Valve
G – Valve take ring
H – O-ring
I – Spacer washer
J – Valve plate
K – O-ring
L – Control shaft
M – Check valve screw
N – Ball
O – Outer sleeve
P – Inner sleeve or spool
Q – Pressure springs
R – Metal ring
S – Spacer
T – Thrust flat washer
U – Roller bearing
V – Flat washer
X – O-ring
Y – Rubber seal with steel ring
Z – Housing

ASSEMBLING HYDROSTATIC STEERING UNIT (M and MP Tractors)

Before assembling the hydrostatic steering unit, proceed as follows:

a) Clean all components carefully with petroleum.

b) Examine all parts for signs of wear or scratches.

c) Should either the outer sleeve (F), the inner spool (G) or the body (Y) appear to be damaged, change the entire hydrostatic unit assembly, except for the O-rings.

1. Position the body (Y) in a vise (bench and lubricate all parts with clean oil. Carry out the entire assembly assembly with absolute cleanliness.
2. Insert the inner sleeve (G) in the outer sleeve (F).
3. Insert the pin (G) through the holes in both pieces.
4. Pinch the 9 springs (R) opposite each other, on either side. The two smallest springs are fitted internally and opposite the other.
5. If previously removed, refit the rubber dust and steel ring (Z).
6. Insert the O-ring (E), making sure it sets properly.
7. Place the washer (V) over the ring (X).
8. Install the roller bearing (U).
9. Place the flat washer (T) with the inner chamfered radius opposite the bearing.
10. Insert the retaining (S).
11. Insert the outer seal inner sleeve assembly (+G) in the hydrostatic steering unit and make sure that all previously assembled parts are in their respective housings.
12. Insert the bolt (H) in the larger threaded hole and tighten the screw (M).
13. Place the O-ring (E) in the hydrostatic unit body groove.
14. Push the plate (J) making sure the holes are correctly aligned.
15. Place the O-ring (K) over the plate (J).
16. Place the outer lug (C) with the inner (R) over the O-ring (K). The outer ring chamfer should be downward. Align the holes.

Fig. 59 — Assembling the hydrostatic steering unit

M — Outer valve screw
F — Outer sleeve
Y — Hydrostatic unit body

Fig. 60 — Building the center shaft

J — Plate
E — Outer lubricating
C — Inner plate
K — O-ring seal

17. Refit the control shaft as follows:

a) The hole end (AA) of the control shaft (L) must be aligned between the holes (AA) on the pinion (F).

b) Once well aligned, insert cone in the assembly and the pinion engage with these all the holes, and the fork end (AB) engages the pin (D).

NOTE: — It is important that the line (AA) is perfectly aligned with (AB). Should this not be the case, the hydraulic unit will not operate correctly.

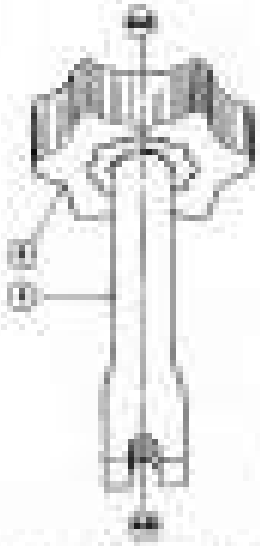


Fig. 89 — Alignment of control shaft with rotor

F = Pinion
D = Pinion pin
AA = Center line between two holes
AB = Center line of the control shaft end fork

18. Place the O-ring (E Fig. 84)

19. Place the spacer washer (I Fig. 88) over the control shaft.

20. Place the end plate (G Fig. 88) over the entire assembly, making sure that the hole housing the check valve (H) stop screw (C) is overhead (flywheel)

21. Tighten the 3 screws with their washers (B) evenly and diagonally. Tighten to 3 m.kg (2.8 kgf m.

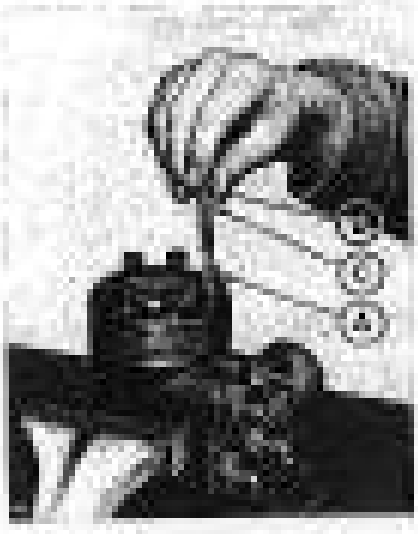


Fig. 90 — Assembling the hydraulic steering unit

A = Check valve stop
B = End washer
C = Hydraulic unit fixing screw

DISMANTLING THE RAM ROD END BALL JOINT 350 and 450 Tractors
Removing the ram from the steering
Rear end ball joint

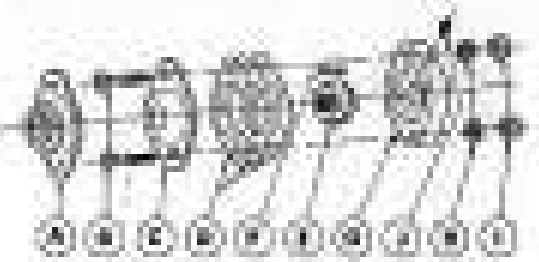
1. Place the cylinder on a vice bench vice.
2. Remove nuts (A), washers (H), outer cap (G) and seal shim (D).
3. With an adequate steel punch (AA), remove the elastic lock pin (F) securing the ball joint (B) to the cylinder rod.
4. Unscrew the ball joint (B) from the rod.
5. Remove the inner cap (C) with the screws (K) and remove the rubber dust cover (N).

To assemble the rear ball joint, invert the dismantling procedure.

After assembling the ball joint, apply multi-purpose grease through the grease nipple (J).

Fig. 59 – Dismantling the rear ball joint
B — Ball joint for support bearing spindle
C — Ball joint body
F — Ball pin
AA — Punch for removal of elastic pin

Fig. 60 – Exploded view of rear ball joint components
A — Rubber dust cover
B — Ball joint on support bearing spindle
C — Joint cap
D — Seal shim
E — Joint ball
F — Elastic pin
G — Outer cap
H — Spring washers
I — Ball joint to support bearing body
J — Rear ball joint grease nipple



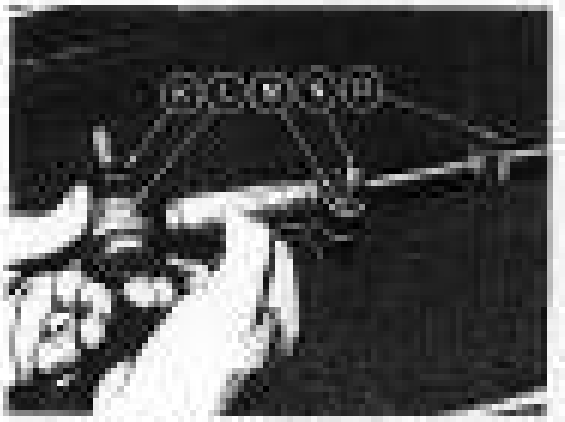


Fig. 61 – Removing the front ball joint track rod
A — Rubber seal
L — Ball joint body
M — Spring washer
N — Ball pin for axle securing nut
O — Cylinder rod

Front end ball joint

Removal

1. Loosen the nut (M).
2. Unscrew the ball joint body (L).

Refitting

1. Screw the ball joint (L) on the axle (N) for a maximum.
2. Tighten the nut (M) until the ball joint is solid with the rod.

Remark. – The ball joint is not equipped with a grease nipple as same is self-lubricating.

HYDRAULIC RAM

Major overhaul

1. Place the cylinder on a work bench vice.
2. Remove the cylinder rear plug rod lock split pin (G).
3. With the tool (CC Fig. 88) unscrew nut (H).
4. Remove the rear plug (I), pulling rams outward.

Inspection

1. Remove front ball joint (see DAC 28).
2. Remove the nut (J) lock split pin (K).
3. With the tool (CC Fig. 88) unscrew the nut (J).
4. Pull out the rod (V) along with front plug (R) piston (T) and rear cylinder (X).
5. Separate the longer cylinder (X) from the front plug (R) and piston (T).
6. Dismantle the rod piston assembly as follows:
   a) Place the rod (W) on a soft vice.
   b) Unscrew the nut (N).
   c) Remove the washer (O) and piston (T).
7. Remove the front plug (R) from the rod (W) through the piston side. Do not attempt to remove same from the opposite side, as this would damage the seals and the front ball joint thread.

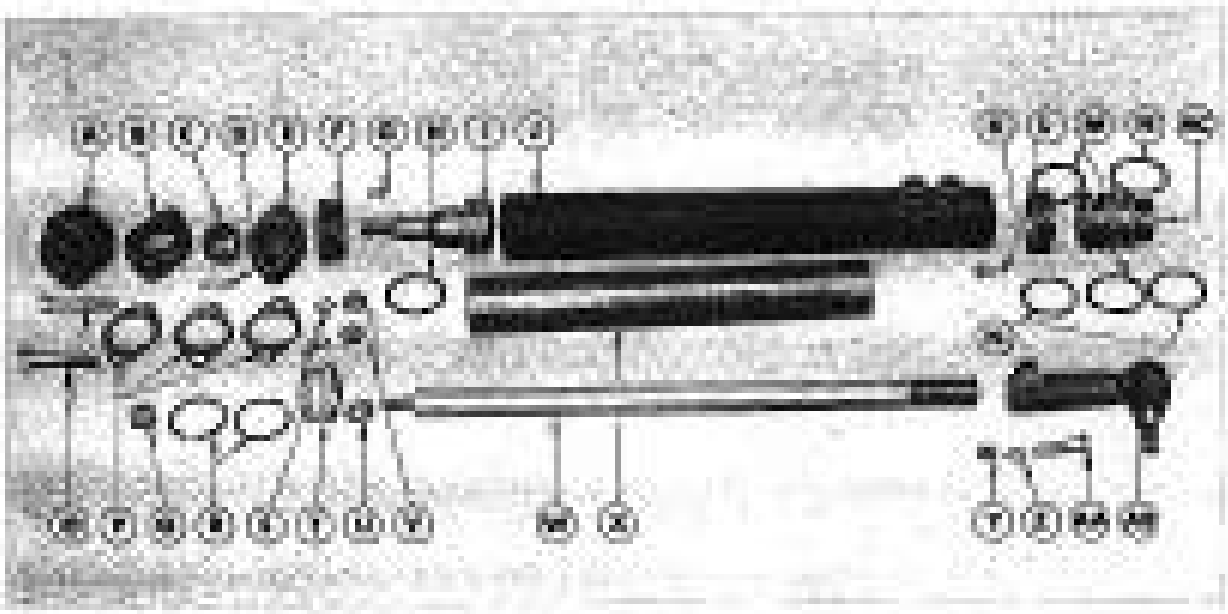


Fig. 88 — Showing the hydraulic cylinder components

A — Rear ball joint dust cover
B — Rear ball joint socket
C — Rear ball joint seat
D — Ball joint to rod lock steady pin
E — Rear ball joint lower cap
F — Rear plug nut
G — Rear plug nut lock pin
H — Rear plug O ring
I — Rear plug
J — Outer cylinder
K — Front plug nut lock pin
L — Front plug nut
M — Front plug O rings
N — Nut lock
O — Rear ball joint balancing washer

P — Rear ball joint steel shims
Q — Piston to rod balancing nut
R — Front plug
S — Ball joint screw spring washers
T — Piston
U — Rod washer
V — Rear ball joint screw balancing rods
W — Rod
X — Inner cylinder
Y — Front ball joint to rod locating nut
Z — Spring washer
AA — Front ball joint to rod locating bolt
BB — Front ball joint body
CC — Cylinder locating ring

ASSEMBLING THE HYDRAULIC RAM (Figs. 042-27.30 to 36)

Carefully clean all cylinder components and change the front and rear plug O-rings.
Change the piston rings.
Check the remaining components and change same where necessary.

1. Insert the front plug (42) on the rod (50), on the piston thread side.
2. Place the piston (7) on the rod (50), with the inner screw outwards.
3. Place the flat washer (8) and tighten the nut (9). To tighten nuts and properly, place the rod in a soft vice and hold the piston placing a wrench in the flat groove provided for this purpose in the front section.
4. Insert the piston (7) in the inner cylinder (6), using a ring compressor. This can also be done by hand, making sure that the ring gaps are opposite each other.
5. Engage the front plug (42) in the inner cylinder (6).
6. Insert the entire front cylinder assembly (2) in the outer cylinder (4), as shown in Fig. 34.
Be careful not to damage the front plug O-rings (42).
7. Insert the rod (50) as far in as possible in the cylinder.
8. Place the nut (51) and, by means of the bolt (52), tighten same properly.
9. By means of the pin (53), block the nut (51) on the outer cylinder (4).

Fig. 33 — Assembly of the rear plug, rod and piston assembly
(6) — Piston in rod fastening nut
(7) — Piston
(8) — Flat washer
(9) — Nut
(42) — Front plug

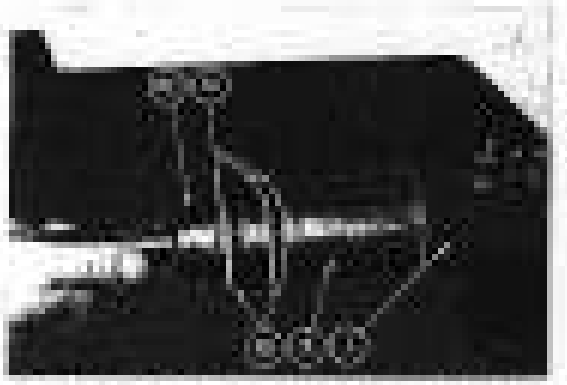


Fig. 34 — Refitting the inner cylinder assembly into the outer cylinder
(4) — Outer cylinder
(4a) — Piston O-rings
(6) — Piston rings
(6) — Inner cylinder
(42) — Front plug

Fig. 35 — Tightening cylinder front plug nut
(4) — Outer cylinder
(42) — Front plug nut
(42) — 10.00 nut

10. In the other end of the cylinder liner sectional, insert the new plug (I) as shown in Fig. 96.

Fig. 96 – Assembling new plug in cylinder

I – New plug
S – Retaining
J – Front cylinder

11. Place the seal plug nut (T) and tighten evenly properly onto the rod (CC).

12. With the pin (G) block the nut (T) on the outer cylinder (J).

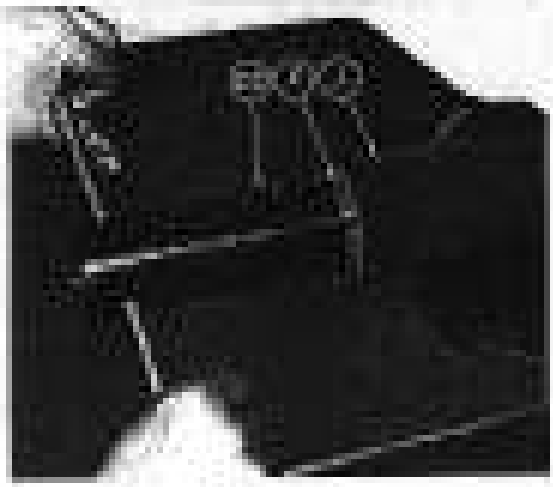


Fig. 97 – Tightening new plug nut

T – New plug nut
J – Outer cylinder
CC – Fixed rod

13. Fit the cylinder rear bolt (pos.

TROUBLE SHOOTING TABLE

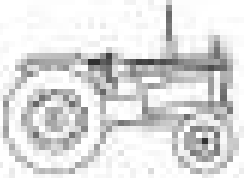
PROBLEM	CAUSE	REMEDY
STEERING SYSTEM VERY HARD WHEN TURNING STEERING WHEEL	1. Faulty pump. 2. A leak at the hydrostatic unit. Check valve or valve ball missing. 3. Pressure relief valve in safety block stuck in open position. 4. Broken or jammed (binding) column bearings.	1. Repair the pump. 2. Mount the ball with a weak spring so an emergency unit assembly can be checked properly. 3. Repair the relief valve assembly. 4. Change steering column. If the bearing can be removed, change same.
STEERING WHEEL TURNS CONTINUOUSLY WITHOUT HOLDING NEUTRAL POSITION	1. The if pressure springs do not apply any pressure on the bottom.	1. Dismantle the hydrostatic unit and change the if pressure springs.
VIBRATION IN THE STEERING WHEEL	1. Air in the hydraulic cylinder. 2. Worn or loosening linkage.	1. Bleed the circuit and eliminate the cause of air intake. 2. Change defective parts.
STEERING WHEEL CANNOT BE TURNED (MECHANICAL)	1. Lack of oil in reservoir. 2. Faulty hydraulic cylinder. 3. Faulty hydrostatic unit. 4. Impacted leaks between hydrostatic unit and any servo supply lines.	1. Fill to level. 2. Change or repair cylinder. 3. Remove, check and repair or change Orbitrol. 4. Change Orbitrol assembly.
THE DRIVEN WHEELS ARE TURNED IN ERROR	1. Incorrect timing of tractor's shaft and hydrostatic unit.	1. Dismantle the unit and reassemble one tooth.

PROBLEM	CAUSE	REMEDY
WHEELS TURN TOO SLOWLY	1. Insufficient amount of oil in circuit. 2. Faulty Steeltrol unit.	1. Increase pump supply rate. 2. Change or repair hydrostatic unit.
STEERING WHEEL DOES NOT RETURN TO NEUTRAL POSITION. HYDROSTATIC UNIT TENDS TO ACT AS AN ENGINE	1. Air pocket or impurities between the outer and inner element. 2. Unserviceable input between outer and inner element, due to excessive pressure.	1. Remove hydrostatic unit from chassis, both clevises or change them along with the hydrostatic unit. Bleed circuit completely and add new oil. 2. Fit a pressure gauge on supply circuit and check pressure. Change safety valve if incorrect resistance.
WHEELS TURN SLIGHTLY. WHEELS TURN ONLY IN ONE DIRECTION	1. Excessive leaks in hydrostatic unit. 2. Uneven travel of piston within the hydraulic cylinder.	1. Repair or change hydrostatic unit. 2. Repair or change cylinder.
OIL LEAKS IN UPPER OR LOWER SECTION OF HYDROSTATIC UNIT	1. Damaged sealing ring or worn side of hydrostatic unit. 2. Hydrostatic base screws loose. 3. Defective washers and O-rings.	1. Dismantle hydrostatic unit and change ring. 2. Retighten the screws to a torque of 5 to 10 mkg. 3. Change washers and O-rings.

SECTION 4:

ENGINE D3.152

INDEX



Publication 9806.4101-I
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SPECIFICATIONS

ENGINE

Make and type	Perkins four cycle, direct diesel injection
Model	4.99
Number of cylinders	Three
Diameter of cylinders	81.44 mm
Stroke	120 mm
Displacement	3.900 c.c.
Compression ratio	19.5 : 1
Rated	67 H.P. at 3,200 r.p.m. of engine.
Maximum torque	17.5 kg/m at 1,600 r.p.m. of engine.
Maximum speed	3,250 r.p.m. under load; 3,600 r.p.m. no load and 600 ± 50 r.p.m. idling.
Timing system	By gears.
Cylinder block	Built of a single high strength grey iron casting.
Type of liners	Thin wall casting.
Cartridge	Cast iron.
Cylinder head	Cast iron with extensive water cooling channels.
Camshaft	Cast iron with hardened cams. Located in the top right-hand part of the block.
Crankshaft	Molybdenum chrome forged steel with high frequency induction heated bearings.
Connecting rods	H-section forged steel.
Pistons	Aluminium alloy with oversize machined head. Provided with one oil control and three compression rings.
Valves	In cylinder head, actuated by camshaft by means of push rods and rocker arms.

Lubrication system

Type	Low pressure through rotor driven oil pump.
Oil filter	Full flow, mounted on block with swaged body and element.
Oil sump capacity	9.6 liters.
Minimum pressure in oil line	2.81 kg/cm² at 3,200 r.p.m. of engine and 1.8 kg/cm² idling with oil temperature (in filter) of 70 to 80° C.
Pump excess pressure valve	Piston type.
Valve opening pressure	3.8 to 4.6 kg/cm².
Filter by-pass valve	Ball type.
Valve opening differential pressure	0.81 to 1.13 kg/cm².
Lubricant	See general information.

DESCRIPTION

The Perkins BE.192 engine is of the three cylinder, water cooled, direct diesel injection type. The bore and stroke diameter of the cylinders is 91.44 mm and the stroke is 127 mm.

The engine has overhead valves mounted vertically in the cylinder head. The camshaft, located in the right hand part of the cylinder block, is driven by a timing gear. The camshaft, in turn, actuates the valves by rods of the tappets and rocker arms.

The cylinder block is a single piece of grey iron casting of high strength.

The aluminium pistons have dished heads and two rings. The pistons are coupled to their connecting rods by piston pins secured with circlips. The connecting rod big end bearings are replaceable and are made up of a shell of steel covered with a tin and aluminium alloy.

The engine has force feed lubrication. The oil is sucked up from the crankcase through the suction filter by means of a rotary pump driven by the crankshaft. The oil passes through the filter before circulating under pressure through the engine.

The crankshaft has five bearing points with their corresponding bearings. It is supported by bearings caps and its axial location is controlled by thrust half washers located on the rear bearing.

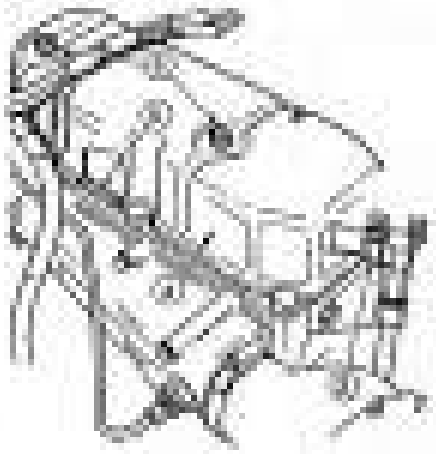
TROUBLE-SHOOTING CHART

Trouble	Possible cause
Insufficient cranking speed The engine does not start Difficult starting Lack of power Combustion failure Excessive fuel consumption Black exhaust smoke Blue/white exhaust smoke Low oil pressure Engine knocking Uneven running Vibrations Excessive oil pressure Engine overheating Excessive pressure in crankcase Low compression Engine starts up and stops	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 31, 32, 5, 7, 8, 10, 11, 12, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 12, 21, 22, 14, 16, 18, 20, 27, 29, 30, 34, 36, 37, 39, 40, 41, 15, 19, 14, 16, 18, 20, 16, 18, 17, 23, 14, 16, 18, 20, 24, 27, 30, 5, 35, 36, 34, 35, 36, 5, 38, 37, 38, 39, 42, 43, 44, 5, 14, 15, 16, 18, 27, 29, 30, 31, 32, 45, 46, 48, 1, 5, 9, 15, 11, 12, 13, 14, 15, 27, 33, 38, 39, 30, 32, 45, 48, 13, 14, 23, 26, 32, 46, 47, 48 5, 11, 16, 19, 20, 28, 46, 50, 51, 52, 53, 54, 57, 26, 31, 33, 34, 50, 56, 16, 20, 21, 22, 32, 46, 10, 11, 12,

Trouble-shooting list

1. Battery charge low.
2. Poor electrical connections.
3. Starter motor faulty.
4. Wrong grade of oil.
5. Insufficient cranking speed.
6. Fuel tank empty.
7. Cut-out control operating.
8. Fuel feed pipe blocked.
9. Faulty lift pump operation.
10. Fuel filter blocked.
11. Air cleaner blocked.
12. Air in fuel system.
13. Faulty injection pump operation.
14. Injectors faulty.
15. Incorrect use of cold-start system.
16. Failure in cold-start system.
17. Injection pump control broken.
18. Injection pump setting incorrect.
19. Valve adjustment incorrect.
20. Low compression.
21. Tank breather blocked.
22. Wrong type or grade of fuel.
23. Accelerator linkage sticking.
24. Exhaust pipe badly blocked.
25. Leaks in cylinder head gasket.
26. Overheating.
27. Operating temperature incorrect.
28. Exhaust pipe partly blocked.
29. Sticky valves.
30. High pressure pipes blocked.
31. Worn cylinders.
32. Valve seat rings pitted.
33. Piston rings broken, worn or seized.
34. Valve stems and guides worn.
35. Engine overfilled or wrong grade of oil.
36. Bearings worn or damaged.
37. Lubrication filter blocked.
38. Oil pump worn.
39. Pressure relief valve stays open.
40. Pressure relief valve stays closed.
41. Relief valve spring broken.
42. Oil pump breather pipe blocked.
43. Oil filter blocked.
45. Pistons seized or stick.
46. Incorrect piston height.
47. Pins damaged.
48. Valve spring broken.
49. Flywheel teeth balanced or wrongly assembled.
50. Thermostat faulty.
51. Blockage in the cylinder block and/or cylinder head water jackets.
52. Fan belt slack.
53. Radiator blocked.
54. Water pump faulty.
56. Breather pipe blocked.
58. Valve seats and/or faces.
57. Cooled lever set low.

ROCKER COVER



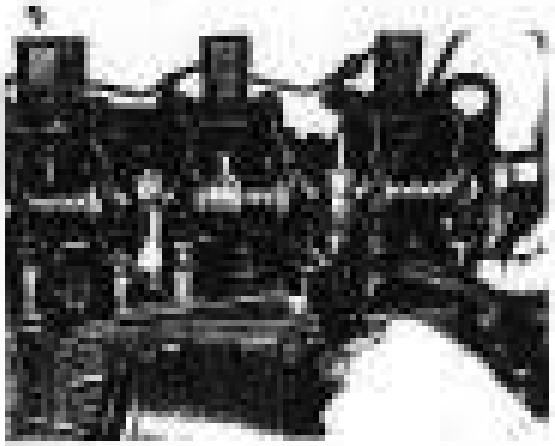
Disassembly

1. Raise hood.
2. Disconnect breather pipe.
3. Remove rocker cover fixing nuts and washers.
4. Take off rocker cover.
5. Remove gasket.

Assembly

6. Reverse operations 1 to 5, except:
   a) Smear gasket lightly with suitable sealing paste before assembling rocker cover.
   b) Do not overtighten rocker cover fixing nuts.

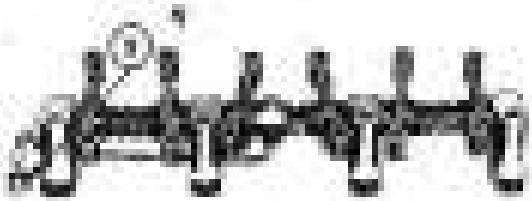
LASH ADJUSTMENT VALVE



The valve lash is measured between the rocker arm and tappet and has to be adjusted to 0.254 mm hot or 0.38 mm cold. For this, carry out the following operations:

1. Disassembly rocker cover.
2. Turn crankshaft until number 1 piston is at T.D.C. and the valves of this cylinder are closed.
3. Adjust clearance of number 1, 2, 3 and 5 valves.
4. Turn crankshaft 360° (one full turn).
5. Adjust clearance of numbers 4 and 6 valves.
6. Assemble rocker cover.

ROCKER ARM SHAFT



Disassembly

1. Disassemble rocker cover.
2. Disconnect rocker shaft oil feed line union.
3. Remove rocker shaft fixing nuts and washers.
4. Withdraw complete rocker shaft.

Assembly

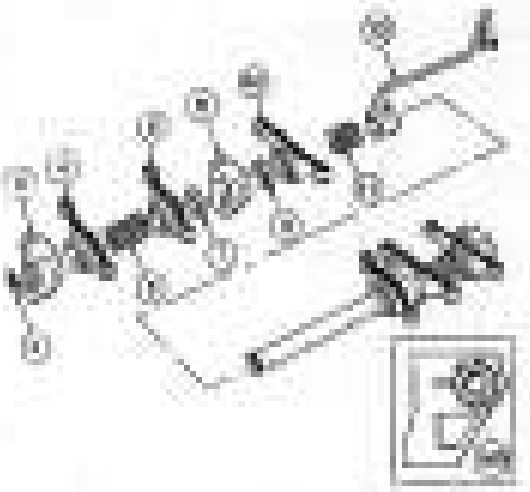
5. Reverse operation 2 to 4.
6. Adjust valve clearance.
7. Assemble rocker cover.

SERVICING ROCKER ARM SHAFT

Disassembly

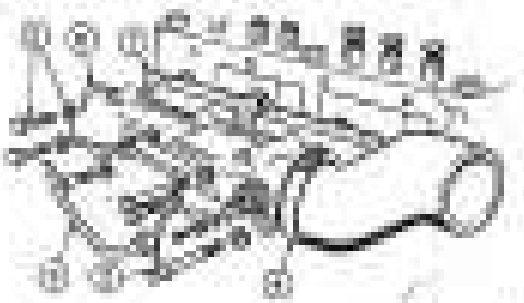
1. Disassemble rocker arm shaft.
2. Remove intake/exhaust bend and oil shaft.
3. Remove shaft support.
4. Remove rocker arm.
5. Remove long spring.
6. Remove rocker arm.
7. Remove spacer.
8. Remove shaft separate.
9. Remove spacer.
10. Remove rocker arm.
11. Remove short spring.
12. Repeat operations 2 to 11 to complete disassembly of rocker shaft.
13. Remove all hard pipe and valve from rocker shaft.

Check for wear or damage to shaft and rocker arm bushes. If rocker arm bushes are worn, replace rocker arms.



Assembly

15. Reverse operations 1 to 13, except:
    a) Check that all parts are clean and lubricated while engine oil before assembling.
    b) The bold end of the rocker arm shaft has a slot; install it as shown in diagram 140.



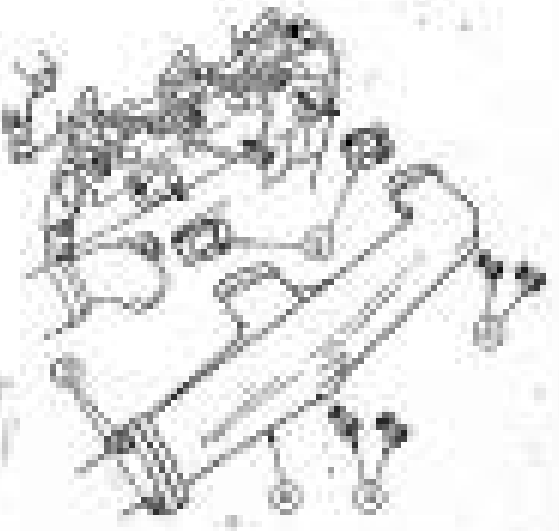
INTAKE MANIFOLD

Disassembly

1. Take it out.
2. Disconnect cold-start heater cable.
3. Disconnect cold-start heater fuel pipe.
4. Release intake pipe clip.
5. Remove fixing bolts and washers.
6. Take off manifold, at the same time separating it from the air intake hose.
7. Remove and discard gasket.

Assembly

8. Install a new gasket.
9. Reverse operations 1 to 6.



EXHAUST MANIFOLD

Disassembly

1. Take hood.
2. Remove exhaust pipe fixing nuts.
3. Remove the four nuts and washers.
4. Withdraw exhaust manifold.
5. Remove and discard gaskets.

Assembly

6. Install new gaskets.
7. Reverse operations 1 to 4.

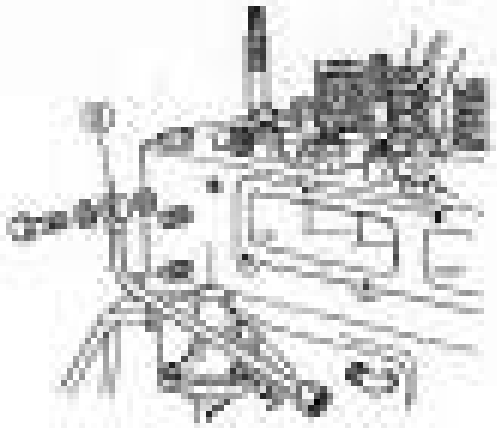
VALVE SPRINGS

Disassembly and assembly

1. Disassemble rocker arm shaft.
2. Turn crankshaft until number 1 piston is at its T.D.C.
3. Compress valve springs 1 and 2 in turn with tools 61 98 0 and 61 98 5.
4. Remove collets.

NOTE. — Do not turn the crankshaft again until the valves have been re-assembled and secured with their collets.

5. Remove caps from springs.
6. Remove springs.
7. Remove sump seals.
8. Check free length of springs. This must be between 49.58 and 50.04 mm.
9. Set seals 1 and 3 in place and reassemble or replace springs as required.
10. Reverse operations 4 and 5.
11. Turn crankshaft until piston number 3 is at its T.D.C.
12. Repeat operations 3 to 9 for valves numbers 5 and 6.
13. Turn crankshaft until number 2 piston is at its T.D.C.
14. Repeat operations 3 to 9 for valves numbers 7 and 8.
15. Assemble rocker arm shaft.



CYLINDER HEAD

Disassembly

1. Drain cooling system.
2. Disassemble hood.
3. Disassemble rocker arm shaft.
4. Disassemble exhaust and inlet manifolds.
5. Disassemble high pressure injection pipes.
6. Disassemble injectors and washers.
7. Disconnect radiator top hose and expansion hose between the thermostat housing and rocker cover.
8. Disconnect external oil feed pipe.
9. Remove cylinder head nuts and fixing bolts in reverse order to the tightening sequence.
10. Take off cylinder head.
11. If necessary, remove thermostat casing.

Assembly

12. Reverse operations 1 to 11, except:
    a) Install a new gasket on the cylinder head with the rest of sealing paste.
    b) Install a new gasket on the thermostat casing (if it has been disassembled).

a) Tighten all the cylinder head fixing bolts and nuts in the correct order, in three uniform stages, to a torque of 10 Kg m. 72 lb ft.

12. Bleed fuel system.
13. Start up engine and run it at approximately 1,200 r.p.m. for ten minutes until normal working temperature is reached. Stop engine.
14. Disassemble rocker shaft.
15. Tighten up cylinder head fixing bolts and nuts in correct sequence to a torque of 10 Kg m.
16. Assemble rocker shaft.
17. Start up engine and check that there are no leaks.

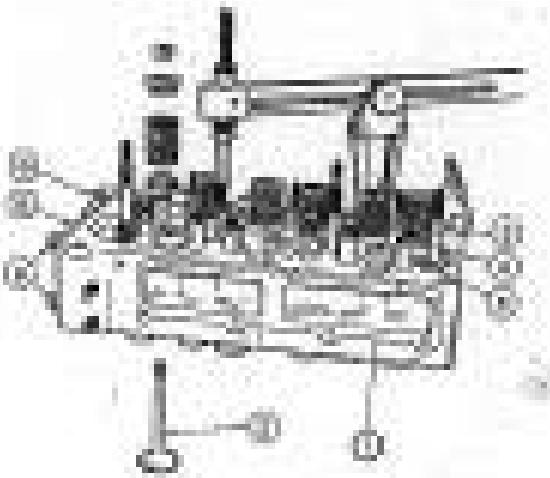
SERVICING CYLINDER HEAD

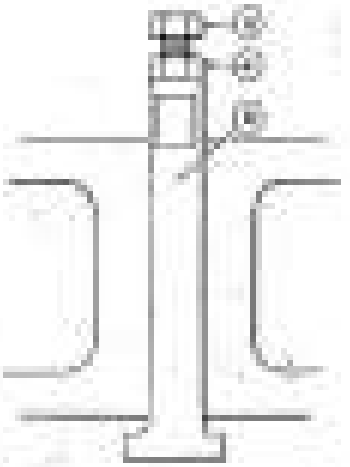
Disassembly and assembly

1. Disassemble cylinder head.
2. Disassemble valve springs.
3. Place cylinder head on its side and extract valves.

NOTE. — Keep valves in order in which they were extracted.

4. Loosen counternut.
5. Remove bolt and counternut.
6. Remove push rod.
7. Repeat operations 4 to 6 for the remaining push rods.
8. Disassemble rear plate and its gasket from cylinder head.
9. Clean all cylinder head openings, leaving there free of pistons or other deposits.
10. If there are excessive deposits in the cylinder head water passages, the use of cleaner EMO Ref. A-80 is recommended.
11. Check for wear on inside diameter of valve guides.
12. If necessary, disassemble valve guides with tool PD.1C.
13. Install new guides using tools PD.1C and PD.1C-4. Make sure guides are assembled correctly. Both ends are beveled one to 45° and the other to 20° (like 20° end is also marked). The 20° end must be inserted into the cylinder head through the top until the opposite end (45° bevel) stands out 14.30 to 15.00 mm above the top surface.
14. Check for excessive pitting or wear on valve seats.
15. If necessary, grind valve seats with the following tools: milling tool, profile cutter for exhaust valve seats, another one for those of inlet valves and the center head. Remove as little metal as possible, polish well and ensure perfect seating.





16. Carefully clean all valves and check that they are not pitted, worn or bent.
17. If necessary, polish the valve faces with a grinder to an angle of 90°, taking off as little metal as possible and providing a satisfactorily smooth finish.
18. Carefully clean valves and lubricate stems with engine oil.
19. If necessary, hand grind valves and respective seats until all pitting is removed and a good seating is obtained.
20. Carefully wash cylinder head and valves with clean paraffin and dry.
21. Check depth of valve head with respect to cylinder head surface. This depth must be between 1.240 and 1.609 mm for inlet valves and between 1.609 and 2.058 mm for exhaust valves.
22. If a valve exceeds these limits, it must be replaced. Check valve head depth again and if it still does not fall within the specified limits, a replaceable seat must be installed (only for exhaust valves). If it is an inlet valve which does not comply with the limits, the cylinder head has to be replaced.
23. Check that cylinder head surface is level and, if necessary, place it on a revolving of stone 0.05 mm, bearing in mind that the fettler is not to stand out more than 0.07 mm. The maximum must not be obtained by adding additional washers.
24. Carefully clean cylinder head.
25. Reverse operations 1 to 5, except:
a) Assemble valves in their correct positions.
b) Lightly coat new valve guides with suitable sealing paste, as well as threads of the plate fixing bolts.

REPLACEABLE VALVE SEATS

Assembly procedure

Replaceable valve seats may only be assembled to EXHAUST valves and only as a last resort to extend cylinder head service life.

The assembly of replaceable valve seats is a precision operation and should therefore only be carried out by specialized personnel.

This operation must never be performed while a worn valve guide is still assembled.

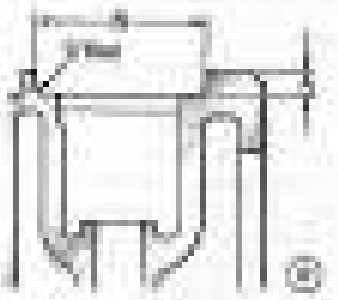
1. Service cylinder head.
2. Using a valve guide housing as visitor, machine cylinder head surface inlet according to instructions given.

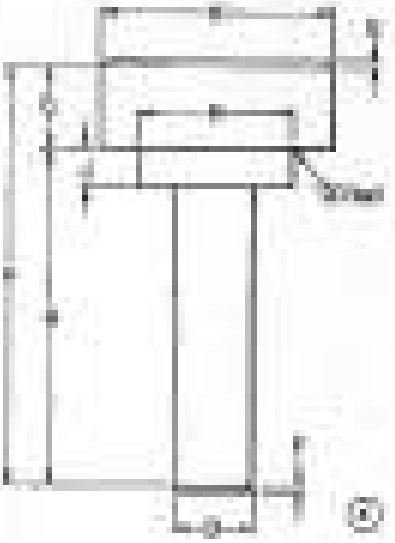
NOTE. — Work as close as possible to minimum machining dimensions to allow for a possible later re-working.

3. Remove machining filings and clean replaceable seat housing.
4. Using valve guide housing, set valve seat in place by means of an insertion tool made to the given measurements.

NOTE. — Replaceable valve seats must not be hammered into place nor lubricated.

5. Check that the replaceable valve seat is fully inserted into its housing and is on a level with the lower part of the cylinder head rim.
6. Remove machining swarf and filings and, if necessary, machine cylinder head surface.
7. Grind valve seat at a conical angle of 150°, so that after grinding the depth of the valve head below the cylinder head surface lies between 1.005 and 1.805 mm (production data), for exhaust valves.





KEY TO FIGURE 2
A. 3.97 to 3.99 mm.
B. 41.66 to 42.54 mm.
C. 0.35 mm max. radius.

KEY TO FIGURE 4
A. 60.30 mm.
B. 59.96 mm.
C. 53.26 mm.
D. 1.95 to 1.97 mm.
E. 1.5 mm at 45°.
F. 1.5 mm at 60°.
G. 0.8 mm.
H. 30.92 to 30.98 mm.
J. 5.38 to 5.48 mm.
K. 40.77 to 41.02 mm.

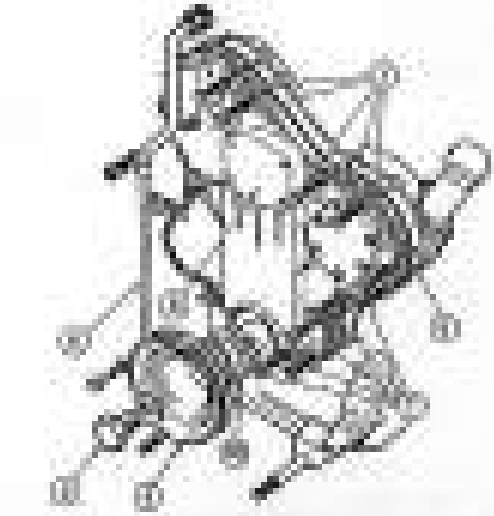
TIMING CASE COVER

Disassembly

1. Disconnect cable between front solenoid engine and disassemble water pump.
2. Release belt and remove.
3. Remove crankshaft pulley.
4. Disconnect alternator cables.
5. Disassemble alternator and its support brackets.
6. Remove breather plate.
7. Remove bolts securing timing case cover.
8. Remove timing case cover.
9. Remove and discard gasket.
10. Remove washer.

Assembly

11. Assemble washer.
12. Install cover with a new gasket coated with suitable sealing paste.
13. Place pulley on crankshaft (carefully to avoid damaging retainer), so as to center retainer and cover.
14. Put in and tighten screw bolts so as to secure cover and retainer pulley.
15. Install remaining bolts and washers in cover.
16. Reverse operations 1 to 9, except:
    a) Tighten pulley fixing bolt to a torque of 15 Kg m.



TIMING GEARS

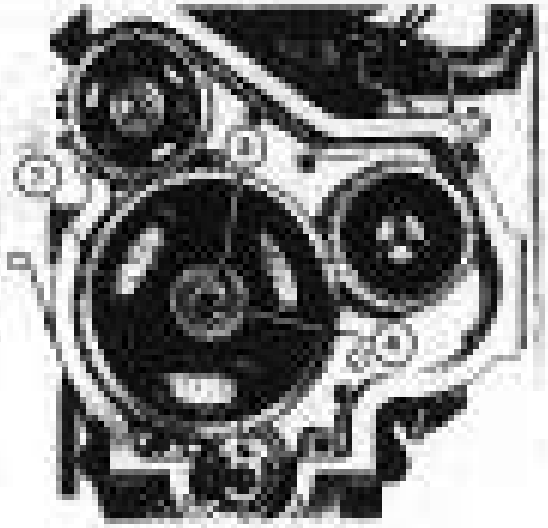
Intermediate gear and hub

Disassembly

1. Disassemble timing case cover.
2. Turn crankshaft until the marks on the injection pump, camshaft and crankshaft gears are lined up with those of the intermediate gear.
3. Bend lock nut plate.
4. Remove bolt.
5. Remove lock plate.
6. Remove lock washer.
7. Remove intermediate gear.
8. If necessary, disassemble intermediate gear hub.

Assembly

9. Assemble gear hub, making sure the dowel is fitted into the hub fixing hole.
10. Assemble gear, making sure that gear marks are lined up.
11. Reverse operations 4 to 6, except:
    a) Tighten bolt to a torque of 7 Kg m.
12. Check intermediate gear axial play, which should be between 0.10 and 0.28 mm.
13. Bend lock plate pins one of the nuts flats.
14. Assemble timing case cover.



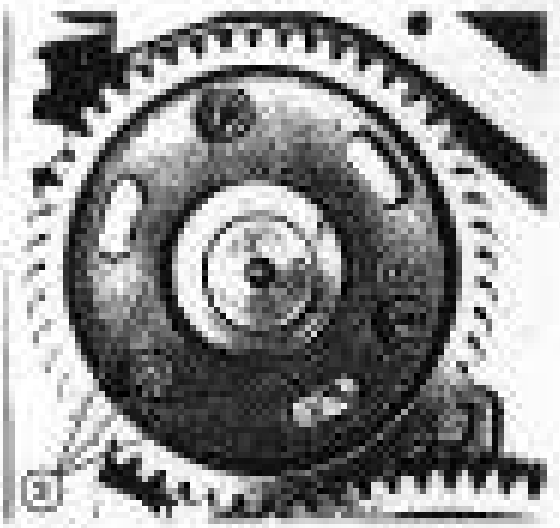
Camshaft gear

Disassembly

1. Disassemble intermediate gear.
2. Remove fixing bolts and washers.
3. Remove gear.

Assembly

4. Reverse operations 2 and 3, except:
   a) Make sure that between an gear and end of camshaft are in line.
5. Assemble intermediate gear.



Injection pump gear

Disassembly

1. Disassemble intermediate gear.
2. Remove fixing bolts and washers.
3. Remove gear.

Assembly

4. Reverse operations 2 and 3, except:
   a) Make sure that gear dowel is inserted in pump hub slot.
   b) Tighten bolts to a torque of 2 Kg m.
5. Assemble intermediate gear.

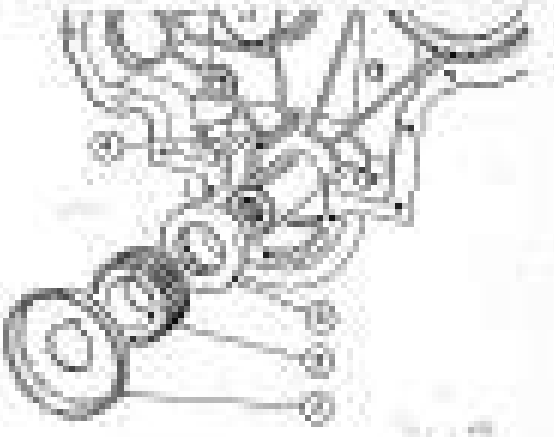
Crankshaft gear

Disassembly

1. Disassemble intermediate gear.
2. Remove pipe.
3. Loosen crankshaft gear.
4. Remove key, (if necessary).
5. Take out spacer, (if necessary).

Assembly

6. Reverse operations 2 to 5.
7. Assemble intermediate gear.



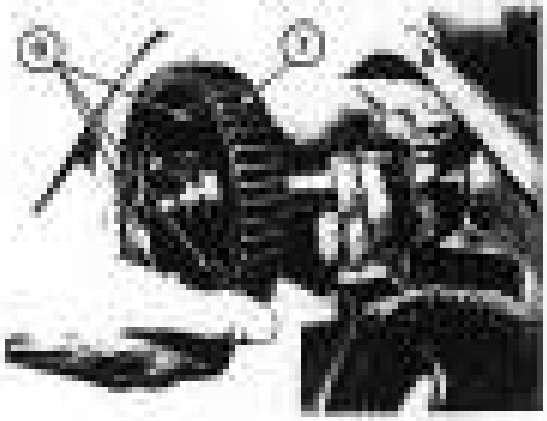
CAMSHAFT

Disassembly

1. Disconnect rocker arm shaft.
2. Disassemble intermediate gear.
3. Disassemble fuel lift pump.
4. Raise tappets.
5. Disassemble camshaft and gear through front of engine, taking care that the cams do not damage the bearings.
6. Remove bolts and washers.
7. Remove gear.

Assembly

8. Reverse operations 6 to 1, except:
   a) When assembling, make sure the lands on the gear and shaft match up.
9. Assemble intermediate gear.
10. Assemble rocker arm shaft.



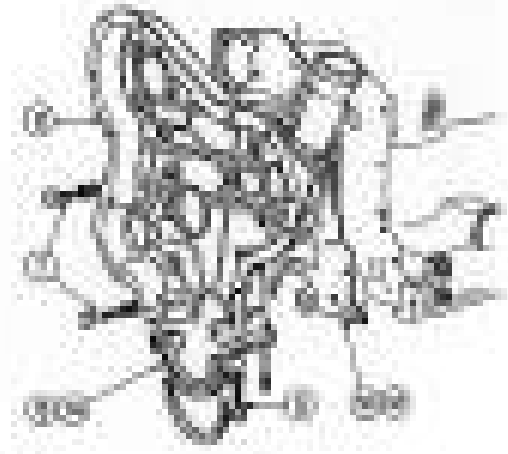
TIMING CASE

Disassembly

1. Disassemble camshaft.
2. Disassemble injection pump gear.
3. Disassemble injection pump.
4. Disassemble engine crankcase.
5. Remove the two bolts and washers.
6. Remove bottom cover of case.
7. Remove fixing bolts and washers.
8. Remove timing case.
9. Remove intermediate gear hub.
10. Remove and discard gasket.

Assembly

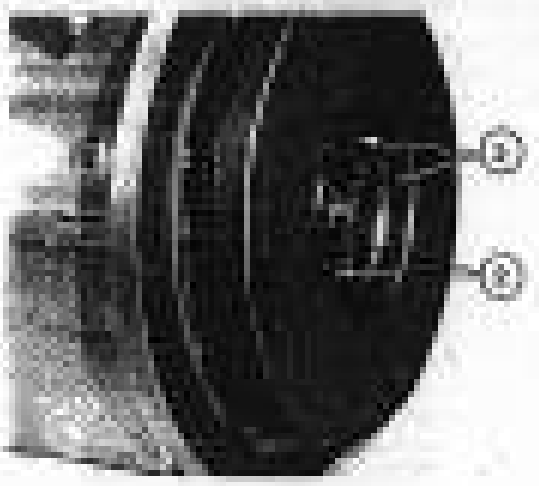
11. Assemble intermediate gear hub.
12. Install a new gasket lightly coated with suitable sealing paste.
13. Reverse operations 7 and 8.
14. Install bottom cover, making sure that the face faces of the cover and timing case are lined up.
15. Reverse operations 3 and 4.
16. Assemble injection pump gear.
17. Assemble camshaft.



FLYWHEEL

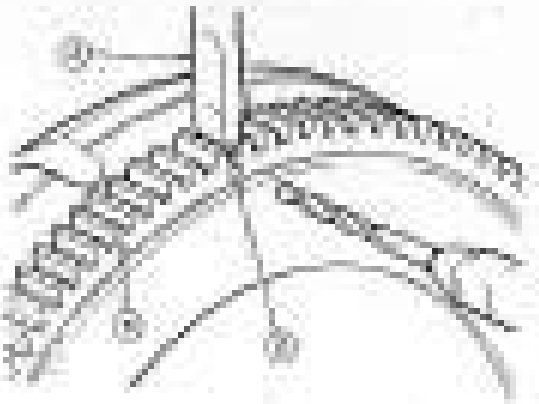
Disassembly
1. Disassemble clutch.
2. Remove the six bolts and lock plates.
3. Remove flywheel.

Assembly
1. Reverse operations 2 and 3, except:
   a) Locate flywheel on crankshaft flange so that the unthreaded hole of flange lines up with the flywheel hole with no bolt.
   b) Tighten flywheel bolts to a torque of 70 ft-lb and secure them with new lock plates.
2. Assemble clutch.



FLYWHEEL RING GEAR

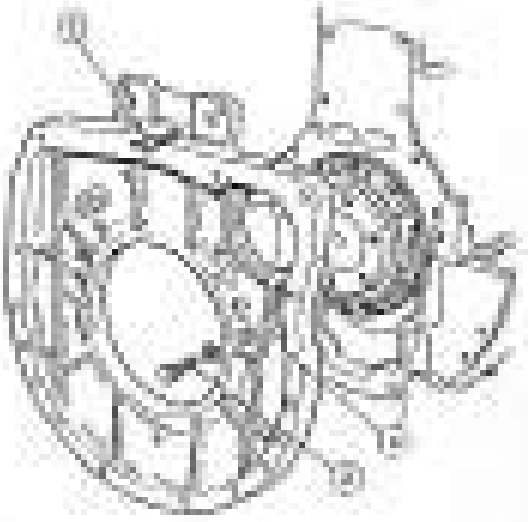
Disassembly
1. Disassemble flywheel.
2. Drill a hole 6 mm in diameter and up to a depth of only 16 mm between-tooth (be flywheel could be damaged) at midway point between bolted diameter of ring gear and base of one of its teeth.
3. Place a cold chisel at base of teeth, above drill hole.
4. Cover flywheel and cutting point with a thick cloth as a protection from fragments that might fly off.
5. Hold flywheel and hammer cold chisel firmly to split ring gear.



Replacement
6. Heat new ring gear to a temperature of approximately 260°C (500°F). A [illegible].
7. Place ring gear on flywheel with teeth-entry guide towards front of flywheel, quickly fit ring gear into its housing and let it cool slowly.
8. Assemble flywheel.

FLYWHEEL HOUSING

Disassembly
1. Disassemble flywheel.
2. Remove bolts and washers.
3. Remove screws.
4. Disengage housing from face.



Assembly
5. Reverse operations 2 to 4, except:
   a) Make sure that flywheel housing and engine block surfaces are meticulously clean.
   b) Lightly coat lock washers with an appropriate sealing paste.
6. Assemble flywheel.

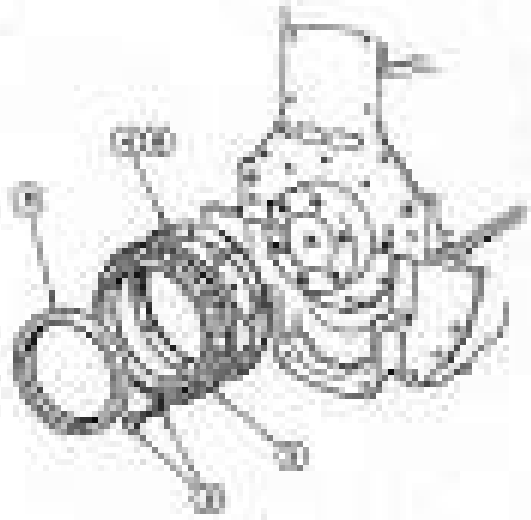
CRANKSHAFT REAR RETAINER

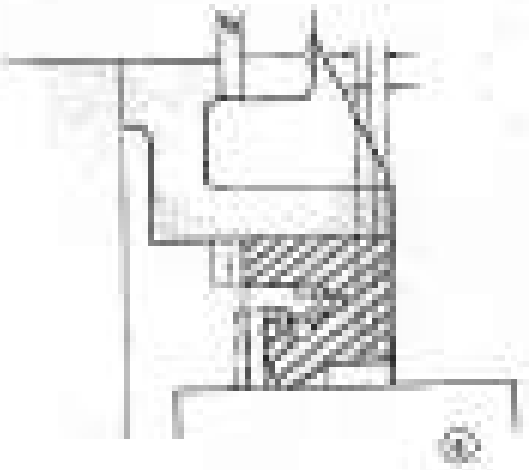
Disassembly

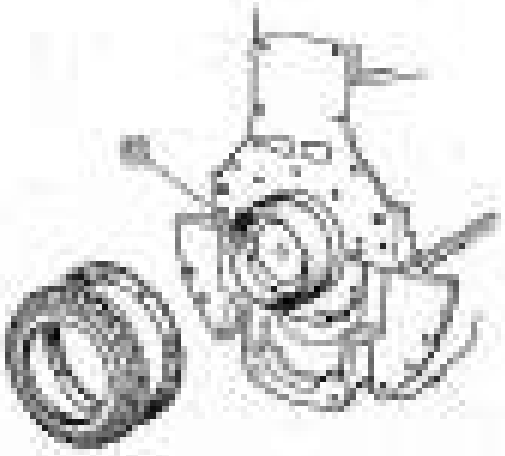
1. Disassemble flywheel housing.
2. Remove bolts and washers.
3. Remove retainer housing together with retainer.
4. Remove and discard gasket.
5. Remove retainer from its housing.

Replacement

6. In manufacture, the lip retainer is assembled with its seal face aligned with the rear surface of its housing. Inspect crankshaft flange and, if it is worn, the new retainer must be inserted further into the housing that it should be inserted 3.2 mm and, if necessary, a further 3.2 mm, making 6.4 mm in all. If deep grooves should not be sufficient, the crankshaft flange contact surface has to be machined.
7. Lubricate retainer and its housing with clean engine oil. Place retainer in its housing in the reversed depth with tool FB 185.1.
8. Install a new gasket lightly smeared with suitable sealing paste.
9. Lubricate retainer, crankshaft flange and tool FB 185.2 with clean engine oil.
10. Using tool FB 185.2, install retainer assembly and its housing. Make sure that it is correctly engaged on the block face.
11. Remove tool FB 185.2.
12. Reverse operations 1 and 2.







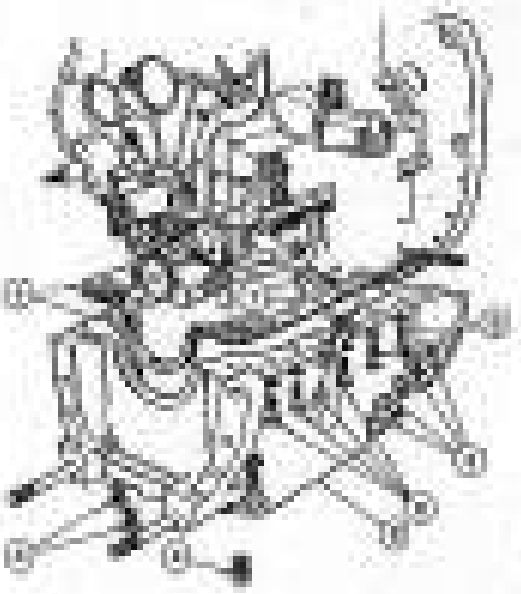
ENGINE CRANKCASE

Disassembly

1. Disconnect traction between front axle and engine.
2. Remove plug from crankcase and drain oil. Collect it in a suitable container.
3. Remove belts and sheaves.
4. Remove rods and weights.
5. Support crankcase and remove bolts and washers.
6. Separate crankcase from block.
7. Remove and discard gasket.

Assembly

8. Reverse operations 1 to 6, except:
   a) Check that contact surfaces are clean.
   b) Fit new gaskets, lightly smeared with suitable sealing paste.
   c) Fill crankcase to the correct level with specified engine oil.



Oil Pump

Disassemble

1. Disassemble engine crankcase.
2. Disassemble timing case cover.
3. Remove timing case bottom cover.
4. Disconnect pump pressure pipe.
5. Remove circlip and intermediate gear.
6. Remove fixing bolts and washers.
7. Withdraw pump.

Assemble

8. Reverse operations 1 to 7.

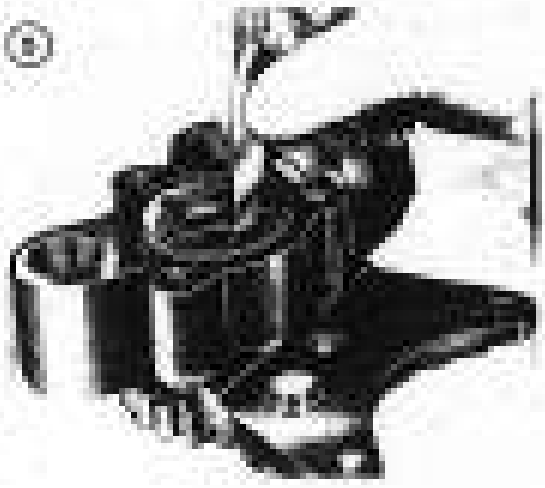
SERVICING OIL PUMP

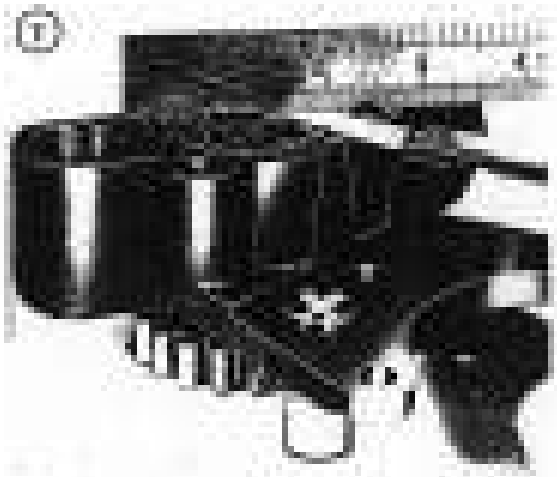
Disassemble

1. Disassemble oil pump.
2. Take out screws.
3. Remove cover.
4. Remove O-ring seal.
5. Check clearance at all points between maximum diameter of internal rotor and minimum diameter of external rotor. If clearance exceeds 0.1524 mm, a new oil pump should be installed.
6. Check clearance between external rotor and pump body. If clearance exceeds 0.203 mm, a new pump must be fitted.
7. Check clearance between top of rotors and pump body. If clearance exceeds 0.762 mm, a new oil pump must be installed.
8. If necessary, take out corner pin.
9. Remove plug.
10. Remove spring.
11. Remove safety valve.
12. If necessary, disassemble gear with tools P3 1000 and PC 130-4A.
    Check for more on damage to parts and replace if necessary.

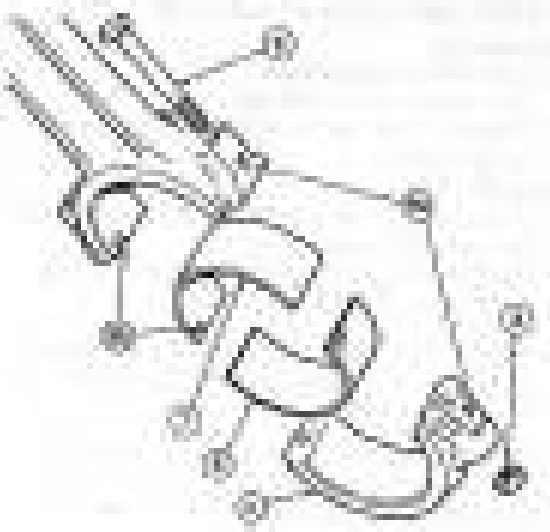
Assembly

13. Reverse operations 8 to 12 and 1 to 5, except:
    a) Insert primary gear with flat face towards exit & is fixed up with nut of shaft. Make sure shaft key fits into gear keyway.
    b) Install a new o-ring.





CONNECTING ROD BIG END BEARINGS



Disassembly

1. Disassemble oil pump.
2. Turn crankshaft until bearing to be disassembled is on its B.D.C.
3. Remove nuts from big end bolts.
4. Remove big end cap together with half bearing.
5. Remove half bearing from cap.
6. Take out big end bolts.
7. Turn crankshaft until upper half bearing can be removed.
8. Repeat operations 2 to 7 to disassemble remaining bearings.

Inspect half bearings for wear or scoring. If one should be faulty, replace complete set.
Check for wear on crankshaft crankpins with a micrometer. The diameter of crankpins should be checked both on a horizontal and vertical plane and at both ends.

Wear on crankpin must not exceed 0.080 mm. If above this limit, the crankshaft must be ground or replaced.

Assembly

9. Reverse operations 1 to 5, except:
   a) Check that all components are meticulously clean and lubricated with clean engine oil specified.
   b) Make sure half bearing lugs fit in connecting rod slots and that they are correctly assembled in their original positions.
   c) The connecting rod nuts and bolts are special and whenever they are replaced this must be with ones supplied by the engine manufacturer.
   d) Make sure that bore of bolt heads is seated correctly on connecting rod shoulder.
   e) Check that connecting rod and big end bearing cap are assembled with matching identification marks and on left side of engine.
   f) Tighten big end nuts to a torque of 7 kg m (68 Nm).

PISTONS AND CONNECTING RODS

Disassembly

1. Disassemble cylinder head.
2. Disassemble big end bearings.
3. Withdraw pistons and connecting rods through top of cylinders.

Assembly

Check condition of pistons, rings and liners and if it is at all suspect, replace them.

4. Clean all parts carefully and lubricate them with clean engine oil specified.

   NOTE: Place rings on pistons in such a way that gap in each ring is at 120° in relation to the previous one.

5. With rod BIG. insert each piston and connecting rod into the top part of its respective cylinder. Make sure that the word «FRONT» is towards front of engine.
6. Assemble big end bearings (no washers) completing of cover.
7. Check height of each piston with tool **POINT.** At tdc 1, 2, 3, C the piston must be 0.030 to 0.150 mm below top surface of block.
8. Assemble oil pump.
9. Assemble cylinder head.

SERVICING PISTONS AND CONNECTING RODS

Disassembly

1. Disassemble pistons and rods.
2. Remove rings from each piston.
3. Remove circlips from each piston.
4. Heat pistons to a clean liquid to a temperature of 80 to 90°.
5. Carefully extract piston pins.
6. Remove carbon deposits from pistons' pay special attention to ring grooves.
7. Inspect pistons for scoring.
8. Check piston pin adjustment.
9. If necessary, extract small end bushes.
10. Place rings in clean, unworn part at top of cylinder and check gap.
    The gap must be between:
    Five piston rings:
    1st rings 0.35 to 0.55 mm.
    2nd, 3rd and 4th rings: 0.25 to 0.45 mm.
    Twelve piston rings:
    1st, 2nd and 3rd rings 0.25 to 0.45 mm.
    4th ring: 0.25 to 0.40 mm.
11. After installing new rings, check vertical clearance of grooves. This clearance must be between:
    Five piston rings:
    1st and 4th rings: 0.07 to 0.102 mm.
    2nd ring: 0.040 to 0.068 mm.
    3rd ring: 0.030 to 0.062 mm.
    Twelve piston rings:
    1st and 2nd rings: 0.08 to 0.091 mm.
    3rd ring: 0.060 to 0.092 mm.
    4th ring: 0.035 to 0.065 mm.

Assembly

12. If necessary, install new small end bushes, lining up their lubrication hole with connecting rod small end.
13. With rod 306, check that each rod is perpendicular and parallel. If there is any distortion, it must be replaced.
14. Heat pistons to a clean liquid, assemble connecting rods to their respective pistons and insert piston pins.

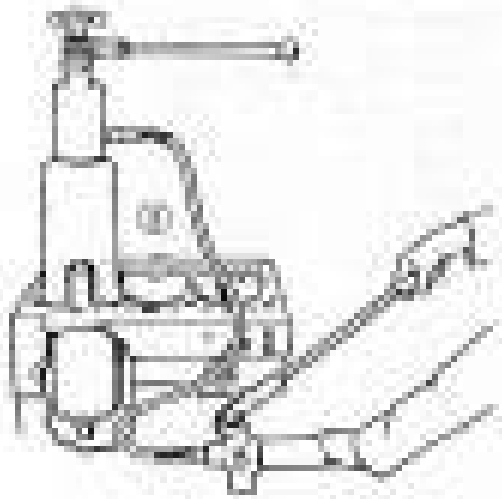
    NOTE: The piston head cavity is off-centered towards one of its sides. Join up pistons to connecting rods with cavity towards connecting rod small big end cap fixing attention marks.

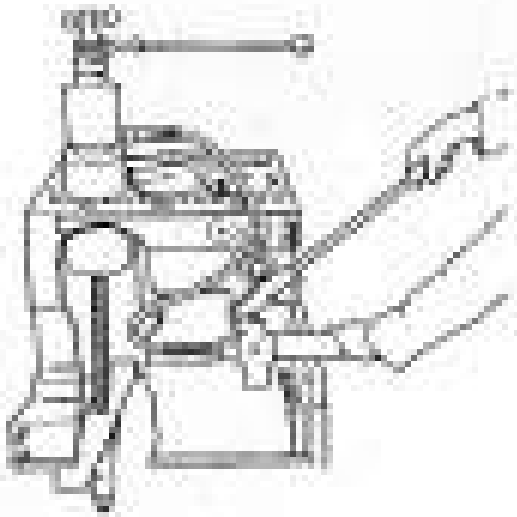
15. Install new circlips on each piston pin.

16. Starting from the top, install rings in the following order:
   1st Chrome ring
   2nd Internally stepped compression ring
   3rd Internally stepped compression ring
   4th Adaptable scraper ring

   NOTE: The internally stepped compression rings must be placed with step towards piston head. Place rings in such position so that the gap of one ring is at 180° in relation to the previous one.

17. Assemble piston and connecting rods.





CYLINDER LINERS

Disassembly

1. Disassemble pistons and rods.
2. Remove studs from cylinder block.
3. With tool PD 180 suitable adapter and hollow hydraulic cylinder, extract liners from underside through top of block.

Replacement

1. Reverse operations 1 to 3, except:
   a) Cylinder liners should be handled and stored with care. The slightest defect on liner would cause considerable damage when assembled in block.
   b) Cast iron liners with flange should not be ground but have to be replaced by new ones. Retained liners.
   c) Before inserting a new liner, both this and the corresponding cylinder should be carefully cleaned, especially the groove at top of cylinder where liner flange is located.
   d) All parts should be copiously lubricated before assembly with clean engine oil.
   e) Check that flange of each liner does not put the housing at top of cylinder out of shape.
   f) When it is impossible to utilize, the top of each liner must be between 0.000 and 0.100 mm below top face of block.
   g) Check condition of pistons and if in all respect, replace them.
   h) Install a pair of new rings.
   i) Allow a setting in period before checking inside diameters of liners.
   j) Each liner must be checked in three positions: upper, middle and lower; the readings must be taken both transversely and parallel to center line of block.

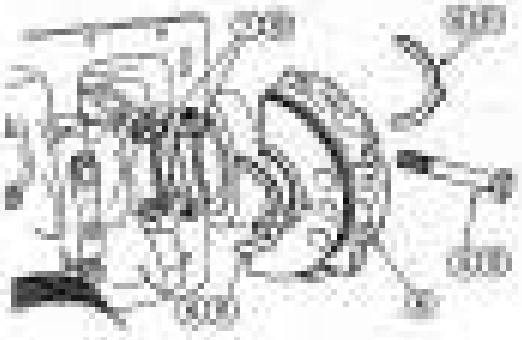
CRANKSHAFT THRUST HALF WASHERS

Disassembly and replacement

1. Disassemble crankcase.
2. Push crankshaft backwards and check axial play between thrust half washer and crankshaft. The clearance should be between 0,050 and 0,280 mm.
3. If axial play does not do within these limits, proceed as follows.
4. Disassemble crankshaft rear retainer.
5. Take out the two fixing bolts.
6. Remove rear crankcase cap together with two lower thrust half washers.
7. Push the two upper half washers with a wire until they can be withdrawn.
8. Replace the two washers.
9. Before re-assembling, lubricate all components with clean engine oil.
10. Place the two new upper thrust half washers in dark housing with flat face towards half bearing.
11. Place the two new lower thrust half washers in rear crankcase cap and assemble it.
12. Put 4 fixing bolts and tighten them to a torque of 18 kg cm.
13. Check crankshaft axial play again, operation 2.
14. If axial play is still not correct, larger size thrust half washers may be installed. Repeat operations 5 to 13.

NOTE: Both upper and lower thrust half washers have to be of the same thickness.

15. Re-assemble rear retainer.
16. Assembly crankcase.



CRANKSHAFT

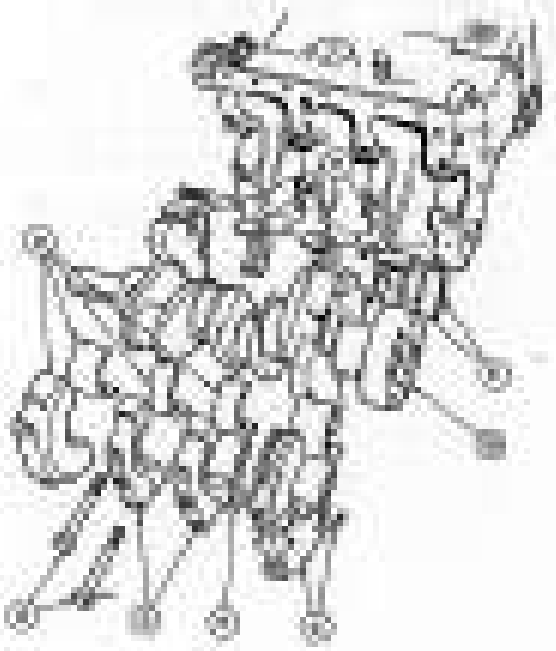
Disassembly

1. Drain engine oil.
2. Support engine on a suitable stand.
3. Separate tractor between front axle and engine and between engine and gearbox.
4. Disassemble timing case.
5. Disassemble big end bearings.
6. Disassemble thrust ball washers.
7. Disassemble crankshaft gear.
8. Take out the six fixing bolts from the other three bearing caps.
9. Remove the three bearing caps with their respective ball bearings.
10. Withdraw crankshaft.
11. Remove taper roll bearings from crankcase supports.
12. Clean all components carefully.

Check with a micrometer the wear of ovalization on crankshaft journals or crankpins. The diameter of journals and crankpins should be checked both horizontally and vertically and at both ends. Wear and ovalization must not exceed 0.0381 mm.
Diameters of crankpins and bore and see journals may be compared to the following measurements:

a) Minus 0.254 mm.
b) Minus 0.508 mm.
c) Minus 0.762 mm.

If crankshaft regular grinding below 0.762 mm, install a new crankshaft. The width of the crankpins might be increased when grinding, but in no circumstances must it exceed 28.58 mm.
It is important to keep journal and crankpin radii in accordance. After grinding, rough edges should be removed from lubrication holes.
Tufftrided crankshafts must be renewed with the Tufftriding process after grinding. If this treatment can not be carried out, a new crankshaft must be mounted.
If the three assembly positions of the crankshaft rear support have been used, the crankshaft flange should be ground.
Remove only the minimum amount of metal from the flange to eliminate wearing. The flange should not be machined below a minimum diameter of 133.17 mm. It is not necessary to apply Tufftriding process to flange. Inspect crankshaft for cracks and damagestone.



Assembly

13. Reverse operations 7 to 12, except:
    a) Check that cylinder block and crankshaft lubrication lines are not blocked.
    b) Check that bearing cap fixing bolts are not stretched. Only bolts supplied by engine manufacturer should be used.
    c) Make sure all components are meticulously clean and copiously lubricated with engine oil.
    d) The bearing caps are numbered starting from front of engine. Each bearing cap is also marked with the same serial number as is stamped on adjacent face of block and they must be matched up.
    e) Tighten bolts to a torque of 16 kg m.
14. Assemble crankshaft thrust ball washers.
15. Assemble connecting rod big end bearings.
16. Assemble timing case.
17. Reverse operation 4.
18. Fill engine with specified oil.

SECTION 4:

ENGINE D4.203

INDEX

Publication 1005-E/4F-I
1st edition 07-78

SPECIFICATIONS

Engine

Make and type	Perkins four stroke, direct diesel injection.
Model	D4.203
Number of cylinders	Four
Cylinder bore	91.44 mm
Stroke	127 mm
Displacement	3.330 c.c.
Compression ratio	18.5 : 1
Power	59.5 H.P. at 2,200 r.p.m. of engine.
Maximum torque	27.8 kg-m at 1,300 r.p.m. of engine.
Maximum speed	2,200 r.p.m. under load; 2,310 r.p.m. no load and 600 ± 50 r.p.m. idling.
Timing system	By gears.
Cylinder block	Built of a single, high strength grey iron casting.
Type of liners	Thin wall casing.
Cylinders	Cast iron.
Cylinder head	Cast iron with extensive water cooling channels.
Camshaft	Cast iron with hardened cams. Located in top right-hand part of cylinder block.
Crankshaft	Molybdenum chrome forged steel with high frequency induction treated crankpins.
Connecting rods	H section forged steel.
Pistons	Aluminium alloy with concave machining in head. Provided with one oil control and three compression rings.
Valves	In cylinder head, driven by camshaft through push rods and rocker arms.

Lubrication system

Type	Link pressure through rotor driven oil pump.
Oil filter	Fuel flow, mounted on block with integral body and element.
Oil sump capacity	7 litres.
Minimum pressure in oil line	2.81 kg/cm² at 2,200 r.p.m. of engine and 1.2 kg/cm² at idling speed with oil temperature (in filter) of 70 to 85° C.
Pump second pressure valve	Piston type.
Valve opening pressure	3.8 to 4.9 kg/cm².
Filter by-pass valve	Ball type.
Valve opening differential pressure	0.91 to 1.3 kg/cm².
Lubricant	See general information.

DESCRIPTION

The Perkins D4.203 engine is of the four cylinder, water-cooled, direct diesel injection type. The rated cylinder bore is 91.44 mm and the stroke is 127 mm.

The engine has overhead valves mounted centrally in the cylinder head. The camshaft, located in the right-hand part of the cylinder block, is driven by a timing gear. The camshaft, in turn, actuates the valve by way of the tappets and rocker arms.

The cylinder block is a single piece of high strength grey iron casting.

The aluminium pistons have slotted heads and four rings. The pistons are coupled to their connecting rods by piston pins secured with circlips. The connecting rod big end bearings are replaceable and are made up of a steel shell covered with a tin and aluminium alloy.

The engine has force feed lubrication. The oil is sucked up from the crankcase through the screen filter by means of a rotary pump driven by the camshaft. The oil passes through the filter before circulating under pressure through the engine.

The crankshaft has five talcum pistons with their corresponding bearings. It is supported by bearing caps and its axial location is controlled by thrust half washers located on the rear flywheel.

TROUBLE SHOOTING CHART

Trouble	Possible cause
Insufficient cranking speed	1, 2, 3, 5.
Engine does not start	4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23.
Difficult starting	6, 7, 9, 10, 11, 12, 14, 15, 16, 18, 19, 20, 21, 24, 25, 26, 27, 28, 29.
Loss of power	10, 11, 13, 14, 15, 18, 20, 21, 23, 24, 25, 27, 31, 32, 35.
Combustion failures	11, 13, 16, 18, 19, 20.
Excessive fuel consumption	13, 15.
Black exhaust smoke	11, 13, 14, 24, 25, 26, 27, 33.
Blue/white exhaust smoke	4, 20, 25, 34, 35, 36.
Low oil pressure	4, 28, 37, 38, 39, 40, 42, 43, 44.
Engine knocking	6, 14, 16, 18, 19, 22, 26, 29, 33, 39, 45, 46, 48.
Uneven running	7, 8, 9, 10, 11, 12, 13, 14, 16, 21, 25, 28, 38, 30, 35, 45, 48.
Vibration	15, 14, 23, 26, 32, 45, 47, 49.
Excessive oil pressure	4, 41.
Engine overheating	16, 18, 24, 25, 46, 50, 51, 52, 53, 54, 57.
Excessive pressure in crankcase	26, 27, 29, 34, 55, 56.
Lower compression	10, 25, 31, 32, 33, 48.
Engine warm up and stops	16, 17, 18.

Trouble shooting key

1. Battery charge low.
2. Poor electrical connections.
3. Starter motor faulty.
4. Wrong grade of oil.
5. Insufficient cranking speed.
6. Fuel tank empty.
7. Cut-out control operating.
8. Fuel feed pipe blocked.
9. Faulty lift pump operation.
10. Fuel filter blocked.
11. Air cleaner blocked.
12. Air in fuel system.
13. Faulty injection pump operation.
14. Injectors faulty.
15. Incorrect use of cold start system.
16. Failure in cold start system.
17. Injection pump control broken.
18. Injection pump setting incorrect.
19. Valve adjustment incorrect.
20. Low compression.
21. Fuel tap partial blocked.
22. Wrong type or grade of oil.
23. Accelerator linkage sticking.
24. Exhaust pipe partly blocked.
25. Leaks in cylinder head gasket.
26. Overheating.
27. Operating temperature incorrect.
28. Exhaust pipe partly blocked.
29. Intake valves.
30. High pressure valve blocked.
31. Worn cylinders.
32. Valves and seats pitted.
33. Piston rings broken, worn or seized.
34. Valve stems and guides worn.
35. Grease overfilled or wrong grade of oil.
36. Bearings worn or damaged.
37. Crankcase oil level low.
38. Crankcase filter blocked.
39. Oil pump worn.
40. Pressure relief valve stuck open.
41. Pressure relief valve stays closed.
42. Relief valve spring broken.
43. Oil pump breather pipe defective.
44. Oil filter blocked.
45. Pistons tend to seize.
46. Incorrect piston height.
47. Fan damaged.
48. Valve spring broken.
49. Flywheel faulty balanced or wrongly assembled.
50. Thermostat faulty.
51. Blockage in the cylinder block and/or cylinder head water jackets.
52. Fan belt slack.
53. Radiator blocked.
54. Water pump faulty.
55. Breather pipe blocked.
56. Valve stem seal(s) broken.
57. Coolant level too low.

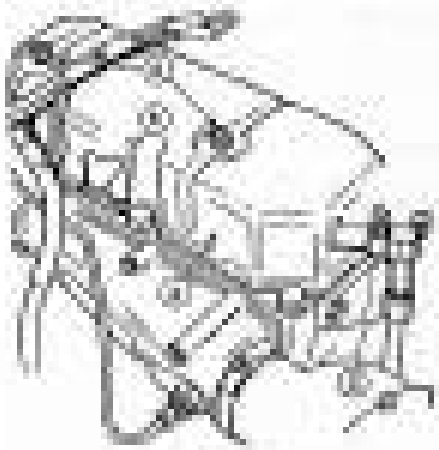
ROCKER COVER

Disassembly

1. Raise hood.
2. Disconnect breather pipe.
3. Remove ball locking nuts, washers and retainers.
4. Take off rocker cover.
5. Remove and discard gasket.

Assembly

6. Reverse operations 1 to 5, except:
   a) Install a new oil gasket.



VALVE LASH ADJUSTMENT

The valve lash is measured between the rocker arm and upper end bar is to be adjusted to 0.203 mm inch or 0.30 mm cold. The procedure is as follows:

1. Disassemble rocker cover.
2. With no. 4 cylinder valves in cross-over position, adjust no. 1 cylinder valves.
   With no. 2 cylinder valves in cross-over position, adjust no. 3 cylinder valves.
   With no. 1 cylinder valve in cross-over position, adjust no. 2 cylinder clearance.
3. Assemble rocker cover.

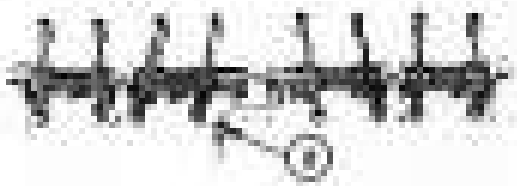
ROCKER ARM SHAFT

Disassembly

1. Disassemble rocker cover.
2. Disconnect oil feed pipe.
3. Remove rocker shaft fixing nuts and washers.
4. Withdraw complete rocker shaft.

Assembly

5. Reverse operations 2 to 4.
6. Adjust valve clearances.
7. Assemble rocker cover.



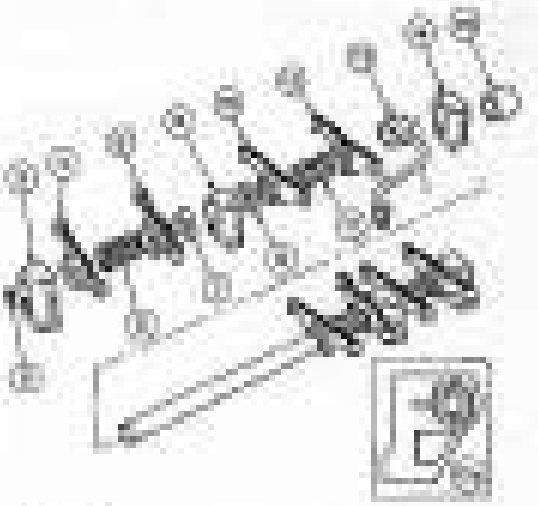
SERVICING ROCKER ARM SHAFT

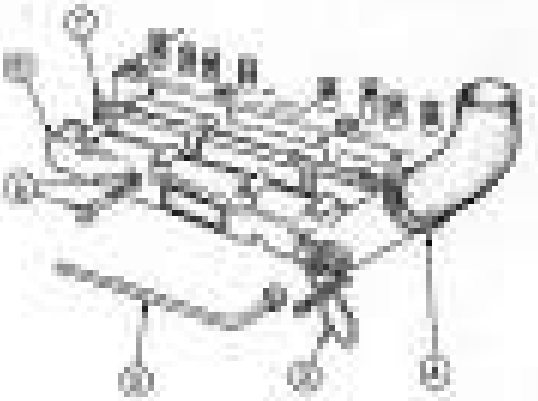
1. Disassemble rocker arm shaft.
2. Remove circlip from front end of rocker shaft.
3. Remove shaft support.
4. Remove 'C' 1 valve rocker arm.
5. Remove spring.
6. Remove 'C' 2 valve rocker arm.
7. Remove washer.
8. Remove shaft support.
9. Remove washer.
10. Remove 'C' 3 valve rocker arm.
11. Remove shaft support.
12. Remove 'C' 4 valve rocker arm.
13. Remove valve seal oil feed pipe.
14. Remove shaft support.
15. Remove spacer.
16. Repeat operations 2 to 13 for other end of rocker shaft, which is identical.

Check for wear or damage to rocker arms or shaft. The rocker arms should be able to be assembled easily on the shaft, without excessive side play.

Assembly

17. Repeat operations 1 to 16, except:
    a) The front end of the rocker arm shaft has a slot and it has to be assembled as is shown in diagram 17 a.
    b) Lubricate all parts with clean engine oil before assembly.





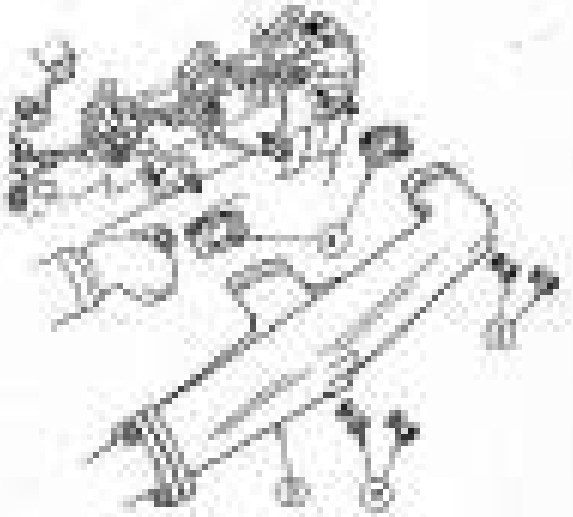
INTAKE MANIFOLD

Disassembly

1. Raise hood.
2. Disconnect cold-start heater cable.
3. Disconnect cold-start heater fuel pipe.
4. Loosen inlet pipe clamp.
5. Remove fixing bolts and washers.
6. Take off manifold, at the same time separating it from intake hose.
7. Remove and discard gasket.

Assembly

8. Install a new gasket.
9. Reverse operations 1 to 5.



EXHAUST MANIFOLD

Disassembly

1. Raise hood.
2. Remove the four nuts and washers.
3. Withdraw manifold.
4. Remove and discard gasket.

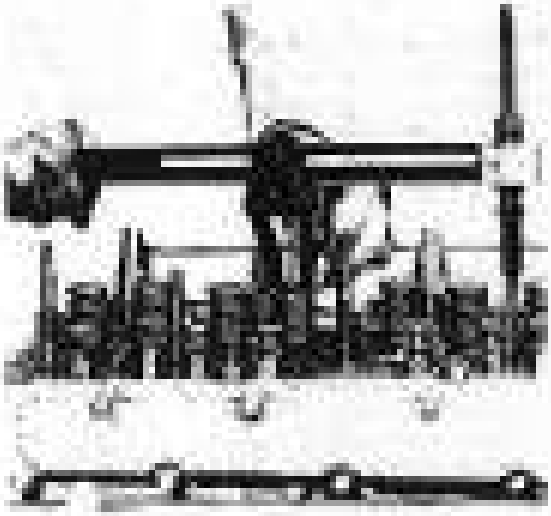
Assembly

5. Install new gaskets.
6. Reverse operations 1 to 3.

VALVE SPRINGS

Disassembly and assembly (with cylinder head in place)

1. Disassemble rocker shafts.
2. Turn crankshaft until cyl. 1 and 4 pistons are at their T.D.C.
3. Compress cylinder no. 1 and 4 valve springs with tools PD 81188 and PD 81184.
4. Remove collars.
5. Slowly release tools PD 81188 and PD 81184.
6. Remove spring seat.
7. Remove springs and valves.



NOTES: a) Do not turn crankshaft again until the valves have been assembled and secured with their collars.

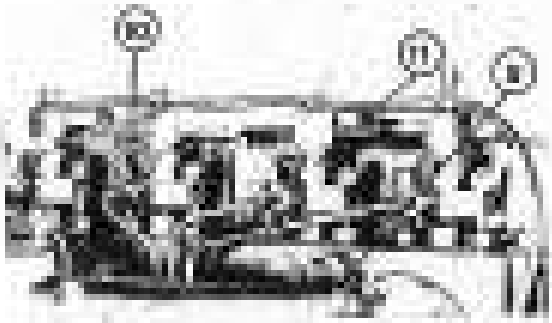
b) If a valve spring requires replacement, a complete set should be assembled.

8. Reverse operations 3 to 7.
9. Turn crankshaft until no. 2 and 3 pistons are at their T.D.C.
10. Repeat operations 3 to 7 for no. 2 and 3 cylinder valves.
11. Reverse operations 1 and 2 to 1.

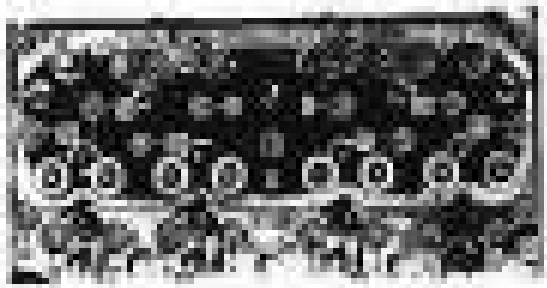
CYLINDER HEAD

Disassembly

1. Disassemble hood.
2. Remove rocker shaft.
3. Disconnect battery leads.
4. Drain cooling system.
5. Disassemble exhaust manifold.
6. Disassemble inlet manifold.
7. Disconnect radiator top hose and connection hose between thermostat housing and water pump.



8. Disassemble thermostat cover.
9. Remove high pressure fuel pipes.
10. Disassemble injectors.
11. Disconnect temperature gauge (sender).
12. Disassemble all bolts and nuts (cylinder head).
13. Remove cylinder head fixing nuts and bolts in inverse order to tightening sequence.
14. Remove cylinder head.
15. If necessary, disassemble thermostat housing and gasket.
16. Remove cylinder head gasket.



Assembly

17. Make sure that all components are PERFECTLY clean and that contact surfaces are free of grease.

18. Reverse operations 1 to 15, except:
    a) Place a new cylinder head gasket with a fine coat of sealing paste.
    b) Tighten up cylinder head fixing nuts and bolts in the correct order, in three equal stages, to a torque of 18 kg.m.
    c) Apply a thin coat of sealing paste to thermostat housing gasket (if disassembled).
19. Bleed fuel system.
20. Start up engine and run it at approximately 1,200 r.p.m. for ten minutes until normal working temperature is reached. Stop engine.
21. Disassemble rocker arm shaft.
22. Tighten cylinder head fixing nuts and bolts to correct order to a torque of 18 kg.m.
23. Assemble rocker arm shaft.
24. Start engine and check that there are no leaks.

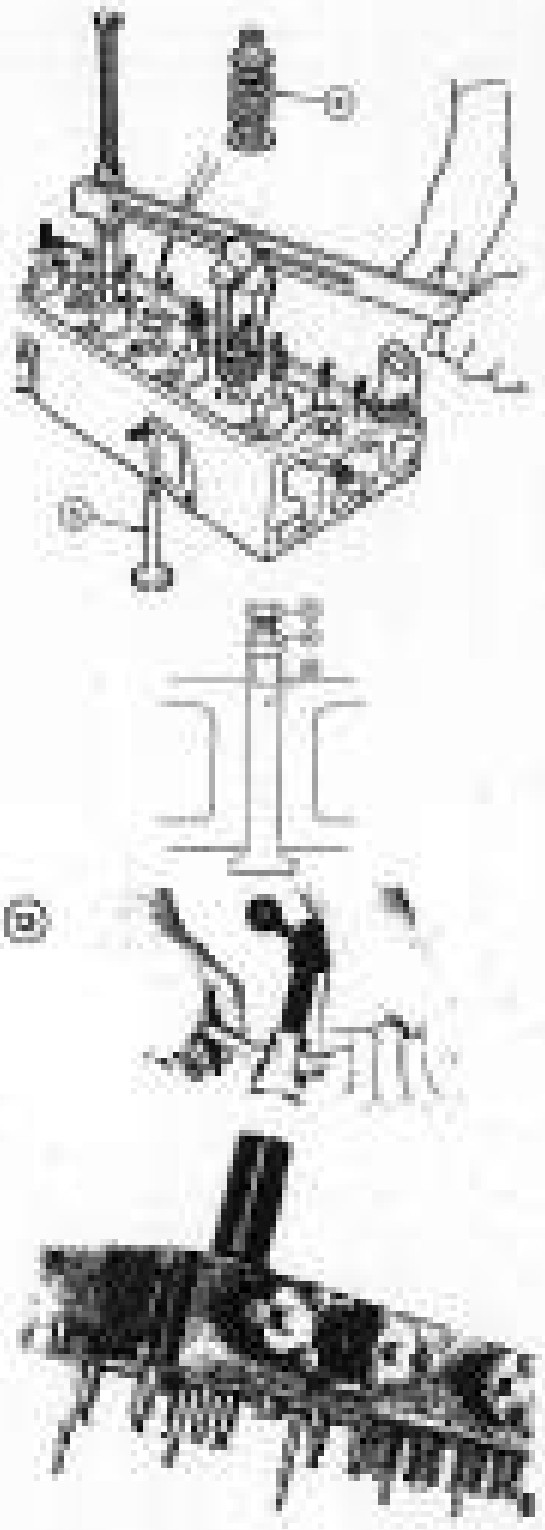
SERVICING CYLINDER HEAD

Disassembly and assembly

1. Disassemble cylinder head.
2. Disassemble valve springs.
3. Place cylinder head on its side and extract valves.

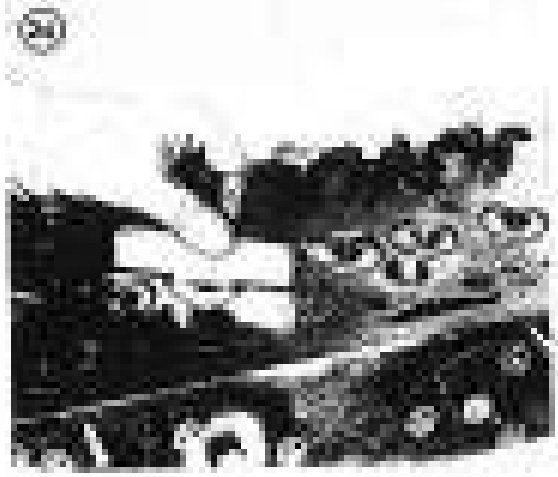
NOTE: Keep valves in same order in which they were extracted.

4. Loosen counternut.
5. Remove bolt and washer.
6. Remove push rod.
7. Repeat operations 4 to 6 for remaining push rods.
8. Disassemble thermostat housing and gasket.
9. Disassemble rear plate and gasket from cylinder head.
10. Clean all cylinder head openings, leaving them free of carbon or other deposits.
11. If there are excessive deposits in the cylinder head water passages, the use of Jabsco 38240 Red, Kit is recommended.
12. Check for wear on inside diameter of valve guides.
13. If necessary, extract valve guides with tool PS. 63.
14. Install new guides with tools PS.10 and PS. 10/1A. Make sure guides are assembled in correct direction. Both ends are beveled, one to 45° and the other to 20° (the 20° end is also recess-



seat. The 30° and must be lapped into the cylinder head through the top until the opposite and (45°) original cut 14.88 to 15.08 mm above the top face.

18. Check for excessive pitting or wear on valve seats.
19. If necessary, grind valve seats with the following tools: lifting cylinder tool, valve seat profile cutter, tommybar and cerise bit. Remove as little metal as possible and ensure a fine, light finish.
17. Carefully oil valves clean and check that they are not pitted, worn or bent.
18. If necessary, machine grind valve cruise edge to a 45° angle. Remove as little metal as possible to achieve a fine finish.
19. Clean valves carefully.
20. Lubricate valve stems with clean engine oil.
21. If necessary, hand grind valves and their respective seats until all pitting is removed and a good sealing is obtained.
22. Carefully wash cylinder head and valves with clean paraffin and then dry.
23. Lightly lubricate valve stems and insert them in cylinder head.
24. Check depth of valve head in relation to cylinder head surface. This depth must be between 1.62 and 2.13 mm.
25. If a valve exceeds this limit, it must be replaced. Measure valve depth again and if it still does not conform to the limits stated, a replaceable valve seat must be installed. Verify on valves returned to the users of an inlet valve, the cylinder head has to be replaced.
26. Check that cylinder head surface is flat and, if necessary, grind surface up to a maximum of 0.38 mm, bearing in mind that the injector is not to stand out more than 4.80 mm. This maximum might must not be obtained by adding extra washers.
27. Carefully clean cylinder head.
28. Reverse operations 1 to 5, ensure:
   (i) Place valves in correct position.
   (ii) Lightly smear back plate and thermostat housing gaskets with suitable sealing paste.



REPLACEABLE VALVE SEATS

Assembly procedure

Replaceable valve seats may only be assembled in EXHAUST valves and only as a last resort to extend cylinder head service life.

The assembly of replaceable valve seats is a precision operation and should therefore only be performed by specialized personnel.

This operation must never be performed while a worn valve guide is still mounted.

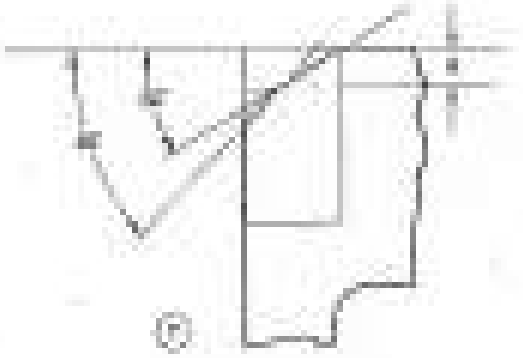
1. Service cylinder head.
2. Using a valve guide locating jig or similar, machine cylinder head surface (refer according to instructions given).

NOTE: Work as close as possible to minimum machining dimensions to allow for a possible later resetting.

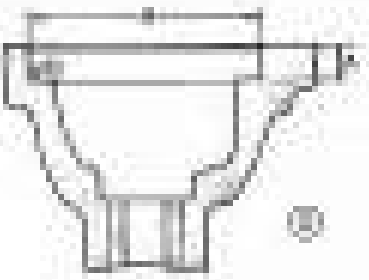
3. Remove machining filings and clean replaceable seat housing.
4. Using valve guide locating, set valve seat in place by means of an insertion tool made to the specified dimensions.

NOTE: Replaceable valve seats must not be hammered into place or lubricated.

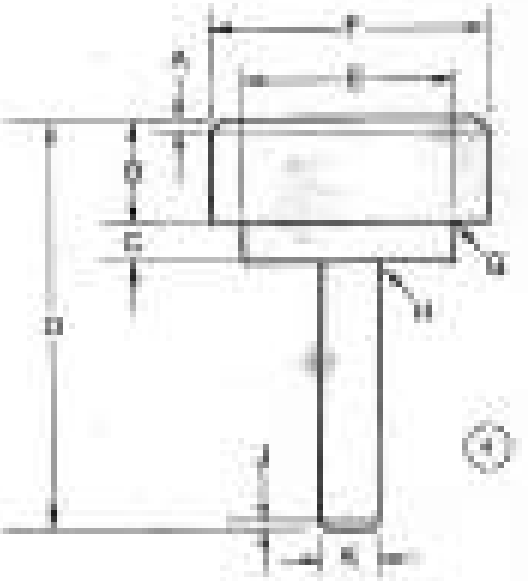
5. Check that replaceable valve seat is fully inserted into the housing and is on a level with the lower part of cylinder head intake.
6. Remove machining swarf and filings and, if necessary, machine cylinder head surface.
7. Grind valve seat at a normal angle of 90°, so that after grinding the depth of the valve head below the cylinder head surface lies between 1.50 and 1.80 mm (production limited for exhaust valves).



KEY TO FIGURE 3
A. 3.30 to 3.50 mm



KEY TO FIGURE 4
A. 7.97 to 7.98 mm
B. 34.975/34.991 mm
C. 8.08 mm min. value



KEY TO FIGURE 4
A. 7.98 mm at 20°
B. 35.000 mm
C. 8.08 mm
D. 60.50 mm
E. 35.00 to 35.62 mm
F. 42.34 to 42.50 mm
G. 0.70 mm radius
H. 1.00 mm radius
I. 1.70 mm at 45°
J. 7.90 to 8.10 mm

TIMING CASE COVER

Disassembly

1. Disconnect tractor between engine and front axle.
2. Remove bolt and washer securing crankshaft pulley.
3. Take off crankshaft pulley.
4. Remove water pump.
5. Remove engine breather pipe.
6. Remove accelerator return spring from injection pump.
7. Remove the four fixture bolts.
8. Disassemble alternator assembly support bracket.
9. Take out timing cover fixing bolts.
10. Take off timing case cover.
11. Remove and discard gasket.
12. Remove washer.

Assembly

13. Install a new washer with big round angles. Place washer 3.4 mm below front surface of timing case.
14. Assemble cover and new gasket.

NOTE: Lightly smear gasket with suitable sealing paste.

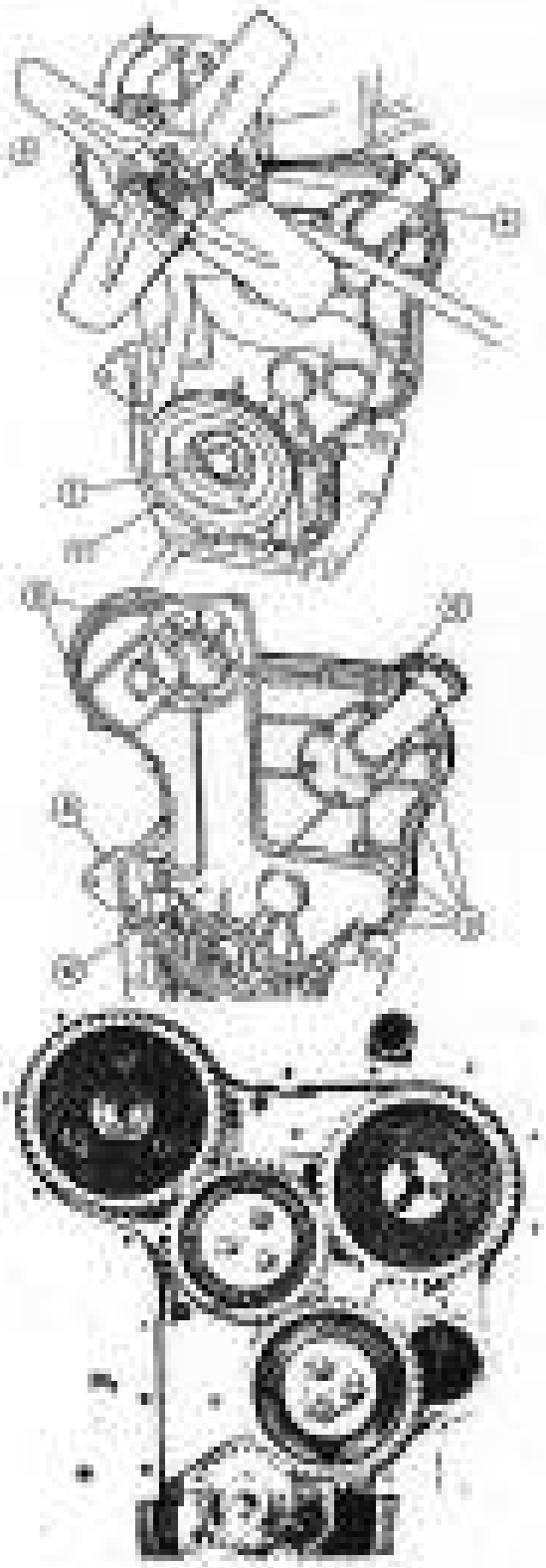
15. Put on crankshaft pulley so as to centre timing case cover.
16. Put in and tighten screw bolts and washers to secure timing cover.
17. Remove crankshaft pulley.
18. Install remaining timing case cover nuts and bolts.
19. Reverse operations 1 to 6, except:
    a) Tighten crankshaft pulley fixing bolt to a torque of 18 kg-m.

TIMING GEARS

Intermediate gears

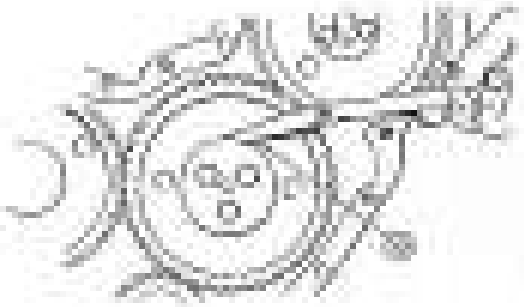
Disassembly

1. Disassemble timing case cover.
2. Turn crankshaft until marks on injector pump, camshaft and crankshaft gears are lined up with those of the corresponding intermediate gears.
3. Bend back lock plate.
4. Remove the three nuts.
5. Remove lock plate.
6. Remove lock washer.
7. Remove upper intermediate gear.
8. If necessary, disassemble intermediate gear hub.
9. Repeat operations 2 to 6 for lower intermediate gear.



Assembly

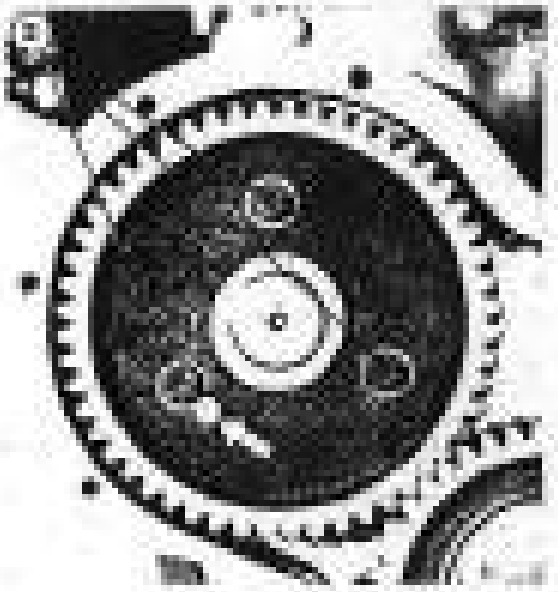
10. Put on intermediate gear hub, making sure that hub oil feed holes are lined up with block of cylinder block.
11. Assemble gear, making sure that injection pump, camshaft and crankshaft gear timing marks are lined up with intermediate gears.
12. Reverse operations 2 to 6.
13. Check axial play of gear, which must be between 0,025 and 0,076 mm.



14. Check clearance between intermediate gears by means of a dial gauge or thickness gauge. The clearance must be between 0,025 and 0,102 mm. Check all points of engagement.

NOTE: If axial play obtained does not fall within the prescribed limits, replace meshing gears involved.

15. Assemble timing case cover.



Camshaft gear

Disassembly

1. Disassemble upper intermediate gear.
2. Remove the three gear fixing nuts and bolts.
3. Remove gear.

Assembly

4. Reverse operations 2 and 3, except:
   a) Make sure gear and camshaft flange lenses are lined up.
5. Assemble upper intermediate gear.

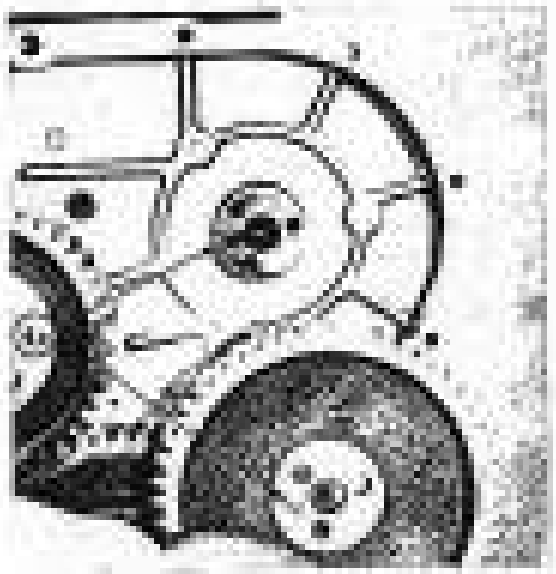
Injector pump gear

Disassembly

1. Disassemble upper inter-mediate gear.
2. Remove the drive fixing nuts and bolts.
3. Remove gear.

Assembly

4. Reverse operations 2 and 3, ensure:
   a) Make sure that gear dowel is housed in injection pump flange slot.
   b) Tighten fixing bolts to a torque of 3 kg m.
5. Assemble upper intermediate gear.



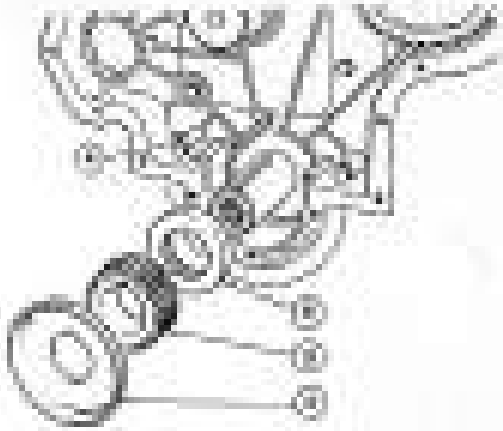
Crankshaft gear

Disassembly

1. Disassemble lower intermediate gear.
2. Remove shield.
3. Withdraw crankshaft gear.
4. Take out key (if necessary).
5. Remove spacer (if necessary).

Assembly

6. Reverse operations 2 to 5.
7. Assemble lower intermediate gear.



GOVERNOR

Disassemble

1. Remove rocker arm shaft.
2. Remove upper intermediate gear.
3. Disconnect tachometer drive cable from rear of camshaft housing.
4. Disassemble fuel lift pump.
5. Disassemble camshaft gear.
6. Raise tappets.
7. Withdraw camshaft through front oil seal. Take care that cams do not damage bearings.
8. Remove thrust washer (if necessary).

Assembly

9. Check that thrust washer is correctly placed on cylinder block-locating pin.
10. Reverse operations 3 to 7, ensure:
    a) Make sure that idleus meshed on gear and camshaft flange are lined up.
11. Assemble upper intermediate gear.
12. Assemble rocker arm shaft.

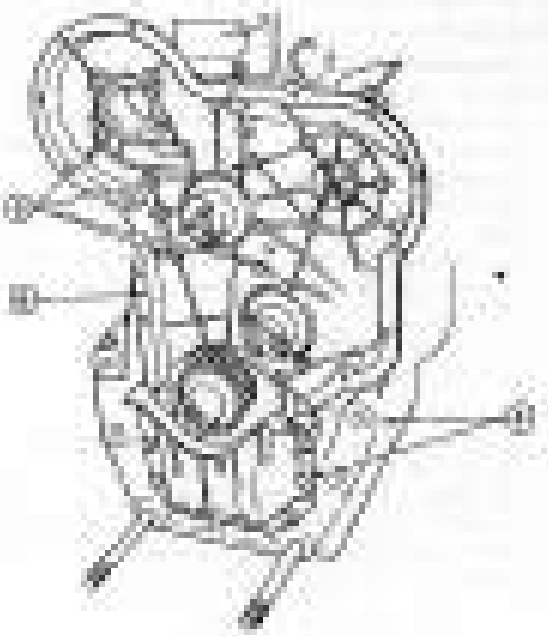
TIMING CASE

Disassembly

1. Disassemble camshaft.
2. Disassemble injector pump gear.
3. Disassemble injector pump.
4. Disassemble crankcase.
5. Remove nuts and bolts securing timing case to cylinder block.
6. Take off timing case.
7. Remove gasket.

Assembly

8. Reverse operations 2 to 7, except:
   a) Install new gasket lightly smeared with sealing joints.
9. Assemble injector pump gear.
10. Assemble camshaft.



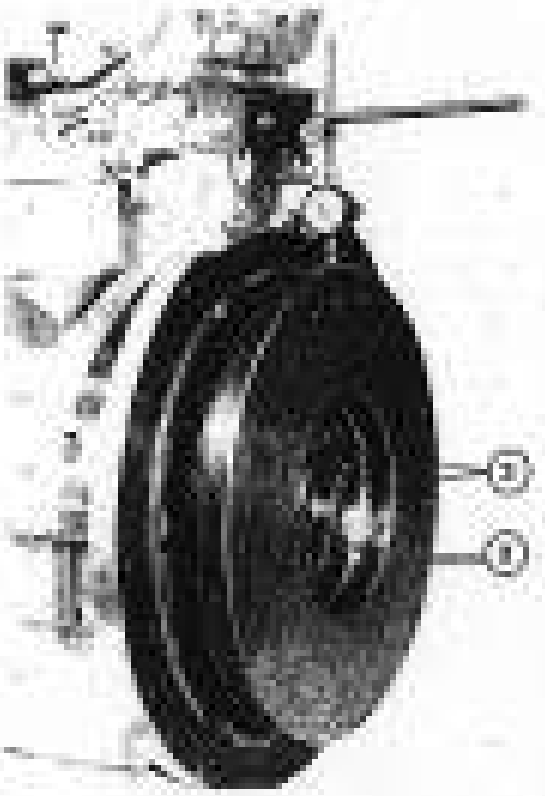
FLYWHEEL

Disassembly

1. Disassemble clutch.
2. Remove the six bolts and lock plates.
3. Remove flywheel.

Assembly

4. Reverse operations 2 and 3, except:
   a) Locate flywheel on crankshaft flange so that the unthreaded hole of flange lines up with the flywheel hole with no lock.
   b) Tighten flywheel bolts to a torque of 10 kg-m secure them with new lock plates. 15 ft-lb
5. Assemble clutch.



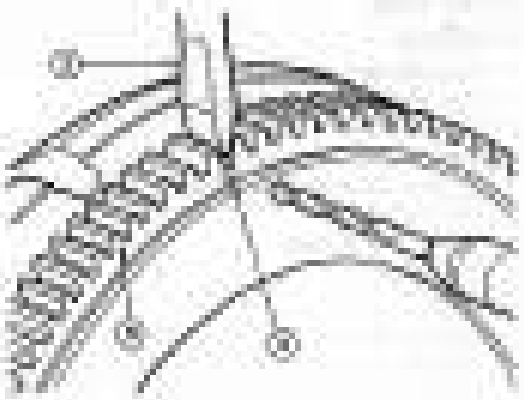
FLYWHEEL RING GEAR

Disassembly

1. Disassemble flywheel.
2. Drill a hole 5 mm in diameter and up to a depth of 65 mm between the flywheel web to (between) at radially outer tangency lines (tooth) of ring gear and base of one of its teeth.
3. Place a cold chisel at base of tooth above drill hole.
4. Cover flywheel and cutting point with a thick cloth as a protection against fragments that might fly off.
5. Hold flywheel and hammer cold chisel firmly to split ring gear.

Replacement

6. Heat new ring gear to a temperature of approximately 200°C. (Refer to FUNDAMENTALS).
7. Place ring gear on flywheel with bevel gear towards head of flywheel, quickly fit ring gear into its housing and let it cool slowly.
8. Assemble flywheel.



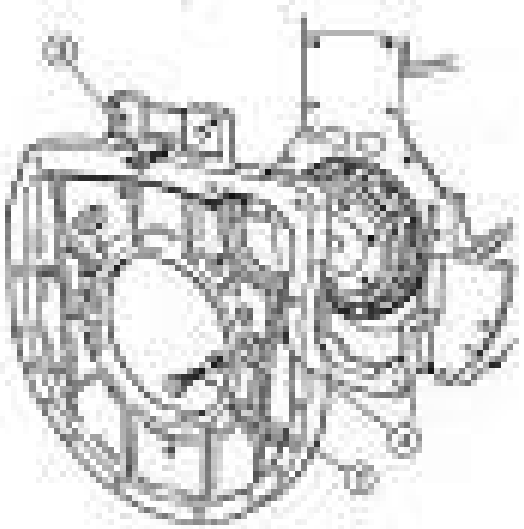
FLYWHEEL HOUSING

Disassembly

1. Disassemble flywheel.
2. Remove bolts and washers.
3. Remove starter.
4. Disengage housing from lugs.

Assembly

5. Reverse operations 2 to 4, except:
   a) Make sure that flywheel housing and engine block surfaces are meticulously clean.
   b) Lightly coat bolts threads with an appropriate sealing paste.
6. Assemble flywheel.



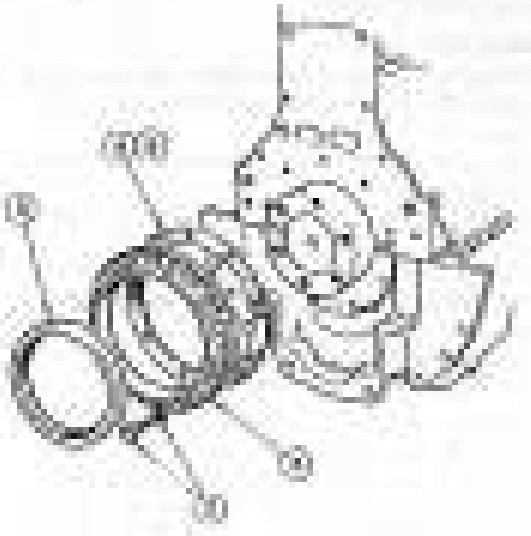
CRANKSHAFT REAR RETAINER

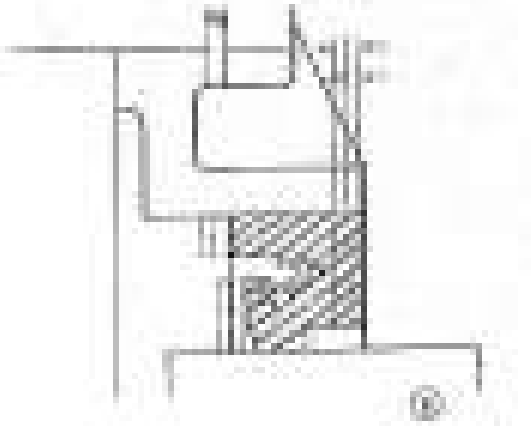
Disassembly

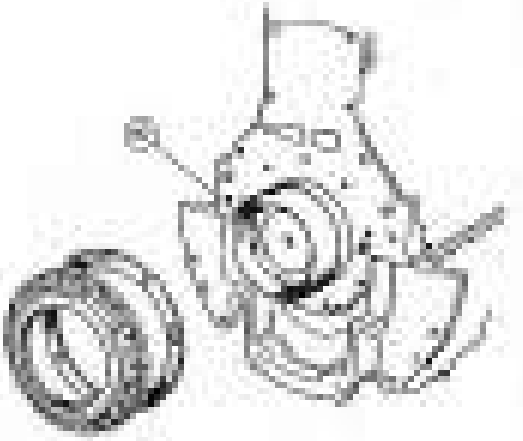
1. Disassemble flywheel housing.
2. Remove bolts and washers.
3. Remove retainer housing together with washer.
4. Remove and discard gasket.
5. Extract retainer from its housing.

Replacement

6. In manufacture, the lip retainer is assembled with its rear face aligned with the rear surface of its housing. Inspect crankshaft flange and, if it is evident that new retainer must be inserted further into its housing, first it should be inserted 8.2 mm and, if necessary, a further 3.2 mm, making 8.4 mm in all. If these operations should not be sufficient, the crankshaft flange contact surface has to be machined.
7. Lubricate retainer seat its housing with clean engine oil. Place retainer in its housing to the required depth with tool PD 146-1.
8. Install a new gasket lightly smeared with suitable sealing paste.
9. Lubricate retainer, crankshaft flange and tool PD 146-2 with clean engine oil.
10. Using tool PD 146-2, install retainer assembly and its housing. Make sure it is correctly engaged on studs lugs.
11. Remove tool PD 146-2.
12. Remove operations 1 and 2.







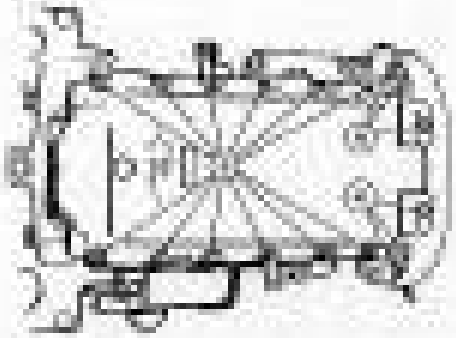
ENGINE CRANKCASE

Disassembly

1. Disconnect mating between front side and engine.
2. Drain oil from crankcase and collect it in suitable container.
3. Remove nuts and washers securing front shafts to swing-arm.
4. Remove bolts securing crankcase to frame/seat housing.
5. Support crankcase and remove bolts, washers and self-locking nuts securing crankcase to engine.
6. Separate crankcase from engine.
7. Remove and discard gasket.

Assembly

8. Reverse operations 1 to 7, noting:
   a) Check that contact surfaces are clean.
   b) Fit new gaskets, lightly smeared with suitable sealing paste.
   c) Place a new gasket in slot located on crankshaft side bearing cap.
   d) Fill crankcase to correct level with specified engine oil.



OIL PUMP

Disassembly

1. Separate crankcase halves.
2. Remove intermediate gear shafts.
3. Withdraw intermediate gear.
4. Disconnect pump/high pressure hose.
5. Remove fixing bolts and washers.
6. Withdraw oil pump.

Assembly

7. Reverse operations 2 to 6.
8. Assemble engine halves.

SERVICING OIL PUMP

Disassembly

1. Disassemble oil pump.
2. Remove pressure pipe.
3. Remove the two bolts and washers securing screen filter plate.
4. Remove pipe and screen filter.
5. Remove circlip.
6. Remove scavenger pump gear.
7. Remove key.
8. Remove the two bolts and nuts securing pump plate.
9. Remove pump plate and safety valve.
10. Remove O-ring seal.
11. Check clearance at all points between maximum diameter of internal rotor and minimum diameter of external rotor. If it exceeds 0.254 mm, a new pump must be installed.
12. Check clearance between top of rotors and pump body. If it is greater than 0.762 mm, a new pump must be installed.
13. If necessary, remove cotter pin.
14. Remove plug.
15. Remove clip ring.
16. Remove safety valve.

Assembly

17. Reverse operations (16 to 11 and 7 to 1), except (1 insert primary gear with flat face outwards, until it is lined up with circlip slot.
18. Install a new retainer.

(11)

(12)

(12)

CONNECTING ROD BIG END BEARINGS

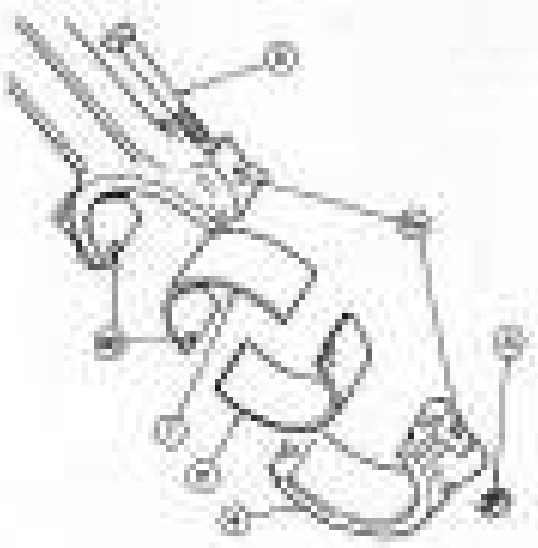
Disassembly

1. Disassemble oil pump.
2. Turn crankshaft bearing to be disassembled to B.D.C.
3. Remove nuts from big end bolts.
4. Remove big end cap together with half bearing.
5. Remove half bearing from cap.
6. Remove big end bolts.
7. Turn crankshaft until upper half bearing can be removed.
8. Repeat operations 2 to 7, to disassemble remaining bearings.

Inspect half bearings for wear or scoring. If one should be faulty, replace complete set.

Check for wear on crankshaft crankpins with a micrometer. The diameter of crankpins should be checked both on a horizontal and vertical plane and at both ends.

Wear and ovalization must not exceed 0.001 mm. If above this limit, the crankshaft must be ground or replaced.



Assembly

6. Reverse operations 1 to 5, inclusive:
   a) Check that all components are methodically oiled and lubricated with clean engine oil according to specifications.
   b) Make sure half bearing tags fit into connecting rod grooves and that they are correctly repositioned in their original positions.
   c) The connecting rod nuts and bolts are specific and non-interchangeable parts and replacement with other than genuine Aprilia parts may cause the engine manufacturer could be void.
   d) Make sure that base of bolt heads is seated correctly on connecting rod shoulder.
   e) Check that connecting rod and big end bearings are assembled with matching identification marks and on left side of engine.
   f) Tighten big end nuts to a torque of 2 kg m.

PISTONS AND CONNECTING RODS

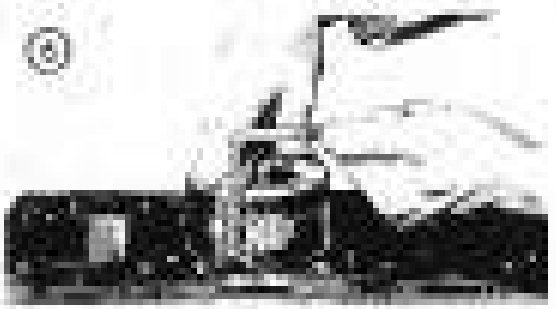
Disassembly

1. Disassemble cylinder head.
2. Disassemble big end bearings.
3. Withdraw pistons and connecting rods through top of cylinders.

Assembly

Check condition of pistons, rings and liners and if they are in all respect, replace them.

4. Clean all parts carefully and lubricate them with clean engine oil according to specifications.
   NOTE: Place rings on pistons in such a way that each ring gap is at 180° to relation to previous one.
5. With new O.R. insert each piston and connecting rod into top of its respective cylinder. Make sure that the word «FRONT» is towards front of engine.
6. Assemble big end bearings, but without assembling oil pump.
7. Check height of each piston with tool P.618. At T.D.C. the piston must be 0.2787 to 0.3169 mm below top surface of block.
8. Assemble oil pump.
9. Assemble cylinder head.



SERVICING PISTONS AND CONNECTING RODS

Disassembly

1. Disassemble pistons and connecting rods.
2. Remove rings from each piston.
3. Remove circlips from each piston.
4. Heat pistons in a clean liquid to a temperature of 80° to 90° C.
5. Carefully extract piston pins.
6. Remove carbon deposits from pistons paying special attention to ring grooves.
7. Inspect pistons for scoring.
8. Check piston pin adjustments.
9. If necessary, extract small end bushing.
10. Place rings in skirt, ensure gap is top of cylinder and check ring gap. This gap must be between:
    Plain piston rings:
    1st ring: 0.28 to 0.35 mm.
    2nd, 3rd and 4th rings: 0.25 to 0.40 mm.
    Tapered piston rings:
    1st, 2nd and 3rd rings: 0.30 to 0.55 mm.
    4th ring: 0.20 to 0.40 mm.
11. After installing new rings, check vertical clearance of grooves. This clearance must be between:
    Plain piston rings:
    1st and 4th rings: 0.07 to 0.107 mm.
    2nd ring: 0.060 to 0.098 mm.
    3rd ring: 0.050 to 0.090 mm.
    Tapered piston rings:
    1st and 2nd rings: 0.058 to 0.091 mm.
    3rd ring: 0.035 to 0.067 mm.
    4th rings: 0.035 to 0.080 mm.

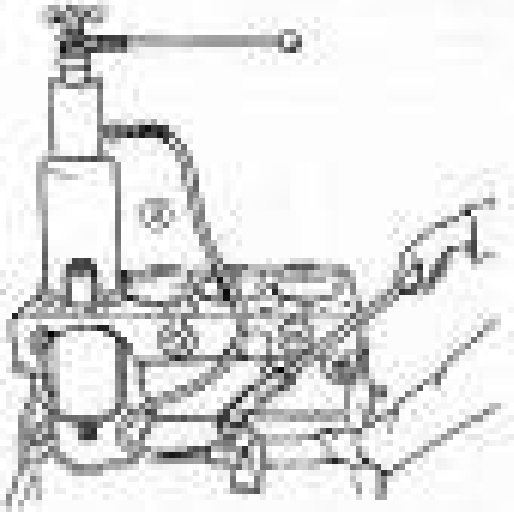
Assembly

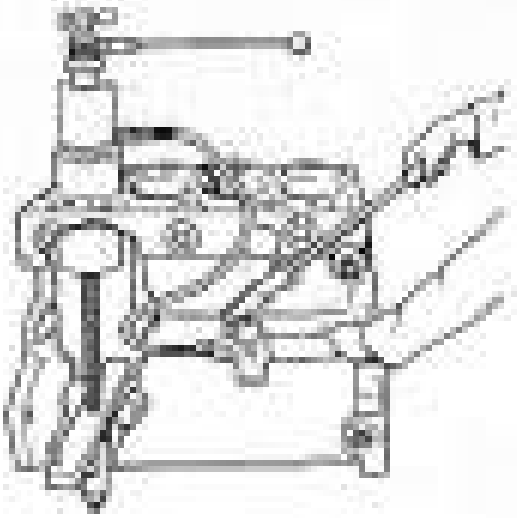
12. If necessary, install new small end bushings, lining up locating lubrication hole with connecting rod small end.
13. With tool 305, check that each rod is perpendicular and parallel. If there is any distortion, it must be replaced.
14. Heat pistons in a clean liquid, place connecting rods in their respective pistons and insert piston pins.

    NOTE: The piston head marks should be towards rear of the stator. Join up pistons to connecting rods with cavity towards connecting rod and top end bearing cap identification marks.

15. Install two new circlips on each piston pin.

19. Starting from the top, install rings in the following order:
1st. Chrome ring.
2nd. Internally stepped compression ring.
3rd. Internally stepped compression ring.
4th. Adjustable scraper ring.
NOTE: The internally stepped compression rings must be placed with step towards piston head. Place rings on each piston so that the gap of one ring is at 180° in relation to the previous one.
20. Assemble pistons and connecting rods.





CYLINDER LINERS

Disassembly

1. Disassemble pistons and rods.
2. Remove cylinder head studs.
3. With tool PE 305, suitable adapter and hollow hydraulic cylinder, extract liners from cylinders through top of block.

Replacement

4. Perform operations 1 to 3, except:
a) Cylinder head liners should be handled and stored with care. The slightest defect or burr could cause considerable damage when assembled in block.
b) Cast iron liners with flange should not be ground, but have to be replaced by new semi-finished liners.
c) Before inserting a new liner, both it and the corresponding cylinder should be carefully cleaned, especially the groove at top of cylinder where liner flange is located.
d) All parts should be copiously lubricated before assembly with clean engine oil.
e) Check that flange of each liner does not deform its housing at top of cylinder.
f) When it is completely in place, the top of each liner must be between 0.088 and 0.132 mm below top face of block.
g) Check condition of plasma seals: if at all suspect, replace them.
h) Allow a settling in period before checking inside diameters of liners.
i) Each liner must be checked in three positions: upper, middle and lower; the readings must be taken both transversely and parallel to centre line of block.

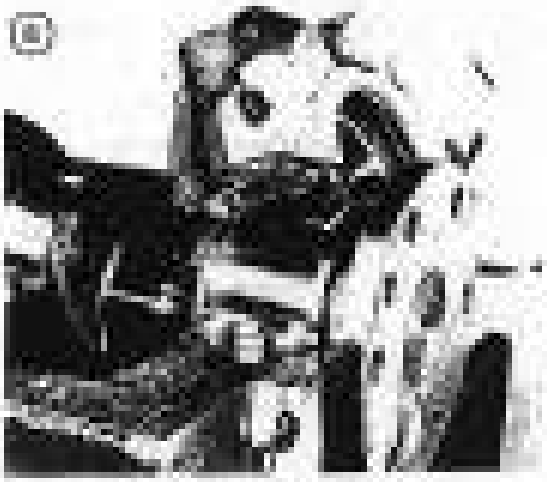
CRANKSHAFT THRUST HALF WASHERS

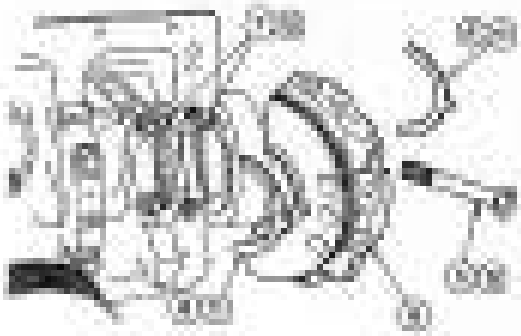
Disassembly and replacement

1. Disassemble crankcase.
2. Push crankshaft backwards and check axial play between thrust half washers and crankshaft. The clearance should be between 0,050 and 0,350 mm.
3. If axial play does not be within these limits, proceed as follows.
4. Disassemble crankshaft rear retainer.
5. Take out the two fixing bolts.
6. Remove crankcase rear bearing cap together with the two lower thrust half washers.
7. Push the two upper half washers with a wire until they can be withdrawn.
8. Replace the two retainers.
9. Before re-assembling, lubricate all components with clean engine oil.
10. Place the two new upper thrust half washers in their housing with flat face towards shaft bearing.
11. Place the two new lower thrust half washers in rear crankcase bearing cap and assemble it.
12. Fix fixing bolts and tighten them on a torque of 90 kg m.
13. Check axial play again.
14. If axial play is still not right, larger size thrust half washers may be installed. Repeat operations 6 to 13.

NOTE: Both upper and lower thrust half washers have no tab of the same thickness.

15. Re-assemble crankshaft rear retainer.
16. Assemble crankcase.





CRANKSHAFT

Disassembly

1. Drain engine oil.
2. Separate motor (between front axle and engine and between engine and gearbox.
3. Support engine on suitable stand.
4. Disassemble timing case.
5. Disassemble big end bearings.
6. Disassemble thrust half washers.
7. Disassemble oil pump.
8. Disassemble camshaft gear.
9. Remove the eight bolts securing retaining bearing caps.
10. Remove the four bearing caps together with their half bearings.
11. Withdraw crankshaft.
12. Remove upper half bearings from crankcase supports.
13. Clean all components carefully. Check with a micrometer for wear or ovalisation on crankshaft journals and crankpins. The diameter of journals and crankpins should be checked both horizontally and vertically and at both ends. Wear and ovalisation must not exceed 0.001 mm. Examine for cracks and damage the crankshaft.

Diameters of crankpins and front and rear journals may be ground to the following measurements:

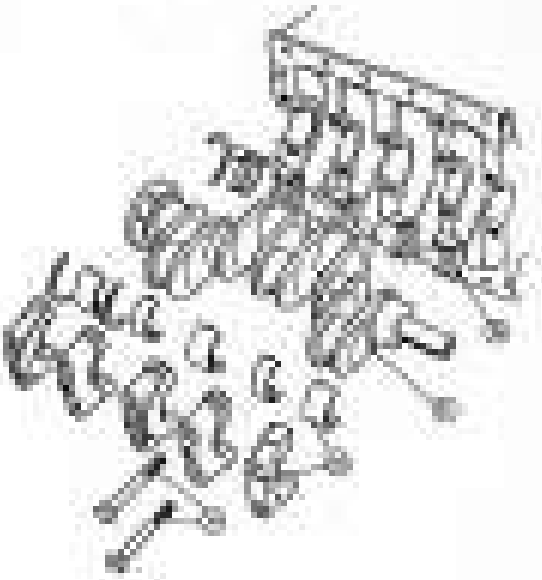
a) Minus 0.254 mm.
b) Minus 0.508 mm.
c) Minus 0.762 mm.

If crankshaft requires grinding below 0.762 mm, install a new crankshaft. The width of the crankpins might be increased on grinding, but in no circumstances must it exceed 59.69 mm.

It is important to keep journal and crankpin radii in accordance. After grinding, rough edges should be removed from lubrication holes. Turbolded crankshafts must be checked with Turbolding process after grinding. If this treatment cannot be carried out, a new crankshaft must be assembled.

If the three assembly positions of the crankshaft new washers have been used, the crankshaft flange should be ground.

Remove only the minimum amount of metal from the flange to eliminate scoring. The flange should not be reshaped below a minimum diameter of 115.11 mm.



It is not necessary to apply Turbolding process to flange. Examine crankshaft for cracks and damaging ratios.

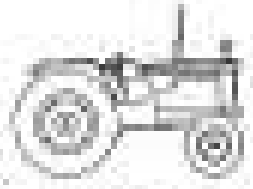
Assembly

14. Reverse operations 8 to 13, except:
    a) Check that cylinder block and crankshaft lubrication lines are not blocked.
    b) Check that bearing cap fixing bolts are not stretched. Only bolts supplied by engine manufacturer should be used.
    c) Make sure all components are meticulously clean and well lubricated with engine oil.
    d) The bearing caps are numbered, starting from front of engine. Each bearing cap is also marked with the same serial number as is stamped on block bottom face and they must be matched up.
    e) Tighten bolts to a torque of 78 kg m.
15. Assemble crankshaft thrust half washers.
16. Assemble oil pump.
17. Assemble big end bearings.
18. Assemble timing case.
19. Reverse operation 2.
20. Fill engine with specified oil.

SECTION 5

FUEL SYSTEM

CONTENTS



Publication SP-1629-E/P-I
1st Edition 1/78

SPECIFICATIONS Model 30

Fuel tank location	In upper part of bonnet, in front of instrument cluster
Fuel tank capacity	60 lt.
Sediment cup	Bubble on fuel pump
Fuel filter	Equipped with replaceable element
Injection	
Make	C.A.V.
Type	D.P.A.
Governor	Mechanical
Maximum delivery	11 cc (+) 200 revolutions (at 700 r.p.m.)
Maximum full load engine speed	3,200 r.p.m.
High idle r.p.m. (no load)	3,300 r.p.m.
Direction of rotation (facing coupling)	Clockwise
Code number on characteristics plate	DW/V/3504/3389
Synchronisation with engine (block injection allowed)	32°
Low idle r.p.m.	800 ÷ 50
Injectors	
Injection pressure	180 atmospheres
Cold weather starting auxiliary device	Electric heater in the intake manifold

SPECIFICATIONS Model 466

Fuel tank location	In appendix of bonnet in front of steering column
Capacity of the fuel tank	66 lts.
Sediment trap	Built-in on fuel filter
Fuel filter	Equipped with replaceable element
Injection pump	
Make	C.A.V.
Type	D.P.A.
Governor	Mechanical
Mixture ratio	11.4 cm. in 300 revolutions 600 c.p.m.
Maximum full load engine speed	2,250 r.p.m.
High idle r.p.m. (no load)	2,370 r.p.m.
Direction of rotation (looking coupling)	Clockwise
Code number on identification plate	90 01 005 8 2389
Synchronization with engine (static in position advance)	20° before T.D.C.
Low idle r.p.m.	600 ± 50
Injectors	
Operating pressure	185 atmospheres
Cold weather starting auxiliary device	Electric heater in the intake manifold

DESCRIPTION

In the fuel system the fuel is sucked up by the mechanically operated feed pump, which supplies it at low pressure, through the filter, to the injection pump. This component distributes the fuel at high pressure to the injectors. The moving parts of the injection pump are lubricated by the fuel which passes through it and do not require any additional lubrication. The fuel leak pipe allows the excess fuel which was not injected to return to the filter.

The cold weather starting heater is fed by means of the fuel leak pipe. The clamp nuts/bolts must be checked when servicing any component of the fuel system. All plugs and sealing strips should be kept on hand so as to stop up the fuel connections as soon as any one of them is disconnected. Do not use rubber, lead or fire-releasing tape to close any part of the system.

AIR FILTER (Fig. 1)

The air cleaner or filter is of the oil bath type and is located in the front part of the engine, behind the front grille and above the battery. It is equipped with a centrifugal type prefilter. The higher-than-average air filtration performance provided by this unit is due to the use of cyclofiltration, which allows the greater part of the particles which are carried in suspension in the air to be deposited. The only maintenance which the prefilter requires is emptying from time to time during the day.

The air passes through the prefilter and enters the cleaner by the centre pipe. On reaching the bottom it displaces the oil contained in the lower cup in order to pass to the cleaner elements. The centrifugal force resulting from the sudden change of direction of the air when it meets the oil, projects a large number of particles into it.

The air continues towards the upper part of the cleaner through the elements which complete the filtration of any possible remaining particles.

The oil and particles drawn by the air towards the elements return to the cup where the particles sink to the bottom by sedimentation. In this way the filtered air reaches the upper part of the cleaner and then goes on to the inlets of the engine intake manifold.

The air cleaner requires constant regular attention if its efficient operation is to be assured. Negligence with the cleaner can impair the performance of the engine.

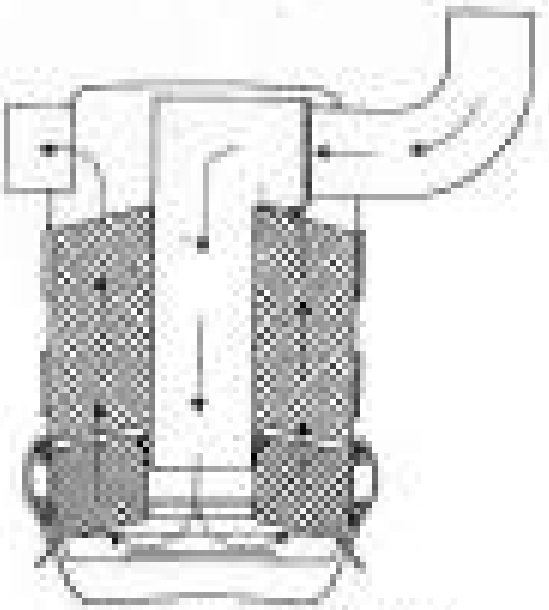


Fig. 1 — Cross section of the air cleaner

The air cleaner cup must be removed, cleaned and filled with new oil up to the oil level mark, every ten service hours or every day.

Attention must be given to the hose and clips which join the filter outlet to the engine intake manifold, since any defect in these components would cancel the effect of the air filter.

Fuel tank

The fuel tank has a capacity of 68 litres and is mounted in the upper part of the tractor, in front of the steering column. This ensures a constant flow of fuel by gravity under all conditions. The tank is mounted on rubber dampers secured by screws. The fuel shut-off cock is located at the bottom of the tank and has a built-in pipe mesh filter. The filler neck, located at the top of the tank, is provided with breather vent cap.

Fuel pump Model 900

The fuel pump is of the mechanical diaphragm type, driven by the engine camshaft. This pump has a built-in manual primer and a direct-viewing sediment cup through which accumulated water and sediment can be removed. The pump is mounted on the lefthand side of the engine, between the fuel shut-off cock and the filter. A wire mesh strainer, located above the sediment cup, protects the anti-return valves located in the upper pump body assembly.

Fuel pump Model 950

The fuel pump is of the mechanical diaphragm type, driven by the engine camshaft. The pump is mounted on the right hand side of the engine between the fuel shut-off cock and the filter, and is equipped with a manual primer. A wire mesh strainer, fitted between the fuel pump cover, protects the anti-return valves located in the pump body.

Fuel filter

The fuel filter is mounted between the fuel pump and the injection pump. This filter prevents the delicate components of the injection equipment from wear, dirt or foreign bodies that might be present in the fuel. Careless filling may overload the filter and impair its operation. On Model 950, the lower part of the filter is composed of a sediment cup with drain cock through which accumulated water and sediment can be removed. The filter element of the replaceable cartridge type, must be changed for a new one every 600 working hours. Do not try to clean or wash it as the used element must be discarded.

Fuel injection pump

The fuel injection pump of the C.A.V. type, is a rotand, high pressure unit with a built-in mechanical governor controlled by a gear from the engine timing case. If the correct, clean fuel is used and attention is given to the fuel filter, the injection pump should give rise to very few problems. When servicing the injection pump, follow the recommendations given on pages 11 to 16.

Fuel injectors

The fuel injectors spray the engine combustion chambers with the required amount of fuel according to the speed of the engine. The operating pressure of the injector is 130 atmospheres. Do not attempt to service the injectors without adequate preparation and the use of suitable equipment. It is advisable to service them at least once every 500 working hours. They will require more frequent attention if the fuel is not kept sufficiently clean or if the engine cooling system is not properly protected to.

Cold weather starting heater

To make cold weather starting easier, there is a thermal heater fitted on the engine intake which facilitates the preheating and priming of the intake manifold and combustion chambers. The first clockwise movement made by the starter switch turns the device on. A second movement in the same direction switches on the heater mounted in the intake manifold, so that the heater coil produces a glowing which causes the fuel valve to rise. At the same time a small amount of fuel flows from the fuel lock pipe through the heater where it is vaporized and then ignited by the heater coil. A third clockwise movement made by the starter switch actuates the starter motor and the ignited fuel is drawn inside the engine. The operation of the heater may be checked by removing the plug (A, fig. 2) from the heater manifold (B, fig. 3).

Fig. 3 — Cold weather starting device

If the device is operating correctly, shortly after it has been turned on by the starter switch, the flame which is produced inside the manifold by the combustion of the diesel fuel may be observed through the plug hole.
If the thermal heater is defective it cannot be repaired.

TO REMOVE AND INSTALL THE AIR CLEANER OIL PAN (fig. 3)

— Remove the horn grille from the bonnet.

— Undo the three clips (A), disengaging the pan (B) and filter element (C).

— Assembly is reverse order, making sure that the oil pan is clean and filled with new oil up to the level indicated.

— Before fastening the clips, check the correct placement of the components so as not to damage the rubber seal which ensures the tightness of the cleaner.

NOTE — It is very important to keep the air cleaner clean to prevent engine performance from being adversely affected.

Fig. 3 – Maintenance of the air cleaner

Fig. 4 – Removal of the air cleaner

REMOVAL AND INSTALLATION OF THE AIR CLEANER ON THE TRACTOR (Fig. 4)

— Disconnect the rubber tube (A) that goes from the air cleaner to the intake manifold.

— Remove the muffler and the air cleaner holder strap (B).

— Take out the four cleaner clamp (D) set screws (C). Install the cleaner by following the procedure in reverse order.

REMOVAL AND INSTALLATION OF THE FUEL TANK ON THE TRACTOR

— Remove the hood and instrument panel.

— Remove the steering wheel.

— Close the fuel shut-off cock and disconnect the pipe from the fuel pump to the shut-off cock at the cock.

— Disconnect the injector fuel leak pipes and the additional heater wiring (304).

— Take out the four screws that secure the fuel tank lock brackets.

— Remove the fuel tank.

To install the tank, carry out the above procedure in reverse order, making sure that the rubber dampers are placed between the tank and the brackets.

TO REMOVE THE FUEL SHUT-OFF COCK FROM THE TANK

— Disconnect and plug (at the shut-off cock end) the pipe which goes from the fuel shut-off cock to the fuel pump.

— Drain the fuel tank.

— Unscrew the fuel tank shut-off cock completely.

TO REMOVE AND INSTALL THE FUEL PUMP (Fig. 5)

— Close the fuel shut-off cock.

— Disconnect the intake and outlet pipes, plugging their ends to prevent the entry of foreign matter.

— Remove the two nuts and washers which secure the pump to the valve lifter inspection cover.

— Remove the pump, spacer ring and gasket.

Install the fuel pump to the engine by inverting the above procedure making sure that the pump flange face and the one in the inspection cover are clean.

Fig. 5 – Removing the fuel pump

Testing a newly installed fuel pump

— Disconnect the outlet pipe from the pump to the filter, providing a free outlet from the pump.

— Crank the engine and check if there is a well defined jet of fuel from the outlet once every four revolutions of the engine.

Alternatively this operation can be carried out with the manual primer, which would give the same result every time the primer is actuated. However, it might happen that the engine stops in a position that causes the cam which allows the fuel pump to be in an over-lighter position, thus making it impossible to operate the manual primer. If such a situation arises, the solution is to crank the engine for one complete revolution.

Testing the fuel pump before installation

To test the fuel pump off the tractor, first operate the manual primer, moving the diaphragm to the limit of its travel downwards, and seal or block the outlet hole with your finger. If the valves or the diaphragm are defective, the diaphragm will immediately return to the upper limit of its travel when the manual primer is released. When placing your finger in the inlet hole and operating the manual primer, a certain depression and resistance to its movement should be observed. When the manual primer is operated with the intake and outlet holes kept free, a characteristic sound should be heard. It should be kept in mind that when the manual primer is operated by hand, it may be applying a greater travel to the diaphragm than it normally would when mounted on the engine.

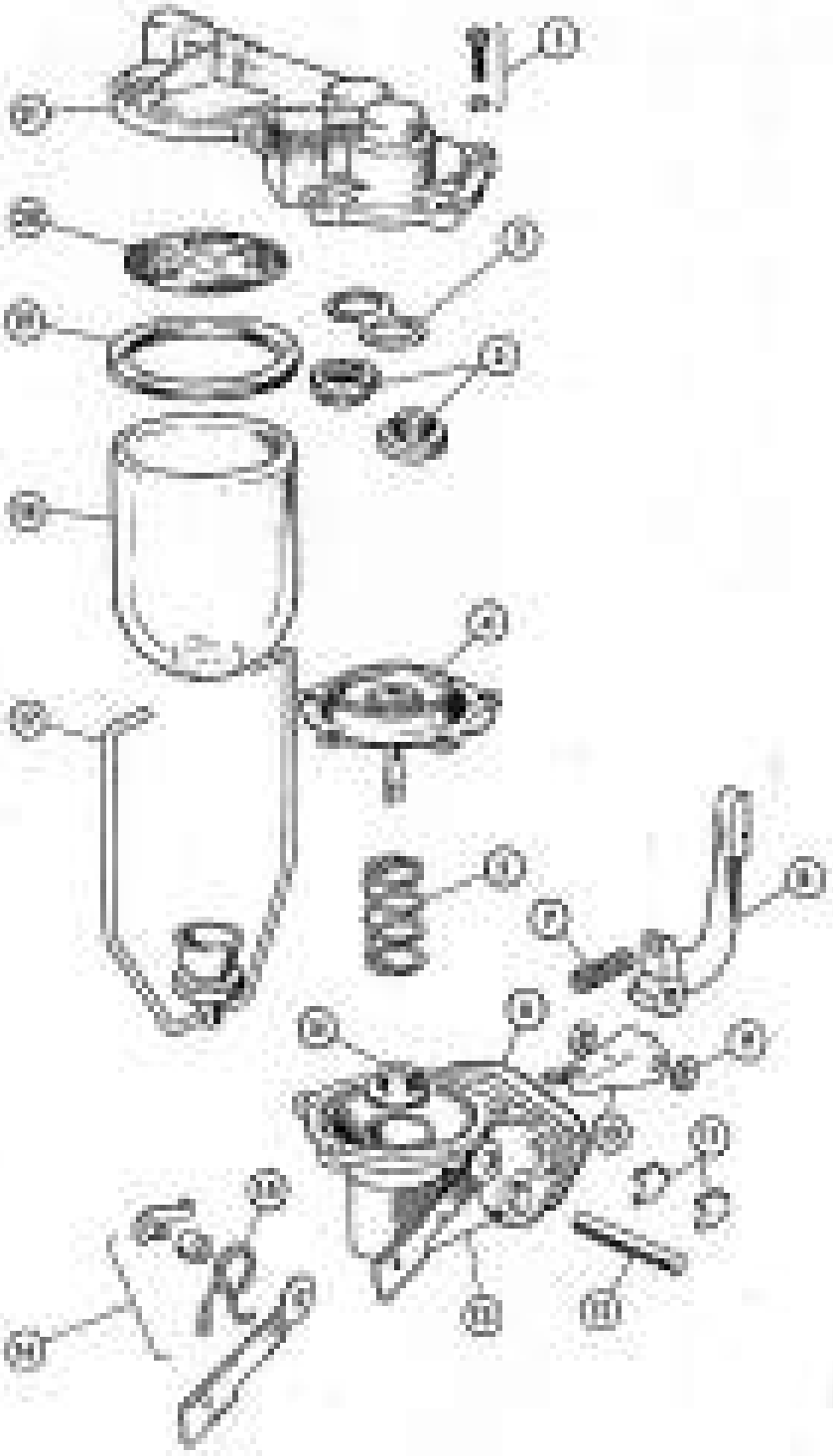


Fig. 9 — Fuel pump Model 288

Exploded view of the Model 280 fuel pump (Fig. 6)

1 — Screw and washer
2 — Cover
3 — Gasket
4 — Diaphragm
5 — Diaphragm spring
6 — Gasket
7 — Rocker spring
8 — Rocker
9 — Washer
10 — Lever
11 — Rocker pin retainer
12 — Rocker pin
13 — Lower pump body
14 — Intermediate washer
15 — Manual primer spring
16 — Gasket
17 — Sediment cup clip
18 — Sediment cup
19 — Gasket
20 — Strainer or sieve filter
21 — Upper pump body

Exploded view of Model 280 fuel pump (Fig. 7)

1 — Screw
2 — Washer
3 — Top cover
4 — Diaphragm
5 — Gasket
6 — Gasket
7 — Lower pump body
8 — Rocker pivot pin
9 — Valve
10 — Diaphragm
11 — Diaphragm spring
12 — Lower pump body
13 — Lever
14 — Lever pin
15 — Rocker
16 — Spring
17 — Manual primer pin
18 — Sealing ring
19 — Manual primer spring
20 — Manual primer

DISASSEMBLY AND ASSEMBLY OF THE FUEL PUMP Model 280 (Fig. 6)

— Remove the fuel pump from the engine.
— Thoroughly clean the outside of the fuel pump.
— Remove the clip (17), the sediment cup (18) and the metal strainer or sieve (20).
— Mark the top cover and the lower body with a line to be re-ensure correct assembly.
— Take out the five screws and their washers (1) which secure the top cover to the body of the pump.
— Separate the cover and the body.
— Turn the diaphragm (5)* and remove it (4), the spring (6) and the washer (16). If the diaphragm is defective, it must be replaced with a new one. At the same time, if there is any sign of either of the two springs (6 and 7) being damaged or rusted or of the rocker (8) and the lower body being damaged, replace them as well.

NOTE. — Wear in the rocker arm of the pump cam may be disregarded provided that it does not exceed 0.25 mm. Bear in mind that accumulated wear in the cam arm, pin, diaphragm rod and pin linkage can absorb a considerable amount of the rocker travel, thereby reducing the movement of the diaphragm and impairing the efficiency of the pump.

Valve assemblies cannot be repaired. If a valve is defective it must be replaced by a new one. Before installing a new valve, first be sure to dip it in petroleum. If the diaphragm assembly does not work properly it is best to fit a new one.

To assemble fuel pump, carry out the above procedure in reverse order.

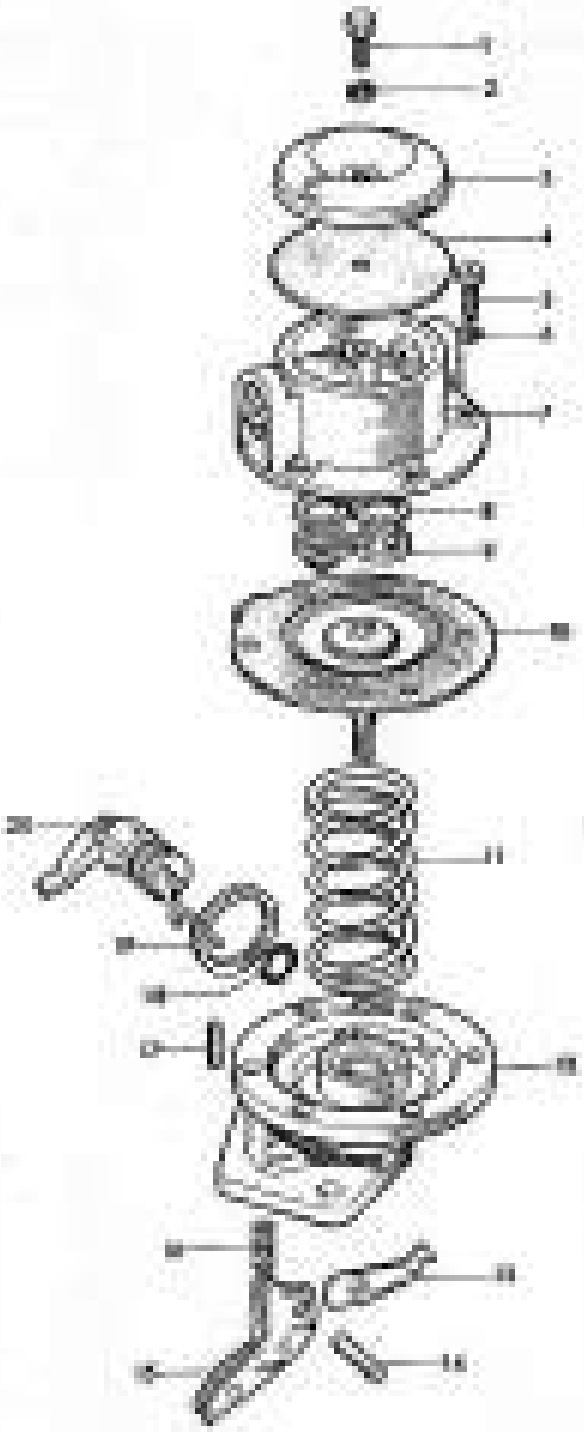


Fig. 7 — [illegible]

DISASSEMBLY AND ASSEMBLY OF THE FUEL PUMP Model MB (fig. 7)

— Remove the fuel pump from the tractor.
— Thoroughly clean the outside of the pump and mark the upper and lower pump body flanges to ensure reassembly in the same position.
— Take out the screws (1) and the washer (2) which secure the cover (3) on the upper body (7) and remove the cover and diaphragm (4). If the diaphragm is not in good condition, it should be replaced by a new one.
— Take out the six screws (5) and washers (6) which secure the upper to the lower body and separate them.
— Very carefully remove the valves (8) from their housing in the upper part of the pump. If the valves are defective replace them. Take out the gaskets (9). Assemble the new valves and gaskets in reverse order. To seat the valve in its housing, use an appropriate punch to four points of the upper body.
— Remove the lower body (10) and the diaphragm to see if it has become hard or cracked and replace it if necessary. At the same time, check the diaphragm pull rod.
— Remove the spring from the lower body of the pump (11) and examine it to see if it is twisted or warp. If the spring has to be changed make sure it is replaced with one of the same characteristics.
— Remove the pin (12), the washer (13), the spring (14) and the linkage (15) from the lower body. Check to see if the parts are worn and replace them if necessary.
— Check to see if the upper and lower body flanges are warped. Lightly polish the wet faces if necessary.
— To assemble the pump follow the disassembly procedure in reverse order, taking care that the edge of the diaphragm (4) is flush with the flanges of the pump bodies. If it projects, this is a sign that it has not been correctly assembled. Special care must be taken to maintain pressure in the gasket and when finally tightening the diaphragm set screws.
— After locating the pin (14), which must be flush with the pump body, use an appropriate punch in three points around the pin so as to secure it.
— After testing the working of the pump, mount it on the block according to previously described procedures.

REMOVAL AND INSTALLATION OF THE FUEL FILTER

— Disconnect and plug the fuel pipes at the filter end.
— Remove the set screws and take out the filter.
— Install the filter in reverse order.

To change the fuel filter element (figs. 8 and 9)

— Remove the bolt (4) from the upper centre of the filter head.
— Separate the filter body (6) from the head (5).
— Check to see if the gaskets are deteriorated.
— Assemble in reverse order, making sure the gaskets are correctly located.

the fuel flow of the Model 480 has a built-in settling cup in the form of a transparent glass (3). Its purpose is to drain off the impurities not retained in the fuel pump. To remove any impurity, sediment or accumulation of resin, it is only necessary to unscrew the ring nut (2) and let the contents drain from the bowls by gravity.

Fig. 5 — Draining fuel from transparent bowl (3)

in the Model 350 tractor, the sediment cup is located on the fuel pump intake. To remove the cup, loosen the nut of the clip (1, fig. 6) and once it has been removed separate the cup (3, fig. 6), the retainer or sleeve (2, fig. 6) and the gasket (4, fig. 6), all of which can be easily cleaned. Assemble by following the procedure in reverse order.

Fig. 6 — Changing fuel filter element Model 480

TO REMOVE THE INJECTION PUMP FROM THE TRACTOR

If it is necessary to remove the injection pump from the unit, proceed according to the following instructions:

- Remove the high pressure pipes between the pump and the injectors, plugging the holes to prevent the entry of foreign matter.
- Remove the low pressure fuel pipes from the intake and outlet connections and plug the holes.
- Disconnect the shut-off and throttle controls and their linkage/rings.
- Remove the screws and washers which secure the injection pump on the mounting flange.
- On a DEPO Model 350 remove, through the inspection cover located in front of the timing gear, the three screws that secure the pump fish plates on the timing gear.
- Mark the position of the control gear to see if it should change position in the event of a wrong connection.
- Carefully take out the injection pump.

TO INSTALL THE INJECTION PUMP IN THE TRACTOR

- Carefully clean the surfaces which have to be in contact with the injection pump and its coupling.
- Set the pump (fig. 11) in place, making sure that the link pistons hole is correctly lined up with the timing gear pin.

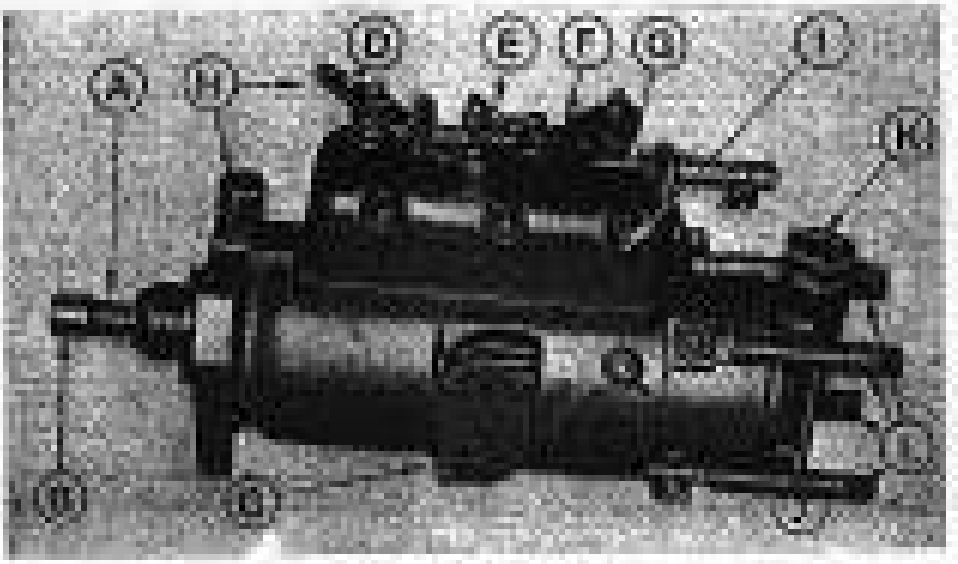


Fig. 9a - Fuel injection pump

A – Drive shaft
C – Drive shaft spline
D – Governor cover
E – Speed/Load control lever
F – Idling screw
G – Throttle control lever
H – High idle adjustment screw
I – Cover plate
K – Injection pump/throttle lever
M – Fuel inlet/filter cover
N – Control rods
O – Outlets to injectors

— the tab piston hole exposes, by means of the timing gear pin, that the pump can only be placed in one position when adjusting.

— When the hole and the pin are correctly lined up, pressure can be put on the pump until the lock flanges match and the lock hole and respective washers can be assembled.

— Before finally tightening, it is necessary to align the pump/casing marks, as is shown in fig. 10.

— Once both marks match, tighten the nuts.

— Assemble the low pressure pipes in their respective fuel intake and outlet connections.

— Assemble the high pressure pipes.

— Re-connect the shut-off and throttle controls with their return springs.

— Eliminate air from fuel system.

INJECTION PUMP SETTING

If the timing order has been followed according to the marks on the timing gears and on the assembly flanges, which should be correctly aligned (fig. 10), then the fuel injection pump setting will be correct.

A further check is possible using the injector adjustment marks on the inside of the pump body.
In order to be able to see these marks, the inspection cover must be removed (C, fig. 9a).

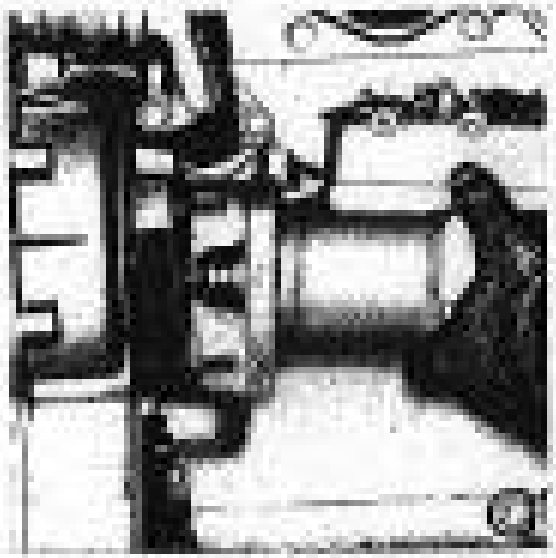


Fig. 11 – Isolating the injection pump

Fig. 12 – Engine adjusting nuts on pump and flange

It must be remembered that in order to gain access to these injector adjustment nuts, the rear fitted oil filter cover must be broken. Therefore, once the necessary checks have been made, the pump must be sealed again with identifiable seals.

After first removing the inspection cover, proceed as follows:

– Turn the engine until the piston is at T.D.C. on the compression stroke.

– Loosen number 1 cylinder exhaust valve adjustment screw sufficiently to allow the rocker arm to be moved to one side and the push rod to be taken out. Turn the rocker arm on the shaft so that the valve spring is accessible for use of valve extractor.

– Remove number 1 exhaust valve spring and allow the head of the valve to rest on the piston head.

– Mount a dial gauge on the end of the valve stem (see Fig. 13) and adjust to zero on the maximum lift point obtained in turning the engine, provided that T.D.C.

– Turn the engine in the OPPOSITE direction to that of normal rotation until the piston and valve have travelled a distance of: 0.24 mm (Model 308 and 8 mm Model 400) downwards in the cylinder.

– This is the equivalent of an angular movement of the T.D.C. to the B.D.C. of the flywheel of 24° (Model 250 and 29° (Model 350 and represents the exact working point. However, to prevent it is advisable to turn the engine beyond this point, that is, 1.20 mm and then adjust to 0.24 mm (Model 308 or 8.48 mm and return to 8 mm (Model 400 in the normal direction of rotation. This will eliminate any error due to the normal timing gear clearances.

– When this point of static adjustment has been determined exactly, the mark «O» (Model 350 or «S» (Model 400 on the injection pump impeller should be aligned with the straight end of the adjustment ring (Fig. 14).

– If so, the pump adjustment is correct. If this is not so, do not attempt to move the ring inside the pump, as this will not alter the adjustment at all. If it were moved it would then be necessary to remove the pump from the engine and place the ring correctly on a test bench.

Fig. 13 – Setting injection pump adjustment

Fig. 14 – Lever and fine bushed on pump impeller aligned with mag slot

– To complete adjustment, in the case in which it is not yet carried, proceed as follows:

– Loosen the nuts which secure the injection pump on the reversing flange and turn the body of the pump in the opposite direction. If after carrying out this last adjustment, the adjusting marks are not aligned, mark new pins on the injection pump flange and remove the old ones.

– Once the injection pump adjustment has been completed, turn the engine in the opposite direction to that of normal operation until the piston has moved 6.84 mm (Model 3B/6 or 8 mm (Model 4B/8, in order to check that the straight part of the ring slot is now aligned with the mark on the impeller.

– Once the injection pump adjustment has been correctly carried out, slowly turn the engine in the normal direction of rotation until number 1 piston reaches T.D.C., in order to remove the dial gauge and reassemble the valve springs.

– TAKE CARE not to turn the engine backwards in the opposite direction, since this would cause the exhaust valve to fall inside the cylinder and make it necessary to remove the cylinder head to get it out.

– Fit guard rail, locate rocker arm cartridge and adjust valves again.

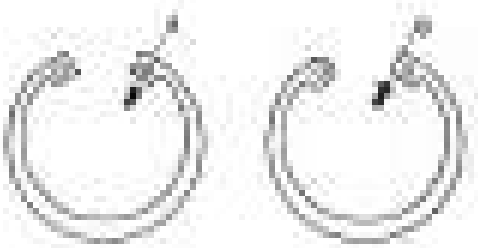


Fig. 15 – Starting engine by hand
A and B – Points of alignment with impeller lever

HIGH IDLE ADJUSTMENT

To adjust the high idle (without load), the code number stamped on the injection pump characteristic plate should be taken as reference. The last four figures of this code correspond to this speed. Code example: IDF 521/7000/1300 (Model 998) and IAP 021/6000/2000 (Model 665); with these codes it would indicate that the engine should turn at a maximum of 3,300 r.p.m. and 2,300 r.p.m., respectively.

Adjustment of this speed has to be made by means of the high idle screw (3), fig. 10, bearing in mind that this screw is sealed and that therefore, should an engine require adjustment to this request, it will have to be sealed again once duly operation has been carried out.

The engine must not be allowed to operate at a speed above the specified one or serious damage will result.

To carry out this adjustment, proceed as follows:

- Check for possible leaks in the fuel system and correct them if there are. Make sure that there is no air in the system.
- Run the engine under fast until normal operating temperature is reached.
- Put a tachometer with appropriate extension and adapter in the center of the crankshaft pulley set screw.
- Accelerate the engine until the maximum r.p.m. indicated on the injection pump characteristic plate is reached. If the speed does not reach the figure, turn the high idle adjustment screw (3), fig. 10, counterclockwise until the applicable speed is obtained. Once adjusted, check it with the tachometer and seal the adjustment screw again.

LOW IDLE ADJUSTMENT

To adjust the low idle r.p.m., first run the engine till it reaches normal operating temperature. Then act the adjustment screw (4), fig. 10, which acts as stop for the throttle lever located above the governor cover, so that the engine turns at a minimum r.p.m. of 800 ± 50 r.p.m. (Model 998) or 600 ± 50 r.p.m. (Model 665). By turning the screw clockwise, engine speed is increased and by turning it counterclockwise, it decreases.
A new engine cannot be expected to idle perfectly until the machined surfaces have had time to adapt themselves to one another properly.

TO REMOVE AND INSTALL THE INJECTORS

- Disconnect and remove the fuel injection pipes from the injectors and plug them.
- Remove the fuel leak pipe.
- Remove the two nuts and flat washer that secure each injector.
- Take out the injectors gently and evenly.

When installing them, review this procedure, making sure to always change the copper washer and to have the bolts nuts correctly tightened.

TO TEST THE INJECTOR NOZZLES

An effective method of checking the operation of a suspected defective nozzle is as follows:

— Run the engine over at slightly above idling speed.

— Loosen the injector pipe connections at each injector, in turn.

— An even drop in the engine r.p.m. indicates that the injectors are working evenly. If a uneven drop in the engine r.p.m. occurs when a particular injector connection is loosened, take out the injector for repair or replacement.

When a defective injector is found, it is advisable to take out all the others of the same type for overhaul, testing or replacement.

NOTE. — Do not attempt to service the injectors without appropriate maps and adequate equipment.

TO BLEED AIR FROM THE FUEL SYSTEM

The presence of air in the fuel system will give rise to poor engine performance and prevent starting. For this reason the system must be bled whenever it is handled.

To bleed the system, carry out the following procedure:

— Check that all connections, apart from those that have to be loosened for bleeding purposes, are well tightened.

— Loosen the filter outlet pipe union nut and operate the fuel pump manual primer until fuel runs out through the nut without bubbles. Tighten the union nuts.

— Loosen the two injection pump bleeder valves and operate the manual primer until fuel runs out through both valves without bubbles. Still operating the manual primer, tighten the rear pump valve first the lower then the upper one.

— Loosen the injection pump supply pipe union nut. Actuate the primer handle and tighten the union nut when fuel runs out through the threads without bubbles.

— Loosen the fuel pipe unions to the injectors.

— Set throttle lever at full open position and check that engine shut-off control is fully tightened.

— Operate starter motor until fuel runs out through injector unions without bubbles.

— Tighten fuel line nuts and check that there are no fuel escape leaks through the pipe or union.

NOTE. — If the fuel supply pipe to the unit existing pump holder has been disconnected for servicing or any other reason, it must be bled. To do this, loosen the hexagon pipe union nut and actuate the manual primer until fuel runs out through the threads without bubbles, and then tighten the union nut.

TROUBLE SHOOTING

Problem	Possible Cause	Solution
A. Engine fails to start	1. Incorrect diesel fuel.	Use only recommended fuel.
	2. Fuel does not reach injection pump.	Check fuel lines for blockages.
		Inspect the fuel pump and fuel line unions.
		Check to see if filter is clogged.
		Air bleed system.
	3. Worn injector pumps.	Install new injection pumps.
	4. Injectors not working properly.	Service injectors.
	5. Injection timing incorrect.	Adjustment is correctly.
	6. Cold weather starting device does not work correctly.	Inspect it is heated.
		Inspect connections.
		Check flow of fuel through heater.
	7. Air filter dirty.	Clean it.
		Clean cup and fill up to level mark with new oil.
	8. Exhaust pipe restricted.	Unblock it.

The majority of these faults can be the cause of loss of engine power.

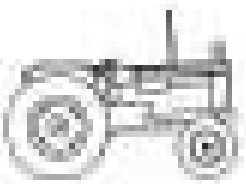
TROUBLE SHOOTING

Problem	Possible Cause	Solution
B. Excessive black smoke	1. Restriction in air supply.	Unblock it.
	2. Excessive fuel.	Adjust fuel maximum correctly.
	3. Injectors not working properly.	Service injectors.
	4. Faulty timing.	Adjust it correctly.
	5. Improper diesel fuel.	Use only recommended fuel.
C. Overheating	1. Faulty timing.	Adjust it correctly.
	2. Injectors not working properly.	Service injectors.
	3. Exhaust pipe restricted.	Unblock it.

SECTION 6:

COOLING SYSTEM

CONTENTS



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SPECIFICATIONS

Type	Water circulation by thermosyphon aided by centrifugal pump and temperature control by thermostat
Height of pump above crankshaft:	
Model 308	282.5 mm
Model 488	297 mm
Radiator	With fins-and-pipes
Fan	With four blades of 412 mm diameter
Cooling circuit capacity	
Model 308	10.5 litres
Model 488	12 litres
Thermostat	
Valve begins to open	79° – 82°C
Maximum opening of valve	89° – 91°C
Fan belt deflection	10 mm

DESCRIPTION

As shown in figure 1, both the components and the fill and oil of the cooling system are to the conventional type. The only attention required for the system is to ensure that there is no obstruction that may hinder the passage of air through the radiator and that the fan belt has the correct tension.

The cooling system water circulates through the action of the pump and thermo-syphon. The thermostat stops off the flow of water towards the radiator and sends it back again to the block until the time when the engine has reached normal operating temperature. The water is cooled by the air which circulates through the radiator. The fan creates a draft or suction effect, which makes the surrounding air pass through the radiator, aided in this action by the fan cowling.

Both radiator and the cylinder block are provided with various plugs for draining the system when necessary.

The radiator filler neck are incorporated a pressure valve which reduces cooling solution evaporation and allows slightly higher temperatures. The filler also incorporates a depression valve to prevent a vacuum from forming when system cooled down.

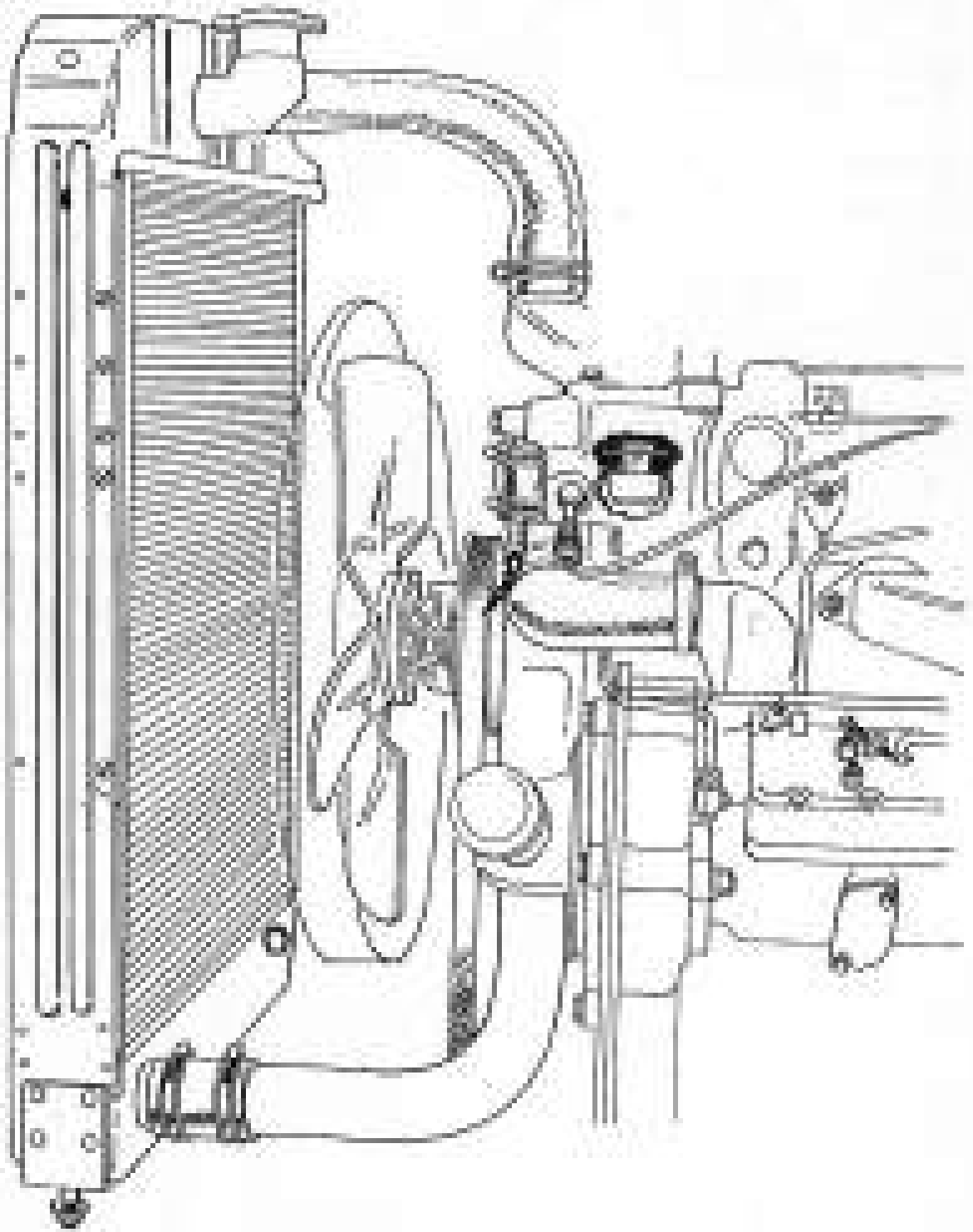

Fig. 1 — Components of the system

REMOVING AND INSTALLING THE RADIATOR (Fig. 2)

To remove the radiator from the unit, carry out the following procedure:

— Remove the bonnet.

— Remove the cap (B) from the radiator (A).

— Remove the drain plugs from:

a) The radiator.

b) The cylinder block.

When draining the system, if anti-freeze solution has been used, it may be collected in a clean container for later use.

— Disconnect the radiator hoses upper (C) and lower (D).

— Disconnect the clean-air-intake manifold hose.

— Remove the top cowling (I) from the radiator (A) by taking out the screws (H).

— Take out the screws (G) which secure the radiator (shroud) to the unit.

— Take out the lower bolts (H) which secure the radiator to the chassis rails.

— Remove the radiator.

To install the radiator, carry out the above procedure in reverse order.

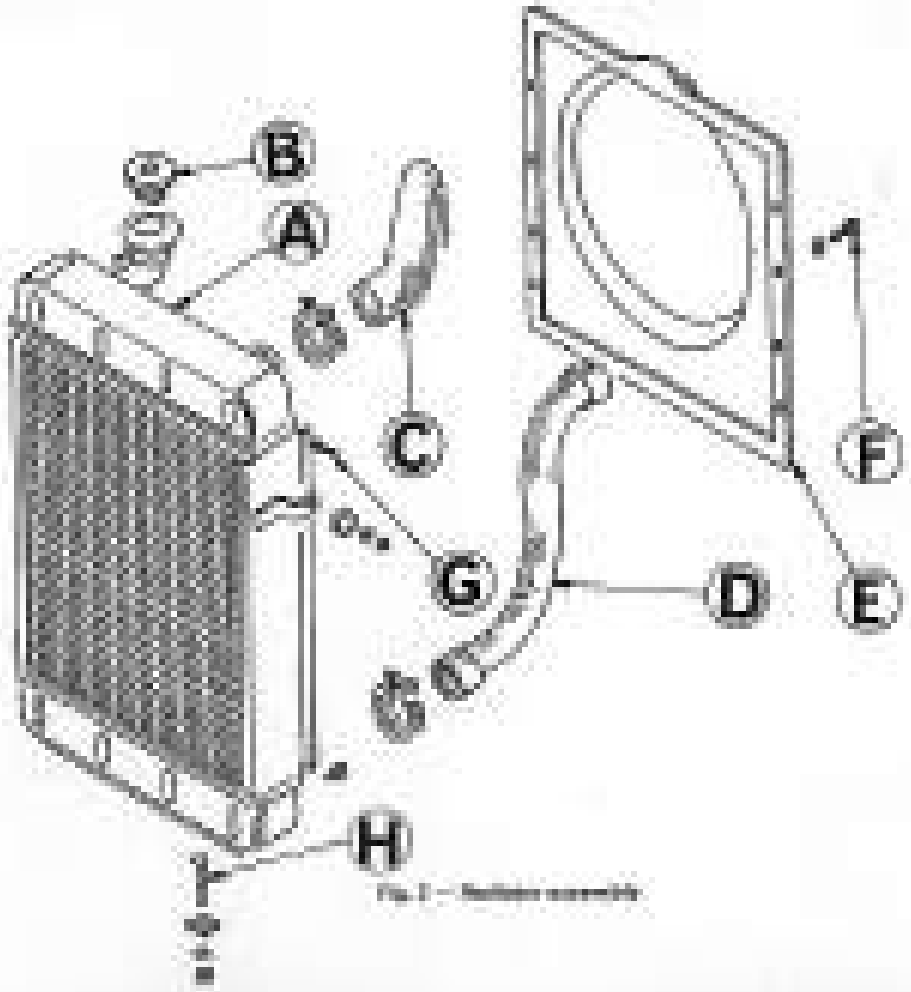

Fig. 2 — Radiator assembly

REMOVING AND INSTALLING THE WATER PUMP

To remove the water pump from the tractor, proceed in the following way:

— Remove the radiator along with the fan cowling.

— Loosen the alternator.

— Take off the fan belt.

— Disconnect the hose that connects the pump to the engine.

— Take out the nuts and bolts that secure the water pump on the timing gear cover. Remove the pump with its gasket.

To install the pump, reverse the above procedure, making sure that the new seal bolts are assembled with their washers.

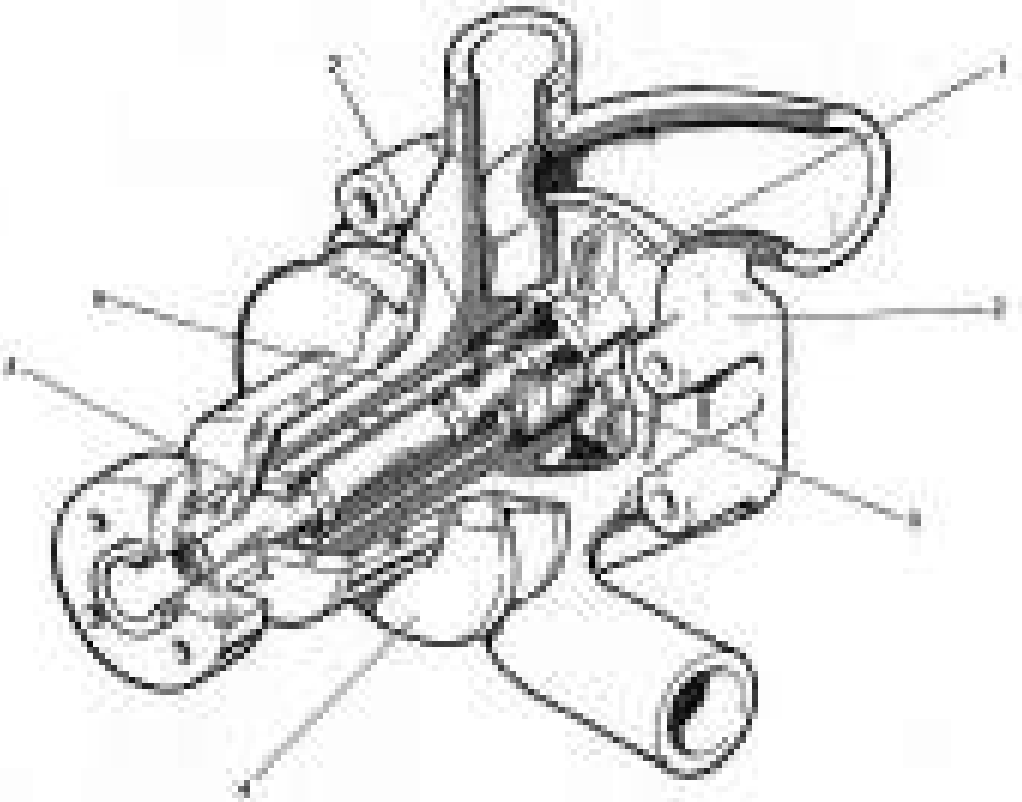

Fig. 4 — Water pump (Model 3M)

1 — Impeller
2 — Pump housing
3 — Bushing
4 — Pulley
5 — Shaft
6 — Bearing
7 — Hydraulic flange

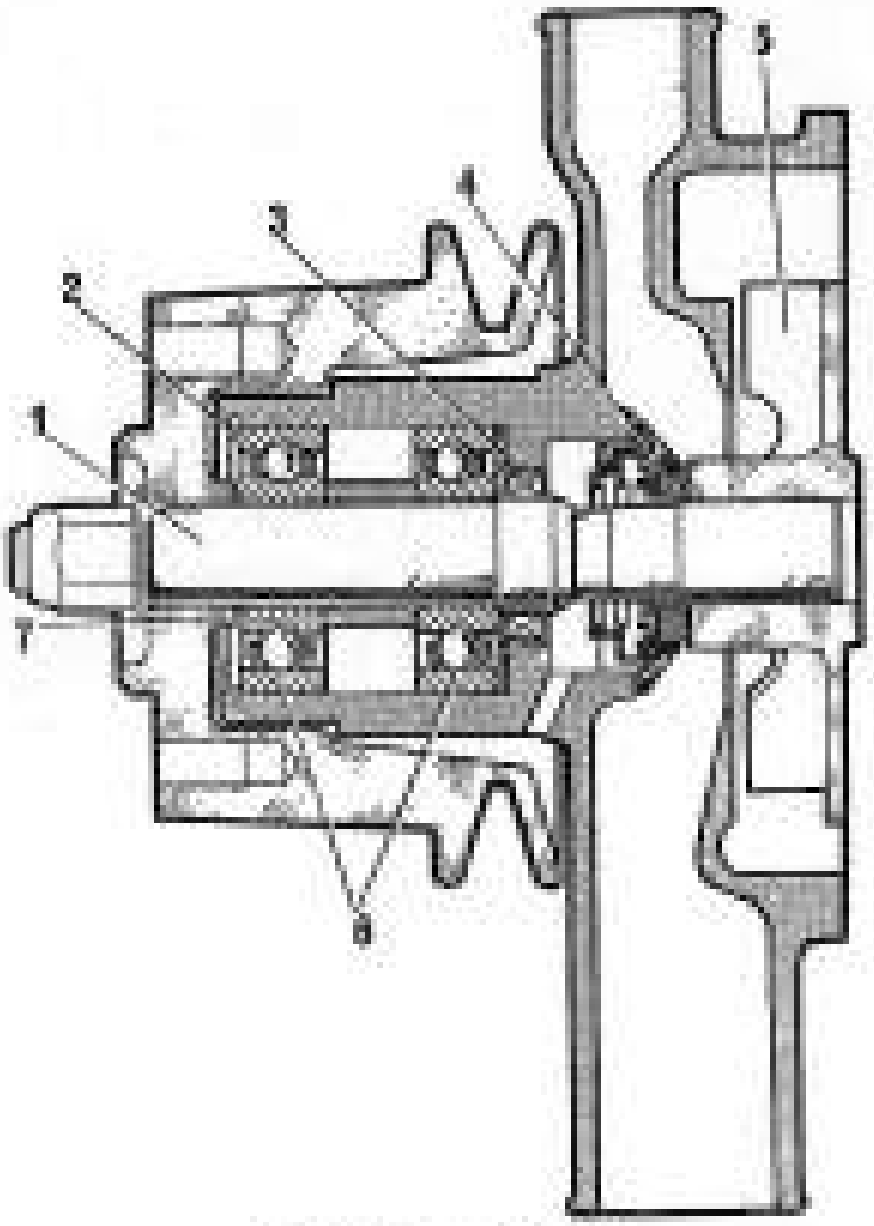

Fig. 4 — Water pump Model 4M

1 — Shaft
2 — Seal ring
3 — Bearing retainer
4 — Pump housing
5 — Impeller
6 — Bearing
7 — Spacer

3 REASSEMBLING THE WATER PUMP
(Overall 308)

To disassemble the water pump, carry out the following procedure:

– Remove the fan after disengaging the pulley set screw locking tabs.

– By means of special tool 318-308 and adaptors MF-308-4 (5 in) SA.C52, remove the pulley from the pump (fig. 6).

Fig. 6 — Removing the pulley

– Using the above mentioned tool and adaptors, extract the bearing shaft from the pump housing by exerting pressure on the end of the shaft for the pulley (fig. 7).

– Take out stainless and impeller with tool MF.308-36 (fig. 7).

NOTE. — The two bearings and the shaft make up a single assembly and cannot be separated.

– Inspect the impeller and pump housing for possible damage or cracks.

– Check to see if shaft is worn or if there is play in the bearings.

If there are obvious signs of wear, replace the complete shaft.

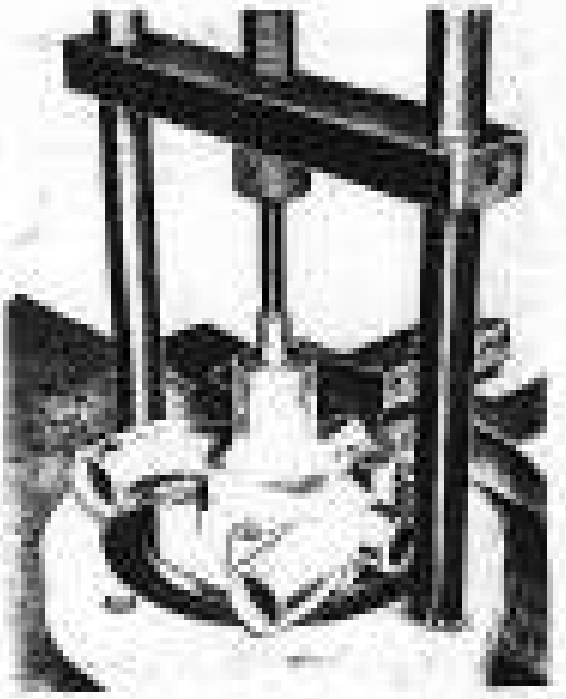

Fig. 8 — Removing the bearing shaft

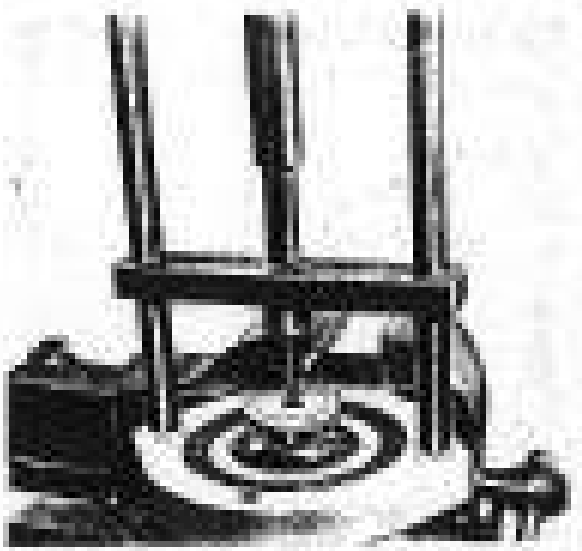

Fig. 7 — Removing the retainer and impeller

ASSEMBLING THE WATER PUMP Model 300

Assemble the water pump in the following way:

— Using tool MF 300, press in the shaft bearing assembly (with the long end of the shaft directed towards the impeller side of the pump) until the bearing is fixed with the pump housing (fig. 8).

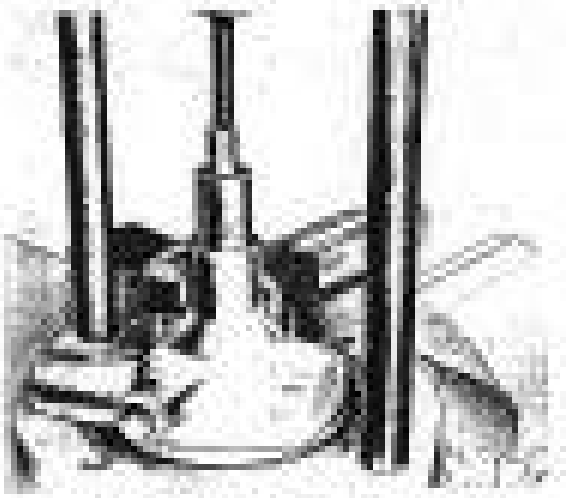

Fig. 8 — Installing the shaft bearing assembly

— Screw the four water pump to timing gear cover set screws.

NOTE. — Use new copper washers and make sure that the longest screw is put in the top right part, sealing an escape from the front.

— Press the pulley onto the front end of the shaft (fig. 9) until the face of the pin is 140,5 mm from the rear of the pump housing.

— Assemble the water distributor flange (with the flange side) front shield.

— Insert the sealing (with thread side towards impeller).

— Press the impeller onto the shaft until there is a clearance of 0,254-0,51 mm between impeller blades and pump surface (fig. 10).

Fig. 9 — Installing the pulley

Fig. 10 — Testing impeller clearance

NOTE. — The boss that forms the back of the impeller has to be flush with rear of pump housing. Make sure that the shaft has no clearance play whatsoever inside the pump housing.

DISASSEMBLING THE WATER PUMP
Model 4M

To disassemble the water pump, proceed as follows:

— Remove the lock nut and washer that secured the pump pulley to the impeller shaft.

— Remove the fan after taking out the few screws that secure it to the pulley (Fig. 11).

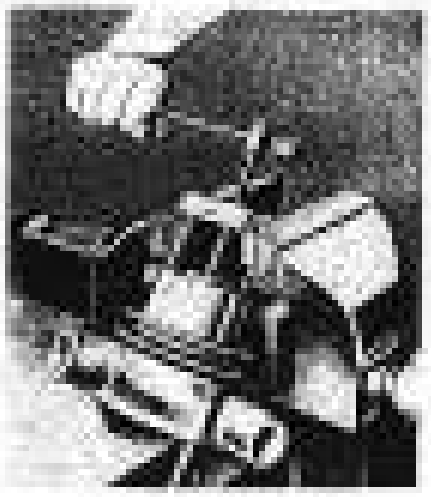

Fig. 11 — Removing the fan

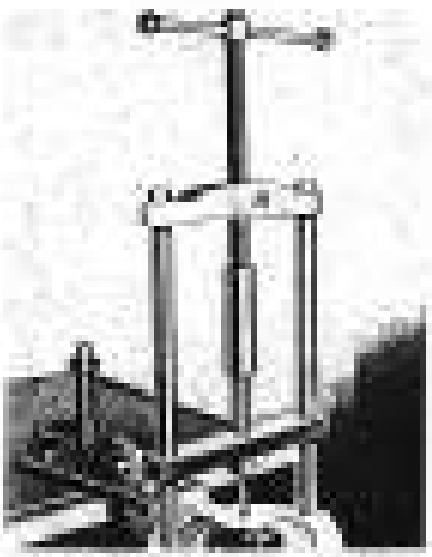

Fig. 12 — Disassembling the impeller and retainer

— Take off pulley, using tool MF-100.

— With help of tool MF-200 and adapter MF-200-4, extract the shaft with the impeller and retainer from shaft (fig. 13).

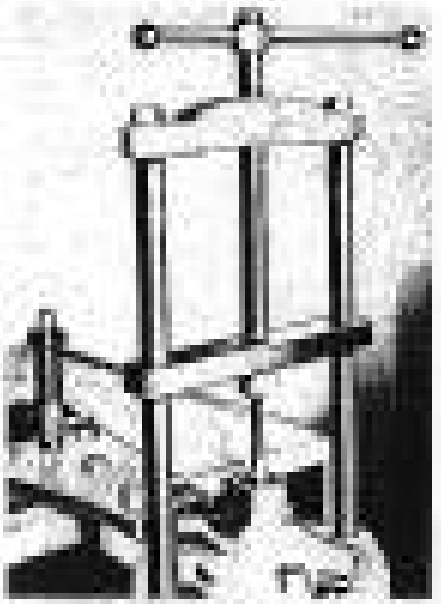

Fig. 13 — Disassembling the pump shaft and retainer

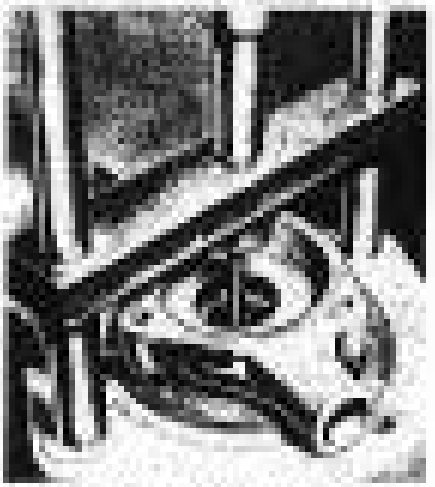

Fig. 14 — Disassembling the impeller, spacer and bearing retainer