Workshop Service Manual

EBRO

TRACTORS

350 AND 460 MODELS

CATION SP-1029-EXP-I

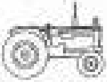
Motor Ibérica

DAVID McNEILL

SECTION 1:

GENERAL INFORMATION

CONTENTS



Publication [illegible]
1st Edition [illegible]

IDENTIFICATION

The identification of the [illegible] 350 and 450 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 frame, adjacent to the back plate.

8TXL97498

Engine Serial number (Fig. 2)

The [illegible] engine of Model 350 bears its own serial number stamped directly in the upper middle part of the left side of the block.

152[illegible]E
2125ODL

Engine Serial number (Fig. 3)

The [illegible] engine of the Model 450 bears its own serial number in the upper rear part of the left side of the block.

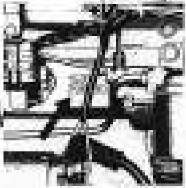


Fig. 2 — Engine serial number of Model 350

Fig. 3 — Engine serial number of Model 450

NOTE. — When making any enquiry, claim or request for information with respect 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.

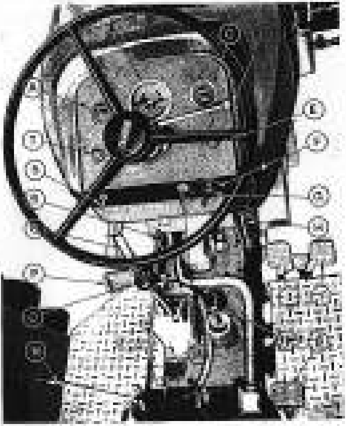


Fig. 4 — Instruments and controls

- [illegible] — Temperature gauge
- [illegible] — Tachometer
- [illegible] — Fuel gauge
- [illegible] — Throttle control lever
- [illegible] — [illegible] control lever
- [illegible] — Light switch
- [illegible] — Horn button
- [illegible] — Power take-off lever
- [illegible] — Right brake pedal
- [illegible] — Left brake pedal
- [illegible] — [illegible] lever
- [illegible] — Differential locking pedal
- [illegible] — Ignition switch
- [illegible] — Auxiliary hydraulic control lever
- [illegible] — Gear shift lever
- [illegible] — Clutch pedal
- [illegible] — Parking brake lever
- [illegible] — Engine cut-out control
- [illegible] — [illegible] switch
- [illegible] — Oil pressure warning light

SPECIFICATIONS

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

Gear box

— Gear ratios

1st	$\frac{16}{33} \times \frac{16}{39} \times \frac{13}{30}$	=	9,20 : 1
2nd	$\frac{16}{33} \times \frac{16}{39} \times \frac{17}{28}$	=	6,18 : 1
3rd	$\frac{16}{33} \times \frac{16}{39} \times \frac{22}{21}$	=	3,82 : 1
4th	$\frac{16}{33} \times \frac{16}{39} \times \frac{25}{16}$	=	3,04 : 1
5th	$\frac{13}{30}$	=	2,30 : 1
6th	$\frac{17}{28}$	=	1,62 : 1
7th	$\frac{22}{21}$	=	0,95 : 1
8th	$\frac{25}{16}$	=	0,65 : 1
Low reverse	$\frac{16}{33} \times \frac{16}{39} \times \frac{15}{22}$	=	6,00 : 1
High reverse	$\frac{15}{22}$	=	2,13 : 1

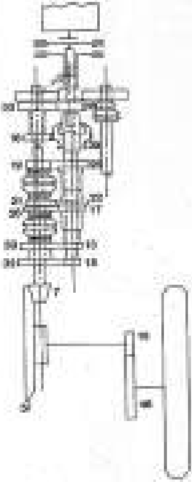


Fig. 8 — Transmission diagram

Rear axle

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

— Pinion-spider wheel reduction: 7,333 : 1 (? pinion teeth – ?? spider wheel teeth)

— Total rear axle reduction: 33,81 : 1

Power take-off

— Position	Rear
— Dimensions	34.9 mm in diameter
— Number of splines	6 (conforming to ISO recommendation)
— Height above the ground	
Model 350	650 mm
Model 450	740 mm
— Distance to the tractor's vertical symmetry plane	8 mm
— Direction of revolution	To the right
— Reduction	$\frac{14}{41} \times \frac{20}{28} = 4.1:1$
— Speed	540 r.p.m. at 2200 r.p.m. of the engine

Weight of the tractor in operating condition (without the driver and with fuel tank full)

— Without ballasting	
Model 350	
Over the front axle	730 kg
Over the rear axle	1,220 kg
Total weight	1,950 kg
Model 450	
Over the front axle	750 kg
Over the rear axle	1,360 kg
Total weight	2,110 kg
— With liquid ballasting and counter-weights	
Model 350	
Over the front axle	1,000 kg
Over the rear axle	1,800 kg
Total weight	2,800 kg
Model 450	
Over the front axle	1,010 kg
Over the rear axle	2,032 kg
Total weight	3,042 kg

[illegible]

[illegible]

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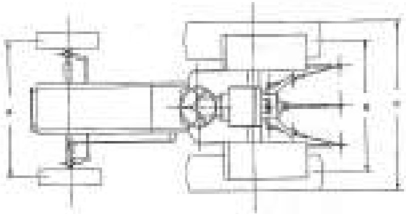

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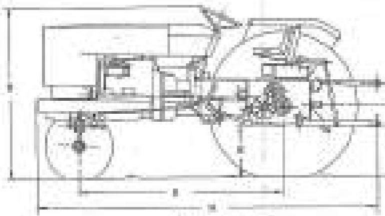

[illegible]

Capacities

Fuel tank	30.0 litres
Crankcase	
Model 350	6.0 litres
Model 460	6.25 litres
Oil filter	0.5 litres
Engine cooling system	
Model 350	10.0 litres
Model 460	13.0 litres
Air cleaner	1.0 litre
Steering box	1.0 litre
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

[illegible]	[illegible]	[illegible]	BP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

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 antifreeze if necessary).

— Check oil cleaner oil level and hermetic 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 free travel of the brake and parking brake pedals.

— Place lifxxx 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

— Clean the centrifugal prefilter of the air 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 fork 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.
- General lubrication in 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 axle spindle bearings.
- Clean and oil accelerator and cut-out (stop) control linkage.

Every 250 hours

- Change crankcase oil and engine filter.
- Check steering box oil level.
- Clean the outside of the radiator honeycomb.
- Clean the hydraulic lift filters.
- Tighten up nuts and bolts in general.

Every 500 hours

- Change fuel filter.
- Clean and test injectors.
- Tighten up cylinder head and manifolds.
- Test and adjust the rocker arms and clean the engine air exhausting tube.
- Clean the cooling system internally.
- Clean the rear axle breather.
- Test the adjustment of the steering linkage.

Every 1000 hours

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

— Clean the hydraulic system filters.

The maintenance operations that the loader requires, which are grouped together in each section, are as follows:

— Empty and clean the fuel tank.

— Check the alternator and starter motor.

SEAT, SHEET METAL AND BODY (Section 2)

— Always keep body parts clean and repaint them as soon as they become scraped or scratched to avoid rust and maintain the good appearance of the tractor.

FRONT AXLE AND STEERING (Section 3)

— Grease the axle pivot pin (Fig. 7).

— Grease king pin bolt (Fig. 8).

— Grease the drag links.

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

— Check or clean and grease the wheel spindle bearings (Fig. 9).

— Test the adjustment of steering linkage.

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

Fig. 7

Fig. 9

Fig. 8

Fig. 10

ENGINE (Section 3)

- Check crankcase oil level (Fig. 11).
- Change crankcase oil (Fig. 12 draining) (Fig. 13 filling) and the engine filter.
- Retighten cylinder head and manifold.
- Check and adjust the rocker arm lash (Fig. 14).

The adjustment of the rocker arm lash when done with a cold engine, is 0.30 mm for both valves. With the engine warm it is 0.25 mm for both intake and exhaust.

- Clean the engine air admitting inlet.

Fig. 11

Fig. 13

Fig. 12

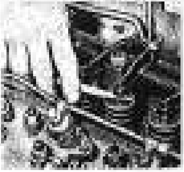


Fig. 14

FUEL FEED SYSTEM (Section 5)

- Clean the oil cleaner prefilter (Fig. 15).
- Check the fuel filter sediment cup (Fig. 16).
- Clean the air cleaner.
- Remove impurities from the fuel filter sediment cup.
- Clean and oil the accelerator and cut-out (stop) control linkage (Fig. 17).
- Change the fuel filter element.
- Clean and test the injectors.
- Drain and clean the fuel tank.

Fig. 15


Fig. 16


Fig. 17


Fig. 18

COOLING SYSTEM (Section 6)

— Check radiator water level.

— Clean the outside of the radiator grille (Fig. 19).

— Flush out the cooling system (fig. 18 block drain plug, but the Model 480 the plug is located behind the starter motor) (Fig. 20 radiator drain plug).

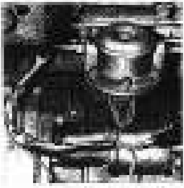


Fig. 19


Fig. 20

CLUTCH (Section 7)

— Grease (rods) and clutch pedal shaft (fig. 28).

— Test clutch pedal free travel.

GEARBOX (Section 8)

— Check the oil level of the gearbox, rear axle and lift (fig. 31). The oil should come up to the level of the plug hole situated on the right side face of the gearbox, below the foot-rest.

— Change the gearbox, rear axle and lift oil (fig. 32 drain plug) (fig. 33 filling hole).

Fig. [illegible]

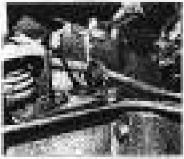


Fig. [illegible]

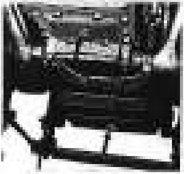


Fig. [illegible]

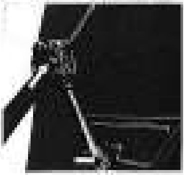


Fig. [illegible]

HYDRAULIC SYSTEM (Section 9)

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

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

— Grease the levelling box (fig. 34).

— Grease lift rods, right and left (figs. 28 and 29).

— Clean the two lift filters (figs. 29 and 33). These two filters are to be cleaned with clean gas oil and dried with air.


Fig. 25


Fig. 27


Fig. 26


Fig. 28

REAR AXLE (Section 10)

— Check oil level of the rear axle, gearbox and lift (fig. 27).

— Clean rear axle breather located above the lift cover.

— Change the rear axle, gearbox and lift oil (figs. 27 and 28).

BRAKES (Section 11)

— Grease the brake and clutch pedal shaft (fig. 28).

— Test brake efficiency and pedal travel.

WHEELS AND TYRES (Section 12)

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

— Test the tire pressure.

— Check the tightness of the wheel nuts.

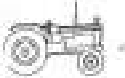
ELECTRICAL EQUIPMENT AND INSTRUMENTS
(Section [illegible])

- Check battery electrolyte level.
- Check or adjust alternator drive belt tension (fig. [illegible]).
- Inspect alternator and starter motor.

Fig. [illegible]

SECTION 2: SEAT SHEET METAL AND BODY

CONTENTS



Publication: [illegible]

1st Edition [illegible]

SEAT

SPECIFICATIONS

Type of seat	[illegible]
Suspension	By helical springs
Type of shock absorber	Controlled by shock absorber

Fig. 1 — Seat

DESCRIPTION (figs. 1 and 2)

The seat is designed to provide comfort 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 tension 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 backlash 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 holder attached to the lift cover are elongated. Loosen and tighten the nut screws once the seat has been set in the most convenient position.

TO REMOVE AND INSTALL THE SEAT

To remove the tractor seat, proceed as follows:

– Loosen the two screws and the bolt nut (E, Fig. 2) and slide the seat forwards (in this way the head of the rear 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. 2 — Removing of the seat

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 swing rods (B).

— The seat back (C) by loosening its set screws.

— The stay bolt (D) of the springs (E) and shock absorber (F).

— The rear knob (G).

— The back support (H) of the springs (E).

— The traveler adjustment rod (I) and the guide clip (L) of the upper fixture of the shock absorber (F).

— The set screws (M) of the seat (N).

— The link bolt (O) and the safety plate (P).

— The link rod (Q).

Once the seat has been taken apart, check the condition of the plastic bushings, rubber stops 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 disassembly procedure in reverse.

Note. — Lubricate the swing rods (B) with oil or graphite grease.

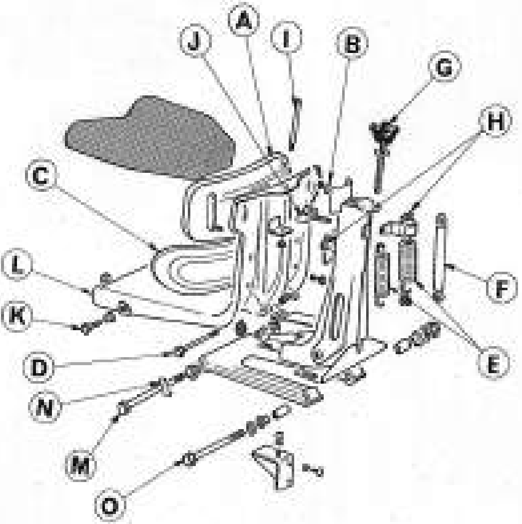


Fig. 4 – Exploded view of the seat

FENDER MOUNTED SEAT (Fig. 8)

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.

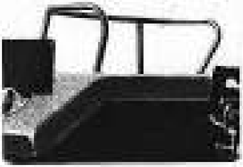


Fig. 8 — Fender-mounted seat

SHEET METAL AND BODYWORK

SPECIFICATIONS

Type of bodywork: Hood with flat fenders and footrests.

DESCRIPTION (Fig. 8)

The plate shows the assembly of the hood (A), front grille (B), front cowling (C), instrument panel (D) and the two fenders (E) which are equipped with a tool box.

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

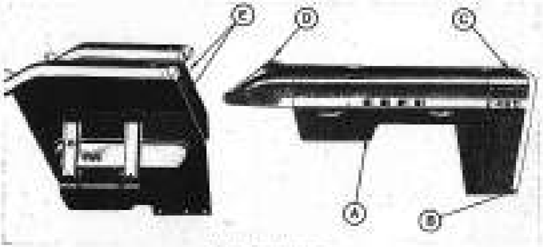


Fig. 8 – Tractor bodywork

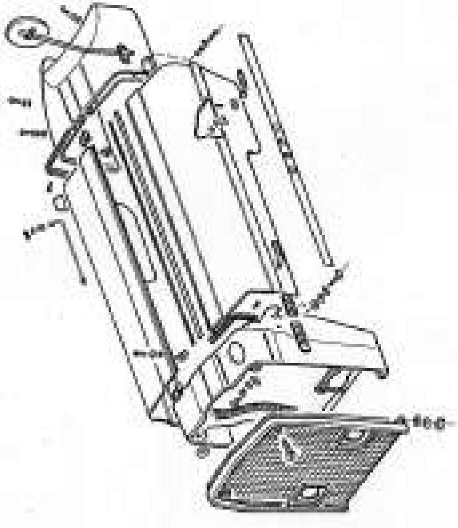


Fig. 7 — Exploded view of the front grille, cowling, hood and instrument panel

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 righthand side of the hood.

— Remove the four screws from their guides.

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

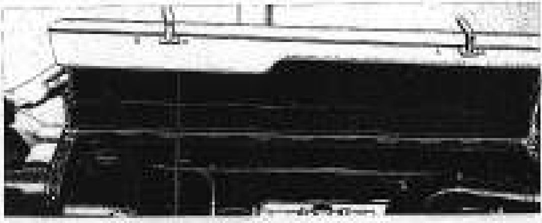


Fig. 9 – Hood attachment screws and guides.

Fig. 12 — 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. 13).

— Disconnect electrical connections of the following:

a) the regulator

b) the horn, as well as its earth wire

c) the front right headlight

— Remove the air pre-filter (fig. 13).

— Remove the cleaner intake elbow (fig. 13).

— Remove the two side cowl-to-radiator set screws (fig. 13) (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 tractor, remove the following:

a) the regulator

b) the air cleaner

c) the horn

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

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

Fig. 11 — Removal of [illegible]

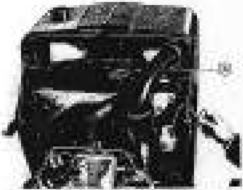


Fig. 12 — [illegible] panel-to-radiator [illegible]

Fig. 14 — Removal of panel-to-chassis [illegible]

Fig. 15 — Taking off the front panel

TO REMOVE AND INSTALL THE INSTRUMENT PANEL

To remove the instrument panel, proceed as follows:

— Remove the knob.

— Loosen the throttle control lever.

Fig. 15 — Disassembly of the panel

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

— Pull the panel towards cable sliding it out (Fig. 16).

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

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 fender-to-footrest set screws (Fig. 18).

— Remove the two set screws of each fender, located inside of the seat frame (Fig. 19).

— Take off the fenders (Fig. 20).

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

Fig. 17 — Connection box

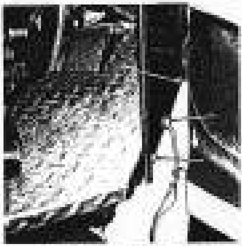


Fig. 18 — Fender to step plate set screws

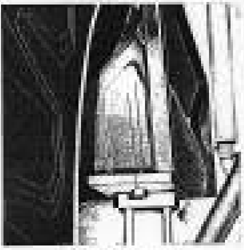


Fig. 19 — Fender set screws

Fig. 20 — Taking off the fender

TO REMOVE AND INSTALL THE STEP PLATES

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

— Remove the step plate-to-fender set screws (Fig. 18).

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

— Remove the step plates.

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

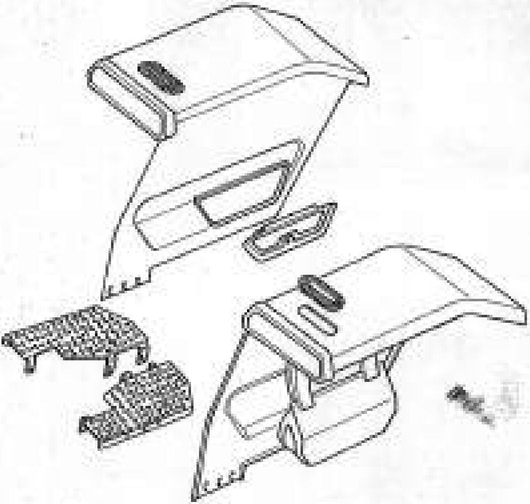
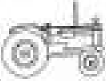


Fig. 21 — Fenders and step plates

SECTION 3:

FRONT AXLE AND STEERING

CONTENTS



Publication SP [illegible]
1st Edition [illegible]

FRONT AXLE

SPECIFICATIONS

Caster angle	0°
Camber angle	2° 30'
Kingpin inclination angle	11°
Toe-in	0 to 6,00 mm
Kingpin diameter	37,95 to 38,00 mm
Kingpin bushing inside diameter	38,00 to 38,05 mm
Diameter of center pivot pin	47,95 to 47,98 mm
Center pivot pin bushing inside diameter	48,00 to 48,05 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 two side rails and is coupled to the engine with four bolts in each rail and six bolts in the cross member itself.

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

ADJUSTMENT OF THE FRONT TREAD (figs. 1 and 2)

The axle side extensions can be moved in gradations of 60 mm per side, which permits the following seven tread widths: 1,29 m, 1,35 m, 1,40 m, 1,48 m, 1,53 m, 1,71 m and 1,87 m.

To adjust the front tread proceed as follows:

— Raise the front part of the tractor.

— Loosen the two clamps (3) which secure the ends of the track rods (4) to the rod forks (5) of the drag links (6). These clamps have a bolt, a castellated nut and a safety cotter pin.

— Take out the bolts which, connected with their respective nuts (1), secure each extension (9) to the center beam (2).

— Place the new extensions at the desired tread spacing at the same time as the necessary adjustments are made on the track rods. For this purpose, the track rods shafts have machined grooves for the different tread dimensions. These grooves fit into the clamp bolts and provide for safe assembly of the track rods.

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

Fig. 1 — Front tread adjustment

Fig. 2 — Front tread adjustment

TOE-IN

The toe-in of the front wheels on the [illegible] 300 and 400 tractors, complies with a standard pre-established production standard, according to the design characteristics of both axles. Its specific value is from 0 to 6.35 mm. As can be gathered from the foregoing, the toe-in is not altered by the different tread adjustments since there is a different track rod length for each tread 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 block under the tractor engine.

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

— Remove the hood.

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

— Drain water from engine and radiator.

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

— Remove all cleaner-to-engine intake manifold hoses.

— Take the front grille off the tractor.

— Disconnect the battery terminals.

— Take out the eight bolts that secure the [illegible] 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.

a) The radiator.
b) The battery, previously moving the front head lamp brackets backwards.
c) The radiator cowl, air cleaner and fuel assembly.

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

Fig. 3 – To remove the front axle cross member assembly

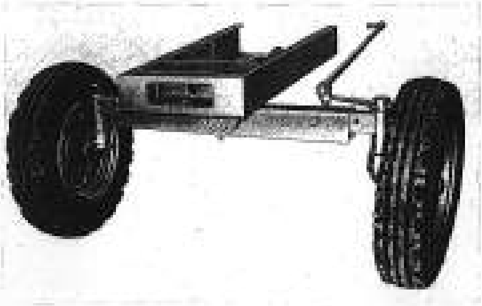


Fig. 4 – Front axle cross member assembly

DISASSEMBLY OF THE FRONT WHEEL HUB ASSEMBLY (Fig. 5)

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 (L).

— Remove the following from the hub: the ball races (H) and (I) of both bearings.

Fig. 5 — Front hub assembly

ASSEMBLY OF THE FRONT WHEEL HUB ASSEMBLY

— Place the ball races in the hub.

— Set the inner bearing in place (G).

— Introduce the retainer (L) 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 3.5 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 that is followed when removing a side extension may also be put to use when 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 blocks 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 kingpin and disengage both parts.

– Take out the king pin retainer (C).

– Remove the blocks 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 hub from the steering swivel can be avoided by disengaging them together and proceeding as follows:

– Remove the three bolts (E) which secure the lower 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 cups are in good condition, replacing them if necessary. To install the side extension, reverse the procedure described above.

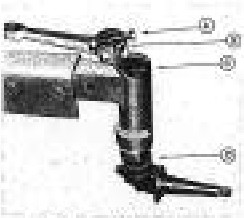


Fig. 6 – Removing a steering swivel

Fig. 7 – Removing a steering swivel-hub assembly

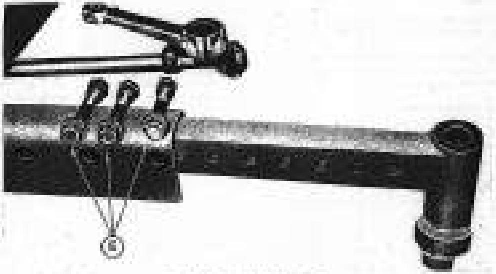


Fig. 5 – Removing axle extension

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 chock up the center beam under both chassis rails.

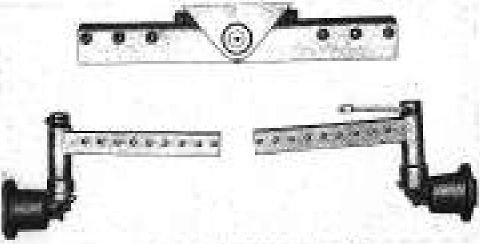


Fig. 6 – Removing and installing the front axle center beam

— Disconnect the steering arm at the drag link.

— Disconnect the track rod at both ends.

— Remove both wheels.

— Take out the [illegible] side extension [illegible].

— Remove both of the side extensions together with their steering arms and hubs.

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

— Withdraw the pivot pin. Being previously secured the center beam and disengage it.

NOTE. — Before mounting the center beam, check the pivot pin housing 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. 3 [illegible]), leave a clearance in (A) of [illegible] to [illegible] 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 [illegible] before assembly, applying a torque of 3 to 4 kg.

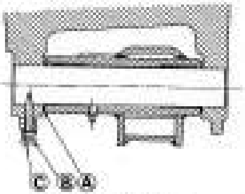


Fig. 3 [illegible] — Mounting of pivot pin

S T E E R I N G

SPECIFICATIONS

Type	Worm and nut recirculating ball system
Center	20.1 : 1
Oil capacity	1 lt.
Lubricant	SAE 90 E.P.
Worm machining	Right-hand thread
Worm bearings	Two radial ball-bearings
Number of upper worm bearing balls	10 Ø 9.52 mm (3/8")
Number of lower worm bearing balls	10 Ø 9.52 mm (3/8")
Number of male worm nut balls	34-7.93 mm (5/16")
Worm adjusting washers	Steel of 0.1-0.15 and 0.20 mm
Stroke net travel	32°
Stroke maximum turn	37°
Steering column gasket	Paper of 0.1 mm
Steering wheel turns from lock to lock	4.8

DESCRIPTION (Fig. 10)

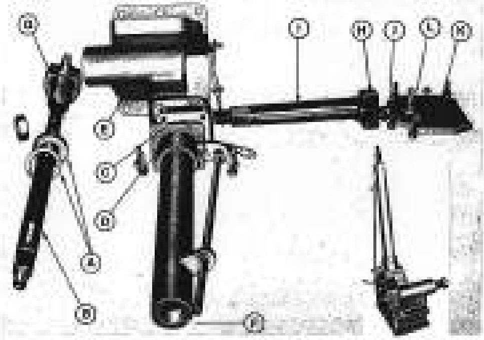


Fig. 10 — Steering assembly

The steering mechanism is of the high performance recirculating ball type and requires 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 neck 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 thirty 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 link (H) of the sector (I) is coupled to the central end of the steering nut. The central end, which stands out from the sector fork, activates the roller (J) which moves longitudinally along the groove in the inner face of the side cover (K).

The function of the roller is to ensure that the steering nut realizes reciprocating motion in a straight line, parallel to the worm shaft, and has the effect of increasing the steering ratio when the steering nut moves away from the position in which the wheels are parallel to the tractor.

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 INSTALL 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 [illegible] cable.
- The fuel tank.
- The throttle linkage.
- The steering arm (use tool [illegible]).
- 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 it as follows:

Remove:

- The side cover and its gasket (fig. 11).
- The steering sector and roller through the side cover housing (fig. 12).
- The steering column and its gasket (fig. 13) [illegible] adjustment shims. They will be needed when installing the steering box again.
- The worm shaft, raising it high enough so its side

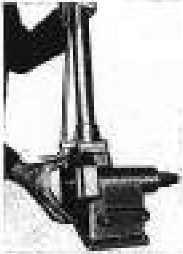


Fig. 11 — Removing the side cover

Fig. 12 — Removing the sector

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

— The worm shaft steering nut (fig. [illegible]), loosening it completely. Be careful with the [illegible] 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 sector shaft housing, the rollers on the sector side and the other components of the assembly. Replace all parts which are defective or worn with new ones.

Fig. [illegible] — Removing the worm shaft

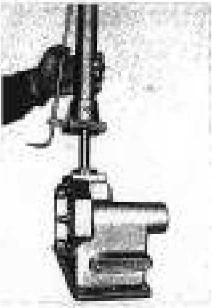


Fig. [illegible] — Removing the column

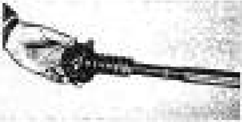


Fig. [illegible] — Removing the steering nut

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, introducing the balls into the guide and transfer tube (Fig. 18).

Fig. 18 — [illegible]

— Place the balls in the bearing race. 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 are not displaced, proceed as follows:

— Set the upper ball race onto the worm shaft, with the ball guide downwards, until it is near its housing 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, put 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 at a 90° angle with respect to the worm, so that the sector finds the central end of the steering nut.

— Fit the roller on the socket edge of the steering nut, which stands out from the sector fork.

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

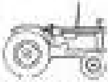
Once the cover has been assembled, turn the worm shaft so that the sector is in a straight position, that is, in the middle of its travel. Check to see if there is any play in the sector shaft end. If there is any play, or else if it is too stiff, adjustment is necessary. The adjusting screw and its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

CONTENTS



Publication [illegible]
2nd Edition [illegible]

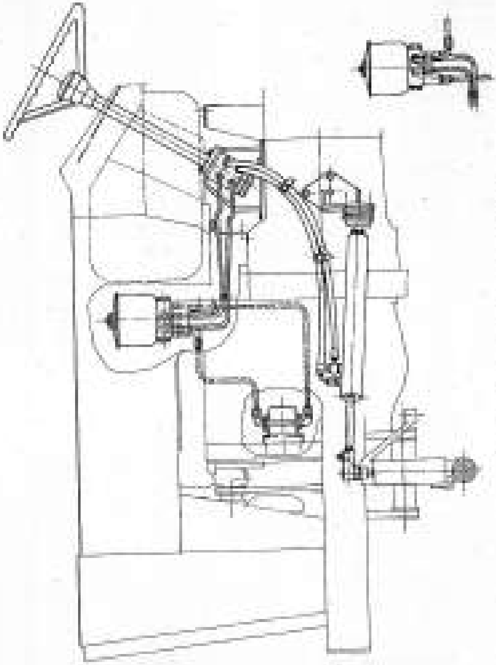
HYDROSTATIC STEERING SYSTEM

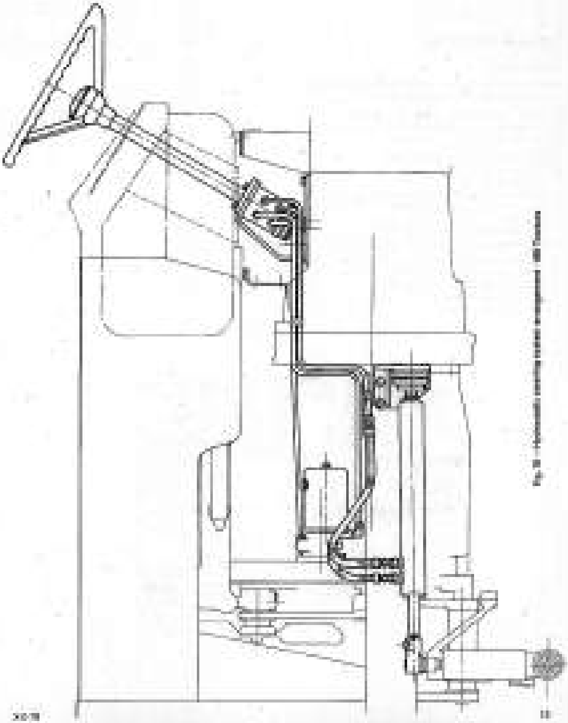
CONTENTS

HYDROSTATIC STEERING SYSTEM

SPECIFICATIONS

Hydraulic ram	
Outer cylinder length	478.5 mm
Bore	57 mm
Outer Diameter	63 mm
Inner cylinder length	376.5 mm
Bore	30 mm
Outer Diameter	35 mm
Steer. overall length	541.5 mm
Stroke	328 mm
Diameter	25 mm
Front end ball joint threaded length	80 mm
Piston diameter	50 mm
Cylinder rear end anchoring ball joint	40 x 28 mm
Union nut screw thread	3/8" BSP
Bar max. working pressure	100 kg/cm²
Steering column	
Overall length	476 mm
Diameter	38 mm
Hydrostatic unit	
Hydrostatic unit output (Standard)	80 cm³/rev. (optional one for 125 cm³/rev.)
Union thread	3/4"-16 UNF
Lower cover screws (7) thread	M-8x1 (DIN 933-10K)
Hydrostatic unit to steering column fastening	
screws - Dia.	5/8"-18 UNC
Thread depth	15.7 mm (min.)
Steering wheel	
Diameter	385 mm
N°. of turns from stop to stop (fitted with 80 cm³/rev. unit)	6 towards the left 6 towards the right
N°. 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	1.3 litres
450 Tractor	1.05 litres
Steering pump flow output	
350 Tractor	10 l per minute
450 Tractor	12 l per minute at 1,800 r.p.m.
Safety valve setting pressures	
350 Tractor	50 kg/cm²
450 Tractor	60 kg/cm²
Recommended hydraulic oils	
Brand	**Company**
Hydraulic HLP-65	ELF
Tellus 33	SHELL
Esstic 33	ESSO
DTE 24	MOBIL
SAE 10	Cepsa: this is the type of oil fitted in tractors on assembly line
Tightening torques	**kgf m**
Flywheel securing nut	7 to 8
Steering arm rear support bracket securing bolts	11.5 to 12.5
Hydrostatic unit to steering column screws	4.0 to 5.0
Hydrostatic unit to tractor frame securing screws	5.5 to 7
Hydraulic oil reservoir support bracket fastening screws	4 to 5





GENERAL DESCRIPTION

300 Tractors

The hydrostatic steering system fitted to 300 model tractors comprises the following components:

1. Gear type hydraulic pump (A), located at 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 exclusive use in the steering circuit, incorporating a safety valve (E).
   This reservoir is fitted at the engine right hand side, towards the rear end 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. Hydrostatic 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.

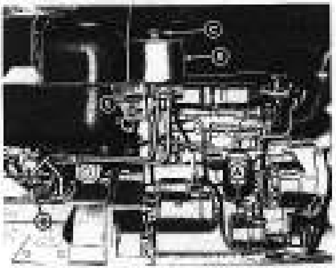


Fig. 31 – Hydrostatic unit arrangement - 300 Tractors

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.

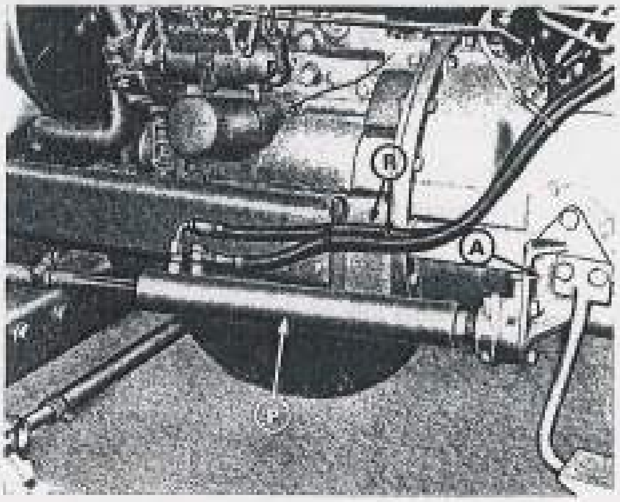


Fig. 20 – Location of the steering ram fitted to 350 Tractors

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.

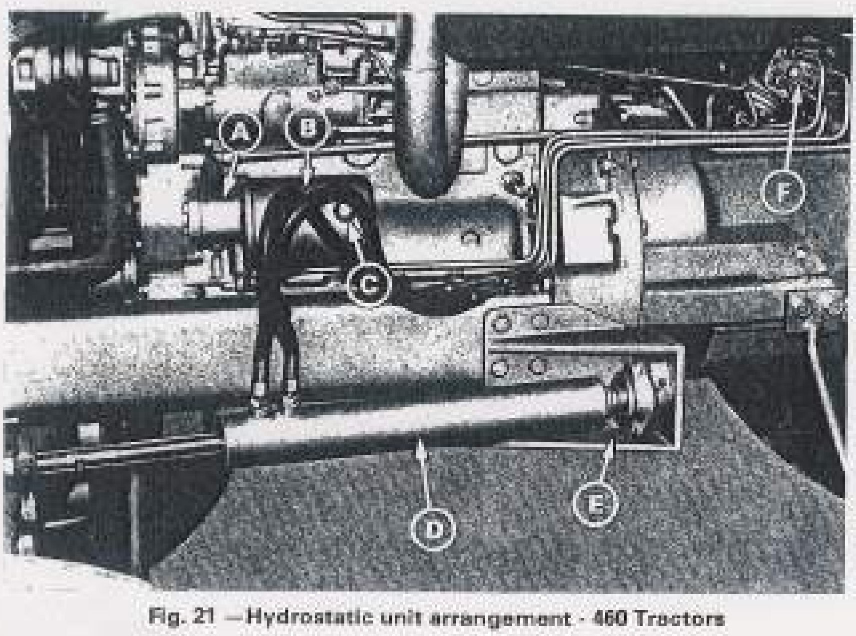


Fig. 21 – Hydrostatic unit arrangement - 460 Tractors

The basic hydrostatic steering unit is a set of gears the function of which is to provide a [illegible] constant oil flow to the steering ram and, in the case of an emergency, it acts as a hand pump.
This unit consists of:

a) A rotary meter comprising a fixed outer ring (G) with seven lobes, and an inner rotor (H) with six lobes.

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

c) A cardan shaft (F) that mechanically connects the rotor (H) to the outer sleeve (D), thus providing [illegible] recirculation.

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

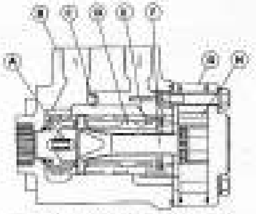
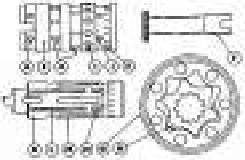


Fig. 22 – Cut-away view of hydrostatic steering unit

A – [illegible]
B – Hydrostatic unit body
C – Check valve
D – [illegible]
E – [illegible]
F – Cardan shaft
G – Rotor outer ring
H – Rotor

Fig. 23 – Hydrostatic steering unit components

A – [illegible]
B – [illegible]
C – [illegible]
D – [illegible]
E – [illegible]
F – [illegible]
G – [illegible]
H – [illegible]
I – [illegible]
J – [illegible]
K – [illegible]
L – [illegible]
M – [illegible]
N – [illegible]



OPERATION

1. The EGYO-350 and 400 tractors equipped with the hydrostatic Steering Unit have an independent hydraulic circuit fitted with an oil reservoir.
2. 400 EGYO Tractors incorporate the hydraulic oil reservoir on the hydraulic pump.

   On 350 EGYO 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 58 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.

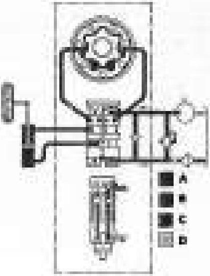


Fig. 41 — Oil circulation in neutral

A — Oil supply line
B — Cycle circuit
C — Oil return line
D — Oil suction line

8. When turning the steering wheel the valve outer and inner sleeves turn the one in respect of the other. The passages leading to the cylinder ports progressively open for an approximate rotation of 1.5°. These passages are fully open for an approximate rotation of 9°.
After a rotation of approximately 4° the neutral ports are closed.

Oil circulation through gear with rotation.

a) Rotor gear rotation.

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

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

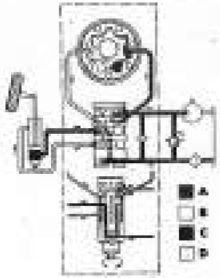


Fig. [illegible] – Hydraulic powered steering oil circulation: Right hand turn
A – Oil in pressure line to rotor
B – Oil in pressure line to cylinder
C – Oil in return line
D – Oil in suction line

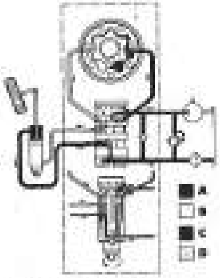


Fig. [illegible] – Hydraulically powered steering oil circulation: Left hand turn
A – Oil in pressure line to rotor
B – Oil in pressure line to cylinder
C – Oil in return line
D – Oil in suction line

MAINTENANCE

[illegible] Tractors

1. Every 50 hours of operation or daily, lubricate the rear ram ball joint with an adequate multipurpose grease, through nipple (B).

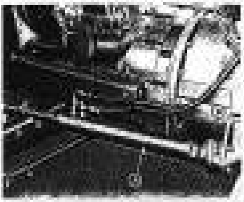


Fig. 37 – Hydraulic cylinder rear anchorage – [illegible] Tractors

A – Cylinder body
B – Rear 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 11).

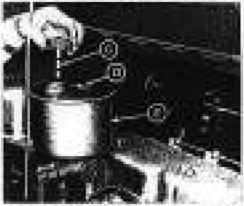


Fig. 38 – Checking oil level – [illegible] Tractors

C – Dipstick
D – Cover end of fine threading 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 magnetic filter fitted inside the reservoir. The oil must be of an adequate quality (see SPECIFICATIONS on page 11).

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

Fig. 39 – Changing oil filter – [illegible] Tractors

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

MAINTENANCE

[illegible] Tractors

1. Every 10 hours or daily, lubricate the steering ram rear end ball joint through nipple (B). Use multi-purpose grease.
2. Every 200 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.

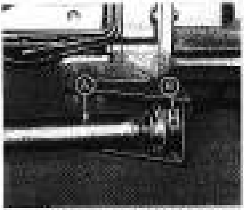


Fig. 30 — Hydraulic ram rear end anchorage

A — Cylinder body
B — Rear 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 lip. Top up if and as required.
- Refit the filler plug. Start the engine and keep it running for another 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 1.6 kgf·m torque.

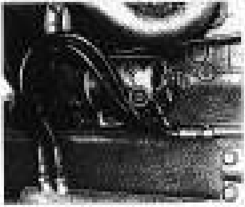


Fig. 31 — Checking steering reservoir oil level — [illegible] Tractors

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. 32).
   - Place suitable clean container under the reservoir.
   - Remove the nut (E).
   - Remove the reservoir (F).
   - Remove the washer (G).
   - Remove the cotter pin (H).
   - Remove the washer (J).
   - Remove the spring (K).
   - Remove the washer (L).
   - Remove the seal (M).
   - Remove the filtering element (N) and discard. Clean all components in paraffin and dry them.
   - Remove the "O" ring (P).

Reassemble 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. 32 — 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 limit.
3. Refit the filler plug and tighten to 3.0 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 both from left to right and from right to left.
6. Stop the engine and refill the reservoir.
7. Start the engine and keep it at 1,200 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 10 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.

200-Tractors

1. To bleed the steering system on 200-tractors follow the procedure outlined in item 12, above.

REMOVING AND REFITTING THE STEERING PUMP ON 200-TRACTORS

1. Loosen out the pressure outlet pipe union (B).
2. Loosen out the suction pipe union (C) letting the oil drip into an adequate container.
3. Unscrew the fastening screws (A) and pull out the pump assembly (D) 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 caring not to change their original fitting position.

Fig. 33 – Bleeding the steering system

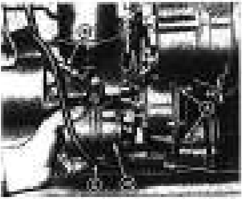


Fig. 34 – Removing the steering pump from 200-Tractors

DISMANTLING THE STEERING PUMP ON TO BE-TRACTORS

1. Straighten the locking washer tabs and remove the nut (O) and locking washer (N) 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 (G) 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 suitable steel [illegible].
6. Extract the D-shaped 'O' ring (E) from its location groove in the pump body, and withdraw the rubber 'O' rings (L) and nylon thrust washers (K) from the front bronze bearing (C). Separate the latter from the gears, taking care not to lose the small expander dowel (D).
7. Withdraw the pump gears (B and J) and the rear bronze bearings (I).
8. Examine the bearings for signs of pitting or scoring on the face or journals. Light score marking can be removed by careful lapping on a surface plate, using '0' grade emery paper and paraffin (kerosene).
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 '0' grade emery paper to remove wear marks. The gear faces may be polished by sandwiching the emery paper between the gear and a scrap bearing and rotating the gear.
11. All rubber seals, nylon washers and 'O' rings should be replaced when overhauling the pump.

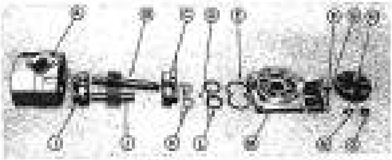


Fig.20 – Exploded view of timing gear driven hydraulic steering pump

A – Pump body
B – Pressure driving gear
C – Front bearings
D – Expander dowel
E – D-shaped 'O' ring
F – Screws and washers
G – Woodruff key
H – Helical gear
I – Rear 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 bronze bearing 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. 38).

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 rigid bronze drift.

2. Fit the rear bearing (2) into the pump body (4). Care should be taken to distinguish these housings from the front ones, which are identified by the small recess in the front edge of their flats, intended to locate the rubber separator dowel (3).

3. Assemble the pressure driving gear ([illegible]) and driven gear ([illegible]) into their respective bearing to mesh with each other. Be careful not to invert the original mounting position of the driven gear, so as to avoid interchange of tooth drive sides.

4. Fit the front bearing ([illegible]) onto the gear journals and insert the rubber dowel ([illegible]) between them.

5. Fit two nylon thrust washers ([illegible]) and rubber rings ([illegible]) on the front bearings, ensuring that the rubber rings seal correctly around the washers.

6. Fit a new D-shaped 'O' ring ([illegible]) into the groove in the pump body ([illegible]).

7. Assemble the pump cover ([illegible]) to the pump body ([illegible]) taking care not to damage the oil seal when passing the driving shaft ([illegible]) through. Fit the eight setscrews and washers ([illegible]) and tighten evenly to 2.8 mkg (20 lbs. ft.). An accurate torque wrench must be used for this operation, to ensure that the torque figure is not exceeded.

8. Position the woodruff key ([illegible]) in the [illegible] driving gear shaft and assemble the helical gear ([illegible]) to the shaft.

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

REMOVING AND REFITTING THE STEERING PUMP, 480 TRACTORS

1. Place a suitably sized container beneath the tractor to collect the oil from the steering circuit.

2. Loosen out the return 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 – 480 Tractors

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

4. Remove the pump (D) and oil 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 mounting.

Fig. 37 – Removing the pump and oil reservoir assembly – 480 Tractors

CHECKING THE SAFETY VALVE SETTING PRESSURE, 80 TRACTORS

1. Start the engine and keep it running at 1,500 r.p.m. with the steering wheel turned against its stop, until the oil temperature reaches 50° C. Stop the engine.
2. Unscrew the pressure outlet pipe union off the pump and tighten a pressure gauge pipe union to its housing.
3. Start the engine.
   The safety valve must relieve pressure and show a pressure reading of 80 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. — Upset the regulating screw in slot and by a welding spot to prevent pressure setting alteration.

— Refit the reservoir.

— Refill with oil branch in the pressure gauge union.

— Start the engine and check that the pressure reading is 80 kg/cm².

Fig. 38 — Checking safety valve pressure setting.

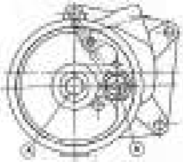


Fig. 39 — Safety valve pressure setting regulating screw.

A — Oil flow housing guide.
B — Safety valve plug.

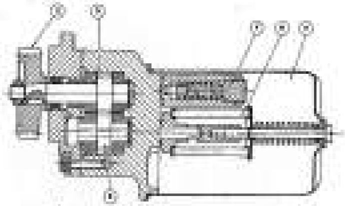


Fig. 40 — Cut-away view of the reservoir, safety valve and pump.

1 — Pump drive gear. 2 — Driven gear. 3 — Driving gear.
4 — Safety valve. 5 — Oil filter. 6 — Oil reservoir.

DISASSEMBLY, INSPECTION AND REASSEMBLY OF STEERING PUMP, [illegible] TRACTORS

Disassembly

1. Remove the reservoir and filter assembly from the pump body (see item 3 on page 30) and place the pump body in a workbench vice.
2. Loosen out the safety valve plug (E) along with its sealing washer.
3. Loosen out the filter housing guide (D) along with its sealing washer.
4. Remove the "O" ring (C) sealing the pump to reservoir mounting from the body (R).
5. Reverse the pump attaching position on the workbench vice.
6. Straighten out the washer tab (T) locking the nut (S).
7. Loosen out the nut (S) and remove along with washer (T).

   Remark. – Lock the gear in order to loosen the nut.
8. Remove the drive gear (R) with a standard gear puller.
9. Remove the gear (R) and the woodruff key (P).
10. Outline a fitting mark on the pump body (F) and the endplate (B) to make the refitting operation easier.
11. Loosen out and remove the (8) "Allen" screws (U) and washers, securing the end plate (B) to the pump body (F).
12. Remove the snap ring (H).
13. Remove the "O" rings (H) and the thrust washers (J).
14. Remove the expander dowel (K).
15. Remove the bearing (L) from the drive gear shaft.
16. Remove the bearing (M) from the driven gear.
17. Remove both, the drive (O) and the driven (N) gears.
18. Remove the oil lip seal from the end plate (B) and fit a new one.

Checks

Check the bearing for wear. Carefully inspect the lubrication grooves and the zone located between the two drilled holes. Any scoring or damage in this area may cause important leaks.

Usually on servicing, the bearings must be pulled out and replaced by new ones. However, if new bearings are not available, the existing ones may be re-conditioned (only if minor scorings are observed). Polish them as per the following instructions: Place grade "0" emery paper coated in paraffin 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.

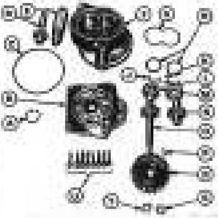


Fig. 31 – Steering pump components - [illegible] Tractor

A – Snap ring
B – End plate
C – Reservoir to pump sealing "O" ring
D – Filter housing [illegible]
E – Safety valve plug
F – Pump body
G – [illegible] "O" ring
H – Backing "O" rings
J – Thrust washers
K – Expander dowel
L – [illegible] bearing
M – [illegible] bearing
N – Driven gear
O – Drive gear
P – Woodruff key
R – [illegible] drive gear
S – [illegible] nut
T – Tab washer
U – [illegible] screws

Visually check for wear, scorings or cracks in the pump body and end plates. 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 of this groove edge with a very fine grit emery paper. Examine closely for damage on the gear teeth or gear shafts. If gear shaft wear or scoring are of minor importance, they can be eliminated with paraffin soaked 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 0.20 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, specially the bottom pressure face since it may get warped if the nut is over-tightened.

Also check the "O" ring sealing surface for condition.

Finally, examine the safety valve and seat for corrosion. If so required, [illegible] the plunger and seat with adequate paste. Then, clean carefully.

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

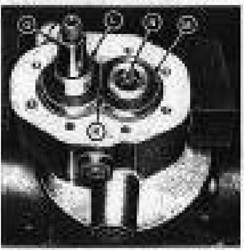


Fig. 42 — Refitting the bearings with the expander dowel between them

Assembly

1. Fit the drive (2) and driven (4) gear shafts into the pump housing.
2. Fit the bearing 5 and 6 on to the corresponding shaft seeing that they have the corresponding fitting position.
3. Fit the expander dowel (3) between the expander dowel and drive the bearing on to their seats.
4. Place an "O" ring (8) round the bearing surface with the corresponding thrust washer (7), as shown in fig. 43.
5. Place the "B" shaped "O" ring (9).
6. Fit the end plate on to the pump body, taking care not to damage the oil lip seal when fitting it on to the drive shaft.
7. Secure the end plate by means of 8 screws. Tighten them diagonally.
8. Fit the snap ring (4).
9. Place the woodruff key [illegible] on to the drive shaft (2) keyway and press the pump [illegible] drive gear (3).
10. Insert the tab washer [illegible] and tighten the nut. Then bend the tab on the washer on to the nut faces.
11. Insert the mounting position of the pump and fit the filter locating guide screw [illegible] with its washer.
12. Drive the safety valve plug [illegible] into its housing.
13. Mount the reservoir, "O" ring and filter.

Fig. 43 — Fitting the ball thrust washers and "O" rings

REMOVING THE OIL RESERVOIR FROM 300 TRACTORS AND DISASSEMBLING AND ASSEMBLING THE SAFETY VALVE

1. Flush the reservoir.
2. Remove the [illegible] 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 tractor.

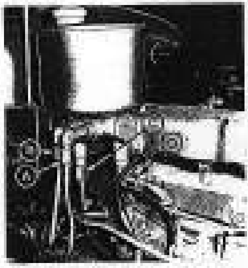


Fig. 14 – Removing the oil reservoir – 300 Tractors

A – Pressure pipe to hydraulic lift
B – Return pipe to reservoir
C – Reservoir to pump oil feed pipe
D – Pressure pipe from pump to hydrostatic unit via the safety valve.

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

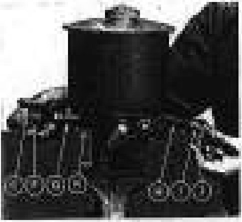


Fig. 15 – Dismantling the safety valve

[illegible] – Safety valve stop screw
[illegible] – Sealing washer
[illegible] – Safety valve spool
[illegible] – Safety valve spring
[illegible] – [illegible]
[illegible] – Sealing washer
[illegible] – Valve housing

REMOVING AND REFITTING THE HYDROSTATIC UNIT

[illegible] and [illegible] Tractors

Removal

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

   Remark. — This [illegible].

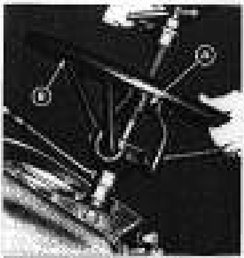


Fig. [illegible] — Removing the steering wheel

2. Remove the hand throttle lever (C).

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

3. Pull out the dust cover (D).

4. Loosen out the six screws (E) securing the instrument panel onto the shield.

Fig. [illegible] — Removing the instrument panel and hand throttle lever

5. Unscrew the tachometer sheath (F) out of the engine socket.

Fig. [illegible] — Tachometer sheath

6. Release the fork end (4) from the hand throttle lever (5).

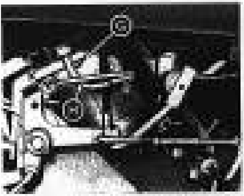


Fig. 49 – Removing the fork end from the hand throttle lever

7. Loosen out the four screws (2) from the hydrostatic unit (3).

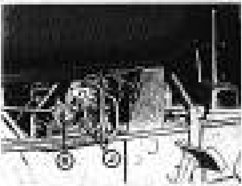


Fig. 50 – Removing the hydrostatic unit

8. Place the instrument panel (M) on the tractor hood.
9. Through the hollow space in the fuel tank, loosen out the four screws securing the steering column (3) to the hydrostatic unit. Use a box wrench with an extension arm (L).

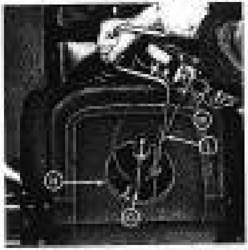


Fig. 51 – Removing the steering column and hydrostatic unit from tractor

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

Fig. [illegible] – Removing the steering column through the bottom space in the [illegible].

11. Slightly push apart the two pipes from circuit (J) and remove the hydrostatic unit from its location on the tractor.

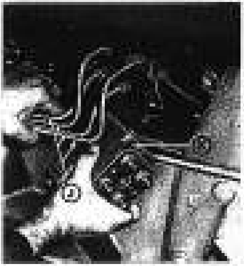


Fig. [illegible] – Removing the hydrostatic unit from the tractor.

Refitting: Reverse the removal operations to refit the hydrostatic system back to the tractor, 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 7 to [illegible] kgf m.

DISMANTLING THE ORBITROL STEERING

Used on [illegible] and [illegible] Tractors

To dismantle the hydrostatic steering unit, place same on a work bench vise with the T-screw base upwards then proceed as follows:

1. Unscrew and remove the T-screws (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 outer tube ring (G) along with the rotor (F) and the O-ring (H).
4. Remove the spacer washer (I).
5. Remove the valve plate (J) and O-ring (K).
6. Remove the cardan 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) until it comes out through the other end.
10. Remove the pin (O) from the outer sleeve (P).
11. Separate the outer sleeve (P) from the spool (Q).
12. Remove the following parts from the hydrostatic unit:
    a) Metal ring (S)
    b) Dismantled 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 (R) until removing same from spool (Q).

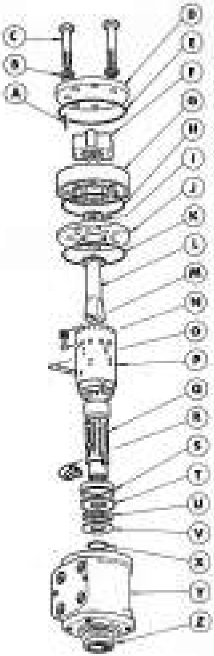


Fig. 66 – Exploded view of hydrostatic unit

A – Check valve stop
B – Flat washers
C – Hydrostatic unit base screws
D – End cover
E – O-ring
F – Rotor
G – Outer tube ring
H – O-ring
I – Spacer washer
J – Valve plate
K – O-ring
L – Cardan shaft
M – Check valve screw
N – Check valve ball
O – Cross pin
P – Outer sleeve
Q – Inner sleeve or spool
R – Pressure springs
S – Metal ring
T – Dismantled flat washer
U – Roller bearing
V – Flat washer
X – O-ring
Y – Hydrostatic unit body
Z – Rubber seal with steel ring

ASSEMBLING HYDROSTATIC STEERING UNIT- [illegible] and [illegible] Tractors

Before assembling the Danfoss 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 ([illegible]), the inner spool ([illegible]) or the body ([illegible]) appear to be damaged, change the entire hydrostatic unit assembly, except for the O-rings.

1. Fasten the body ([illegible]) to a work bench and lubricate all parts with clean oil. Carry out the subsequent assembly with absolute cleanliness.
2. Insert the inner sleeve ([illegible]) in the outer sleeve ([illegible]).
3. Insert the pin ([illegible]) through the holes in both sleeves.
4. Place the 6 springs ([illegible]) opposite each other, on either side. The two bevelled springs are fitted internally and opposite the other.
5. If previously removed, refit the rubber seal and steel ring ([illegible]).
6. Insert the O-ring ([illegible]), making sure it seats properly.
7. Place the washer ([illegible]) over the ring ([illegible]).
8. Insert the roller bearing ([illegible]).
9. Place the thin washer ([illegible]) with the lower chamfered radius opposite the bearing.
10. Insert the retaining ring ([illegible]).
11. Insert the outer and inner sleeve assembly inside the hydrostatic steering unit and make sure that all previously assembled parts are in their respective housings.
12. Insert the ball ([illegible]) in the larger threaded hole and tighten the screw ([illegible]).
13. Place the O-ring ([illegible]) in the hydrostatic unit body groove.
14. Refit the plate ([illegible]) making sure the holes are correctly aligned.
15. Place the O-ring ([illegible]) over the plate ([illegible]).
16. Place the outer ring ([illegible]) with the rotor ([illegible]) over the O-ring ([illegible]). The outer ring chamfers should be downward. Align the holes.

Fig. [illegible] — Assembling the hydrostatic steering unit

[illegible]

Fig. [illegible] — Fitting the cardan shaft

[illegible]

17. Refit the cardan shaft as follows:

a) The fork end (AB) of the cardan shaft (L) must be aligned between the lobes (AA) on the rotor (F).

b) Once well aligned, insert cardan in the assembly until the splines engage with those of the rotor, and the fork end (AB) engages the pin (C).

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

18. Place the O-ring (E-Fig. 56).

19. Place the spacer washer (I-Fig. 58) over the cardan shaft.

20. Place the end plate (O-Fig. 58) over the entire assembly, making sure that the hole housing the check valve (A) stop screw (G) is [illegible].

21. Tighten the 7 screws with their washers (B) evenly and diagonally. Tighten to 3 to 3.5 kgf·m.

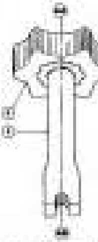


Fig. 57 — Alignment of cardan shaft with rotor

F — Rotor
L — Cardan shaft
AA — Center line between rotor lobes
AB — Center line of the cardan shaft and fork

Fig. 58 — Assembling the hydrostatic steering unit

A — Check valve stop
B — Bolt washer
C — Hydrostatic unit fixing screw

DISMANTLING THE RAM REAR END BALL JOINT 380 and 480 Tractors

Removing the ram from the tractor

Rear end ball joint

1. Place the cylinder on a work bench vice.
2. Remove nuts (I), washers (H), outer cap (G) and steel shims (E).
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 (D) and replace the rubber dust cover (A).

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

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

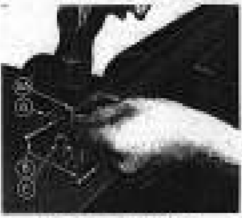


Fig. 89 – Dismantling the rear ball joint

B – Ball joint to support securing screws
E – Ball joint body
G – Outer cap
AA – Punch for removal of elastic pin

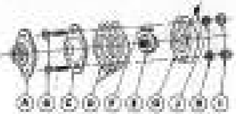


Fig. 90 – Exploded view of rear ball joint components

A – Rubber dust cover
B – Ball joint to support securing screws
C – Inner cap
D – Steel shims
E – Joint ball
F – Elastic pin
G – Outer cap
H – Spring washers
I – Ball joint to support securing nuts
J – Rear ball joint grease nipple

Front end ball joint

Removal

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

Refitment

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

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

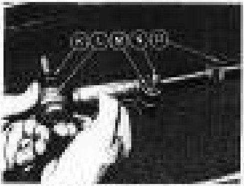


Fig. 91 – Removing the front ball joint from rod

K – Rubber seal
L – Ball joint body
M – Spring washer
N – Ball joint to rod securing nut
O – Cylinder rod

HYDRAULIC RAM

Rear section

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

Front section

1. Remove front ball joint bar (AC) (BB).
2. Remove the nut (L) lock split pin (K).
3. With the tool (CC-Fig. 88), unscrew the nut (L).
4. Pull out the rod (W) along with front plug (AC), piston (T) and inner cylinder (X).
5. Separate the inner cylinder (X) from the front plug (AC) and piston (T).
6. Dismantle the rod-piston assembly as follows:
   a) Place the rod (W) on a soft vise.
   b) Unscrew the nut (Q).
   c) Remove the washer (U) and piston (T).
7. Remove the front plug (AC) 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.

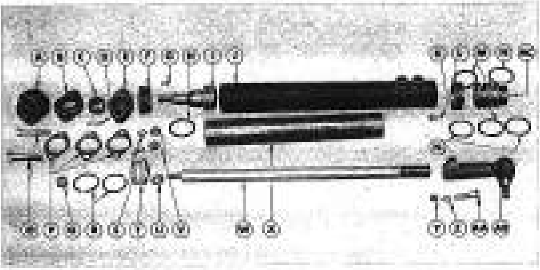


Fig. 88 — Dismantling the hydraulic cylinder components.

A — [illegible]
B — [illegible]
C — [illegible]
D — [illegible]
E — [illegible]
F — Rear plug nut
G — [illegible]
H — Rear plug O-ring
I — Rear plug
J — Outer cylinder
K — [illegible]
L — Front plug nut
M — Front plug O-rings
N — [illegible]
O — [illegible]
P — [illegible]
Q — [illegible]
R — [illegible]
S — [illegible]
T — Piston
U — Flat washer
V — [illegible]
W — Rod
X — Inner cylinder
Y — [illegible]
Z — [illegible]
AA — [illegible]
BB — [illegible]
CC — [illegible]

ASSEMBLING THE HYDRAULIC RAM (Figs. [illegible] to [illegible])

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 wherever necessary.

1. Insert the front plug (40) on the rod ([illegible]) on the piston thread side.

2. Place the piston (7) on the rod ([illegible]), with the [illegible] outward.

3. Place the flat washer (8) and tighten the nut (6). To tighten this nut properly, place the rod in a soft vise and hold the rod by placing a wrench in the flat groove provided for this purpose in the [illegible] section.

4. Insert the piston (7) in the inner cylinder ([illegible]), 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 (40) in the inner cylinder ([illegible]).

6. Insert the entire inner cylinder assembly ([illegible]) in the outer cylinder (J), as shown in Fig. [illegible]. Be careful not to damage the front plug O-rings (40).

7. Insert the rod ([illegible]) as far in as possible in the cylinder.

8. Place the nut ([illegible]) and, by means of the tool ([illegible]), tighten same properly.

9. By means of the pin ([illegible]), block the nut ([illegible]) on the outer cylinder (J).

Fig. [illegible] — Assembly of the rear plug, rod and piston as [illegible]

6 — Piston to rod fastening nut
7 — Piston
8 — Flat washer
9 — Rod
40 — Front plug

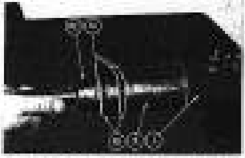


Fig. [illegible] — Refitting the inner cylinder assembly into the outer cylinder

J — Outer cylinder
[illegible] — [illegible] O-rings
[illegible] — Piston rings
[illegible] — Inner cylinder
40 — Front plug

Fig. [illegible] — Tightening cylinder front plug nut

J — Outer cylinder
[illegible] — Front plug nut
[illegible] — [illegible] tool

10. In the other end of the cylinder liner [illegible], insert the rear plug [illegible] as shown in Fig. 86.

Fig. 86 – Assembling rear plug of cylinder

[illegible] – [illegible]
[illegible] – [illegible]
J – Outer cylinder

11. Place the rear plug nut (F) and tighten [illegible] properly with the tool (CC).

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

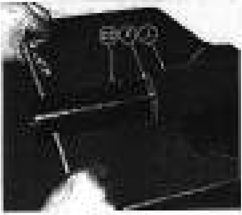


Fig. 87 – Tightening rear plug nut

F – [illegible]
J – Outer cylinder
CC – [illegible]

13. Fit the cylinder rear ball joint.

TROUBLE SHOOTING TABLE

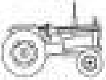
PROBLEM	CAUSE	REMEDY
STEERING SYSTEM VERY HARD WHEN TURNING STEERING WHEEL	1. Faulty pump. 2. A leak at the hydrostatic unit. Check valve or valve ball missing. 3. Pressure relief valve in safety block stuck in open position. 4. Broken or jammed steering column bearing.	1. Repair the pump. 2. Mount the ball with a weak spring (as emergency) until 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 [illegible] pressure springs do not apply any pressure or are broken.	1. Dismantle the hydrostatic unit and change the [illegible] pressure springs.
VIBRATION IN THE DRIVE WHEELS	1. Air in the hydraulic cylinder. 2. Wear on steering linkage.	1. Bleed the circuit and eliminate the cause of air leaks. 2. Change defective parts.
STEERING WHEEL CAN BE TURNED INDEFINITELY	1. Lack of oil in reservoir. 2. Faulty hydraulic cylinder. 3. Faulty hydrostatic unit. 4. Important leaks between hydrostatic unit and [illegible] supply hose.	1. Fill to level. 2. Change or repair cylinder. 3. Remove, check and repair or change Orbitrol. 4. Change Orbitrol assembly.
THE DRIVE WHEELS ARE TURNED IN JERKS	1. Incorrect timing of cardan shaft and hydrostatic unit.	1. Dismantle the unit and reassemble properly.

PROBLEM	CAUSE	REMEDY
WHEELS TURN TOO SLOWLY	1. Insufficient amount of oil in circuit. 2. Faulty [illegible] unit.	1. Increase pump supply speed. 2. Change or repair hydrostatic unit.
STEERING WHEEL DOES NOT RETURN TO NEUTRAL POSITION. HYDROSTATIC UNIT TENDS TO ACT AS AN ENGINE	1. [illegible] of impurities between the outer and inner element. 2. [illegible] wear between outer and inner element, due to excessive pressure.	1. Remove hydrostatic unit [illegible] both cleanse or change them along with the hydrostatic unit. Clean circuit completely and add new oil. 2. Place a pressure gauge on supply circuit and check pressure. Change safety valve whenever necessary.
WHEELS TURN [illegible] DENTLY. WHEELS TURN ONLY IN ONE DIRECTION	1. Excessive leaks in hydrostatic unit. 2. Uneven wear 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 on upper 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 [illegible] to [illegible] kg·m. 3. Change washers and O-rings.

SECTION 4:

ENGINE D3.152

INDEX



Publication [illegible]
1st edition [illegible]

SPECIFICATIONS

ENGINE

Make and type	Perkins four stroke, direct diesel injection.
Model	03.152
Number of cylinders	Three.
Diameter of cylinders	91.44 mm.
Stroke	127 mm.
Displacement	2,500 c.c.
Compression ratio	18.5 : 1
Power	47 H.P. at 2,250 r.p.m. of engine.
Maximum torque	17.5 kg/m at 1,300 r.p.m. of engine.
Maximum speed	2,250 r.p.m. under load; 2,500 r.p.m. no load and 650 ± 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.
Crankcase	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 treated crankpins.
Connecting rods	H-section forged steel.
Piston	Aluminium alloy with concave combustion 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 integral body and element.
Oil sump capacity	6.5 liters.
Minimum pressure in oil line	2.81 kg/cm² at 2,250 r.p.m. of engine and 1.2 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 4.5 kg/cm².
Filter by-pass valve	Ball type.
Valve opening differential pressure	0.61 to 1.2 kg/cm².
Lubricant	See general information.

DESCRIPTION

The Perkins D3.152 engine is of the three cylinder, water-cooled, direct diesel injection type. The rated inside 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 way of the tappets and rocker arms.

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

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 sheet 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 screen 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 four journals with their corresponding bearings. It is supported by bearings caps and its axial location is controlled by thrust half washers located on the rear journal.

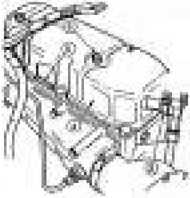
TROUBLE-SHOOTING CHART

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

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. Improper 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 blocked.
25. Leaks in cylinder head gasket.
26. Overheating.
27. Operating temperature incorrect.
28. Exhaust pipe partly blocked.
29. Sticky valves.
31. High pressure pipes blocked.
32. Worn cylinders.
33. Valve seats pitted.
34. Piston rings broken, worn or seized.
35. Valve stems and guides worn.
36. Crankcase overfilled or wrong grade of oil.
37. Bearings worn or damaged.
38. Crankcase filter blocked.
39. Oil pump worn.
40. Pressure relief valve stays open.
41. Pressure relief valve stays closed.
42. Relief valve spring broken.
43. Oil pump breather pipe defective.
44. Oil filter blocked.
45. Pistons seized or stick.
46. Incorrect piston height.
47. Fan damaged.
48. Valve spring broken.
49. Flywheel badly 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 retainers broken.
57. Coolant level too low.

ROCKER COVER



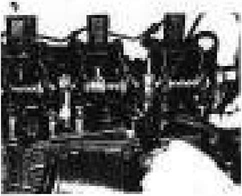
Disassembly

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.

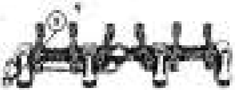
LASH ADJUSTMENT VALVE



The valve lash is measured between the rocker arm and tappet and has to be adjusted to 0,254 mm (hot) or 0,30 mm cold. For this, carry out the following operations.

1. Disassemble 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

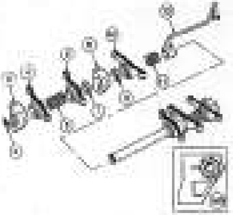
5. Reverse operation 2 to 4.
6. Adjust valve clearances.
7. Assemble rocker cover.

SERVICING ROCKER ARM SHAFT

Disassembly

1. Disassemble rocker arm shaft.
2. Remove circlip from front end of shaft.
3. Remove shaft support.
4. Remove rocker arm.
5. Remove long spring.
6. Remove rocker arm.
7. Remove spacer.
8. Remove shaft support.
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 oil feed pipe and union from rocker shaft.

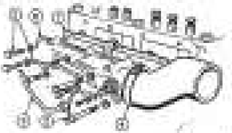
Check for wear or damage to shaft and rocker arm bushes. If rocker arm bushes are worn, replace rocker arms.



Assembly

14. Reverse operations 1 to 13, EXCEPT:
    a) Check that all parts are clean and lubricated with engine oil before assembling.
    b) The front end of the rocker arm shaft has a slot. Install it as shown in diagram [illegible].

INTAKE MANIFOLD



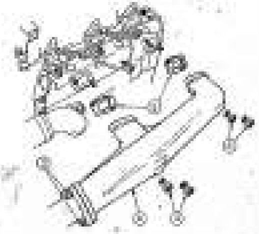
Disassembly

1. Raise hood.
2. Disconnect cold-start heater cable.
3. Disconnect cold-start heater fuel pipe.
4. Release brake pipe clips.
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. Raise hood.
2. Remove exhaust pipe fixing bolts.
3. Remove the four nuts and washers.
4. Withdraw exhaust manifold.
5. Remove and discard gasket.

Assembly

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

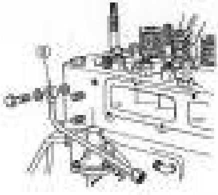
VALVE SPRINGS

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 [illegible] and [illegible].
4. Remove cotters.

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

5. Remove caps from springs.
6. Remove springs.
7. Remove spring seats.
8. Check free length of springs. This must be between [illegible] and [illegible] mm.
9. Set valves 1 and 2 in place and reassemble or replace springs as required.
10. Reverse operations 4 and 5.
11. Turn crankshaft until piston number 2 is at its T.D.C.
12. Repeat operations 3 to 9 for valves numbers 3 and 4.
13. Turn crankshaft until number 3 piston is at its T.D.C.
14. Repeat operations 3 to 9 for valves numbers 5 and 6.
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 connection hose between the thermostat housing and water pump.
8. Disconnect external oil feed pipe.
9. Remove cylinder head nuts and fixing ledge 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 [illegible].
    b) Install a new gasket on the thermostat casing if it has been disassembled.

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

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

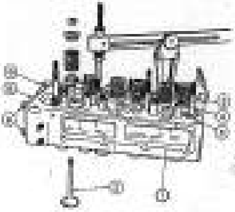
SERVICING CYLINDER HEAD

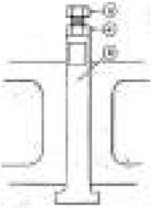
Disassembly and assembly

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 locknut.
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 them free of carbon or other deposits.
10. If there are excessive deposits in the cylinder head water passages, the use of cleaner EBRO Ref. A-50 is recommended.
11. Check for wear on inside diameter of valve guides.
12. If necessary, disassemble valve guides with tool PD 1 C.
13. Install new guides with tools PD 1C and PD 1C-4. Make sure guides are assembled correctly. Both ends are bevelled, one to 45° and the other to 30° (the 30° end is also recessed). The 30° end must be inserted into the cylinder head through the top until the opposite end (45° bevel) stands out 14.00 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 sealing.





16. Carefully clean all valves and check that they are not pitted, worn or burnt.
17. If necessary, polish the valve flange with a grinder to an angle of 30°, 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 1,280 and 1,620 mm for inlet valves and between 1,670 and 2,030 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 even and, if necessary, plane it, to a maximum of some 0,30 mm, bearing in mind that the injector is not to stand out more than 4,47 mm. This measurement must not be obtained by adding additional washers.
24. Carefully clean cylinder head.
25. Reverse operations 1 to 15, except:
a) Assemble valves in their correct positions.
b) Lightly coat new plate gasket 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 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 carried out by specialized personnel.

This operation must never be performed when a new valve guide is not assembled.

1. Service cylinder head.
2. Using a valve guide housing as center, 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-seating.

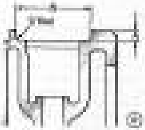
3. Remove machining filings and clean replaceable seat housing.
4. Using valve guide housing, set valve seat in place by means of an insertion tool made to the given measurements.

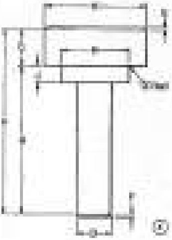
NOTE. — Replaceable valve seats must not be hammered into place nor lubricated.

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 inlet.
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 1.000 and 1.800 mm (production limits), for exhaust valves.

KEY TO FIGURE 5
A. 7.07 to 7.20 mm.
B. 41.00 to 41.04 mm.
C. 0.30 mm max. radius.

KEY TO FIGURE 6
A. 50.00 mm.
B. 45.00 mm.
C. 18.00 mm.
D. 7.00 to 7.07 mm.
E. 1.5 mm at 45°.
F. 1.0 mm at 45°.
G. 0.8 mm.
H. 30.00 to 30.08 mm.
J. 5.30 to 5.46 mm.
K. 40.77 to 41.02 mm.





TIMING CASE COVER

Disassembly

1. Disconnect [illegible] between front exhaust engine and disassemble water pump.
2. Remove bolt and washer.
3. Remove crankshaft pulley.
4. Disconnect alternator cables.
5. Disassemble alternator and its support brackets.
6. Remove breather pipe.
7. Remove bolts securing timing case cover.
8. Remove timing case cover.
9. Remove and discard gasket.
10. Remove retainer.

Assembly

11. Assemble retainer.
12. Install cover with a new gasket coated with [illegible] sealing paste.
13. Place pulley on crankshaft (carefully to avoid damaging retainer), so as to center retainer and cover.
14. Fit in and tighten lower bolts so as to secure cover and remove pulley.
15. Install remaining bolts and washers in cover.
16. Reverse operations 1 to 5, except:
    a) Tighten pulley fixing bolt to a torque of 15 Kg m.

TIMING GEARS

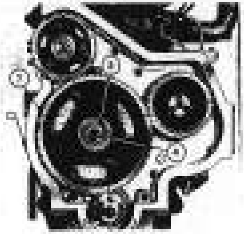
Intermediate gear and hub

Disassembly

1. Disassemble timing case cover.
2. Turn crankshaft until the marks on the injector pump, camshaft and crankshaft gears are lined up with those of the intermediate gear.
3. Bend back lock 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 end play, which should be between [illegible] and [illegible] mm.
13. Bend lock plate over one of the bolt flats.
14. Assemble timing case cover.



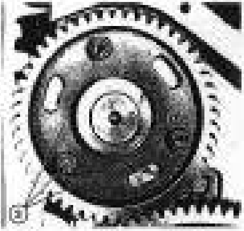
Camshaft gear

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 letters on gear and end of camshaft are in line.
5. Assemble intermediate gear.



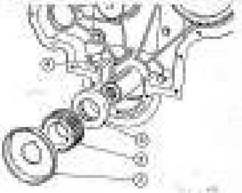
Injection pump gear

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 housed in pump hub slot.
   b) Tighten bolts to a torque of 3 Kg m.
5. Assemble intermediate gear.



Crankshaft gear

Disassembly

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

Assembly

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

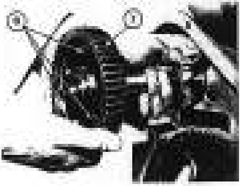
CAMSHAFT

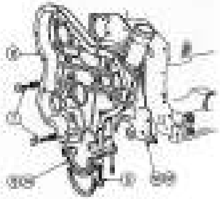
Disassembly

1. Disassemble 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 7, except:
   a) When assembling, make sure the letters 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 front faces of the cover and timing case are lined up.
15. Reverse operations 4 and 5.
16. Assemble injection pump gear.
17. Assemble camshaft.

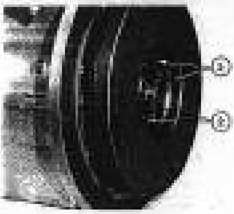
FLYWHEEL

Disassembly

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

Assembly

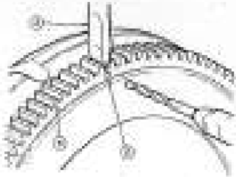
4. Reverse operations 2 and 3, except:
   a) Locate flywheel on crankshaft flange so that the unthreaded hole of flange lines up with the flywheel hole with no bolt.
   b) Tighten flywheel bolts to a torque of 70 [illegible] and secure them with new lock plates.
5. Assemble clutch.



FLYWHEEL RING GEAR

Disassembly

1. Disassemble flywheel.
2. Drill a hole 5 mm in diameter and up to a depth of only 10 mm (otherwise the flywheel could be damaged) at midway point between base diameter 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 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 180°C (356°F) in a [illegible].
7. Place ring gear on flywheel with tooth entry guide towards front of flywheel, quickly fit ring gear into its housing and let it cool slowly.
8. Assemble flywheel.

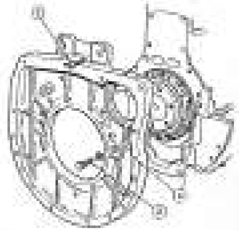
FLYWHEEL HOUSING

Disassembly

1. Disassemble flywheel.
2. Remove bolts and washers.
3. Remove screws.
4. Disengage housing from 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 lugs threads with an appropriate sealing paste.
6. Assemble flywheel.



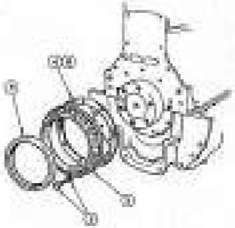
CRANKSHAFT REAR RETAINER

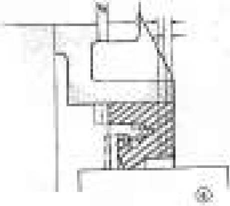
Dismantle

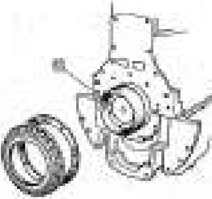
1. Disassemble flywheel housing.
2. Remove bolts and washers.
3. Remove retainer housing together with retainer.
4. Remove and discard gasket.
5. Extract retainer from its housing.

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 scored, the new retainer must be inserted further into the housing; first it should be inserted 3.2 mm and, if necessary, a further 3.2 mm, making 6.4 mm in all. If these operations 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 to the required depth with tool PD 145-1.
8. Install a new gasket lightly smeared with suitable sealing paste.
9. Lubricate retainer, crankshaft flange and tool PD 145-2 with clean engine oil.
10. Using tool PD 145-2, install retainer assembly and its housing. Make sure that it is correctly engaged on the block lugs.
11. Remove tool PD 145-2.
12. Reverse operations 1 and 2.







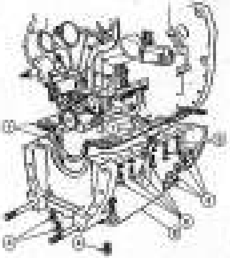
ENGINE CRANKCASE

Disassemble

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

Assemble

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 study and intermediate gear.
6. Remove fixing bolts and washers.
7. Withdraw pump.

Assemble

8. Reverse operations 1 to 7.

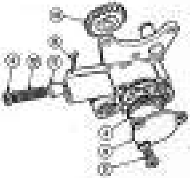
SERVICING OIL PUMP

Disassembly

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 [illegible] mm, a new oil pump should be installed.
6. Check clearance between external rotor and pump body. If clearance exceeds [illegible] mm, a new pump must be fitted.
7. Check clearance between top of rotors and pump body. If clearance exceeds [illegible] mm, a new oil pump must be installed.
8. If necessary, take out cotter pin.
9. Remove plug.
10. Remove spring.
11. Remove safety valve.
12. If necessary, disassemble gear with tools PD [illegible] and PD [illegible].
    Check for wear or damage to parts and replace if necessary.

Assembly

13. Reverse operations 8 to 12 and 1 to 6, except:
    a) Insert primary gear with flat face outwards until it is lined up with end of shaft. Make sure shaft key fits into gear keyway.
    b) Install a new plug.



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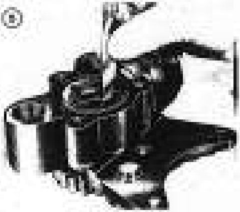

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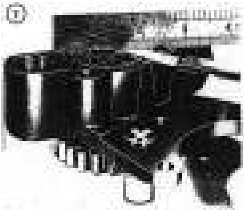
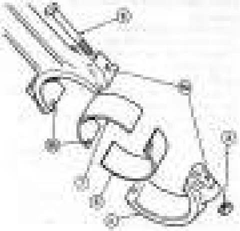


CONNECTING ROD BIG END BEARINGS



Disassembly

1. Disassemble oil pump.
2. Turn crankshaft until bearing to be disassembled is at 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 and ovalization must not exceed [illegible] mm. If above this limit, the crankshaft must be ground or replaced.

Assembly

9. Reverse operations 7 to 8, 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 they must be with ones supplied by the engine manufacturer.
   d) Make sure that base of bolt heads is seated correctly on connecting rod shoulders.
   e) Check that connecting rod and big end lower 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 ([illegible] lbf).

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

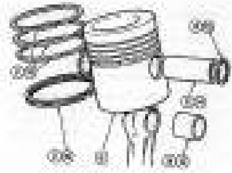
Check condition of pistons, rings and liners and if it is out of gauge, replace them.

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.

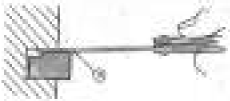
5. With tool [illegible], insert each piston and connecting rod into the top part of its respective cylinder. Make sure that the word «FRONT» is towards front of engine.
6. Assemble cap and bearings but without tightening of screws.
7. Check height of each piston with tool [illegible]. At its T.D.C. the piston must be [illegible] 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 in a clean liquid to a temperature of [illegible] to [illegible]°.
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 sleeve, uneven part at top of cylinder and check gap.
    The gap must be between:
    [illegible] piston rings:
    1st rings [illegible] to [illegible] mm.
    2nd, 3rd and 4th rings [illegible] to [illegible] mm.
    [illegible] piston rings:
    1st, 2nd and 3rd rings [illegible] to [illegible] mm.
    4th ring [illegible] to [illegible] mm.
11. After installing new rings, check vertical clearance of grooves. This clearance must be between:
    [illegible] piston rings:
    1st and 4th rings [illegible] to [illegible] mm.
    2nd ring [illegible] to [illegible] mm.
    3rd ring [illegible] to [illegible] mm.
    [illegible] piston rings:
    1st and 2nd rings [illegible] to [illegible] mm.
    3rd ring [illegible] to [illegible] mm.
    4th ring [illegible] to [illegible] mm.



Assembly

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

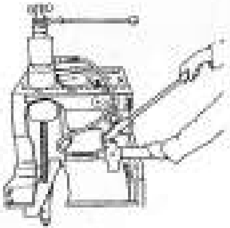
    NOTE: The piston head cavity is off-centered towards one of its sides. Join up pistons to connecting rods with cavity towards connecting rod and big end cap identification marks.

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 each piston 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 "D 780" suitable adapter and hollow hydraulic cylinder, extract liners from cylinders 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 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 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 its housing at top of cylinder out of shape.
   f) When it is completely in place, 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 fit in all cases, replace them.
   h) Install a set of new rings.
   i) Allow a settling in period before checking inside diameter 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

Dismantling and replacement

1. Dismantle crankcase.
2. Push crankshaft backwards and check axial play between thrust half washer and crankshaft. The clearance should be between 0.050 and 0.200 mm.
3. If axial play does not lie within these limits, proceed as follows:
4. Dismantle 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 their 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 in fixing bolts and tighten them to a torque of [illegible] kg m.
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. Assemble crankcase.

CRANKSHAFT

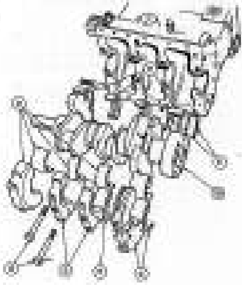
Disassembly

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 half washers.
7. Disassemble crankshaft gear.
8. Take out the six fixing bolts from the three main bearing caps.
9. Remove the three bearing caps with their removable half bearings.
10. Withdraw crankshaft.
11. Remove upper half bearings from crankcase supports.
12. Clean all components carefully.

Check with a micrometer for wear of ovalisation on crankshaft journals or crankpins. The diameter of journals and crankpins should be checked both horizontally and vertically and at both ends. Wear and ovalisation must not exceed 0,0381 mm.
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 when grinding, but in no circumstances must it exceed 30,00 mm.
It is important to keep journal and crankpin radii in accordance. After grinding, rough edges should be removed from lubrication holes.
Tuftrided 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 all three assembly positions of the crankshaft rear washer 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 machined below a minimum diameter of 113,17 mm. It is not necessary to apply Tufftriding process to flange. Inspect crankshaft for cracks and demagnetize.



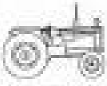
Assembly

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 series number as is stamped on bottom face of block and they must be matched up.
   e) Tighten bolts to a torque of 16 kg m.
14. Assemble crankshaft thrust half washers.
15. Assemble connecting rod big end bearings.
16. Assemble timing case.
17. Reverse operation 3.
18. Fill engine with specified oil.

SECTION 4:

ENGINE D4.203

INDEX



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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	58.5 H.P. at 2,250 r.p.m. of engine.
Maximum torque	21.0 kg m at 1,300 r.p.m. of engine.
Maximum speed	2,250 r.p.m. under load; 2,370 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.
Crankcase	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	Precision forged steel.
Pistons	Aluminium alloy with concave machining in head. Provided with one oil scraper and three compression rings.
Valves	In cylinder head, driven by camshaft through push rods and rocker arms.

Lubrication system

Type	Low pressure through rotor driven oil pump.
Oil filter	Full flow, mounted on block with integral body and element.
Oil sump capacity	7 liters.
Minimum pressure in oil line	2.81 kg/cm² at 2,250 r.p.m. of engine and 1.2 kg/cm² at idling speed with oil temperature (in filter) of 70 to 80° C.
Pump excess pressure relief valve	Piston type.
Valve opening pressure	3.5 to 4.9 kg/cm².
Filter by-pass valve	Ball type.
Valve opening differential pressure	0.91 to 1.2 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 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 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 crankshaft. The oil passes through the filter before circulating under pressure through the engine.

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

TROUBLE-SHOOTING CHART

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

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. Tank breather blocked.
22. Wrong type or grade of oil.
23. Accelerator linkage sticking.
24. Exhaust pipe totally blocked.
25. Leaks in cylinder head gasket.
26. Overheating.
27. Operating temperature incorrect.
28. Exhaust pipe partly blocked.
29. Sticking valves.
30. High pressure pipe blocked.
31. Worn cylinders.
32. Valves and seats pitted.
33. Piston rings broken, worn or seized.
34. Valve stems and guides worn.
35. Dipstick 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 stays open.
41. Pressure relief valve stays closed.
42. Relief valve spring broken.
43. Oil pump induction pipe defective.
44. Oil filter blocked.
45. Pistons tend to seize.
46. Incorrect piston height.
47. Fan damaged.
48. Valve spring broken.
49. Flywheel body (intercooler) 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 retainers broken.
57. Coolant level too low.

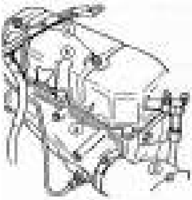
ROCKER COVER

Disassembly

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

Assembly

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



VALVE LASH ADJUSTMENT

The valve lash is measured between the rocker arm and tappet and has to be adjusted to [illegible] mm hot or [illegible] mm cold. The procedure is as follows:

1. Disassemble rocker cover.
2. With n° 4 cylinder valves in cross-over position, adjust n° 1 cylinder valves.
   With n° 2 cylinder valves in cross-over position, adjust n° 3 cylinder valves.
   With n° 3 cylinder valves in cross-over position, adjust n° 2 cylinder valves.
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 clearance.
7. Assemble rocker cover.

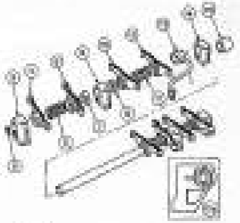
SERVICING ROCKER ARM SHAFT

1. Disassemble rocker arm shaft.
2. Remove circlip from front end of rocker shaft.
3. Remove shaft support.
4. Remove n° 1 valve rocker arm.
5. Remove spring.
6. Remove n° 2 valve rocker arm.
7. Remove washer.
8. Remove shaft support.
9. Remove washer.
10. Remove n° 3 valve rocker arm.
11. Remove shaft support.
12. Remove n° 4 valve rocker arm.
13. Remove union and 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 37 a.
    b) Lubricate all parts with clean engine oil before assembly.



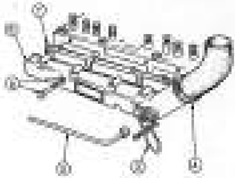
INTAKE MANIFOLD

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.



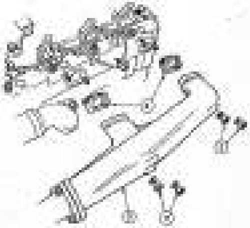
EXHAUST MANIFOLD

Disassembly

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

Assembly

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



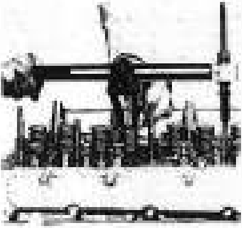
VALVE SPRINGS

Disassembly and assembly (with cylinder head in place)

1. Disassemble rocker shaft.
2. Turn crankshaft until n° 1 and 4 pistons are at their T.D.C.
3. Compress valves of 1 and 4 valve springs with tools [illegible] and [illegible].
4. Remove collars.
5. Slowly release tools [illegible] and [illegible].
6. Remove spring flaps.
7. Remove springs and seats.

NOTES: a) Do not turn crankshaft again until the valves have been re-assembled and secured with their collars.
b) If a valve spring requires replacement, a complete set should be assembled.

8. Reverse operations 2 to 7.
9. Turn crankshaft until n° 2 and 3 pistons are at their T.D.C.
10. Repeat operations 3 to 7 for n° 2 and 3 cylinder valves.
11. Reverse operations 1 and 8 to 7.



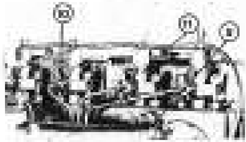
CYLINDER HEAD

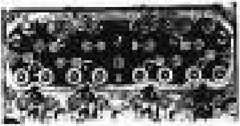
Disassembly

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.
9. Disassemble thermostat cover.
10. Remove high pressure fuel pipes.
11. Disassemble injectors.
12. Disconnect temperature gauge [illegible].
13. Disconnect all feed pipes from cylinder head.
14. Release cylinder head fixing nuts and bolts in reverse order to tightening sequence.
15. Remove cylinder head.
16. If necessary, disassemble thermostat housing and gasket.
17. Remove cylinder head gasket.

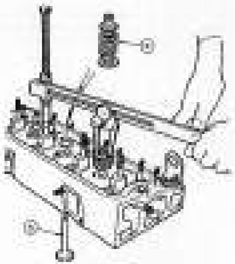
Assembly

18. Make sure that all components are meticulously clean and that contact surfaces are free of grease.





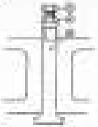
19. Reverse operations 1 to 15, except:
    a) Place a new cylinder head gasket with a fine coat of sealing paste.
    b) Tighten up cylinder head fixing nuts and bolts in the correct order, in three equal stages, to a torque of [illegible] kg.m.
    c) Apply a thin coat of sealing paste to thermostat housing gasket [illegible].
20. Bleed fuel system.
21. Start up engine and run it at approximately 1,200 r.p.m. for ten minutes until normal working temperature is reached. Stop engine.
22. Disassemble rocker arm shaft.
23. Tighten cylinder head fixing nuts and bolts in correct order to a torque of [illegible] kg.m.
24. Assemble rocker arm shaft.
25. 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.

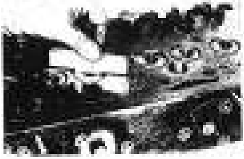
4. Loosen locknut.
5. Remove ball and [illegible].
6. Remove push rod.
7. Repeat operations 4 to 6 for remaining push rods.
8. Disassemble thermostat housing and gasket.
9. Disassemble rear plate and gasket from cylinder head.
10. Clean all cylinder head openings, leaving them free of carbon or other deposits.
11. If there are excessive deposits in the cylinder head water passages, the use of [illegible] Ref. [illegible] is recommended.
12. Check for wear on inside diameter of valve guides.
13. If necessary, extract valve guides with tool FS. [illegible].
14. Install new guides with tools FS.10 and FS. 10.1A. Make sure guides are assembled in correct direction. Both ends are beveled, one to [illegible]° and the other to 20°. The 20° end is also [illegible]

seat. The 30° end must be inserted into the cylinder head through the top until the opposite end (45°) stands out 14.00 to 15.00 mm above the top face.

15. Check for excessive pitting or wear on valve seats.
16. If necessary, grind valve seats with the following tools: milling cutter tool, valve seat profile cutter, cylindrical and centre kit. Remove as little metal as possible and ensure a fine, tight finish.
17. Carefully all valves clean and check that they are not pitted, worn or burnt.
18. If necessary, machine grind valve cross 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 seating 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.[illegible] and 2.[illegible] 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 (only on exhaust valves). In the case of an intake 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.[illegible] mm, bearing in mind that the injector is not to stand out more than 4.00 mm. This measurement must not be obtained by adding extra washers.
27. Carefully clean cylinder head.
28. Reverse operations 1 to 5, except:
    a) Place valves in normal position.
    b) Lightly smear back plate and [illegible] housing gaskets with suitable sealing paste.

23

24



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 performed by specialized personnel.
The operation must never be performed while a worn valve guide is still mounted.

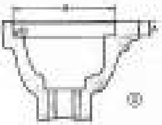
1. Service cylinder head.
2. Using a valve guide housing as center, machine cylinder head surface inlet according to instructions given.

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

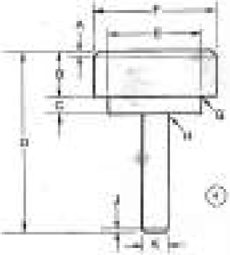
3. Remove machining filings and clean replaceable seat housing.
4. Using valve guide housing, set valve seat in place by means of an insertion tool made to the specified dimensions.

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

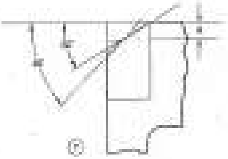
5. Check that replaceable valve seat is fully inserted into its housing and is on a level with the lower part of cylinder head intake.
6. Remove machining insert and filings and, if necessary, machine cylinder head surface.
7. Grind valve seat at a central angle of 90°, so that after grinding the depth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



KEY TO FIGURE 8
A. 7.25 to 7.30 mm
B. [illegible] mm
C. [illegible]



KEY TO FIGURE 9
A. 1.50 mm at 45°
B. 10.00 mm
C. 6.00 mm
D. 50.00 mm
E. 30.80 to 30.90 mm
F. 42.[illegible] to 42.[illegible] mm
G. 0.75 mm radius
H. 1.00 mm radius
J. 1.50 mm at [illegible]°
K. 7.00 to 7.[illegible] mm



KEY TO FIGURE 7
A. 3.30 to 3.34 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 bottom 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 lip towards engine. Press washer 3.4 mm below front surface of timing case.
14. Assemble cover and new gasket.

NOTE: Lightly smear gasket with suitable sealing paste.

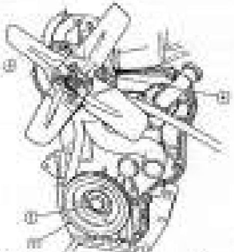
15. Put on crankshaft pulley so as to center timing case cover.
16. Put in and tighten some bolts and washers to secure timing cover.
17. Remove crankshaft pulley.
18. Install remaining timing case cover nuts and bolts.
19. Reverse operations 1 to 8, except:
    a) Tighten crankshaft pulley fixing bolt to a torque of 16 kg-m.

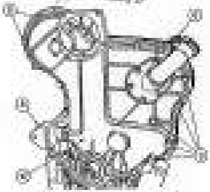
TIMING GEARS

Intermediate gears

Disassembly

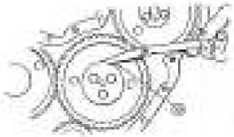
1. Disassemble timing case cover.
2. Turn crankshaft until marks on injector pump, camshaft and crankshaft gears are lined up with those of the corresponding intermediate gears.
3. Bend back lock plate.
4. Remove the three nuts.
5. Remove lock plate.
6. Remove lock washer.
7. Remove upper intermediate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





Assembly

10. Put on intermediate gear hub, making sure that hub oil feed holes are lined up with those 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 8 to 6.
13. Check axial play of gear, which must be between 0,050 and 0,170 mm.



14. Check clearance between intermediate gears by means of a dial gauge or thickness gauge. The clearance must be between 0,085 and 0,188 mm. Check all points of engagement.

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

15. Assemble timing case cover.

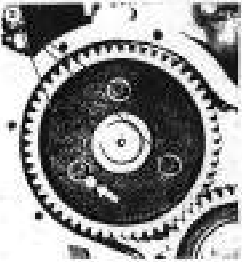
Camshaft gear

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 bores are lined up.
5. Assemble upper intermediate gear.



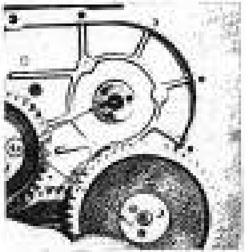
Injector pump gear

Disassembly

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

Assembly

4. Reverse operations 2 and 3, except:
   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.



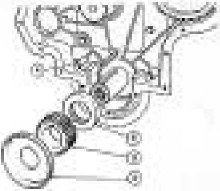
Crankshaft gear

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.



CAMSHAFT

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 of engine. Take care that cams do not damage bushings.
8. Remove thrust washer (if necessary).

Assembly

9. Check that thrust washer is correctly placed on cylinder block joining pin.
10. Reverse operations 8 to 7, except:
    a) Make sure that letters marked on gear and camshaft flange are lined up.
11. Assemble upper intermediate gear.
12. Assemble rocker arm shaft.

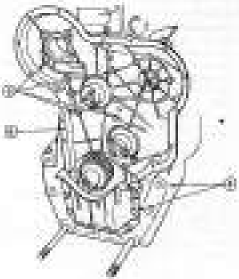
TIMING CASE

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 suitable sealing paste.
9. Assemble injector pump gear.
10. Assemble camshaft.



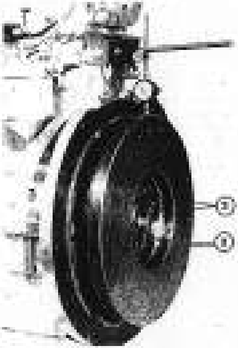
FLYWHEEL

Disassembly

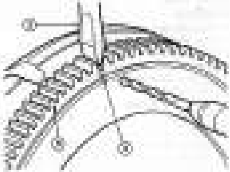
1. Disassemble clutch.
2. Remove the six bolts and lock plates.
3. Remove flywheel.

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 bolt.
   b) Tighten flywheel bolts to a torque of [illegible] and secure them with new lock plates.
5. Assemble clutch.



FLYWHEEL RING GEAR



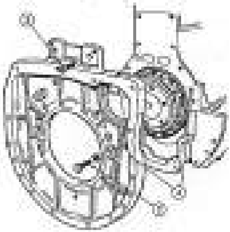
Disassembly

1. Disassemble flywheel.
2. Drill a hole 5 mm in diameter and up to a depth of 8.5 mm (whereafter the flywheel would be damaged) at midway point between lower diameter 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 cloth, such 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, (heat in a FURNACE).
7. Place ring gear on flywheel with tooth entry bevels 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 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 bolt threads with an appropriate sealing paste.
6. Assemble flywheel.

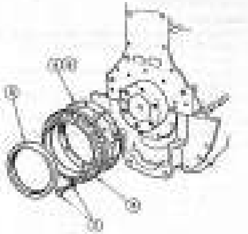
CRANKSHAFT REAR RETAINER

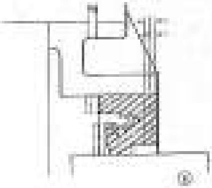
Dismantle

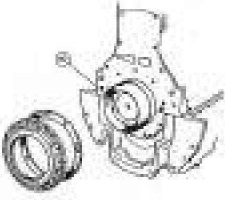
1. Disassemble flywheel housing.
2. Remove bolts and washers.
3. Remove retainer housing together with retainer.
4. Remove and discard gasket.
5. Extract retainer from its housing.

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 scored, the new retainer must be inserted further into its housing; that is it should be inserted 3.2 mm and, if necessary, a further 3.2 mm, making 6.4 mm in all. If these operations should not be sufficient the crankshaft flange contact surface has to be machined.
7. Lubricate retainer and its housing with clean engine oil. Press retainer in its housing to the required depth with tool PD 145-1.
8. Install a new gasket lightly smeared with suitable sealing paste.
9. Lubricate retainer, crankshaft flange and tool PD 145-2 with clean engine oil.
10. Using tool PD 145-2, install retainer assembly and its housing. Make sure it is correctly engaged on dowel rings.
11. Remove tool PD 145-2.
12. Reverse operations 1 and 2.







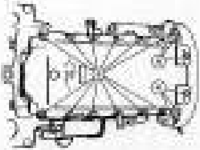
ENGINE CRANKCASE

Disassembly

1. Disconnect struts between front axle and engine.
2. Drain oil from crankcase and collect it in suitable container.
3. Remove nuts and washers securing front struts to [illegible].
4. Remove bolts securing crankcase to flywheel 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, except:
   a) Check that contact surfaces are clean.
   b) Fit new gaskets, lightly smeared with suitable sealing paste.
   c) Place a new gasket in seal located on crankshaft rear bearing cap.
   d) Fill crankcase to correct level with specified engine oil.



OIL PUMP

Disassembly

1. Disassemble engine crankcase.
2. Remove intermediate gear shaft.
3. Withdraw intermediate gear.
4. Disconnect pump high pressure pipe.
5. Remove fixing bolts and washers.
6. Withdraw oil pump.

Assembly

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

SERVICING OIL PUMP

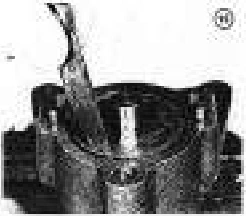
Disassembly

1. Disassemble oil pump.
2. Remove pressure pipe.
3. Remove the two bolts and washers securing screen filter pipe.
4. Remove pipe and screen filter.
5. Remove circlip.
6. Remove pump primary 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 0.2024 mm, a new pump must be installed.
12. Check clearance between top of rotors and pump body. If it is greater than 0.?? mm, a new pump must be installed.
14. If necessary, remove cotter pin.
15. Remove plug.
16. Remove spring.
17. Remove safety valve.

Assembly

18. Reverse operations 15 to 17 and 1 to 10, except:
    a) insert primary gear with the hub outwards, until it is lined up with circlip slot.
19. Install a new washer.

11



12

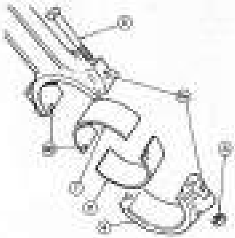
13

CONNECTING ROD BIG END BEARINGS

Disassembly

1. Disassemble oil sump.
2. Turn crankshaft bearing to be disassembled is at 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 ovalisation must not exceed 0.0051 mm. If above this limit, the crankshaft must be ground or replaced.



Assembly

9. Reverse operations 1 to 8, except:
   a) Check that all components are meticulously clean and lubricated with clean engine oil according to specifications.
   b) Make sure half bearing lugs fit into connecting rod grooves and that they are correctly positioned in their original positions.
   c) The connecting rod nuts and bolts are special and whenever they are replaced original parts from the engine manufacturer must be used.
   d) Make sure that base of bolt heads is seated correctly on connecting rod shoulder.
   e) Check that connecting rod and big end lower 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.

PISTONS AND CONNECTING RODS

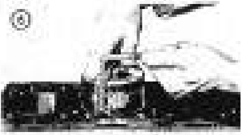
Disassembly

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 at all suspect, 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° in relation to previous one.
5. With tool [illegible], 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 [illegible]. At T.D.C. the piston must be [illegible] to [illegible] mm below top surface of block.
8. Assemble oil pump.
9. Assemble cylinder head.



SERVICING PISTONS AND CONNECTING RODS

Disassembly

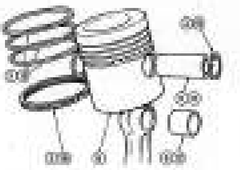
1. Disassemble pistons and connecting rods.
2. Remove rings from each piston.
3. Remove circlips from each piston.
4. Heat pistons in a clean liquid to a temperature of [illegible] to [illegible] C.
5. Carefully extract piston pins.
6. Remove carbon deposits from pistons; pay special attention to ring grooves.
7. Inspect pistons for cracks.
8. Check piston pin adjustment.
9. If necessary, extract small end bushing.
10. Place rings in sleeve, remove part at top of cylinder and check ring gap. This gap must be between:
    Flat piston rings:
    1st ring: [illegible] to [illegible] mm.
    2nd, 3rd and 4th rings: [illegible] to [illegible] mm.
    Tandem piston rings:
    1st, 2nd and 3rd rings: [illegible] to [illegible] mm.
    4th ring: [illegible] to [illegible] mm.
11. After installing new rings, check vertical clearance of grooves. This clearance must be between:
    Flat piston rings:
    1st and 4th rings: [illegible] to [illegible] mm.
    2nd ring: [illegible] to [illegible] mm.
    3rd ring: [illegible] to [illegible] mm.
    Tandem piston rings:
    1st and 2nd rings: [illegible] to [illegible] mm.
    3rd ring: [illegible] to [illegible] mm.
    4th ring: [illegible] to [illegible] mm.

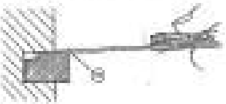
Assembly

12. If necessary, install new small end bushings, lining up bushing lubrication hole with connecting rod small end.
13. With tool 300, 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.

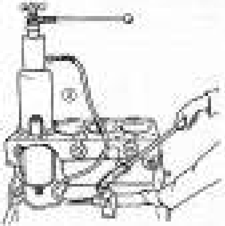
    NOTE: The piston head cavity is off-centered towards one of the sides. Join up pistons to connecting rods with cavity towards non-marking rod and big end bearing cap identification marks.

15. Install two new circlips on each piston pin.





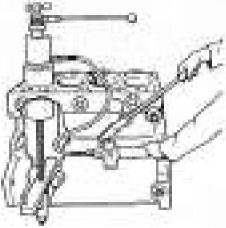
16. Starting from the top, install rings in the following order:
1st. Chrome ring.
2nd. Internally stepped compression ring.
3rd. Internally stepped compression ring.
4th. Adaptable scraper ring.
NOTE: The internally stepped compression rings must be placed with step towards piston head. Place rings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



CYLINDER LINERS

Disassembly

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



Replacement

4. Reverse operations 1 to 3, except:
   a) Cylinder head liners should be handled and stored with care. The slightest defect or flaw 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 [illegible] and [illegible] mm below top face of block.
   g) Check positions of pistons and if at all suitable, 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.

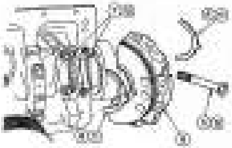
CRANKSHAFT THRUST HALF WASHERS

Disassembly and replacement

1. Disassemble [illegible].
2. Push crankshaft backwards and check end play between thrust half washer and crankshaft. The clearance should be between [illegible] mm.
3. If end play does not lie 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 washers.
9. Before re-assembling, lubricate all components with clean engine oil.
10. Place the two new upper thrust half washers in their housing with the face towards half bearing.
11. Place the two new lower thrust half washers in rear crankcase bearing cap and assemble it.
12. Put in fixing bolts and tighten them to a torque of [illegible] kg m.
13. Check end play again.
14. If end play is still not right, larger size thrust half washers may be installed. Repeat operations 4 to 13.

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

15. Re-assemble crankshaft rear retainer.
16. Assemble [illegible].



CRANKSHAFT

Disassembly

1. Drain engine oil.
2. Separate tractor 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 crankshaft gear.
9. Remove the eight bolts securing remaining 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 0.0001 mm. Examine for cracks and demagnetise crankshaft.

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

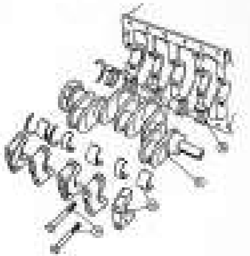
a) Minus 0.254 mm.
b) Minus 0.508 mm.
c) Minus 0.762 mm.

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 58.88 mm.

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

If the three assembly positions of the crankshaft rear retainer 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 machined below a minimum diameter of 115.77 mm.



It is not necessary to apply Tuftriding process to flange. Examine crankshaft for cracks and demagnetise.

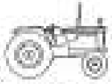
Assembly

14. Reverse operations 8 to 11, 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 16 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 [illegible]
1st Edition 1/78

SPECIFICATIONS Model [illegible]

Fuel tank location	In upper part of tractor, in front of steering column
Fuel tank capacity	[illegible]
Sediment cup	Built-in on fuel pump
Fuel filter	Equipped with replaceable element
Injection pump	
Make	C.A.V.
Type	D.P.A.
Governor	Mechanical
Maximum output	[illegible]
Maximum full load engine speed	[illegible] r.p.m.
High idle r.p.m. (no load)	[illegible] r.p.m.
Direction of rotation (facing coupling)	Clockwise
Code number on characteristics plate	[illegible]
Synchronisation with engine (Static injection advance)	[illegible]°
Low idle r.p.m.	[illegible]
Injectors	
Opening pressure	[illegible] atmospheres
Cold weather starting auxiliary device	Electric heater in the intake manifold

SPECIFICATIONS Model [illegible]

Fuel tank location	In upper part of tractor in front of steering column
Capacity of the fuel tank	[illegible] lt.
Sediment cup	Built-in on fuel filter
Fuel filter	Equipped with replaceable element
Injection pump	
Make	[illegible]
Type	[illegible]
Governor	Mechanical
Mixture ratio	[illegible] r.p.m.
Maximum full load engine speed	[illegible] r.p.m.
High idle r.p.m. (no load)	[illegible] r.p.m.
Direction of rotation (facing coupling)	Clockwise
Code number on characteristic plate	[illegible]
Synchronization with engine (static injection advance)	[illegible]° before T.D.C.
Low idle r.p.m.	[illegible]
Injectors	
Operating pressure	[illegible] 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 utmost cleanliness must be observed 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 cotton waste or fluff-releasing rags to clean 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 tractor, behind the front grille and above the battery. It is equipped with a centrifuge type prefilter. The higher than average air filtration performance provided by this unit is due to the use of centrifugation, 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 central 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, retains a large number of particles inside.

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 inside of the engine intake manifold.

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

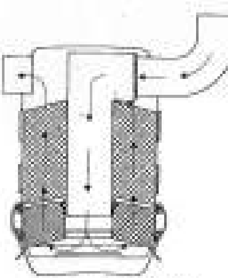


Fig. 1 – Cross-section of the air cleaner

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 could cancel the effect of the air filter.

Fuel tank

The fuel tank has a capacity of 55 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 wire mesh filter. The filler neck, located at the top of the tank, is provided with breather vent cap.

Fuel pump Model [illegible]

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 righthand 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 [illegible]

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 beneath 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 protects the delicate components of the injection equipment from water, dirt or foreign bodies that might be present in the fuel. Careless filling may overload the filter and impair its operation. On Model [illegible], 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 500 working hours. Do not try to clean or wash it: the used element must be discarded.

Fuel injection pump

The fuel injection pump of the C.A.V. type, is a robust, high precision 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 injection

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 [illegible] 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 [illegible] 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 attended 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 dilation which causes the ball valve to rise. At the same time a small amount of fuel flows from the fuel tank pipe through the heater where it is vaporised 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. 2).

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.

Fig. 2 — Cold weather starting device

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

— Remove the front grille from the tractor.

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

— Assemble in 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. [illegible] — Maintenance of the air cleaner

Fig. [illegible] — 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 prefilter and the air cleaner intake elbow (B).

— Take out the four cleaner clamp (D) set screws (C). Install the cleaner by following this 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 pipe and the cold start heater priming pipe.

— Take out the four screws that secure the fuel tank to the 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. 8)

— 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 in the tractor by reversing the above procedure making sure that the pump flange face and its seat in the inspection cover are clean.

Fig. 8 – 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 few 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 operated. However, it might happen that the engine stops in a position that causes the cam which drives the fuel pump to be in an even higher 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 (upwards), 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.

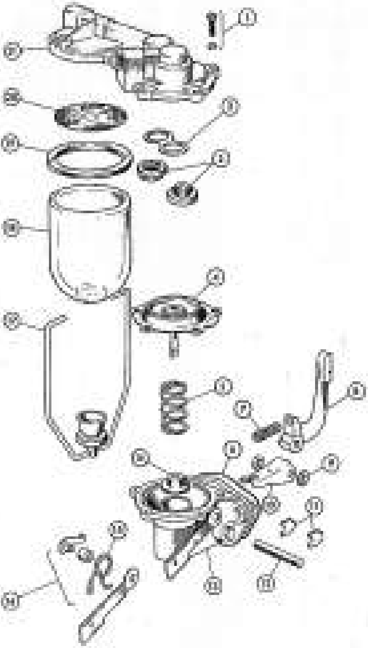


Fig. 1 — Fuel pump [illegible]

Exploded view of the Model 260 fuel pump (Fig. 6)

1 — Screw and washer
2 — Gasket
3 — Valves
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 — Manual primer assembly
15 — Manual primer spring
16 — Gasket
17 — Sediment cup clip
18 — Sediment cup
19 — Gasket
20 — Strainer or mesh filter
21 — Upper pump cover

Exploded view of Model [illegible] fuel pump (Fig. 7)

1 — Screw
2 — Washer
3 — Top cover
4 — Diaphragm
5 — Screw
6 — Washer
7 — Upper pump body
8 — [illegible]
9 — Valves
10 — Diaphragm
11 — Diaphragm spring
12 — Lower pump body
13 — Yoke
14 — Yoke 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 260 (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 so as to 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 90° and remove it (4), the spring (5) and the retainer (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 (5 and 7) being damaged or weak or of the rocker (8) and the lower body being damaged, replace them as well.

NOTE. — Wear in the contact area 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 yoke 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.

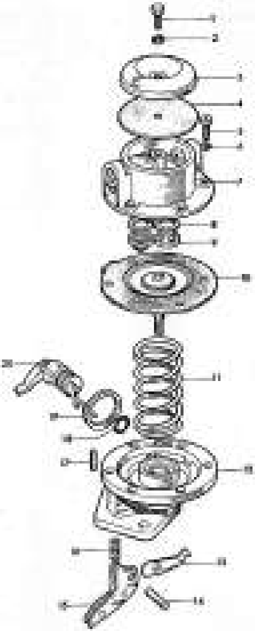


Fig. 7 – Fuel pump (Model 60)

DISASSEMBLY AND ASSEMBLY OF THE FUEL PUMP Model [illegible] (fig. 7)

— Remove the fuel pump from the bracket.
— 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 screw (1) and the washer (2) which secure the cover (3) to the upper body (7) and remove the cover and diaphragm (4). If this 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 (9) from their housing in the upper part of the pump. If the valves are defective replace them. Take out the gaskets (8). Assemble the new valves and gaskets in reverse order. To retain the valve in its housing, use an appropriate punch in 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 pushrod.
— Remove the spring from the lower body of the pump (11) and examine it to see if it is twisted or rusty. If the spring has to be changed make sure it is replaced with one of the same characteristics.
— Remove the pin (13), the washer (12), the spring (16) 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 grind the seat faces if necessary.
— To assemble the pump follow the disassembly procedure in reverse order, taking care that the edge of the diaphragm (10) 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 on the push rod 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 (A) from the upper center of the filter head.
— Separate the filter body (B) from the head (C).
— Check to see if the gaskets have deteriorated.
— Assemble in reverse order, making sure the gaskets are correctly located.

The fuel filter of the Model [illegible] has a built-in sediment 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 water, it is only necessary to unscrew the wing nut (2) and let the contents drain from the bowl by gravity.

In the Model [illegible] 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 strainer or sieve (2, fig. 6) and the gasket (4, fig. 6), all of which can be easily cleaned. Assemble by following this procedure in reverse order.

Fig. 5 — Changing fuel filter element Model [illegible]

Fig. 6 — Changing fuel filter element Model [illegible]

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.
— Remove the screws and washers which secure the injection pump on the mounting flange.
— On the [illegible] Model [illegible] remove, through the inspection cover located in front of the timing gear, the three screws that secure the pump hub pinion on the timing gear.
— Mark the position of the control gear in case it should change position in the event of a wrong movement.
— 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 first piston hole is correctly lined up with the timing gear pin.

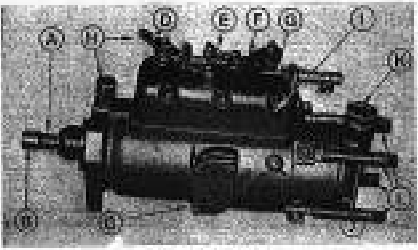


Fig. 10 — Fuel injection pump

A — [illegible]
B — [illegible]
C — [illegible]
D — [illegible]
E — [illegible]
F — [illegible]
G — [illegible]
H — [illegible]
I — [illegible]
J — [illegible]
K — [illegible]
L — [illegible]

— The lock pinion hole ensures, 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 nuts and respective washers can be assembled.

— Before finally tightening, it is necessary to align the pump setting marks, as is shown in fig. 12.

— 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.

— Reconnect 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. 12), then the fuel injection pump setting will be correct.

A further check is possible using the interior 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. 10).

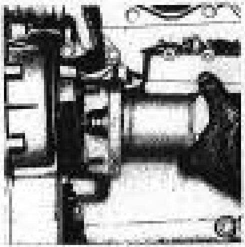


Fig. 11 — Installing the injection pump

Fig. 13 — Aligning adjusting marks on pump and flange

It must be remembered that in order to gain access to these injector adjustment marks, the seal fitted on this 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. 12) and adjust to zero on the maximum lift point obtained in turning the engine, precisely the 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 5.84 mm (Model 200 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 200) and 28° (Model 400) and represents the static setting point. However, in practice it is advisable to turn the engine beyond this point, that is, 7.20 mm and then return to 5.84 mm (Model 200) 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 [illegible] (Model 200) or [illegible] (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. 33 — Testing injection pump adjustment

Fig. 34 — Lower end flat stamped on pump impeller aligned with lug end

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

— Loosen the nuts which secure the injection pump on the mounting flange and turn the body of the pump in the appropriate direction. If after carrying out this last adjustment, the adjusting marks are not aligned, mark new ones 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 correct operation until the piston has moved 8.84 mm (Model 360) or 8 mm (Model 460), in order to check that the straight part of the lug end is now aligned with the mark on the impeller.

— Once the injection pump adjustment has been correctly carried out, slowly turn the engine in its 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 push rod, lower rocker arm carrier and adjust valves again.

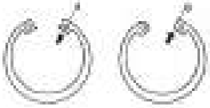


Fig. 35 — Starting engine lugs.
A and B. — Points of alignment with injection lever

HIGH IDLE ADJUSTMENT

To adjust the high idle (without load), the code number stamped on the injection pump characteristics plate should be taken as reference. The last four figures of this code correspond to this speed. Code example: [illegible] (Model [illegible]) and [illegible] (Model [illegible]); with these codes it would indicate that the engine should turn at a maximum of [illegible] r.p.m. and [illegible] r.p.m., respectively.

Adjustment of this speed has to be made by means of the high idle screw ([illegible], fig. [illegible]), bearing in mind that this screw is sealed and that therefore, should an engine require adjustment in this respect, it will have to be sealed again once this 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 load 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 characteristics plate is reached. If the speed does not reach this figure, turn the high idle adjustment screw ([illegible], fig. [illegible]) counterclockwise until the appropriate 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 set the adjustment screw ([illegible], fig. [illegible]), 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 [illegible] ± 50 r.p.m. (Model [illegible]) or [illegible] ± [illegible] r.p.m. (Model [illegible]). 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 adjust 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 the washer that secure each injector.
- Take out the injectors gently and evenly.

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

TO TEST THE INJECTOR NOZZLES

An effective method of checking the operation of a supposedly 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 constant 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 at the same time for overhaul, testing or replacement.

NOTE. — Do not attempt to service the injectors without appropriate means 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, aside 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 actuate the manual primer until fuel runs out through both valves without bubbles. Still operating the manual primer tighten the two pump valves 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 at 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 any pipe or union.

NOTE. — If the fuel supply pipe to the cold weather starting heater has been disassembled for servicing or any other reason, it must be bled. To do this, loosen the heater 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. Improper 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 injection pump.	Install new injection pump.
	4. Injectors not working properly.	Service injectors.
	5. Injection timing incorrect.	Adjustment it correctly.
	6. Cold weather starting device does not work correctly.	Inspect the heater. Inspect connections. Check flow of fuel through heater.
	7. Air filter dirty.	Clean it. Drain cup and fill up to level mark with new oil.
	8. Exhaust pipe restricted.	Unblock it.

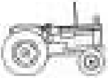
The majority of these faults can be the cause of loss of engine power.

TROUBLE SHOOTING

Problem	Possible Cause	Remedies
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



Publication [illegible]
1st Edition [illegible]

SPECIFICATIONS

Type	Water circulation by thermosyphon aided by centrifugal pump and temperature control by thermostat.
Height of pump above crankshaft:	
Model 350	293.3 mm
Model 400	[illegible] mm
Radiator	With fins and pipes.
Fan	With four blades of 412 mm diameter.
Cooling circuit capacity:	
Model 350	10.5 litres
Model 400	12 litres
Thermostat:	
Valve begins to open	78° – 82°C
Maximum opening of valve	88° – 91°C
Fan belt deflection	10 mm

DESCRIPTION

As shown in figure 1, both the components and the lay out of the cooling system are to the conventional type. The only attention required by 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 shuts 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 cap incorporates a pressure valve which reduces cooling solution evaporation and allows slightly higher temperatures. The cap also incorporates a depression valve to prevent a vacuum from forming when system coolant cools down.

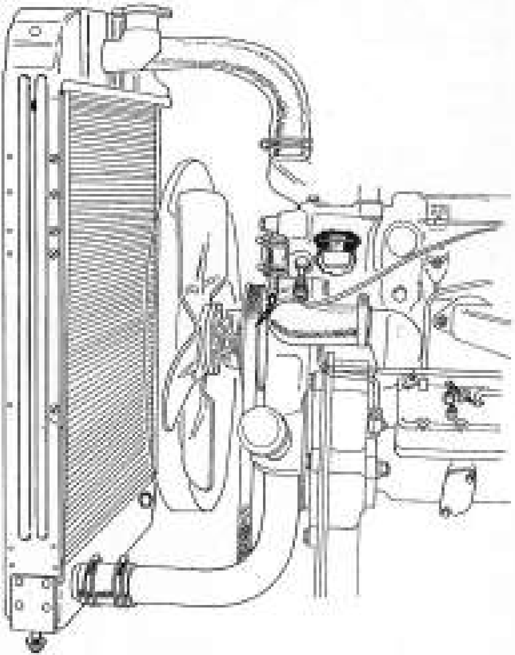


Fig. 1 – Components of the system

REMOVING AND INSTALLING THE RADIATOR (Fig. 2)

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

— Remove the hood.

— 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 expansion tank overflow hose.

— Remove the fan cowling (E) from the radiator (A) by taking out the screws (F).

— Take out the screws (G) which secure the radiator laterally on the hood.

— Take out the lower bolts (H) which secure the radiator on the chassis side.

— Remove the radiator.

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

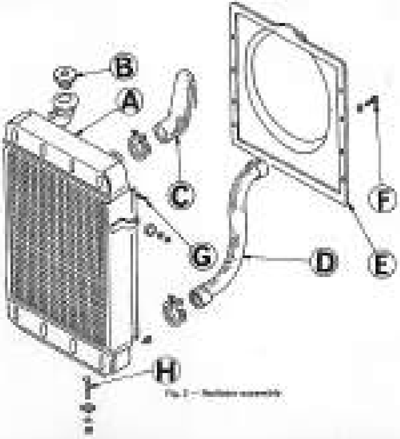


Fig. 2 — Radiator assembly

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 nuts and bolts are assembled with their washers.

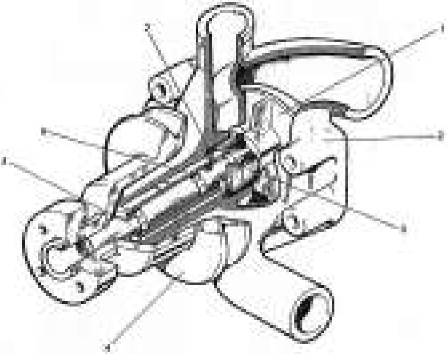


Fig. [illegible] — Water pump [illegible]

1 — Impeller
2 — Pump housing
3 — [illegible]
4 — Pulley
5 — Shaft
6 — Bearing
7 — [illegible] flange

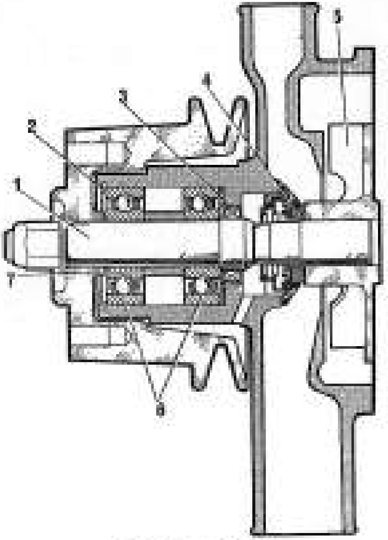


Fig. 4 — Water pump Model [illegible]

1 — [illegible]
2 — [illegible]
3 — [illegible]
4 — [illegible]
5 — [illegible]
6 — [illegible]
7 — [illegible]

DISASSEMBLING THE WATER PUMP
(Model [illegible])

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

— Remove the fan after disengaging the pulley and screw locking bolts.

— By means of special tool [illegible] and adaptors [illegible], remove the pulley from the pump (Fig. 5).

Fig. 5 — 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. 6).

— Take out rotative and impeller with tool MT [illegible] (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.

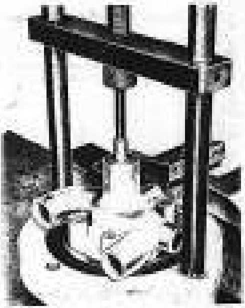


Fig. 6 — Extracting the bearing shaft

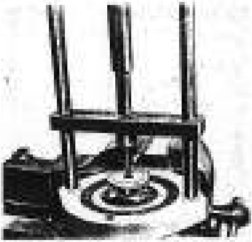


Fig. 7 — Removing the rotative and impeller

ASSEMBLING THE WATER PUMP Model 300

Assemble the water pump in the following way:

— Using tool MT-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 flush with the pump housing (Fig. 8).

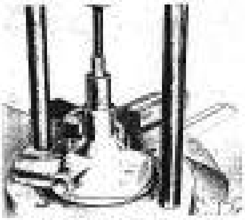


Fig. 8 — Installing the shaft bearing assembly

— 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, looking at pump from the front.

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

— Assemble the water deflector flange (with the flange side front wards).

— Insert the adapter (with dowel side towards the pulley).

— Press the impeller onto the shaft until there is a clearance of 0,30-0,37 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 noticeable play whatsoever inside the pump housing.

DISASSEMBLING THE WATER PUMP
Model [illegible]

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 four screws that secure it to the pulley (fig. 11).

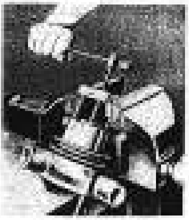


Fig. 11 — Removing the fan

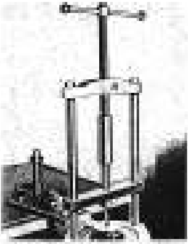


Fig. 13 — Disassembling the impeller and retainer

— Take off pulley, using tool MF-[illegible].

— With help of tool MF-200 and adaptors MF-200-4, extract the shaft with the impeller and retainer from shaft (fig. 12).

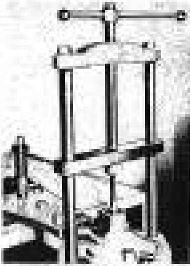


Fig. 12 — Disassembling the pump shaft and retainer

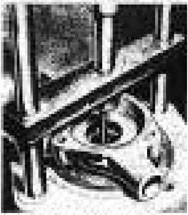


Fig. 14 — Disassembling the [illegible] sleeve and front retainer

— Remove retainer ring from shaft bearings.

ASSEMBLING THE WATER PUMP [illegible]

Carry out assembly of pump in the following way:

— Mount the deflector washer and inner bearing in the pump housing.

NOTE. — The inner bearing has to be mounted with its protected side facing the deflector plate. It is important to make sure that the deflector plate is properly assembled and that there is no contact with the inner ball race.

— Assemble the bearing spacer and fill space between both bearings with grease.

— Using special tool MF-[illegible] and adaptor MF-[illegible], center the spacer and insert the outer bearing (with protected side outwards) (Fig. [illegible]).

Fig. [illegible] — Centering the spacer

— Put the retainer ring on.

— Install shaft in pump housing from impeller side (Fig. [illegible]).

— Put a new retainer on, making sure friction side is next to impeller.

— With tool MF-[illegible] and adaptors, [illegible] bearings, spacer and inner retainer (Fig. [illegible]).

Fig. [illegible] — Installing the shaft in pump housing

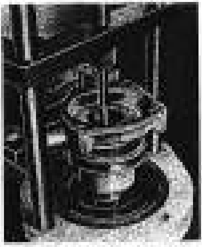


Fig. [illegible] — Installing the impeller

— Screw the long pump hub bolt to bottom right hole taken from the front of the pump.

— Install the pulley together with fan (Fig. 17).

— Press on the impeller (Fig. 18) and check clearance (Fig. 19).

Between the front edge of the impeller blades and the pump housing, there has to be a clearance or play of 0.30 to 0.5 mm.

NOTE. — The clearance can be tested by placing a ruler on the rear surfaces of the pump. If the clearance is correct, the ruler will also be in contact with rear surface of impeller.

— Tighten lock nut to a torque of 7,0 to 8,3 kg/m.

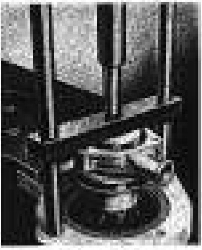


Fig. 18 — Installing the impeller

Fig. 19 — Testing impeller clearance

RADIATOR CAP (fig. 20)

The radiator filler neck cap is equipped with pressure and depression valves. When the cap is working correctly, it allows there to be pressure in the cooling system during periods of excessive temperature. This pressure raises the boiling point of the coolant, thereby reducing losses due to overflow. The efficiency of the cap is limited by its pressure of opening and by the boiling point of the coolant. To effect the lower shut-off, the radiator cap uses the pressure valve which is actuated by the force of the spring (R), causing the rubber seal (C) to close on the lower seat of the filler neck (D). The pressure spring is set at 450 g/cm² ± 20%. This pressure determines the opening of the valve.

The left-hand illustration of fig. 20 shows the operation of the pressure valve.

If when flushing out the system, the circuit is filled completely, it is possible that during the warming up phase, the volume of the water may increase, subsequently will the pressure when the pressure builds up under the valve and rubber gasket (C), the excess liquid and pressure will be expelled through the overflow hose (E).

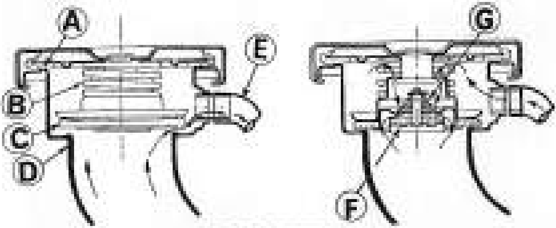


Fig. 28 — Radiator filler neck cap

In the right-hand illustration of fig. 28, the operation of the depression valve is shown.

When the engine is shut off, the whole cooling system cools down and the volume of the coolant subsequently decreases. To prevent a vacuum from forming as the system cools down, the cap contains a depression valve (F) which is normally held against its seat by the gentle pressure of its spring (G) (50 gr/cm² ± 15%). As the volume of the coolant decreases, there is a progressive change of pressure with formation of a vacuum which pulls the valve (F) downwards, overcoming the spring, with the result that air, aided by atmospheric pressure, penetrates into the system through the overflow hose (E) and the valve (F).

Although the cap mechanism does not require maintenance, periodically examine the cap to see that it is clean and working properly. Also examine the cap gasket and radiator filler neck to ensure correct sealing. If the rubber surface of the valve is damaged, install a new cap.

NOTE. — If a new cap is needed, always fit one of the specified type and pressure. Never allow the cap to be replaced with an ordinary one.

WARNING. — Be very careful when taking off the radiator pressure cap. In overheated engines, the sudden escape of a jet of steam may cause physical injuries.

To remove the radiator cap when the temperature of the coolant is very high or boiling, place a cloth over the cap and give it a quarter turn to the left as far as the first position release notch. Hold the cap in this position while the pressure escapes. Then press the cap downwards and continue turning it until it can be taken off. When putting the pressure cap on, place it in position and turn it clockwise as far as possible.

THERMAL RESISTOR OR THERMISTOR
(Fig. 29)

The thermistor is mounted on the top front part of the cylinder head (next to the thermostat). Its upper terminal (A) is wired up to the temperature gauge installed in the instrument panel.

It has an inside resistor (C) and metal insulator (B) at the bottom end, the resistance (Ω) of which decreases as the surrounding coolant temperature rises.

With a coolant temperature of 60°C, it offers a resistance of 130 Ω; at 80°C a resistance of 49 Ω; at 100°C about 26 Ω; and at 115°C about 17 Ω. Thus, as the temperature of the coolant rises, the device causes the temperature indicator needle to move.

If there is any doubt about the correct operation of the thermostat, replace it with a new one. If it still fails to give correct indications, check the general wiring and the temperature gauge.

When installing, check that the correct surfaces with the head are satisfactory.

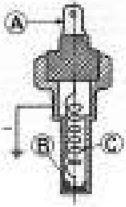


Fig. [illegible] – [illegible]

REMOVING AND INSTALLING

To remove the thermostat, proceed as follows:

— Take off the radiator cap.

— Partly drain the cooling system.

— Disconnect the thermostat chamber-to-radiator hose.

— Take out the two bolts, nuts and washers which secure thermostat cover.

— Take off thermostat chamber cover and take out thermostat.

To install thermostat, reverse above procedure, making sure that chamber surfaces are clean and that gasket is in good condition.

TESTING THE THERMOSTAT

To test operation of thermostat, follow the procedure described below:

— Submerge thermostat in a container of water in which a thermometer bulb has also been placed.

— Heat the water gradually and observe behaviour of the thermostat as the water temperature rises.

— The thermostat should begin to open between [illegible]° to [illegible]° and be fully open between [illegible]° and [illegible]° C.

If the thermostat does not open or does not do so progressively in the temperature range as indicated, discard it and install a new one.

ANTI-FROST PRECAUTIONS

For obvious reasons it is necessary to adopt preventive measures against the freezing of cooling system water and avoid the damage that this could cause to the engine. The best preventive measure is the use of anti-freeze, which is the most common procedure nowadays. Anti-freeze solutions naturally possess a much greater penetration capacity than water. In a cooling system that is normally in good condition, some loss may occur through seeping and [illegible] when anti-freeze is used. Even if such loss is not apparent, after filling the system for the first time with anti-freeze solution, there is a possibility that it may arise later. It is for this reason that all the hoses, connections, etc. of the cooling system should be in perfect condition if serious damage is to be avoided. In a system which loses coolant and requires frequent additions, anti-freeze protection will be reduced to dangerous limits.

Before filling the cooling system with anti-freeze mixture, the system must first be thoroughly flushed. To make the flushing easier, the use of «EBRO» Cooling Circuits cleaner Ref. A-85 and «EBRO» protector Ref. A-84 is recommended following the instructions printed on each container.

NOTE. — «EBRO» Cooling Circuit Cleaner Ref. A-85 should be used the first time that the system is flushed out. On successive occasions, use only «EBRO» Protector Ref. A-84.

At the same time, check the cylinder head torque to avoid any possibility of the mixture passing to the cylinders or crankcase where it could cause serious damage.

In the EBRO 300 and 460 tractors, whose capacities are 10.5 and 12 liters respectively, use «EBRO» anti-freeze in the proportion described in the following tables:

Model 300			
Protection limit	Proportion	Anti-freeze	Water liters
− 7° C	15 %	1,6	8,9
− 10° C	20 %	2,1	8,4
− 15° C	30 %	3,1	7,4
− 20° C	40 %	4,2	6,3
− 30° C	50 %	5,2	5,3

Model 460			
Protection limit	Proportion	Anti-freeze	Water liters
− 7° C	15%	1,8	10,2
− 10° C	20%	2,4	9,6
− 15° C	30%	3,6	8,4
− 20° C	40%	4,8	7,2
− 30° C	50%	6	6

TROUBLE SHOOTING

All troubles leading to engine overheating must be carefully investigated, determining and correcting any causes alien to the cooling system. A defect that may apparently be attributable to the system, may disappear, for example, through the correct adjustment of the injection system or by tightening the fan belt. In this section we shall not attempt to explain the causes that may give rise to engine overheating. The abnormalities described below are defects of the cooling system, although they may obviously be aggravated by deficiencies in the engine, heavier loading or other causes foreign to the system we are dealing with here.

Trouble	Possible Cause	Remedies
Overheats	Insufficient water in radiator.	Add water.
	Loss of water through [illegible] cap.	Correct.
	Leak through hoses or connections.	Correct.
	Leak through water pump retainer.	Correct.
	Radiator cap spring weak or defective, or faulty valve seat.	Replace cap.
	Fan blades badly fitted.	Correct.
	Belt loose or worn.	Tighten or replace it.
	[illegible]	Select gear appropriate to work being done.
	Faulty thermostat (remains closed or does not open sufficiently).	Replace thermostat.
	Hoses crushed.	Replace.
	Obstructions in radiator tubes or water lines.	[illegible]
	Faulty or corroded nipples.	Fit new one.
	Radiator core blocked with mud or chaff.	Clean radiator and grille.
Engine does not reach operating temperature.	Faulty thermostat (remains open or does not close sufficiently).	Replace thermostat.
	Adverse weather conditions ([illegible]).	Cover part of the radiator.

SECTION 7: CLUTCH

CONTENTS

Publication [illegible]
1st Edition [illegible]

SPECIFICATIONS

Main disc diameter	280 mm
Power take-off disc diameter	280 mm
Main disc friction surface	400 cm² (each face)
Power take-off disc friction surface	400 cm² (each face)
Control system	Foot operated
Pressure plate	12 calibrated springs (9 blue and 3 orange)
Length under load	117 kg ± 6 (blue) 39.8 mm 80 kg ± 3 (orange) 39.8 mm
Tension	Blue 7.5 kg/mm Orange 6.6 kg/mm
Free length	Blue 54.5 mm Orange 55.4 mm

Thickness of a new friction disc

Power take-off disc	$8.8 \begin{smallmatrix} +0.3 \\ -0.1 \end{smallmatrix}$ mm
Main disc	$8.8 \begin{smallmatrix} +0.6 \\ -0.1 \end{smallmatrix}$ mm
Pedal free travel	20 mm

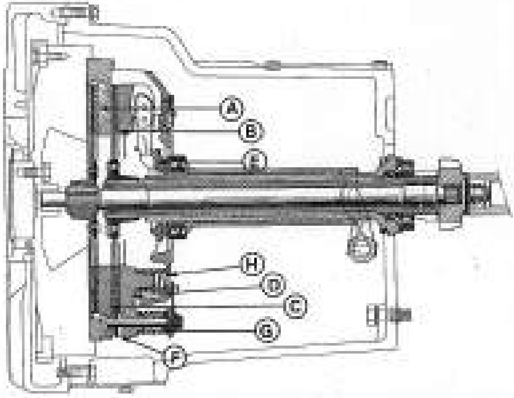


Fig. 1 — Clutch

A — Main friction disc
B — Secondary friction disc
C — Main pressure plate
D — Secondary pressure plate
E — Clutch release [illegible]
F — [illegible]
G — Springs - [illegible]
H — Springs - [illegible]

DESCRIPTION (fig. [illegible])

The double clutch consists of two friction discs: the main one actuates the primary shaft, while the secondary disc drives the power take-off shaft.

The double disc clutch device allows the main transmission to be disconnected without interrupting the operation of the hydraulic pump or power take-off shaft.

When the main transmission is disengaged, the implements driven by the power take-off continue working. When the pedal is fully depressed, the operation of the implements driven by the power take-off and the hydraulic pump is stopped.

The main friction disc acts through the main pressure plate ([illegible]) against the engine flywheel. The secondary friction disc acts through the secondary pressure plate ([illegible]) against a false flywheel.

The pressure plate is actuated by three clutch release levers ([illegible]) which rock in the forks set in the clutch cover.

With the first travel of the clutch pedal, the levers partly compress the disc springs (blue) and move the main pressure plate backwards until it comes up against the [illegible] ([illegible]), releasing the main friction disc. When the clutch pedal is fully depressed the [illegible] compress the disc springs (blue) and at the same time the three springs (orange), whereby the secondary pressure plate and secondary friction disc are released, leaving the drive and power take-off totally disengaged.

DISCONNECTION FROM TRACTOR

- Block front axle with wedges.
- Secure mobile jack at tractor axle with [illegible] and a chain hoist to support rear assembly.
- Apply hand brake.
- Remove hood.
- Disconnect steering drag link.
- Disconnect accelerator cable.
- Disconnect choke cable.
- Remove fuel tank and heater feed pipes.

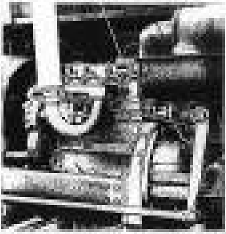


Fig. [illegible] — Disconnection from tractor

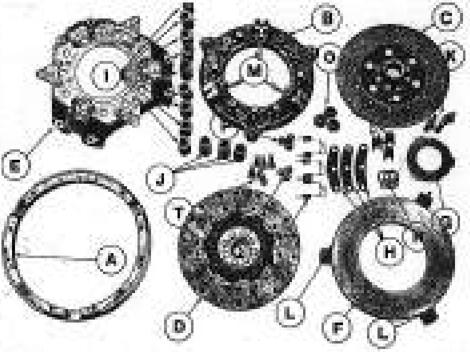


Fig. 2 — Exploded view of the clutch assembly

[illegible]

— Disconnect lift pump feed pipe.

— Disconnect drive cable from tachometer to engine.

— Disconnect all wiring, piping to front part of tractor.

— Remove clutch hood housing-engine lock screws.

Fig. 4 — Balance marks.

REMOVAL OF CLUTCH FROM TRACTOR

Once the clutch has been disconnected from the tractor, proceed as follows in order to remove it.

— Mark the position of the clutch press with respect to the flywheel (Fig. 4); this will ensure their balance upon re-assembly.

— Take out the six press-to-flywheel set screws and the adjustment shims (maximum of 3 per screw).

— Withdraw clutch press.

— Take out the friction disc assembly.

DISASSEMBLING THE PRESS (Fig. 5)

— Use a single line to mark the positions on the cover (A), main pressure plate (B), secondary pressure plate (C), ring nut (D) and thrust plate (E).

— Remove coupler nuts (F).

— Exert a slight pressure on the cover to take out the three screws (G) which lock the fork springs and the nut straps.

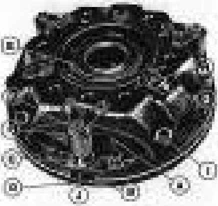


Fig. 5 — Disassembling the clutch cover

Fig. 6 — [illegible] check

— Take out three nuts (H) which secure forks to cover, and six screws (I) which secure cover to ring gear.

— Remove ring gear, cone and cone springs.

— Remove three nuts (K) and three springs, secondary pressure plate, secondary friction disc, [illegible] plate (J) and the main pressure plate.

— Take out the three spindles 14, fig. 11 of levers 38, fig. 11.

— Remove the levers and needles (? per lever).

— Take out spindles (C) from forks (D) (? per fork).

Fig. 7 — Disassembling the clutch release levers

TESTING AND REPAIRING THE CLUTCH

Engine flywheel

With the aid of a comparator, check that wear of friction face (A, fig. 8) of flywheel, at its greatest diameter, does not exceed 0.2 mm. If it does exceed this value, grind it.

This face must never show heat cracks or scratches.

Maximum grinding value: 3 mm.

The distance (l, fig. 9) should not exceed 5 mm; if it should be greater, grind the flywheel.

It would then be necessary to reduce the faces (a and b, fig. 9) by the same amount.

NOTE: When carrying out these measurements, make sure the contact faces between the flywheel and the crankshaft are clean of impurities.

Fig. 8 – Testing flywheel

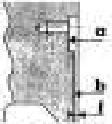


Fig. 9 – Testing flywheel

Fig. 10 – Testing secondary pressure plate

Make sure that wear of secondary pressure plate face does not exceed 0.2 mm. The friction face must never present heat marks or scratches. If there are any, grind the face. Maximum grinding value: 0.2 mm. If the distance (R) is less than 26 mm, change secondary pressure plate. The distance (R) is measured with a slide gauge [illegible] in hole.

Fig. 51 – Testing main pressure plate

Check that warp of plate faces does not exceed 0.2 mm. As is the case with the secondary pressure plate, the friction faces should not show any heat marks or scratches.

Maximum grinding value: 0.3 mm per face.

If the value of 3.5 is less than 15.6 mm, replace the plate.

ASSEMBLY OF CLUTCH PRESS

Assembly of clutch press is to be carried out in the following order:

Assembly of forks to levers (Fig. 52)

Holding lever in a horizontal position, assemble a provisional spindle of Ø7 mm and 8 mm in length, to allow centering of the needles. Insert the 17 needles in their housings around spindle, with bearing grease.

Put the fork in the lever (threaded stem facing backwards).

Insert lever spindle, which will push out provisional spindle that had been assembled, and secure it with a lock pin.

The lever spindle has a bevel on one of its ends: this bevel indicates the direction of assembly.

Characteristic of needles: Ø 1.00 mm, length 6.4 mm.

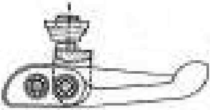


Fig. 52 – Assembling forks

Assembling clutch release levers (Fig. 13)

Carry out the same operations as for a fork spindle, with a [illegible] spindle of 0.7 mm and 8 mm in length (number of needles is also 17 per lever).

Fig. 13 — Assembling levers

Fig. 14 — Assembling cover-pressure plate assembly

Assembling cover-recovering pressure plate assembly

— Place the nine springs (blue) in their housings on pressure plate (Fig. 14).

— Assemble cover so that marks made on it before it was disassembled match up and set springs in their corresponding housing in cover.

— Check that springs are correctly assembled.

— Assemble thrust plate, holding stop spring with a hook and exerting pressure on plate spring with a screwdriver (Fig. 15).

— Assemble bolt nuts, exerting slight pressure on cover to facilitate assembly.

Fig. 15 — Assembling thrust plate

Assembly of P.T.O. friction disc and main pressure plate

With the engine flywheel on a bench, assemble the ring gear, friction disc [illegible], main pressure plate and power take-off friction disc. Center them with tool [illegible] (fig. 16).

Assemble the pressure plate-clutch assembly so that marks match up. Place the three springs [illegible] on secondary pressure plate (fig. 17), securing them with the nuts. Tighten [illegible] sufficiently to obtain the distance of 84 ± 0.5 mm (see fig. 18).

Install nuts and counter-nuts, fitting new shims.

Fit the lock nut shims.

Fig. 16 – Assembling P.T.O. friction disc-primary pressure plate assembly

Fig. 17 – Assembling springs [illegible]

Fig. 18 – Adjusting thrust plate

Adjusting height of thrust plate

With special tool, Refs. 13, adjust height between thrust plate and ring gear plane by means of lever nuts (A), so as to obtain a measurement of:

$$43.5 \begin{smallmatrix} +1.1 \\ -0.4 \end{smallmatrix}$$

Adjusting main pressure plate

To adjust a clutch assembly with new discs and plates, the separation distance (C) (fig. 29) of 1.5 mm is obtained by inserting three shims (A, fig. 30) for each screw.

When adjustment has to be made with used discs and plates, the separation distance of 1.5 mm (C) is obtained by removing shims as required.

Once the necessary number of shims has been determined, check the main pressure plate travel (fig. 31), which must be at least 1.8 mm.

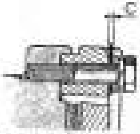


Fig. 29 — Bearing adjustment

Fig. 30 — Adjusting the main pressure plate

INSTALLING CLUTCH ON TRACTOR

Having completed adjustment on a bench, separate clutch assembly and flywheel.

Mount flywheel on engine.

Assemble clutch assembly with aid of tool 7A. Extr. 48, previously inserting friction disc advance hubs facing base towards flywheel.

Tighten the clutch-to-flywheel set screws, making use of the number of shims required according to the adjustment.

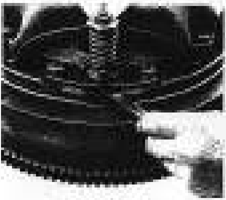


Fig. 31 — Adjusting the main pressure plate

Adjustment of clutch pedal free travel (fig. 29)

In order to ensure the correct operation of the clutch assembly, the pedal must have a free travel of 20 mm (0.8"). This free travel is adjusted by means of the control rod after first loosening the counter-nuts.

It may happen that, after setting this adjustment, the pedal operation travel will be insufficient to provide complete disengagement of the power take-off, in which case see under pressure plate adjustments section, figs. 19 and 20.

To overcome this irregularity, proceed as follows:

— Take off the lower clutch housing inspection cover (fig. 30).

— Turn engine with a crank handle so that two of the six set screws (11), from ring gear (12) to flywheel, are in front of opening.

— Take out these screws and remove one adjustment shim (13) per screw; the shims are located between intermediate plate stop plate (13) and starting gear (12); in this way a minimum travel of 1.5 will be ensured.

— Put these screws on and proceed with the other four in the same way.

— Check that operation of clutch is correct: if it is not, repeat the above operations removing a second shim.

NOTE. The same number of shims must be left on each screw.

If after removing all the shims, the clutch still cannot be released completely, dismantle the clutch and test and replace any parts as required.

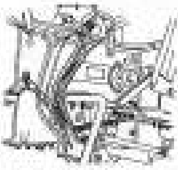


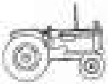
Fig. 29 – Adjusting pedal free travel

Fig. 30 – Adjusting clutch

SECTION 6:

GEARBOX

CONTENTS



Publication: [illegible]
1st Edition [illegible]

SPECIFICATIONS

Number of gears: 8 forward (synchronised) and 2 reverse (unsynchronised).

Reduction ratios

1st	9.25 : 1	5th	2.40 : 1
2nd	6.13 : 1	6th	1.60 : 1
3rd	3.83 : 1	7th	0.95 : 1
4th	3.04 : 1	8th	0.76 : 1
Reverse-low	6.98 : 1	Reverse-high	2.10 : 1

Adjustments

Power take-off shaft: Front bearing side play adjusting shims, spacers: 0.5·1 - 0.3 or 0.5.

Main shaft

Rear: Contact distance adjusting shims, spacers 0.1 - 0.2 - 0.25 - 0.5 - 1 mm.

Front: Side play adjusting shims spacers 0.1 - 0.2 mm.

Reduction gear: Main shaft side play adjusting shims, spacers 0.1 - 0.2 - 0.5 - 1 mm (maximum play 0.5).

Oil

Capacity (gearbox, rear axle and lift): 26.5 litres.
Viscosity: C9 2

Power take-off

Maximum shaft speed: 540 r.p.m. at 2,200 r.p.m. of engine.

DESCRIPTION (fig. 1)

The gearbox of the [illegible] and [illegible] tractors has four forward gears, totally synchronised, and one straight-[illegible] reverse gear. It is equipped with a gear reducer which permits a range of eight forward gears synchronised and two reverse gears [illegible].

This box consists of:

- A casing attached to the clutch and rear axle casings.
- A fixed train shaft (1) with five constant mesh gears.

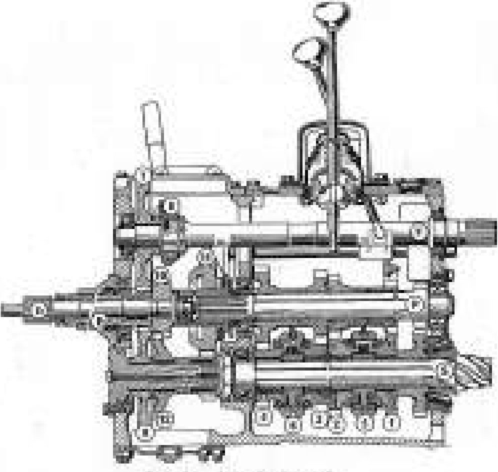


Fig. 1 – Schematic view of gearbox operation

— A bolster or axle shaft (13), which forms the drive gear and bar.

— Two sliding gears (3) and (8) which lock 1st to 2nd and 3rd & 4th gears respectively.

— A reverse gear.

— A sliding reverse bar shown in the figure.

A primary transmission shaft (11), joined to the gear (12) which transmits motion to the fixed train shaft (9) by means of reduction gear (reducer).

A primary power take-off shaft (12) terminating in a gear which controls:

— Power take-off shaft (1) through gear (7) and sliding gear (8).

— Lower power take-off gear (6).

The reduction gear consists of a sliding gear (11) and an intermediate gear train (12) formed by two united gears.

Normal position of gear reducer

The sliding gear (11) is in mesh with gear (10). Motion passes directly to the fixed train shaft (9).

Geared down position of gear reducer

The gear (10) transmits motion to the intermediate train (12) which transmits it to the sliding gear (11), which in turn transmits it to the fixed train shaft (9).
If the gearbox must be disassembled for any reason, the outside should be cleaned. Never hit it with hard objects and preferably use plastic, rubber or aluminium, bronze or wooden-faced hammers.

Once the box has been disassembled, before proceeding to assemble it clean all gears and replace the ones that have been damaged.

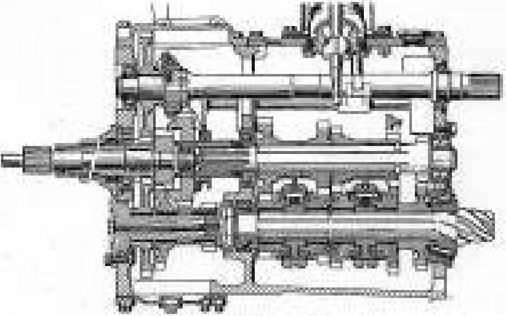


Fig. 2 – Schematic view of high gears

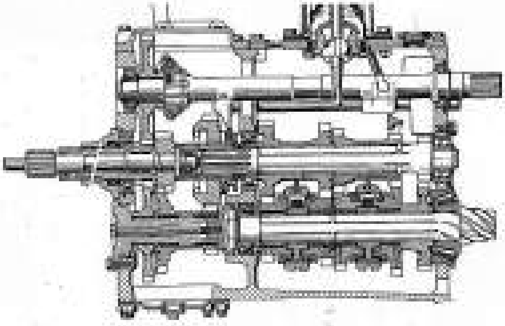


Fig. 3 – Schematic view of low gears

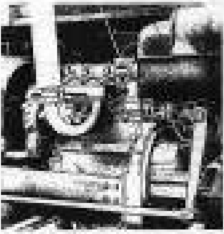


Fig. 4 – Clutch-engine disconnection

DISCONNECTION FROM TRACTOR

Before proceeding to remove the gearbox, it must first be disconnected from the tractor. This should be done according to the following instructions:

— Disconnect the tractor at the clutch-engine coupling (see clutch section) and then remove:

— Steering wheel.
— Throttle control lever.

— Instrument panel.

— Fuel tank and rear bracket.

— Hydraulic pipes.

— Fuel tank front bracket with main hydraulic system filter.

— Bracket with throttle linkage.

— Steering box.

— Hydraulic pump and its lock cock.

— Footrests.

— Brake and clutch pedal spindles.

— Brake control lever.

— Casing and gear shift and reduction levers.

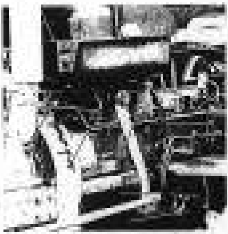


Fig. 5 – Gearbox-clutch disconnection

REMOVING GEARBOX FROM TRACTOR

Once the gearbox has been disconnected from the [illegible] and the oil has been drained from the gearbox-rear axle, proceed as follows:

— Working inside the clutch housing, loosen the bolts that secure the gearbox to its casing (Fig. 6).

— Loosen the two bolts which secure the gearbox casing to the rear axle housing (Fig. 7).

— Attach lifting sling [illegible] on upper face of gearbox casing. Support gearbox with the aid of a hoist, and after loosening the exterior bolts which secure it to the rear axle housing, raise it (Fig. 8).

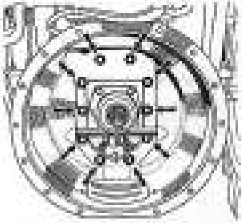


Fig. 6 — Removing clutch housing gearbox bolts

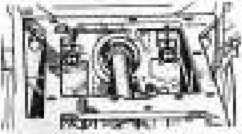


Fig. 7 — Removing gearbox rear axle housing inside bolts

Fig. 8 — Removing gearbox rear axle housing outside bolts

INSTALLING GEARBOX IN TRACTOR

The gearbox is installed in the tractor by reversing the procedure described for its removal, paying particular attention to:

— Check that the two centering guides are correctly located in the rear axle housing.

— Assemble the gasket (smearing it with sealing paste).

— Check tightness of two lock bolts located on sides of gearbox.

— Assemble the two longest lock bolts in the centering guide housings.

INSTALLING CASING OF GEAR SHIFT AND REDUCER LEVERS

The gear shift and reducer lever casing is installed in the following way:

— Put all the shift forks in neutral, with shaft forks lined up to facilitate cover assembly.

— Assemble the gasket (smearing it with sealing paste).

— Set the control lever fingers (gear shift and reducer) in hole of shift forks and secure the cover.

GEARBOX CLUTCH HOUSING CONNECTION

The gearbox is connected to the clutch housing in the following way:

— Check that the two centering guides are correctly set in the gearbox casing.

— Assemble the gasket (smearing it with sealing paste).

— Connect them with lock-bolts and mount clutch bearing.

DISASSEMBLING GEARBOX

To disassemble gearbox when it has been removed from unit and placed on a work-bench, proceed as follows:

Fig. 9 – Disassembly of P.T.O. sliding gear control lever

Disassembling the power take-off shaft

Remove P.T.O. sliding gear control lever (fig. 9) according to this procedure:

– Take out shift fork lever coupling screw.

– Remove selector spring covers (A, fig. 11).

– Remove shift fork rod selector (B, fig. 11) the detent with balls and springs.

– Take out front bearing locking ring and washer.

– Move P.T.O. drive gear lengthwise.

– Push P.T.O. shaft back (fig. 12). Be careful with sliding gear balls and lever lock springs.

Fig. 10 – P.T.O. sliding gear control lever

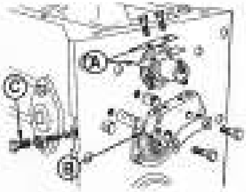


Fig. 11 – Shift fork rods cover and selector

— Remove drive gear.

— Remove P.T.O. sliding gear.

— If necessary, remove P.T.O. shaft rear bearing. Use a press to remove it after first taking out the lock ring.

Fig. 10 — Extraction of power take-off sha...

Fig. 11 — Power take-off shaft assembly

Dismantling intermediate and P.T.O. gears

Remove the intermediate reduce gear and lower P.T.O. gear (fig. [illegible]).

— Take out the set screw (A, fig. 15).

— Take out the three locking plate set screws (B, fig. 15) and remove the plate.

The intermediate reduce gear and lower P.T.O. gear will then fall to the bottom of the casing.

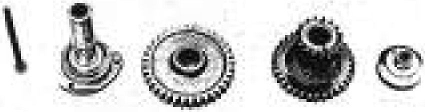


Fig. [illegible] – Intermediate reducer and P.T.O. gears

Disassembly of transmission and P.T.O. primary shafts, reducer sliding gear and drive gear.

To disassemble primary shafts, sliding gear and drive gear, proceed as follows:

— Remove hub guide retainer from primary shafts.

— Push shafts (fig. [illegible]) towards (fig. [illegible]).

— Remove drive gear from reducer sliding gear, taking out slide hub and nut connection screw.

— Remove sliding gear and its hub, being careful with the balls and spring(s), adjusting washers and thrust washers.

— From the bottom of the casing take out the pins which have fallen, and with the help of the set screws, remove hub guide from intermediate gear.

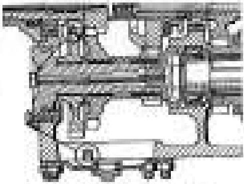


Fig. [illegible] – Intermediate gear set screws

Fig. [illegible] – Transmission and P.T.O. primary shafts

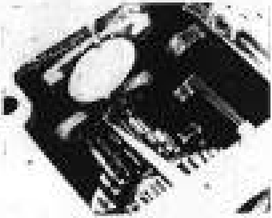


Fig. 17 – Disassembling primary shafts

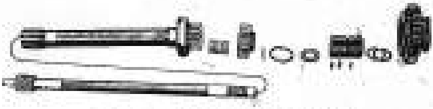


Fig. 18 – Assembling transmission and P.T.O. primary shafts

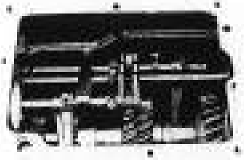


Fig. 19 – Disassembling shift forks

Disassembling shift forks (fig. 19)

Take out fork-to-rod connection screws, removing reverse gear shift-fork. Be careful with the two lock pins situated between the rods.

Dismantling fixed axle

Unlock fixed axle lock nut. Use spanner TA-Bd. 80 to loosen nut fig. 30.

Remove rear bearing retainer plate (A, fig. 31).

Withdraw fixed axle shaft through the rear.

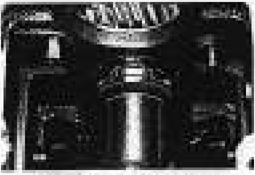


Fig. 30 — Removing fixed axle lock nut

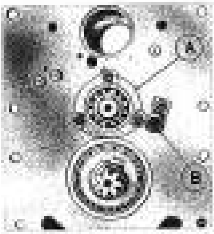


Fig. 31 — Dismantling rear bearing retainer plate

Fig. 32 — Fixed axle assembly

fig. 23 — Reverse gear

Dismantling reverse gear

Remove lock strap 18, fig. 23 and take out reverse gear shaft.

Dismantling main shaft (figs. 24 and 25)

To do so, proceed as follows:

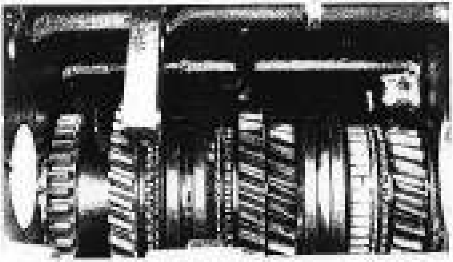


fig. 24 — Dismantling main shaft

Remove:

— 1st and 2nd gear shift fork and fork rod.

— Selector screw (C, fig. 11) of 3rd and 4th gear shift fork rod (be careful with ball and spring).

— 3rd and 4th gear shift fork and its rod. Take care with the lock pin located in the shaft mounting bracket.

— Main shaft lock nut (blocking it so it does not turn), and then withdraw the main shaft through the front.

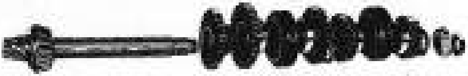


Fig. [illegible] — Main shaft assembly

ASSEMBLING GEARBOX

The assembly of the gearbox should be carried out in the following order:

Assembly of main shaft

Before proceeding to install the main shaft in the gearbox, first adjust the position of the drive gear. To do so, carry out the following procedure:

Positioning drive gear (Fig. 26)

The drive gear is in correct position when its front face is at a distance of:

A = 60.75 to 60.80 mm from the outside face of the gearbox casing. This distance is obtained by fitting shims (C) between the flange formed by the outer bearing ball race and the outside face of the gearbox casing.

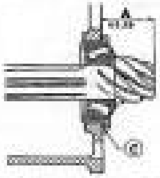


Fig. 26 — Drive pinion dimensional figure

Determining shim thickness

To determine the shim thickness necessary for mounting drive gear, carry out the following operations:

— Mount the bearing on the main shaft and secure the outer ball race to the gearbox casing, without shims.

— Place gearbox in a vertical position.

— Assemble the drive gear shaft without gears.

— Check the distance (A, fig. 26) with respect to the tool TA.fol. (A, fig. 27) by means of a comparator.

The difference will be equal to thickness of shims required. To make up this thickness, shims of 0.1 - 0.2 - 0.25 - 0.5 and 1 mm are available.

Fig. 27 — Checking drive gear spacing

SPECIAL CASE

If the drive gear has a number marked in a circle on the hard face, this value must be subtracted from the shim thickness.

Example:

Shim thickness obtained: 1.8 mm.

Indication marked on the gear: [illegible].

Value of shim thickness: 1.80 - [illegible] = [illegible] mm.

Remove shaft and outer ball race, assemble shim thickness (C, fig. [illegible]) and [illegible].

Adjustment of main shaft axial play (D), fig. [illegible]

Once the correct position of the drive gear has been determined, the main shaft axial play should be adjusted. To do so, mount the front bearing ball race on the inside of the gearbox, without adjusting shims.

ADJUSTMENT OF BEVEL GEAR

The drive gear and bevel gear are made as one piece and are NOT SEPARABLE.

Each gear bears a common mark for their control.

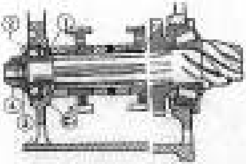


Fig. [illegible] — Main shaft axial adjustment

Fig. [illegible] — Checking main shaft axial adjustment

Install the main shaft along with reverse gear, split bushes, synchronizer hub, spacer [illegible], [illegible] and bearing, and tighten the lock nut to 15 kgm.

[illegible] the gearbox setting weight (Fig. 29).

Place a comparator on the front face of the drive gear.

Move the shaft lengthwise in both directions by hand.

The maximum value recorded on the comparator corresponds to the thickness of shims (2), Fig. 29.

To make up this thickness, shims of 0.1 and 0.2 mm are available.

Remove the shaft and the bell case.

Insert the shims, install the shaft and bell case and check: the shaft must turn without end play.

Assembling main shaft (Fig. 30)

After carrying out drive gear adjustments described above, assemble the main shaft in the following way:

Install:

— Reverse gear.

— 1st and 2nd gear assembly.

— Grooved washer.

— 3rd and 4th gear assembly.

— Spacer.

— Bearing.

— Nut, tightening it to 15 kgm.

NOTE: The nut is to be locked with a drop of [illegible], after removing grease from shaft threads and nut.

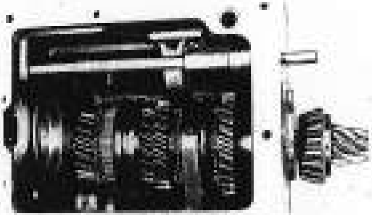


Fig. 30 — Assembling main shaft

Once the main shaft has been mounted, assemble gearbox in the following order.

Install:

— Reverse sliding gear.

— Shift forks of 1st to 2nd and of 3rd to 4th and their rods (secure rod screws with wire).

— Intermediate gear hub-guide after main shaft nut. (Place in correct position on bottom of gearbox using for later assembly, [illegible] intermediate gear shaft and lower power take-off gear).

— The fixed train shaft, the bearing washer to set with bevels concealed.

— The nut retainer ring.

— Fixed train unthreaded lock nut, tightening it to 10 kg using special spanner [illegible], then lock the nut with its seat.

— The hub spline.

— Clutch and transmission primary shafts, checking that clearance between fixed train lock nut and hub spline is of 0.8 mm (fig. 31). Assembling shims should the clearance be greater.

NOTE: This clearance should be measured with clutch and transmission primary shafts and fixed train as close to one another as possible.

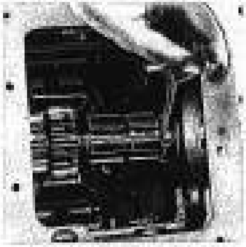


Fig. 31 — Testing clearance of primary shafts

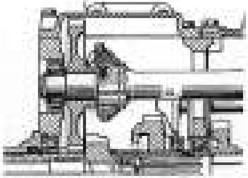


Fig. 32 — Assembling P.T.O. shaft

— Clutch primary shaft hub guide window, fitting the gasket smeared with sealing paste.

— Intermediate reduce gear shaft and power take-off gear (which has previously been left on the bottom of the casing). Assemble the lock plate and the connecting screw (lock it with [illegible]).

— The power take-off shaft (fig. 30), not forgetting the spacer washer between the casing and the rear bearing. Set the washer with the pin and then fit the ball cage and bearing.

— Power take-off lever, locking the screw with wire.

Assembling 3rd to 4th shift fork rod

To assemble 3rd to 4th shift fork rod, place the connection pin in tool T.[illegible] (fig. 31), place the assembly in the path of the fork rod and press in the connection pin with a rod.

DISASSEMBLING THE GEAR SHIFT AND REDUCER OPERATING LEVERS

Gear shift operating lever

To disassemble gear shift lever, proceed as follows:

— Remove the ball.

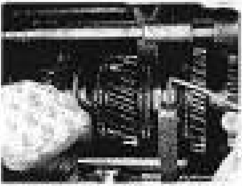


Fig. 31 — Assembling 3rd to 4th shift fork rod pin

— Remove operating lever synchronizing casing, dustguard and its belt washer.

— Remove dowel pin and take lever out downwards.

Reducer operating lever

Without having to remove lever housing:

– Remove dustguard lock pins and withdraw the lever upwards.

ASSEMBLING GEAR SHIFT AND REDUCER OPERATING LEVERS

To assemble the levers, follow the procedure described above in reverse order.

The assembly of the lever housing is described on page [illegible].

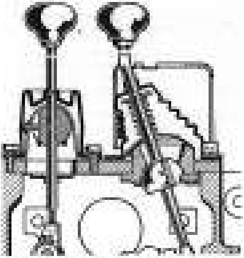


Fig. [illegible] – Disassembling gear shift and reducer control levers

GEAR SHIFTING (Fig. [illegible])

Gears are shifted by means of the control lever and reducer lever located above gear box. The eight forward and two reverse gears which the box provides, can be obtained by using both levers in combination. The positions of both levers are illustrated in Fig. [illegible]. Key to Fig. [illegible].

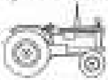
Corta - Low; Larga - High
M.A. Corta - Low reverse
M.A. Larga - High reverse

Fig. [illegible] – Positions of gear shift and reducer levers

SECTION 9:

HYDRAULIC SYSTEM

CONTENTS



Publication EP 1026 EXP 1
1st Edition 1/78

SPECIFICATIONS

Hydraulic lift

Type	Automatic depth control, controlled position and traction modulation.
Cylinder diameter	90 mm.
Piston stroke	150 mm.
Maximum force on piston	8,807 kg.
Maximum lifting force end of traction connecting rods	3,900 kg.
Depth adjustment for pulls included between	50 and 3,700 kg.
Oil capacity lift, gearbox and rear axle	38.5 L.
Lubricant lift, gearbox and rear axle	[illegible]

Hitch

Type	Three point, category II.
Third point	Telescopic.
Stabilisers	Telescopic.
Sensitivity	In lower rods.
Maximum upward movement of lifting arms	340 mm.
Maximum downward movement of lifting arms	End of arms on a plane with junction point between cover plate and lift.

Hydraulic pump

Type	Gear. Driven by gear on power take-off shaft.
Engine-pump ratio	15 : 19
Flow	50 L/min. at 2,000 r.p.m.
Pressure	160 kg/cm²

[illegible]
[illegible]

Auxiliary services distributor

Type	Double-acting.
Pressure limiting valve	160 to 170 kg/cm².

DESCRIPTION OF HYDRAULIC LIFT CONTROLS (Figs. 1 and 2)

The [illegible]-Control type hydraulic lift provides two selective systems: automatic Pull Control and Position Control. It is also equipped with rate adjustment in Pull Control and lower adjustment in Position Control. The lift controls are described below.

Position Control operating lever

The Position Control operating lever (A) is that corresponding to the outer quadrant and it operates throughout the whole sector. It controls the raising and lowering of the implement and the maintaining at a constant height.

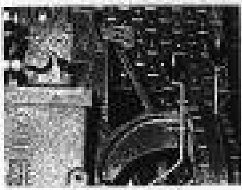


Fig. 1 – Hydraulic lift controls

Pull Control operating lever

The Pull Control operating lever (B) is that corresponding to the inner quadrant, and it automatically determines the operating depth with respect to pull. It moves along the inner sector with the following indications:
MAX: maximum depth, MIN: minimum depth, A: cancellation of automatic depth adjustment.

The combination of levers (A) and (B) allows operation with Traction Stabilization.

Raising adjustment control
This control (C), located on the upper face of the lift distributor, controls speed of raise in Pull Control.
This control has the two following positions: Position (D): fast raise speed. Position (E): slow raise speed.

Adjustment of lowering speed

The adjustment of lowering speed in Position Control is achieved in the following way:
The position Control lever quadrant has a stop (F) in the lower part at which the lever comes to a stop: fast speed. By passing beyond the stop in a downward direction: slow speed.

Fig. 2 – Hydraulic lift controls

HITCH ADJUSTMENTS

To use to the implement the tilting speed of the implements, fast at the beginning and slow at the end of travel, it is essential that the arms should be as short as possible.

When working, the arms should be elevated as low as possible, always leaving a sufficient height to allow the «Tractor Control» to correct position variations of course.

Length of third point arm

— Arm in fixed position

Adjust the length so that it is sufficient to obtain a weak plough feeding and so as to prevent it exerting a pull force on itself.

— Arm in sliding position.

To be used only on stony ground or where the implement may suffer violent shocks.

Hitch position (Fig. 5)

When working, respect the position of the hitch bars (B) and the third point arm (A), indicated in the figure with dotted line in respect of a horizontal plane represented by a continuous line, in order to obtain the best results especially with ordinary plows.

These positions have been obtained by considering the height of the hitch points over implement and the extent of the force.

Stabilizer rods (Fig. 5)

The two stabilizer rods (E) include a sliding mechanism in order to allow the hitch bars to be moved backwards. To permit correct working of the lift, the stabilizer rods must not be blocked under any circumstances. There must be a minimum play of 5 mm on each side. Keep this warning in mind at all times.

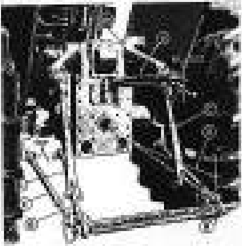


Fig. 5 — Hydraulic lift hitch

A — Third point arm
B — Hitch bars
C — Lift rods
D — Lift arms
E — Stabilizer rods

OPERATION OF LIFT

The Tractor Control type hydraulic lift permits operation with:

Automatic adjustment of depth (Fig. 4)

— Suspended implements: ploughs, cultivators...
The automatic depth adjustment through transfer of permanent load, obtained by the hitch bar reaction connection rod, transmits directly to the lift distributor the different forces recorded by the implements according to the nature of the soil, its profile and the position of traction.

To determine the depth of operation:

— Move the Position Control lever forwards (A) to the lower part of its quadrant.

— Place the Pull Control lever (B) in front of MINI in its quadrant.

— Move the tractor forwards, progressively lowering the Pull Control lever (B) until the desired working depth is obtained.

This depth is adjusted automatically with regard to soil. As long as the work lasts do not touch this lever again.

Manoeuvre

At the end of the run, move the Position Control lever (A) to the top part of its quadrant to raise the implement. The implement is lowered by placing this lever in the lower part of its quadrant.

Fig. 4 — Automatic depth adjustment

Note: When the Position Control lever (A) is moved from the low to the high position, the implement at first rises quickly and then reduces its speed before end of travel to prevent mechanical shaking and to increase driver comfort.
Suspended implements can also be used in Traction Modulation. All implements: ploughs, cultivators, etc., should be used without depth wheels.

Traction Modulation (Fig. 5)

— Suspended implements: ploughs, cultivators...
— Semi-suspended implements: simple disc ploughs...
— Drawn implements: disc harrows, harrows...

Traction Modulation is obtained through the combination of the two control levers and has the advantage of Automatic Depth Adjustment. In addition, it prevents suspended and semi-suspended implements from going below the desired depth in soils of a very varied nature and in particular when passing through stretches of very soft ground.

To determine working depth:

— Move the Position Control lever (A) fore/aft to the lower part of quadrant.
— Put Pull Control lever (B) in front of [illegible] in its quadrant.
— Move the tractor forwards, progressively lowering Pull Control lever (B) until desired working depth is obtained.

— Slowly raise Position Control lever (A) again until the arms begin to rise. Once having done this, lower the same lever [illegible] the space between [illegible] fixed.

Fig. 7 — Traction Modulation

[illegible]

At the end of the tractor run, situate the Position Control lever (A) in the top part of its quadrant to raise the implement, moving it back to the former position for the implement to return to working position.
Do not touch Pull Control lever (B).

Note: To obtain Traction Modulation and best results when using harrows and rolling harrows, it is necessary to block the implement head or boom to prevent its movement in a vertical direction, blocking it [illegible] carried out this operation to the crossbar that joins the two draw bars.

Position Control (Fig. 8)

— Semi-suspended implements: rakes, seed drills, hay rakes.... The position Control enables the implement to be maintained at a fixed height in relation to the tractor.
To determine the position of implement:
— Move Pull Control lever forwards (B) to the end of quadrant (cancellation).
— Progressively lower Position Control lever (A) until the desired position of implement is obtained.

Fig. 8 — Position Control

Operation:
At the end of [illegible] run, place Position Control lever (A) in the top part of quadrant to raise implement, putting it back again in the former position to lower implement.

The Sensor-Control type hydraulic lift increases its possibilities even more, thanks to the multiple combinations that can be selected in its operation. For example:

Floating drawbar

— Implements drawn over ground: rotary cultivators, [illegible] Cultivators.

The floating drawbar can be free for use of implements that have to rest on the soil.

For use of implements:
- Move the two control levers forward in their respective quadrants to maximum point of travel.
- Use Position Control lever to raise and lower implements.

Transporting

For any transfer of any implement, put the Pull Control lever in the bottom part of its quadrant. Use Position Control lever.

Suspended implements

At the end of furrow or when transporting, in order to lift, move Pull Control lever to lower part of its quadrant and Position Control lever backwards to full extent of travel. In this position the arms will remain raised no matter how long the movement is.

Trailing and semi-suspended implements

— Hitched on tool bar, [illegible].

Put the Pull Control lever to the bottom part of its sector [illegible] and Position Control lever in the position that corresponds to the height at which we wish the [illegible] or implement to work or be transported.

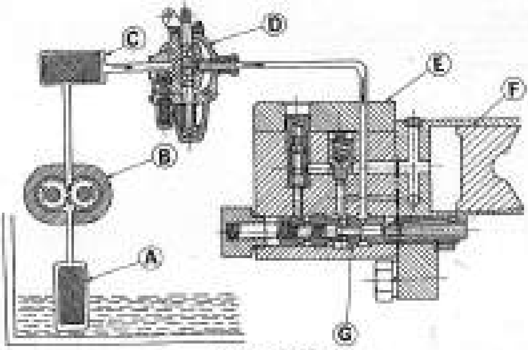


Fig. 7 — Hydraulic circuit

DESCRIPTION OF HYDRAULIC CIRCUIT (Fig. 7)

The oil shared by transmission and hydraulic lift is sucked by hydraulic pump (B) through primary filter (A), sending it to secondary filter (C) and auxiliary services distributor (D), from where it passes to the hydraulic lift distributor (E).

The oil which flows through auxiliary services distributor (D) only reaches the lift distributor (E) provided that the former is in neutral position, that is with control lever in central position, whereas whenever oil is used to external services it is cut off to lift system. The auxiliary services distributor includes pressure limiting valve of 160 to 170 kg/cm².
The lift distributor (E), situated on the front right of hydraulic lift housing, assures the different functions of the system.

The main valve or spool (G) of the lift distributor (E) is moved by different cams or levers according to the work to be done. This main valve or spool can be moved in three main positions: Forwards: intake or raise. Central Position: neutral. Backwards: down.

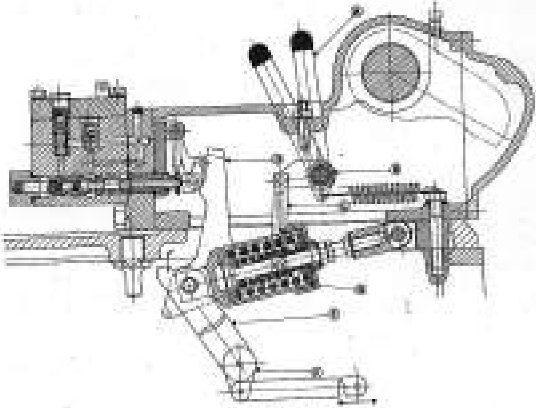


Fig. 8 — Pull Control

DESCRIPTION OF INTERIOR LIFT LINKAGE POSITIONS

Pull Control (fig. 8)

The Pull Control lever ([illegible]), connected to shaft ([illegible]), operates sliding link ([illegible]). This sliding link moves Pull lever ([illegible]) which is in contact with the main valve or spool. The Pull lever ([illegible]) is similarly pivoted to lever connecting rod of Pull Control ([illegible]) which, in turn, is moved by the straight connecting rods ([illegible]), which transmit to it the pull registered by the implement. The springs ([illegible]) balance the lever connecting rod of Pull Control ([illegible]) in accordance with pull on ([illegible]).
Different positions of the Pull lever ([illegible]) correspond to different positions of the lever ([illegible]). Therefore, to put the main valve or spool in neutral, there corresponds a given pull on the tow bars in accordance with positions of Pull lever ([illegible]).

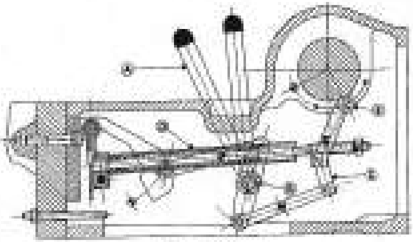


Fig. 8 — Position Control

DESCRIPTION OF INTERIOR LIFT LINKAGE POSITIONS

Position Control (Fig. 8)

The main Position Control lever (A), connected to shaft (B), controls the rods (C) which push the spring tube (D), putting the main valve or spool in the raise position. While the lift arms rise, the pivot pin (E), attached to the cam, goes backwards allowing the linkage (C) to [illegible], which puts the main valve or spool in the neutral position. So, different positions in the linkage for putting main valve or spool in neutral in accordance with pivot pin (E) correspond to different positions in the main lever, both in raising and lowering.

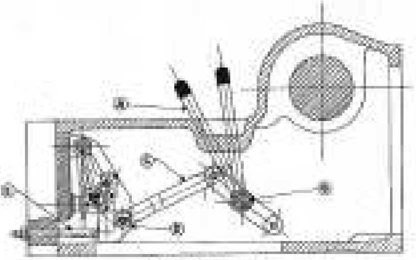


Fig. 10 – Lowering control

DESCRIPTION OF INTERIOR LIFT LINKAGE POSITIONS

Lowering control (Fig. 10)

The Lowering Control, fast or slow, is obtained by means of Position Control lever (A), operating in bottom part of its quadrant. In its lower part, the quadrant is provided with a plate against which the lever comes to stop, fast lower being thereby obtained. Slow lower is achieved by passing beyond this stop in a downward direction.

Position Control lever inner shaft (B) controls cam (D) by means of linkage (C). Travel of cam (D) comes to an end at adjusting screw (E), which determines the slow or fast lowering of lifting arms. To determine position of this screw, see the adjustments section.

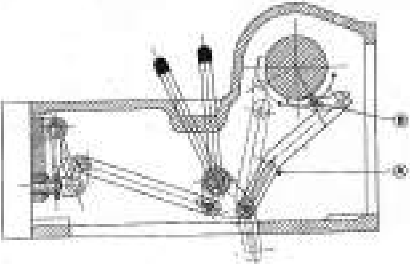


Fig. 71 — Safety linkage

DESCRIPTION OF LIFT INTERIOR LINKAGE POSITIONS

Maximum lift safety (Fig. 71)

This safety linkage only operates when the lift arms reach their point of maximum lift. The movement of linkage (A) is governed by pivot pin (B) which is attached to the ram.

If, for any irregularity in the lift, the main valve or spool were pushed towards the raise position the arms would continue rising until the pivot pin (B) in its backward turning movement pulls the linkage (A), automatically disconnecting all the items which could be pushing the main valve or spool, which then returns to its neutral position.

Note. — The purpose of this safety linkage is mainly to put the circuit in neutral in the event of a bad adjustment, incorrect movement of control levers, ending up in breakage of items, etc.

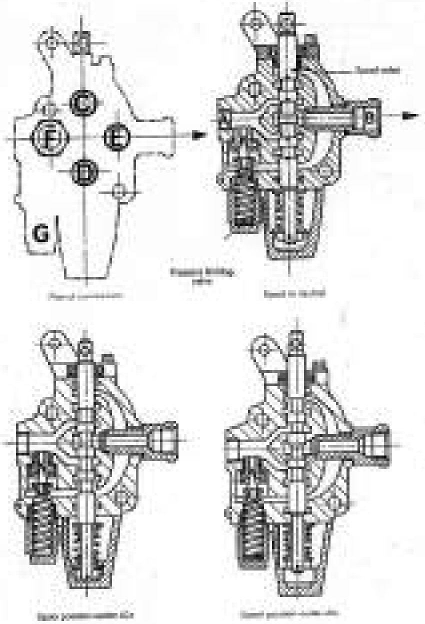


Fig. [illegible] — Auxiliary Services Distributor

DESCRIPTION OF AUXILIARY SERVICES DISTRIBUTOR (Fig. 13)

The auxiliary services distributor is of the double-acting type but nevertheless it can be used in a single-acting circuit, for which, fit a return line in the distributor on the outlet which is not being used. Example: see fig. 12 plan of connections. If we fit a single-acting cylinder on (C) we must install a return line on (D) or viceversa. With this operation we avoid the pressure limiting valve opening every time the lower is used and as a result we achieve a faster lowering.
This distributor has a pressure limiting valve which is set at 165 to 170 kg/cm², being shared by both auxiliary services port (F). To check hydraulic pressure install a pressure gauge of 200 kg/cm² in quick couplers of lines (C) or (D), run engine up to 2,000 r.p.m. and actuate distributor control lever.

Oil enters the distributor by (A) and leaves by (B) and while the spool is in the neutral position it circulates freely from (A) to (B). When the spool valve is actuated in one direction or another by means of control lever, the circuit is cut at (B) with the oil going out to the external service selected.
Pressure tappings will be carried out (see plan of connections fig. 12) through (C) and (D). The return from (C) and (D) is made through (E). In (F) we have a plug which can be used as a hydraulic tapping point without passing through the spool valve. Install another distributor in parallel in which the oil will never be able to be cut off.

LIFT DISTRIBUTOR

In the lift distributor the main spool or valve has three positions with respect to its body. These positions are obtained through the movement of the push rod which is in turn controlled by the control levers, (draft connecting rod or Position control).

Any movement of the above mechanism is transferred directly to the main spool or valve.

As we shall see in the later figures, the main spool or valve has the three following positions:

Valve in neutral position, neutral.

Valve to the left, raise.

Valve to the right, lower.

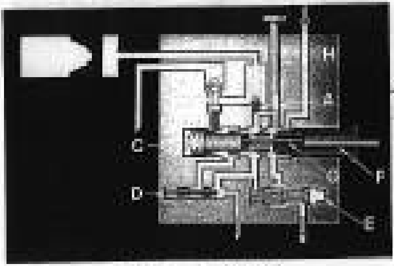


Fig. 18 – Main spool or valve in neutral

A – Raising valve
B – Lowering valve
C – Main spool or valve
D – Pilot valve
E – Flow regulator valve
F – Main valve push rod
G – Intermediate valve piston
H – Lowering adjustment screw

OPERATION OF LIFT DISTRIBUTOR

Main spool or valve in neutral

POSITION CONTROL. Fig. 18

The oil coming from the hydraulic pump has its inlet to the distributor as is indicated by the upper arrow. The chambers of the flow regulator valve and the main spool or valve are in constant communication, so the oil arrives at both at the same time. The flow regulator valve has a small side hole which communicates with another longitudinal one which connects the closed chamber (right-hand side of valve). In its opposite part it has a spring located in a chamber which connects by means of a gallery with the front part of the pilot valve.
The main spool or valve in its neutral position shuts off the passage of oil to rear chamber of pilot valve. As this valve only receives oil in its front part, the return line to reservoir is easily opened, producing thus a depression in the spring chamber of flow regulator valve to its left-hand side. This valve, on receiving more pressure on its right side, shifts to the left, overcoming the resistance of the spring and in turn opening another return line to reservoir. As long as the main valve or spool is not moved in any direction the oil will leave freely to the two above mentioned return lines.

Note: in the distributor at the present lift the raising valve (A) has been replaced by another (see A and B, fig. 30 and page 38) whose function is identical to that represented in this figure.

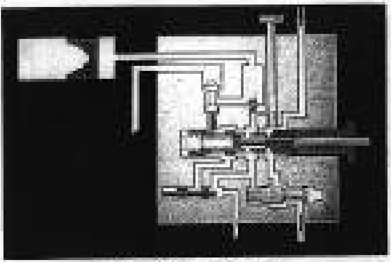


Fig. 14 – Main spool or valve in neutral

OPERATION OF LIFT DISTRIBUTOR

Main spool or valve in neutral
PULL CONTROL (fig. 14)

Except for the position of the main spool or valve (bellow piston) which blocks the passage of oil to the inside of this valve, all the other valves occupy the same positions as in the previous figure.
The only difference is that the passage of oil from main spool or valve to pilot valve is regulated by main spool or valve inside piston. In this position the flow of oil which passes to the riser through flow regulator valve is greater and the [illegible] through pilot valve is less.

This position of main spool or valve, with internal piston displaced to left, corresponds solely to the neutral position of Pull Control. In this way we can obtain, by means of the raising adjustment control, a variable raising speed, something which cannot be obtained in Position Control since it does not displace main spool or valve internal piston.

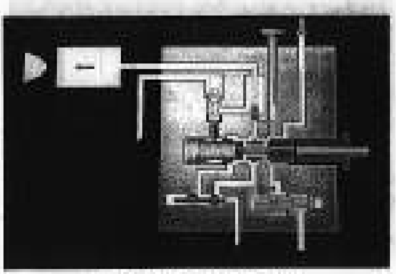


Fig. [illegible] – Main spool or valve on intake (fast raise)

OPERATION OF LIFT DISTRIBUTOR

MAIN SPOOL OR VALVE ON INTAKE (FAST RAISE) POSITION CONTROL Fig. [illegible]

The main spool or valve is moved to the left, [illegible], opening the [illegible] line of pilot valve and closing the return line. The depression which existed in the left chamber of flow regulator valve, where the spring is housed, disappears, balancing the chamber pressures on both sides of the valve. The spring then pushes flow regulator valve to the right, closing [illegible] to reservoir.
With both spools closed, the pressure rises rapidly and lifts the raising valve, compressing its spring. The oil passes directly to the lift cylinder, displacing the piston, and consequently an upward movement is produced. In this position the raising adjustment cannot [illegible] owing to the great passage of oil through the [illegible] of main valve or spool as it is not blocked by the internal piston of valve. Therefore raising in Position Control is always fast.

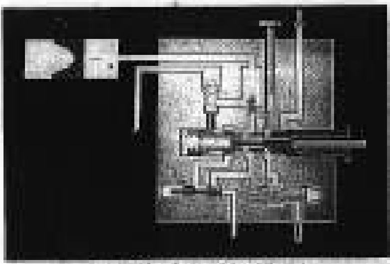


Fig. [illegible] - Main spool or valve [illegible]

OPERATION OF LIFT DISTRIBUTOR

Main spool or valve [illegible]
FULL CONTROL (Fig. [illegible])

As in the previous case, the main spool or valve is moved to the left, opening the line in the rear part of the pilot valve and closing its return. This creates pressure in the spring chamber of flow regulator valve. The process is the same as the previous one with the difference that, in this case, the main spool or valve internal piston is displaced to the left, pushed by the cams or levers of Full Control, thus blocking the passage of oil through the interior of main spool or valve. In addition, in this case the raising adjustment control has been moved, closing an oil line to the cylinder. As a result, the pressure on the right-hand side of the flow regulator valve increases, moving it to the left, whereby part of the flow from the hydraulic pump is evacuated through the return line. In this case only a small part of the flow passes to the ram cylinder, through the raising valve, as a result of which it gives us slow upward movement since the flow from the hydraulic pump is shared between the cylinder and the return.

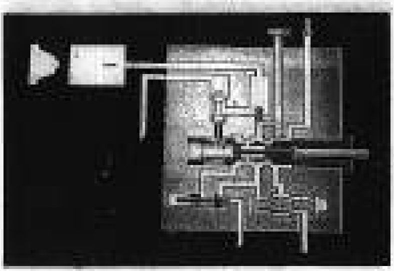


Fig. 17 – [illegible]

OPERATION OF LIFT DISTRIBUTOR

[illegible]
PULL CONTROL (fig. 17)

To obtain fast raise in Pull Control it is necessary to modify the position of the raising adjustment control. In this figure it can be seen how the control puts the distributor oil intake in communication with the flow regulator valve left-hand chamber. The valve, constant flow causes an increase in pressure on left face of the flow regulator valve which closes a little more and only allows to pass to the return a small part of the flow which therefore goes to the cylinder, producing a faster raising. In this way two different speeds of raise are obtained, as has been said before. This is only achieved in Pull Control.

To obtain slow raise speed, see text of figure 16.
The raising adjustment control is best used for heavy work or work at considerable depth. It enables a high performance to be obtained and reduces vibration and the risk of the front wheels losing contact with the ground.
Note: With the raising adjustment control intermediate positions can be selected, progressively modifying the raising speed in Pull Control. This control has no effect on the raising speed in Position Control.

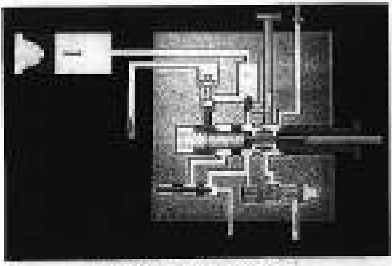


Fig. [illegible] - Main spool or valve on descent (lower)

OPERATION OF LIFT DISTRIBUTOR

Main spool or valve on descent (lower) POSITION CONTROL OR FULL CONTROL Fig. [illegible]

The main valve has been moved fully to the right and its lower part pushes the needle which comes into contact with the lowering valve, progressively lifting it from its seat. The oil contained in the ram cylinder is evacuated by the lowering valve and returned to the reservoir.

The other valves play no part in this position and continue sending to the reservoir all the flow delivered by the hydraulic pump, exactly as occurs in the neutral position.

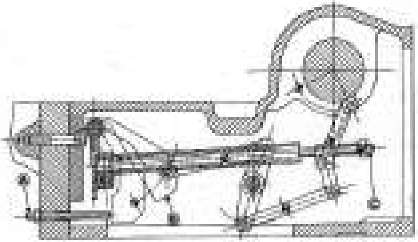


Fig. 18 — Adjustment of lowering control speed

HYDRAULIC LIFT ADJUSTMENT

Adjustment of speed of Lowering Control (Response Control) (fig. 18). To carry out adjustment of lowering speed (Response Control) proceed as follows:

a) Pull approximately 400 kg. on the hitch bars.

b) Loosen screw (A).

d) With Position Control lever make lift rise.

e) Steadily move Position Control lever downwards until a slow lowering is obtained. Test the lowering with Pull Control lever.

f) Having effected previous operation, adjust screw (A) till coming up against Pull Intake lever (D). Tighten counter nut.

g) With Pull Control lever check slow lowering of 2 to 3 seconds. In the event of not attaining it, repeat adjustment from point (b).

h) Loosen flange of Position Control lever shaft and without moving this, push the lever downwards (passing the quadrant stop plate) until 2 to 3 mm before end of travel and tighten flange securing the lever.

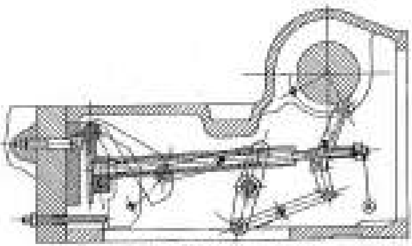


Fig. 30 – Maximum raised position of arms

HYDRAULIC LIFT ADJUSTMENTS

Maximum raised position of arms
POSITION CONTROL (Fig. 30)

To adjust maximum raised position of arms (POSITION CONTROL), carry out following operations:

a) Loosen screw (A) and counter nut.

b) Put Position Control lever in top part of its quadrant and tie the arms rear and stop in that position.

c) Remove rear cover of lift.

d) With Position Control lever make a complete lowering, then a raising: the piston must be on the measurement previously quoted.

e) Slowly tighten up screw (A), ultimately causing a raising of arms; continue tightening until piston has about 2 to 3 mm to reach end of its travel in the cylinder on up stroke.

f) Lock counter nut. Fit lift rear cover and check again.

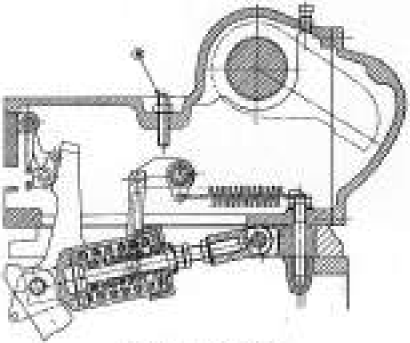


Fig. 37 — Control of Pull or depth

HYDRAULIC LIFT ADJUSTMENTS

Control of Pull or depth (Fig. 37)

To adjust Pull or Depth control, proceed as follows:

a) Place Position Control lever in bottom part of its quadrant up against the stop plate. Pull lever.
b) Loosen nut and tighten screw (A).
c) Begin to raise with Pull Control lever and continue loosening screw (A), progressively moving up the lever until raising is made to begin at some 60 or 65 mm before reaching quadrant stop.
d) Tighten nut and check again.

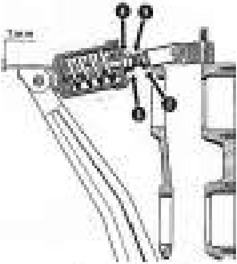


Fig. [illegible] — Detection spring

HYDRAULIC LIFT ADJUSTMENT

Detection spring (Fig. [illegible])

Between the upper part of lever (Pull connecting rod) and upper face of rear shaft cover, there has to be a clearance of 7 mm. This play is obtained by adjusting length of the threaded rod [illegible].

To carry out adjustment of detection spring proceed in the following way:

a) [illegible] and [illegible] plate.

b) Loosen counter nut [illegible].

c) Place a rule on rear shaft cover.

d) Turn screws [illegible] and [illegible] at the same time so that the distance between Pull lever connecting rod and rule is 7 mm.

e) Lock counter nut [illegible].

f) Adjust Pull Control lever.

If nuts [illegible] and [illegible] are loose, tighten [illegible] by hand to correct zero play and then lock with nut [illegible]. Torque value of [illegible] to [illegible] kg m.

REPAIRING HYDRAULIC LIFT

All lift repair operations should be carried out in scrupulously clean conditions. Since it has been assembled with high precision, any impurity introduced into the circuit may cause serious problems.

DISASSEMBLING THE HYDRAULIC LIFT

Carry out this operation in the following way:

— Uncouple lift links.

— Disconnect right side light connection.

— Remove seat.

— Disconnect the following five auxiliary service lines from the distributor (Fig. [illegible]).

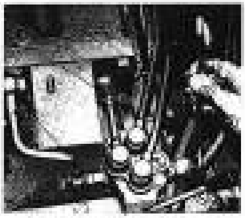


Fig. [illegible] — External services distributor

a) Internal distributor.
b) Quick-fit distributor.
c) External service.
d) External service.
e) Return.

— Remove lift rear cover (Fig. [illegible]) to take out screw (A) and nut (B).

— Take out lift and cover plate with nuts and bolts (at this point remove external services distributor).

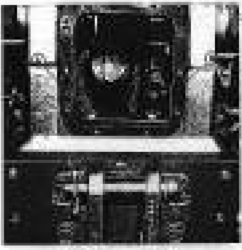


Fig. [illegible] — Dismantling lift

— Fit lifting tool [illegible] in seat mounting holes (Fig. [illegible]).

— Raise and withdraw lift and cover section plate with aid of a hoist, [illegible].

— Separate lift and cover (they are joined by three bolts).

Fig. [illegible] — Fixing lifting tool

TO INSTALL HYDRAULIC LIFT

To mount hydraulic lift assembly on tractor carry out the following operations:

— Carefully clean the following contact surfaces:

a) Cover section plate.
b) Rear axle housing.
c) Lift back cover.

— Fit Pull lever (A) with tool TA.T or .2? (Fig. 26).

Fig. 26 — Securing Pull lever

— Join cover section plate and lift with the three screws.
— Fit lifting tool TA.T... on lift.
— With aid of hoist, lift, etc., offer cover section and lift so to mounting position on rear axle housing.
— Put Pull Control lever to front part of the quadrant (transmitted). In this way the travel of the rod (A) and the sliding link (B, fig. 27) is greater.
— Hold rod (A) in vertical position using a spanner (fig. 27).
— Slowly lower lift and cover section, introducing rod into sliding link (fig. 28).

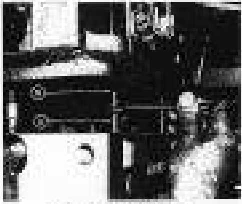


Fig. 27 — Fitting cover section lift

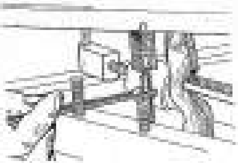


Fig. 28 — Inserting rod in sliding link

— When the four rear axle housing guide studs are introduced into lift cover section mounting holes, remove:

a) Spanner.
b) Tool securing Pull lever.

— Finish off lowering lift-cover section. Perform in reverse order the remaining operations carried out to remove lift.

TO REMOVE LIFT DISTRIBUTOR

To remove lift distributor, carry out the following operations:

— Unhitch auxiliary services distributor from and remove the distributor.

— Put the two lift control levers in the lower part of their quadrant and lifting arms in horizontal position.

— Take out the eight screws that fix front plate to lift (Fig. 30).

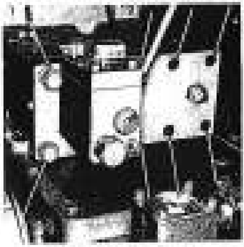


Fig. 30 — Removing lift front plate

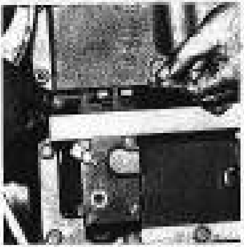


Fig. [illegible] — Removing lever linkage front plate

— Move lift distributor together with front plate forwards until lever linkage pin is in the way.

— Through the space that remains between the front plate and lift take out the circlip and pin (Fig. 30). This space will be smaller if the control levers and lift lever are not set in position as indicated above.

— Remove the four Allen screws that secure front plate to distributor (Fig. 31) and separate both pieces.

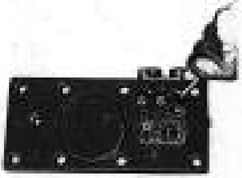


Fig. 31 — Removing front plate from distributor

TO INSTALL LIFT DISTRIBUTOR

To install lift distributor carry out the following operations:

— Fit O-ring seals in housings on front plate (Fig. [illegible]) (a light layer of grease will help).
— Set the distributor in place.
— Carry out the disassembly procedure in reverse order.

Fig. [illegible] — Installing lift distributor

LIFT DISTRIBUTOR (Fig. [illegible])

A — Raising valve
B — Lowering valve
C — Main spool or valve
D — Main valve push rod
E — Flow regulator valve
F — Pilot valve

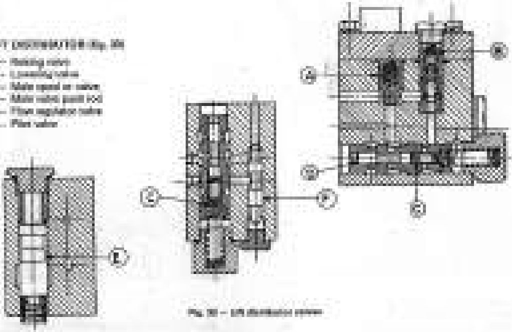


Fig. [illegible] — Lift distributor valves

TO REMOVE RAISING AND LOWERING VALVES

To remove these valves, proceed as follows:

— Remove seat.

— Remove lift distributor upper cover by undoing four set screws (Fig. 34).

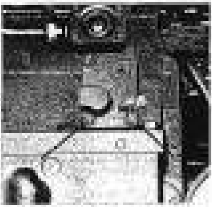


Fig. 34 — Lift distributor cover set screws

Fig. 35 — Removing lift distributor upper cover

Having removed top cover (Fig. 35) proceed as follows (Fig. 36):

— Take out both valve springs (A and C).

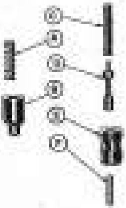


Fig. 36 — Raising and lowering valves

Fig. 37 — Disassembling lowering valve seat

— Extract valves (B and D) with sharp nosed pliers (proceed with caution).

— Extract lowering valve seat (E) with help of tool T.A. no. 28 (Fig. 37).

— Extract lowering valve needle (F) with sharp nosed pliers. For this:

a) Put the lifter control lever in lower part of quadrant.

b) Raise the lifting arms.

TO INSTALL RAISING AND LOWERING VALVES

To install both valves carry out operations of removal in reverse order, taking care:

- To clean valves and seats carefully.
- To change O-ring seals.
- That the flat face of lowering valve needle is mounted on flat end of valve.

In the lowered position, between needle and lowering valve, there is an opening clearance of [illegible] mm (fig. 38). This clearance is necessary when mounting both parts.

Lowering valves and seat are interchangeable: they have been rectified together.

The lowering valve bushing torque is 0.5 kg/m. Coat it with some drops of sealant. To use torque wrench, it is necessary to have tool TS. [illegible] 27 (fig. 39). The torque value of wrench set screwed is 0.8 to 1.2 kg/m.

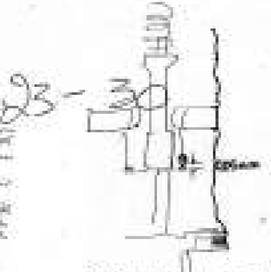


Fig. 38 — Clearance between needle and lowering valve.

[illegible] and lowering [illegible] not without having [illegible]

Fig. 39 — Tightening lowering valve bushing

TO REMOVE AND INSTALL MAIN SPOOL OR VALVE (Fig. [illegible])

To remove main spool or valve, proceed as follows:

— Remove [illegible] valve and its [illegible] as described previously.

— Unscrew and take out plug (A).

— Take out spring (B), washer (C) and spring (D).

To install main spool or valve, reverse the above procedure. The washer (C) which separates the springs (B) and (D) is mounted with bevelled part facing spool.

The plug torque value is 2 to 3 kg/m.

Note: To extract the main spool or valve piece [illegible], the [illegible] distributor has to be disassembled.

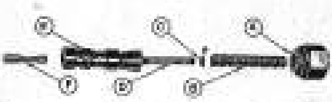


Fig. [illegible] – Main spool or valve

TO REMOVE AND INSTALL REGULATOR VALVE (Fig. [illegible])

Fig. [illegible] – Flow regulator valve

To remove flow regulator valve, carry out the following procedure:

— Unscrew and take out plug (A).

— Remove bushing (B).

— Remove regulator valve (C).

— Remove spring (D).

To install regulator valve, reverse the above operations. The plug torque value is 2 to 3 kg/m.

TO REMOVE AND INSTALL PILOT VALVE (Fig. [illegible])

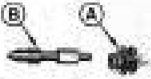


Fig. [illegible] – Pilot valve

The pilot valve is removed in the following way:

— Unscrew and take out plug (A).

— Take out valve (B).

To install valve, carry out the above operations in reverse order.

TO REMOVE INTERIOR PULL CONTROL MECHANISM (Fig. 44)

To remove this mechanism, proceed in the following way:

- Remove lift and cover [illegible].
- Drain all gearbox, rear axle and hydraulic system.
- Remove spring (A), retainer washer (B) and Pull fork (C).
- Withdraw shaft (D) towards the left.
- Remove connecting rod of right-hand hitch link.
- Remove the two screws from lock plate of left-hand connecting rod.
- Take out drive shaft of Inner Pull connecting rod, from right to left (Fig. 45).

Fig. 44 – Disassembly of Interior Pull Control mechanism

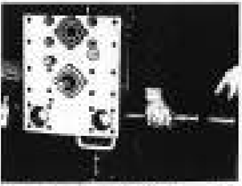


Fig. 45 – Removing Inner Pull Control connecting rod drive shaft

TO INSTALL INTERIOR PULL CONTROL MECHANISM

To install Inner Pull Control mechanism, carry out the following procedure:

- Introduce Inner Pull connecting rod drive shaft through left side.

Take care with position of drive shaft and Inner Pull connecting rod. (The drive shaft bevelled facing has to coincide with connecting rod hole) (Fig. 46).

- Then carry out disassembly operations in reverse order.

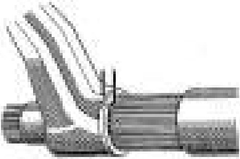


Fig. 46 – Position of drive shaft and Inner Pull connecting rod

Note. — Pay attention to position of Inner Pull lever spring (fig. 49) and to position of hitch bar connecting rods (fig. 50).

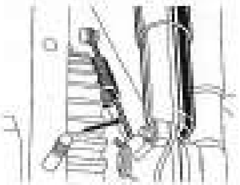


Fig. 49 — [illegible] spring Position

Fig. 50 — Connecting rod position

TO REPLACE RETAINERS OR BUSHINGS OF INNER PULL CONNECTING ROD DRIVE SHAFT

To carry out these replacements, perform the following operations:

— Drain all [illegible], rear axle and hydraulic system oil.

— Remove hitch bar connecting rods.

— Remove connecting rod lock plates.

— Push shaft a few centimetres in one direction or the other to replace retainers or bushings. (The bushings can be extracted with the aid of pliers). Once having made the replacements, assemble in reverse order.

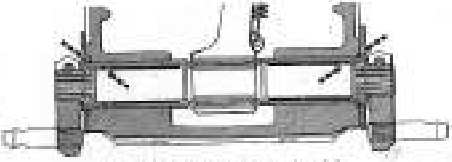


Fig. 51 — Replacing retainers or bushings of Inner Pull connecting rod drive shaft

TO REPLACE RETAINERS OR BUSHINGS OF LIFTING AND DRIVE SHAFT

Carry out these operations in the following order:

- Remove lifting arms.
- Remove lift back cover (see fig. 34).
- Take out inner circlip 8, fig. 46, located on left side of thrust rod.
- Withdraw drive shaft from left to right.
- Replace retainers.
- Replace bushings; use extractor and inserter 7A. Tar. 37 and 7A. Tar. 38 (figs. 50 and 51).

The bushings are greased and then fitted with grease inwards. To install the assembly, carry out the above operations in reverse order.

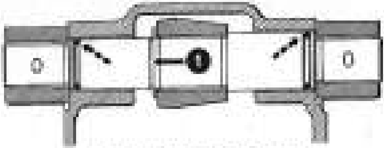


Fig. 49 — Removing lift and drive shaft retainers

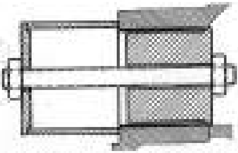


Fig. 50 — Removing and installing lifting arm bushings

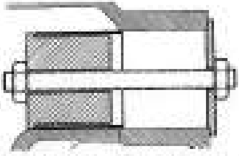


Fig. 51 — Removing and installing lifting arm bushings

TO REPLACE LIFT CYLINDER PISTON RETAINER (Fig. [illegible])

The replacement of the piston retainer is done in the following way:

— Disconnect auxiliary services distributor lines and remove distributor.

— Remove front plate together with lift distributor.

— Change piston retainer and front plate gasket.

To install assembly again, reverse the above procedure.

TO REPLACE SEAL AND RETAINER OF CONTROL LEVER SHAFTS (Fig. [illegible])

To replace O-ring seal and retainer of shafts of control levers, proceed as follows:

— Mark the two control levers with respect to their shafts and remove them.

— Remove lift back cover.

— Extract pin from Position Control lever shaft (fig. [illegible]).

— Take out shafts.

— Remove O-ring seal and retainer.

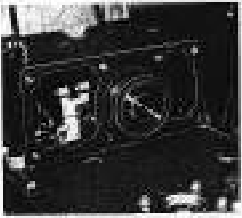


Fig. [illegible] — Replacing piston retainer

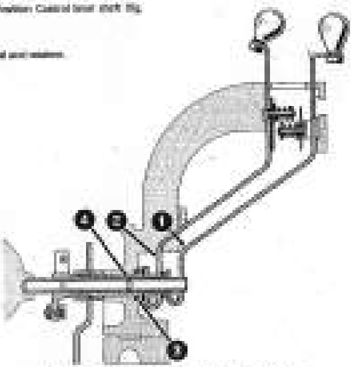


Fig. [illegible] — Replacing seal and retainer of control lever shafts

TO INSTALL LIFT CONTROL LEVERS

Once the O-ring seal and washer have been replaced, proceed as follows:

— Fit shafts, making the marks coincide.

— Fit washers, circlips or retainer plates, following reverse order to that of disassembly.

— Install control levers.

— Check that control levers are well adjusted (see adjustments).

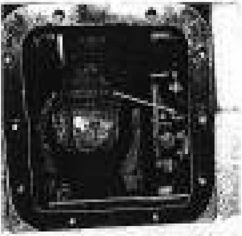


Fig. [illegible] — [illegible]

TO REMOVE AND INSTALL HYDRAULIC PUMP

To remove and install hydraulic pump, carry out the following operations:

— Disconnect the intake line.

— Disconnect the outlet line.

— Take out the two pump set screws.

— Pull out the pump backwards (Fig. [illegible]).

To mount the pump, carry out the above operations in reverse, previously smearing the gasket with sealing paste.

Fig. [illegible] — Hydraulic pump

DISASSEMBLE AND ASSEMBLE HYDRAULIC TO PUMP

The hydraulic pump disassembly procedure is as follows:

— Separate pump from mounting.

— Clean pump with petroleum and dry it with compressed air. Handle pump in a place free from dust and dirt.

— Take out pump shaft cotter pin.

— Take out Allen screws that hold pump cover.

— Remove the cover and you will be in a position to be able to take out easily and remaining parts. In order to remove oil retainer which has remained secured to the cover, push it through back part of cover, gently tapping lower part of retainer with a bronze rod, having first taken the precaution of removing back washer.

To assemble the pump, carry out the above operations in reverse order, always taking the precaution to clean thoroughly with petroleum or gasoline. If it is necessary to hit pump, either during disassembly or assembly, a plastic hammer should be used.

Note: The precaution should be taken of fitting the bearings in the same position as they were before disassembly.

HYDRAULIC PUMP REPAIRS

As regards hydraulic pump repairs, can easily solved troubles which may arise are the following:

a) Loss of oil through operating shaft

This is due to wear or rupture of double retainer and therefore the pump cover must be removed and retainer replaced as has been described above. As a general rule it can be said that most often when retainer rupture occurs it is due to wear on bearings, since then internal leaks increase and since they cannot be absorbed, they tend to force out the retainer or burst it. Therefore, when any retainer troubles arises, it is advisable to check the wear state of bearings.

b) Loss of oil between body and pump cover

This may occur when, for any reason, cover set screws have been loosened or the aforementioned gasket is not in good condition. The screws should be tightened firmly and if this does not solve the problem, remove cover and replace worn gasket.

When a lack of pressure is observed in pump, check the following:

— Cleanliness of suction filter.

— Possibility of air intake.

If these points are correct, inspect operating shaft retainer or cover gasket. If they are in good condition, replace the pump.

Note: When pump is replaced in a unit that has been operating, clean all lines and components thereof.

TROUBLE-SHOOTING TABLE

CAUSES	LOCATION	SOLUTION
LOWERING OF IMPLEMENT WHEN TRACTOR IS STATIONARY		
[illegible]	— [illegible] — [illegible]	— [illegible] — [illegible]
[illegible]	— [illegible]	— [illegible]
Leak in lowering valve	— [illegible] — [illegible] — [illegible] — [illegible]	— [illegible] — [illegible] — [illegible] — [illegible]
Leak in [illegible] valve	— [illegible] — [illegible] — [illegible]	— [illegible] — [illegible]
INSUFFICIENT RAISING OR LOWERING OF LIFT ARMS		
Position Control lever badly adjusted.		— Carry out adjustment.
RAISE DOES NOT WORK OR WORKS INCORRECTLY		
Position Control lever [illegible]	— [illegible]	— [illegible]
Insufficient oil capacity.	— Check level.	— Fill up if needed.
[illegible]		— [illegible]
[illegible]		— [illegible]
[illegible]		— [illegible]

CAUSE	LOCATION	SOLUTION
Primary filter	— Dirty.	— Clean or change.
	— Tightness bad.	— Correct.
Hydraulic pump	— [illegible]	— Replace gaskets.
	— Faulty.	— Replace pump.
Secondary filter	— Dirty.	— Clean or replace it.

LOWER DOES NOT WORK OR WORKS INCORRECTLY

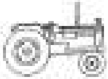
Pull-Control regulation faulty adjusted		— Adjust.
Distributor valves seized		— Inspect valves.
[illegible] seized		— Replace.
Connecting rods broken or unhooked	— [illegible]	— Replace or connect.
[illegible]	— [illegible]	— Correct or replace.

INCORRECT OPERATION OF PULL CONTROL REGULATION

Insufficient or excessive sensitivity to springs	— Bad adjustment of lower Pull connecting rod.	— Adjust.
Does not work	— [illegible]	— Change faulty parts.

SECTION 10: REAR AXLE

CONTENTS



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SPECIFICATIONS

Bevel gear	Crown wheel [illegible] teeth. Drive gear 7 teeth.
Spur gear	[illegible] x 40
Clearance between drive gear and crown wheel	[illegible] mm.
Thickness of adjusting shims for: — P.T.O. shaft bearing	0.1 and 0.15 mm.
— Differential shaft bearing	0.2 mm.
— Axle shaft bearing	0.5 mm.
— Differential bearing	0.1 - 0.15 - 0.2 - 0.5 and 1 mm.
Gear-reducer crown wheels	[illegible]
Oil: Capacity (gearbox, rear axle and lift)	[illegible] litres
Viscosity	[illegible]

NOTE: The drive gear and crown wheel are matched together in manufacturing; they are therefore inseparable.

DESCRIPTION

The rear axle is of the semi-floating type with helical bevel type drive gear and crown wheel.

The differential has four pinion gears and is secured to the crown wheel. The four pinion gears mesh with two planetary gears equipped with interior splines in which the differential shafts fit.

The differential shafts come into contact with the gear reducer wheels which mesh with splines of the axle shafts. The transmission wheel is mounted on the plate formed by the axle shaft at its outer end which is equipped with conical roller bearing.

TO REMOVE REAR AXLE ASSEMBLY FROM TRACTOR

Having put chocks under rear axle housing and drained the oil from rear axle — gearbox assembly, the rear axle unit should be taken off the tractor by removing:

— Hitch system.

— Driver's seat.

— The two rear wheels.

— Right fender and direction indicator wire.

— Left fender and connection box.

— The two step plates.

— Lift oil lines.

— Casing of gearbox levers to give access to the two gearbox - rear axle housing lock bolts (Fig. 1).

— Disconnect control rods of brake boxes.

Set the gearbox on a trolley jack and take out the gearbox - rear axle housing interior mounting bolts (Fig. 2). Separate gearbox - rear axle housing.

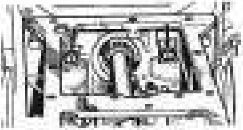


Fig. 1 — Taking out lower gearbox rear axle housing bolt screws.

Fig. 2 — Taking out inner gearbox rear axle housing bolt screws.

INSTALLING REAR AXLE ASSEMBLY IN TRACTOR

To install the rear axle assembly in the tractor, carry out the operations previously described for removal, in reverse order, bearing in mind the following points:

— Fit the two longest reversing screws in the center top guide bushings.

Gearbox - rear axle housing recoupling

— Check that the two centring guide bushings are correctly located in the rear axle housing.

— Assemble gasket smeared with sealing paste.

Gearbox lever casing

— Check that the lever casing centering pin is in correct position.

— Assemble gasket smeared with sealing paste.

— Put fingers on the gear levers in fulcrum of shift forks.

DISASSEMBLY AND ASSEMBLY OF REAR AXLE

To disassemble the rear axle the operations described [for] removing rear axle from tractor should first be carried out. Once the rear axle is in a suitable position, proceed as follows:

— Disconnect lift.

— Remove rear axle top cover.

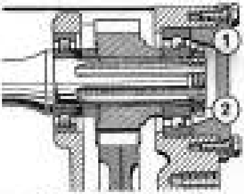


Fig. 8 — Extracting P.T.O. upper shaft

Disassembling power take-off (Fig. 7)

— Remove lock nut of power take-off shaft.

— Remove lock from crenellated nut (2) and unscrew it with spanner Ta. Bit. 40.

Take out power take-off upper shaft through front part of housing. At the same time as you slide P.T.O. upper shaft forwards take out P.T.O. drive gear.

Removing Inner Pull Control connecting rod

Disassembling block bar connecting rods

To disassemble connecting rods, perform the following operations:

— Take out mounting screws of connecting rod plates.

— Remove right connecting rod.
— Take out connecting rod shaft (fig. 4).

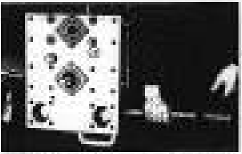


Fig. 4 – Removing block bar connecting rod mounting plate

Disassembling differential blocking control

The differential blocking control is disassembled as the following:

— The clutch rod pedal.

— The two set screws of pedal mounting bracket.

— The fork fixing screw-rods.

— Spindle.

— The fork.

Fig. 5 – Disassembling differential blocking control

Disassembling wheel axle shafts

To disassemble the axle shafts, proceed as follows:

— Unlock axle shaft lock nuts and unscrew them with a [illegible] mm spanner (Fig. 6).

— Remove axle shaft nut screws to the tubes and take out axle shafts (Fig. 7).

— Remove axle shaft outer bearing with aid of the press and bearing extractor T.[illegible] (Fig. 8).

NOTE: On the left axle shaft it may happen that the nut which supports the float sleeve cannot be completely unscrewed, in which case wait until the axle shaft assembly starts to be removed.

Fig. 7 — Extraction of axle shafts

Fig. 6 — Taking out axle shaft lock nuts

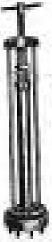


Fig. 8 — Extracting outer axle shaft bearing

Disassembling gear reducer wheels

To disassemble gear reducer wheels, carry out the following procedure:

— Remove brake boxes.

— Remove axle side tubes.

— Take out reducer wheel bearing inner race (rear part).

— Remove gear reducer wheel (to take out bearing mounted in crown wheel, use a three-arm extractor (Fig. 9).

NOTE: The tool is brought to bear on the roller cage, therefore if the bearing is to be used again, it will be necessary to proceed with great care.

Fig. 9 – Extracting reducer wheel bearing

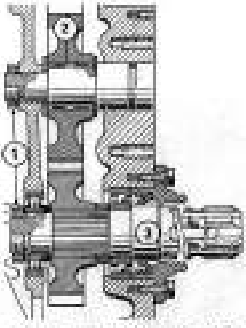


Fig. 10 – Disassembling power take-off lower shaft

Disassembling P.T.O. lower shaft and intermediate gear (Fig. 10)

The P.T.O. lower shaft and intermediate gear should be disassembled in the following order:

— Unlock and loosen castellated nut (1) with wrench [illegible].

— Remove P.T.O. lower shaft (2) using a bronze rod on the appropriate extractor (Fig. 10). At the same time as the shaft slides out extract drive gear.

Fig. 11 — Disassembling P.T.O. lower shaft

Disassembling differential shafts

The disassembly of the differential shafts is to be carried out as follows:

— Remove differential axles together with axle mounting cage (fig. 13). Then separate axles from cage (fig. 12).

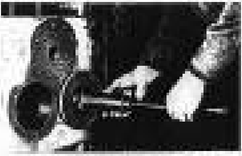


Fig. 12 — Disassembling differential axles

Fig. 13 — Disassembling differential axles and axle mounting cage

Disassembling the differential

Having taken out the differential gear cage from the rear axle housing, proceed in the following way:

— Mark differential gear cage before disassembling.

— Remove differential gear cage and crown wheel set screws (fig. 15).

— With a punch, push out differential gear spindle cotters towards the bottom of their housing (fig. 16) (the cotter is superimposed in order to see the position in which it has to remain until they come to stop, in which position the cotters are centred in the diameter of the spindle).

— Take out the spindles (the long spindle will come out more easily through the side where the cotter is housed).

— Remove pinion gears, friction washers and planetary gears.

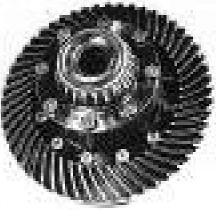


Fig. 15 — Extracting pinion gear spindles

Fig. 14 — Disassembling differential gear cage set screws

Fig. 16 — Differential gear cage disassembled

Disassembling differential unit bearings

Once the differential assembly has been removed in order to extract bearings, use tool [illegible] with adaptors [illegible].

NOTE: The bearings are sealed with [illegible] and have to be carefully diagnosed.

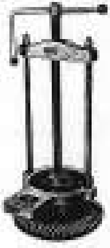


Fig. [illegible] — Removing differential unit bearings

Assembling differential

To assemble the differential gear cage, proceed as follows:

— Grease pinions.

— Assemble planetary gears.

— Assemble pinion gears and friction washers with their respective spindles.

— Secure spindles with lock pins.

NOTE: When securing spindles, the pins should be inserted approximately [illegible] mm in their housings measured from the head of the pin to the upper face of the housing (fig. [illegible]). The center pin is superimposed to the position in which it has to remain.

— Fit the crown wheel with a torque value of [illegible] kg/m.

Fig. [illegible] — Fitting lock pins

When installing the differential the following adjustments should be made:

Adjusting axial play of differential bearings

For this adjustment spacers are available of 0.1 - 0.2 - 0.5 - 1 and 2 mm.

When carrying out differential bearing axial adjustment, two cases must be considered:

a. Differential assembly installed without replacing any parts. The assembly is installed fitting the spacers that were already there when it was dismantled.

Once the assembly has been installed it should be turned to see that the differential gear cage turns without play and that there is no more than a slight resistance to its rotation.

b. Differential assembly installed with new parts:

– Assemble left-hand side differential side cage with a shim thickness of approximately 8 mm.

– Assemble left-hand side differential side cage with a shim thickness of approximately 8 mm.

– Secure the two mounting cages and check the axial clearance of the differential gear cage.

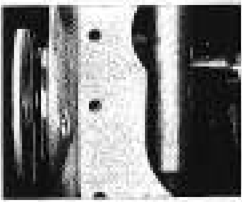


Fig. 31 – Adjusting axial play of differential bearings

Adjust shim thickness in such a way that differential turns without play and that there is no more than a slight resistance (preload: 0.2 kg. m.).

Having adjusted the bearings, couple rear axle to gearbox so as to be able to adjust clearance between crown wheel and pinion.

When mounting, take care on introducing the power take-off shaft into the coupling sleeve.

Adjustment of teeth clearance between crown wheel and drive gear.

Small gear teeth clearance: 0.2 mm.

To adjust teeth clearance between crown wheel and drive gear, carry out the following operations:

— Fit the comparator on rear axle housing with the perpendicular point at the flank of a crown wheel tooth (fig. 26).

— Measure free play between crown wheel and drive gear.

— Calculate the difference between the measurement obtained and the said clearance (0.2 mm) to find out what thickness of shims has to be taken from the right hand side differential shaft mounting edge to that of the left-hand side.

Fig. [illegible] — Adjusting teeth play between crown wheel and drive gear

Example:

— Play measured: 2.1 mm.

— Shim thickness that has to change sides: 2.1 - 0.2 = 1.9 mm.

The shims that have to pass from the left side to the right will be of 1.9 mm. Check clearance again, which has to be 0.2 mm.

Adjusting axle shaft bevel bearing play

This adjustment is made off the tractor.

— Assemble provisionally without adjusting shims (9, fig. 27).

— Measure axial play (from 0.00 to 0.05) with a comparator to determine thickness of shims necessary.

— Disassemble and assemble again for a new check.

Assembling axle shafts

The wheel axle shafts are assembled in the following order:

— Assemble gear reducer wheel.

— Assemble bearing with the shim thickness determined previously.

— Install the tube (torque of screws: [illegible] kg/m) and the paper gasket lubricated with sealing paint.

— Mount axle shaft (do not forget to locate the sleeve the shaft between the bearing and the flange), assembling the nut lock-plate, the nut and lock sleeve in that order.

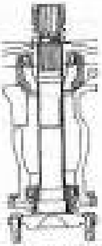


Fig. [illegible] — Adjusting play of axle shaft bevel bearings

Assembling and adjusting differential blocking control

The differential blocking control is assembled and adjusted in the following way:

— Set shaft in place.

— Fit blocking fork and spring, pushing shaft to [illegible].

— Secure fork on shaft with set screw, locking screw with wire.

— Assemble pedal bracket.

— Compress spring in order to fit pedal, adjusting the lever with clevis.

The assembly will be correct when the sliding lock sleeve ([illegible], fig. [illegible]) is at a distance (D, fig. [illegible]) equal to 4 mm from fixed lock sleeve ([illegible], fig. [illegible]).

Carry out this adjustment (fig. [illegible]), whenever the rear axle is [illegible], in the following way:

— Measure distance (D) comprised between the two sleeves. If this distance is not of 4 mm, loosen the counter nut ([illegible]) and correct the distance by means of screw ([illegible]) until correct distance is obtained.

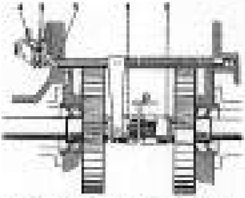


Fig. [illegible] – Differential blocking sleeve adjustment

Differential blocking control actuator adjustment (Fig. [illegible])

When the working of differential blocking is not correct, carry out actuator adjustment in the following way:

— Raise back, right wheel of tractor.

— Gently turn the wheel, at the same time pressing blocking pedal so that the two sleeves are resting against each other (overmesh position).

— In this position, make a mark on the shaft (A) flush with face of rear axle housing.

— Release blocking pedal and check backward motion of shaft, measuring the distance (D) that exists between the mark and housing face.

— If the distance is not of [illegible] mm, loosen counter nut (B) and correct it by means of screw ([illegible]) (Fig. [illegible]) until correct measurement is obtained.

Fig. [illegible] – Differential blocking actuator adjustment

Assembling Pull Control lower connecting rod (Fig. 34)

The Pull Control lower connecting rod is assembled by making the assembly marks match up.

The reference spline on the shaft is distinguished by the cutout on the tooth head, coinciding with the [illegible] point to connecting rod reference point (the shaft is fitted from the left side).

Do not forget to fit O-ring seals to lower bearings.

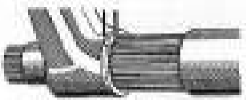


Fig. 34 – Assembling Pull Control lower connecting rod

Installing power take-off assembly (Fig. 35)

The power take-off assembly is installed in the following order:

— Fit front bearings (1).

— Offer up P.T.O. shaft (2), assembling the [illegible] (3), the gear (4) and bearing (5) in that order.

— Stake and lock castellated nut (6).

— Fit lock plate and the [illegible], filled with grease.

Assembling intermediate gear (Fig. 35)

— Set shaft (7) in place.

— Assemble washer (grooved [illegible]) (8).

— Install gear (9) with its needle bearings (10).

— Assemble second washer (11), pushing the shaft so as to be able to locate the washer in position on the [illegible].

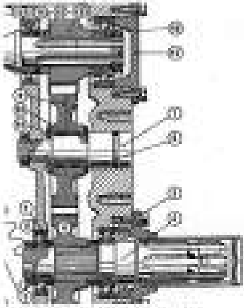


Fig. 35 – Installing P.T.O. assembly

Assembling P.T.O. upper shaft (fig. [illegible])

Slide the roller bearing ([illegible]) in its place, fit gear ([illegible]) in the rear bearing housing.

— Set top shaft in place and fit ball bearing bushing ([illegible]) and separator ([illegible]). Make shaft and gear splines match up.

— Fit ball bearing ([illegible]).

— Block and lock nut.

— Fit lock cover ([illegible]).

Replacing a gear reducer wheel

The gear reducer wheel should be replaced according to the following procedure:

— Remove oil.

— Remove rear axle housing cap screws.

— Remove rear wheel from reducer on the corresponding side.

— Remove axle shaft.

— Remove brake box and tube.

— Remove bearing and replace gear reducer wheel.

Assembly is carried out in reverse order.

Replacing differential crown wheel

The differential crown wheel is replaced in the following way:

NOTE: The replacement of the crown wheel involves the replacement of the gearbox main shaft.

— Remove gearbox (see gearbox section).

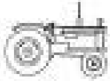
— Remove rear axle (see rear axle section).

— Replace crown wheel and main shaft.

NOTE: When assembling these parts, it is necessary to carry out the corresponding adjustments (see pages [illegible] and [illegible] gearbox section and pages [illegible] and [illegible] rear axle section).

SECTION 11: BRAKES

CONTENTS



Publication [illegible]
1st Edition [illegible]

SPECIFICATIONS

Type	GIRLING, double disc operated jointly or separately located in casing.
Outer surface of discs	15.2 cm.
Inner surface of discs	7.9 cm.
Friction surface of discs	150.8 cm² per face.
Section of new discs	12.50 to 12.80 mm.
Maximum admissible wear of discs	2 mm (one per face).
Free travel of brake pedals	35 mm.
Handbrake	Blocks both wheels.

DESCRIPTION

The fully protected disc brakes are self-adjusting and are equipped with two rotating friction discs. The two discs, secured to the differential shafts by means of a splined connection, are located one on each side of an assembly of drive plates whose inner faces are provided with four wedge-shaped cavities, in each of which a steel ball is housed. Two spiral springs hold the drive plates in contact with the steel balls and act as return springs.

On applying pressure to the brake pedal, it is transmitted to the drive plates by means of linkage.

This causes the drive plates to rotate in the opposite direction, as a result of which the balls climb up the inclinations of the cavity and force the plates to separate. On separating, the plates come into contact with the friction discs, pressing them against the casing and the cover and consequently they brake the differential shafts.

When the pressure exerted on the pedal is removed, the springs force the plates to return to their original position and the balls house themselves again in the deepest part of the cavities. As a result, the friction discs are able to turn freely.

Fig. 1 — Brake system arrangement

To guarantee uniform braking when engaging both brakes, the control linkage is provided with a compensator spring (C, fig. 3), which is blocked by means of a nut secured with a spot weld.

The characteristics of this spring are:

— Diameter of wire: 5.5 mm.
— Spring free no load: 88 mm.
— Spring compressed when fitted: 67 mm.

The brakes are operated by two independent pedals situated on the right side of the tractor. The right pedal controls the right brake and the left pedal the left brake in order to assist when it is necessary to make very tight turns.

ADJUSTMENT OF BRAKES

Although it is recommended to adjust the brakes every 100 hours under normal conditions, this time may vary since it depends on many factors, such as type of work, skill of driver, etc. The need for adjustment will become obvious when a reduction in brake efficiency and the need to exert more pressure on the pedals are observed.

With use, the friction discs gradually wear down. This wear which, on the other hand, may occur unequally on either wheel, is noticeable through increased free travel of the pedals.

The free play of the brake pedals has to be adjusted 10-20 mm., measured between the pedal arm and the floor of the seat (A, fig. 3) when the brake is cold. During operation, this separation will decrease owing to increased temperature in the brake. On the other hand, if the separation were greater, there is a danger that when fully depressing the pedals, they reach their maximum travel before applying the brake completely.

The adjustment of the brakes is carried out in the following way:

— Raise rear of tractor so that wheels are free.

— Disconnect pedal return springs.

— Loosen counter nut (A, fig. 3).

Fig. 2 — Adjusting brakes

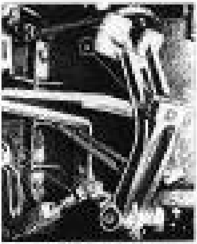


Fig. 3 — Adjusting pedal free travel

- Tighten nut (B, fig. 2) until wheel is blocked; in this position unscrew the nut one or two turns, locking it again with counter nut.
- Adjust pedal free travel by means of adjustment fork (B, fig. 3) of control linkage.
- Connect pedal return spring.
- Proceed similarly with the other brake and lower the tractor.

The handbrake is adjusted simultaneously when adjusting footbrakes.

DISASSEMBLING AND ASSEMBLING BRAKES

DISASSEMBLING BRAKE BOXES

To disassemble one of the brakes boxes, proceed as follows:

- Remove stop plate and return spring of brake and clutch pedals.
- Remove fender.
- Raise rear of tractor and remove wheel.

— Disconnect brake control linkage at pedal arm.

— Remove brake box cover.

— Remove box dust guard.

Remove in this order:

— Outer friction disc.

— Drive plate assembly.

— Inner friction disc.
— Brake box casing.

Disassembling drive plate assembly.

On the workbench, disassemble the two plates, linkage and springs and the balls. It will be observed that the [illegible] are factory locked to secure them to the [illegible].

Fig. 4 — Disassembling brake box

Fig. 5 — Disassembling drive plate assembly

Assembling drive plate assembly.

To assemble the drive plate unit, carry out the following operations:

— Thoroughly clean and inspect all components, replacing any faulty or worn parts.

NOTE: Neither steel balls nor their housings should be lubricated.

— Install the four balls in their cavities.

– Place the outer drive plate on top of the balls.

– Assemble the two spire springs.

– Assemble linkages and control fork, securing the nuts on the tie rods.

Assembling brake boxes

Before proceeding to assemble a brake box, check:

– That the friction faces of the casing and cover do not have excessive wear and are not scored or cracked.

– That the friction do not have brake dusts. Check that the discs are not deformed, worn or cracked and that there is no wear on the splines.

Having made these checks, to assemble brake box, carry out the disassembly procedure in reverse order.

Disassembling brake pedals

The brake pedals should be disassembled in the following order:

– Unhook brake and clutch pedal return springs.

– Disconnect clutch control rod and control linkages of brake pedals.

– Remove brake and clutch pedal shaft bracket.

– Withdraw pedal assembly.

Assembling brake pedals

To assemble brake pedals, carry out forementioned procedure in reverse order.

Disassembling brake pedal shaft

Disconnect the parts according to the order of figure 8.

In case of clutch pedal bushing wear, replace the bushing with a new one so that the pedal turns on its shaft without play.

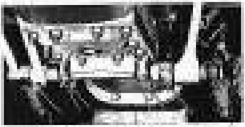


Fig. 6 – Disassembling brake pedal shaft

Assembling brake pedal shaft

Carry out assembly in reverse order to the disassembly procedure.

When mounting the parts on the pedal shaft, sufficient side play has to be left so that the pedals can turn freely.

Disassembling handbrake lever (Fig. 7)

To disassemble handbrake lever, perform the following operations, removing:

— The two return springs.

— The left fastener (1).

— The left brake control linkage (2).

— The clutch control rod (3).

— The assembly made up of the clutch pedal (4) and the left brake control connecting rod (5).

— The handbrake lever (6).

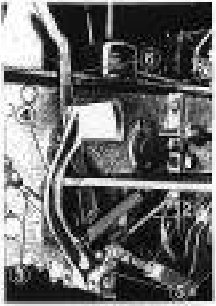


Fig. 7 – Disassembling hand brake lever

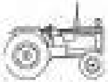
Assembling the handbrake lever

To assemble the handbrake lever, carry out the foregoing disassembly procedure in reverse order.

SECTION 12:

WHEELS, TIRES AND WHEEL COUNTERWEIGHTS

CONTENTS



Publication [illegible]
1st Edition [illegible]

SPECIFICATIONS

Wheels

Front	Pressed steel rim and disc with holes for attaching counter-weight, welded to rim.
Rear	Pressed steel rim with welded cradles and disc with holes for attaching counterweights.
Dimensions Model 500	
Front	[illegible] x 16
Rear	W11 x 28 (options: W12 x 28 — W9 x 28 — W10 x 28 — W13 x 28)
Dimensions Model 480	
Front	W5.50 x 16 — 4.50 x 15 and 3.00 x 16 W12 x 28 (options: W13 x 28 — W12 x 28 W10 x 28 and W14L x 28).

TIRES

Dimensions Model 500	
Front	6.00 x 16 (option 5.50 x 16)
Rear	12 x 28 (options: 13 x 28 — 11 x 28 — 11 x 36 and [illegible])
Dimensions Model 480	
Front	6.50 x 16 (options 6.00 x 16 and 6.00 x 19)
Rear	12 x 36 (options: 12 x 28 — 13 x 28 — 14 x 28 and 11 x 28)
Maximum admissible weight per tire Model 500	
Front (6.00 x 16)	560 kg.
Rear (12 x 28)	1,400 kg.
Maximum admissible weight per tire Model 480	
Front (6.50 x 16)	610 kg.
Rear (12 x 36)	1,470 kg.
Front wheel tread width	From 1.28 to 1.87 m in seven different positions, adjusted by front axle extension.
Rear tread width Model 500	From 1.12 to 1.80 m in eight different positions of disc and rim.
Rear tread width Model 480	From 1.20 to 1.80 m in eight different positions of disc and rim.

Counterweights

Front	8 of 22.5 kg. approx.
Front wheels	2, one on each wheel of 28 kg. approx.
Rear wheels	4, two on each wheel of 45 kg. each approx. (only attached on Model 480 with 12 x 36 wheels).

DESCRIPTION

An important factor in the care of the tractor is the proper maintenance of its tires. The tires used by the [illegible] 350 and 480 tractors have been designed to obtain the best traction and the least wear in the conditions specified.

TRACTION

Few tractors are used to their maximum traction capacity, mainly because the user cannot control the excessive wheelslip or slide. If a tractor is driven over a smooth flat surface, the tire tread or pattern will grip the ground both road and soil, as long as the rear wheel torque (engine torque applied to the wheel) is not greater than the coefficient of traction between tire and ground. When the tire grips the ground without slipping the traction will be 100%.

But owing to tread pattern design and other factors, the maximum traction percentage in the most favourable conditions (smooth, flat soil) is approximately 90%. In this case, a tractor capable of hauling a load of 5,000 kg will haul approximately:

$$\frac{5,000}{1} \times \frac{90}{100} = 4,500 \text{ kg}$$

In ploughing or other similar field tasks, the coefficient of traction is reduced to approximately 60-80%. For this reason ballasting is added to the rear of the tractor to increase the weight over the rear axle and the traction force of the tractor.

To achieve the necessary coefficient of traction, it is essential that all the factors that affect the performance of the tractor be adjusted in accordance with the condition of the soil.

Some of these factors include the following:

— The pressure of the tire: the tires are to be the minimum permitted for the load which it bears and the size and ply rating of the tire used.

— The tire used for ploughing must not be more than 1/3 to 1/2 worn. The tread bars have to be in the correct direction (almost all tires have an arrow on the sidewall which indicates the correct rotation).

— The tire width and size in accordance with the condition of the soil, for example:

a) Clay soil. Large diameter and narrow section tire. These tires have little contact area with the soil and concentrate more weight per unit than the wide section ones so that the tread bars bite the soil better and improve traction.

b) Very light sandy soil. The wide section tire concentrates less weight per unit than the narrow section one so as to prevent the wheel from sinking in the soil.

c) Stony soil. In fields with stones the wide section, narrow section the tires [illegible] better and last longer as the traction is applied over a wider contact area.

d) Sandy soil. These soils require a completely different type of tire. Using a tire with normal bar would [illegible] rapidly sinks into the soil. In these conditions, the main tread tire has to be used so as to achieve good floating and to turn up the soil as little as possible.

INFLATION PRESSURE

The long life and good performance of a tire depends on its maintenance, in general, and on correct inflation, in particular. The tires should never be used underinflated or overinflated.

In accordance with the load it is carrying, the condition and type of ground over which it is travelling and the speed of operation, the tractor tire requires a certain degree of elasticity, that is, the tire casing must be capable of changing shape so as to be able to absorb the forces it receives from the ground as it turns. However, this is true within specified limits, since if the tire should mistakenly be given an excessive rigidity by modifying the recommended inflation pressure, it is liable to suffer from a series of troubles and premature wear due to operation under abnormal conditions.

Overinflation reduces the ground contact area, making the tire vulnerable in this part and harder, even under load. There are, however, exceptions: when the tractor regularly travels on road it is advisable to increase the pressure slightly above that recommended for field working so that as the casing becomes more rigid, the tread rolls more evenly – no floating tire – whereby a typical form of irregular wear through the tread of each lug is prevented. It has also been observed that, when the tractor is working on a hard, smooth surface, it is equally advantageous to increase the inflation pressure, since a more effective traction is obtained with this, although without exceeding in any circumstances the maximum permitted for the size of the tire concerned.

Keeping to the recommendations that are made in respect of the inflation is the most fundamental aspect of their care and maintenance, due to the great influence it has on their performance, although, paradoxically, it is the most generally neglected.

Underinflation produces excessive deflection and gives rise to abnormal strains in certain parts of the tire. It is true, however, that it is acceptable to reduce the air pressure to obtain an increase in traction in certain conditions, such as working on loose, sandy soil, by up to 0.14 kg/cm² below the recommended. In any case, in these circumstances it is much better to increase the weight of the driving wheels, whereby the ground contact area of the tire will be increased while still maintaining the correct air pressure.

The tire pressure can also be reduced somewhat if work has to be done in very tough conditions on muddy ground where the floating factor acquires importance, but always bearing in mind that this is detrimental to the tire casing while additional weight is not.

The tire always warms up somewhat with work as the temperature of the air contained in the tube rises, which gives rise to a proportional increase in pressure. Consequently, after a few hours operation, the pressure is greater than the recommended; this is normal and therefore such increase should not be reduced as, when the tire cools down, it will again acquire the correct pressure. Pressure must always be measured when cold. In a tire whose tube is in good condition, that is, which does not have any more than a normal loss of pressure, the pressure should be checked at least once a week. It goes without saying that, after being idle for a long period, the pressure loss experienced should be made up immediately. Incorrect tire pressure causes the following effects:

a) Overinflation. Overinflation is the cause of troubles in the tire casing. Contrary to what might be supposed it does not increase the work capacity of the tire in any way. On the other hand, it weakens the casing fabric cords by reducing their shock absorbing power owing to the greater tension of the fabric, thereby making it more liable to burst.

Furthermore, it produces premature wear in the tread as well as favoring the "break up" of the tire against the ground and as a result, the loss of traction and increase in fuel consumption.

Blow-outs or impact bursts of a purely accidental nature are a typical failure of the casing, due to the rupture of the textile wires which compose it when they are subjected to a tension force which exceeds their maximum limit of resistance, resulting from a brusque impact or blow received by any part of the tire casing.

Blow-outs or impact bursts can present different forms. They may adopt the form of a simple rupture of the fabric in a single direction, diagonal to the casing and following the direction of the fabric wires, or they may take the form of a double burst in the shape of an «X» or cross, following the two main directions of the wires of the different plies. If the impact is sufficiently extensive and the pressure very excessive, the burst may embrace the whole casing from bead to bead.

With excessively high pressure the tire casing is more vulnerable to impacts or blows against external objects. Nevertheless, at the correct pressure, a very concentrated impact of high intensity, such as that caused by a sharp-pointed rock or a projecting piece of wood, may produce a very deep penetration through deformation in the carcass and cause a blow-out like those described above, since the elasticity of the assembly is not able to absorb the energy released in such an impact.

An excessive inflation pressure is not only detrimental to the casing, through the possible blow-outs we have just referred to, but because it also affects the life of the tread rubber through irregular wear and by making it liable to cuts and tears. When a tractor tire works with excessive pressure the ground contact area of the tread is very small. In such circumstances the track that the tractor leaves on the ground will be almost exclusively that which corresponds to the central part of the tread pattern. Apart from the rapid wear due to a greater contact pressure with the ground and, consequently greater wheelslip, it entails a noticeable loss of speed and traction. In fact, the better the traction sought from the tractor, the greater the contact area of the wheels required, so that the tire lugs —which are those which impart grip— may penetrate and hold fast in the ground.

The belief that an increase in pressure increases working capacity of the tire casing is false, as we have just seen. However, for certain tasks it is correct to inflate the tires slightly above the normal, but only temporarily.

When working, for example, on sloping ground or with considerable elevation on both sides of the tractor or when very hard surfaces are concerned, the tires must be inflated slightly more than the normal, but without exceeding the maximum specified.

b) Underinflation. Underinflation of a tire has as much or more influence in the reduction of its working life as the opposite fault of overinflating.

Lack of pressure produces faults in the tire carcass through the rapid fatigue of the fabric due to the abnormal flexure —excessive and continuous— in the cables of the sidewalls.

In the case of an overinflated tire, the sidewall integrity is at risk when by chance, and therefore, only occasionally, it receives an exceptionally strong impact; on the other hand, when working underinflated, the excessive deflection to which the sidewall plies are subjected is continuous, with an energy being absorbed —and lost— which is converted and dispelled in the form of heat. This overheats these plies in such a way that it may give rise to ruptures, separations and tearing of the fabric layers, favoring, besides, the formation of cracks in the sidewalls.

Lack of pressure also causes uneven tread wear, not to mention the possibility of the casing sliding on the rim, with the resultant air tube failure through tearing its valve off.

In ploughing work, when the right wheel of the tractor is always kept in the furrow, the tractor runs at an angle and is, in addition, subjected to the lurching characteristic of this kind of work; then the tire sidewall is forced to bend. Consistency of the inflation pressure is not correct. In this way correct pressure helps to prevent cracks in the sidewalls due to low pressure and also minimizes the formation of bulges from rubbing against the furrow.

This rubbing is caused on the sidewalls of the front tires when the center of application of the driving forces or tractive effort of the tractor (back tires or belt pivot) are not in line with the center of application of the resisting forces (implements, moldboards etc. see ...).

In this case a rotation torque is built up which tends to divert the tractor from advancing in a straight line. The driver counteracts this pull by turning the wheel in the opposite direction. The steering tires do not advance in planes completely parallel to the driving ones but rather they turn slightly askew, thereby producing a lateral rubbing force which cancels out the previously mentioned rotation torque. The front tires have a mixed rotating and sliding movement.

Therefore, the front right tire outer sidewall and the front left tire inner sidewall are rubbing and pressing against the ploughed furrow in the first case and against the hard ground (still unploughed) in the second. This lateral force can cause an uneven and permanent deformation of the sidewalls, which if it is also accompanied by systematic low pressure, can wear down the fabric until producing blow-out or separation of plies in the shoulder area.

To prevent this trouble, inflate the furrow tire an additional 0.28 kg/cm², apart from attaching the correct counterweight on the other wheel to counteract the bad unbalance and prevent wheelslip through poor adhesion. Since the wear on the wheels is uneven in this work, they should be changed over from time to time, taking care to install them in the correct rotation direction.

Excessive flexure cracks and wears down the rubber. The forementioned phenomenon, as well as flexure in general, since the tire case is excessively flattened through lack of air pressure, can produce typical flexure cracks at the base of the tread bars, which in some cases can even affect all the plies, perforating the innermost one as well. In fact, the bars are housed, so to speak, in the heart of the tire, producing very pronounced changes of shape or undulations as they are repeated with every turn and which finally produce internal fabric fatigue and the formation of cracks on the outside of the tread bar peri angles. This fault, due to the fact the tread bars are too mobile because the casing which holds them is not sufficiently rigid, may be counteracted by inflating the furrow tire an additional 0.28 kg/cm².

Low pressure is also harmful when the tractor is used to a large extent on the road, not only with regard to typical permanent wear, which we mentioned when dealing with overinflation, but also for the risk of weakening the fabric situated underneath the bars, especially when travelling at high speed. This premature wear due to low pressure, when the tractor is working on the road, can be largely prevented by changing the direction of rotation of the tire, which is achieved by rotating the right and left wheels. Experience shows that by this the life of the tires can be prolonged by up to 20% in this way.

Of course, when the tractor returns to its normal work in the field, the wheels have to be fitted in the normal position with the arrow in the direction in which the tractor is driven. If this is not done, the tire loses its capacity to grip and clean itself.

PRESSURE TABLES

LOAD PER TIRE IN KILOGRAMS AT THE FOLLOWING PRESSURES

FRONT WHEELS																								
		kg/cm²																						
Sizes	Ply	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7
5.50 x 16	4	300	310	330	340	350	360	380	390	400	410	420												
6.00 x 16	6												430	440	450	460	470	480	490	500	505	510	520	525
6.00 x 16	4	340	360	370	380	400	410	420	440	450														
6.50 x 16	6										460	475	485	490	500	515	525	540	550	560				
6.50 x 16	8														580	590	605	615						
6.50 x 16	6										520	540	550	560	580	590	600	610	620	640				

NOTE: These pressures are valid for road driving at a maximum speed of 30 kg/h.

FOR FIELD OPERATION INSTEAD OF REDUCING THE PRESSURE OF THE TIRES, ADD BALLAST ON THE REAR WHEELS TO INCREASE THEIR GRIP.

REAR WHEELS											
		kg/cm²									
Sizes	Ply	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
11 x 28	4	850	900	950	1,000						
11 x 28	6					1,050	1,090	1,140	1,180	1,220	1,270
11 x 36	6					1,180	1,220	1,260	1,300	1,360	1,400
12 x 28	4	960	1,040	1,100							
12 x 28	6				1,150	1,210	1,260	1,320	1,370	1,400	
12 x 36	6				1,300	1,360	1,420	1,480	1,550	1,610	
13 x 28	6		1,300	1,320	1,400	1,470	1,540	1,600			
14 x 30	6	1,450	1,500	1,540	1,720	1,815	1,900				
14 x 30	8							1,960	2,050	2,100	2,240
18 x 30	8						2,130	2,200	2,320	2,420	2,500

BALLASTING OF THE TRACTOR

The tractive force of the tractor can be increased by ballasting. According to the conditions of the ground and implements that the tractor carries or tows, a given tractive force, different in each case, is required, which makes a special study advisable.

The nature or type of additional load to be attached to the drive wheels has no importance in itself.

Whether it is by means of cast iron counterweights which are generally secured to the wheel disc, or [illegible] to the well-known practice of water ballasting [illegible], any system is acceptable. Weights have the advantage that they can be attached and removed quickly and easily. However, what is important, as always, is the principle of the procedure in itself. The routine of water ballasting the rear wheels, as sometimes happens, for the simple fact that someone did it that way [illegible] has to be avoided. The important thing is to know how to decide when it is right to apply it in a specific way or when it is superfluous or even detrimental to resort to this system of ballasting.

The basis of all this lies in whether the tractor wheels spin when making a strong effort or towing a heavy load, why it does so, and what has to be done to prevent it. Above all, a clear idea must be had of the serious consequences that this problem has for the correct preservation of the tyre tread [illegible] which are exposed to premature and uneven wear through rubbing and tears in the rubber. The greater the intensity, the quicker this will occur. Generally speaking, it is best to ballast for tough, heavy tasks (deep-ploughing, cultivating, [illegible] ploughing etc.), which is when the power of the tractor must be used to the full, while it is not necessary in lighter jobs and transport operations.

Attempts must not be made to solve traction problems by means of increasing or reducing the pressure [illegible], apart from the fact that these variations have little effect on traction; they can, on the other hand, lead to the destruction of the tire.

It is natural to find that in each particular case varying conditions are met, both in relation to soil and working implements, whereby different degrees of pull power on the draw bar are required. Thus, to achieve optimum performance in each tractor, it will be necessary to find the most suitable weight for ballasting. In practice, the value of the [illegible] pull can vary considerably, as it depends on the soil surface, degree of compaction and the tread pattern of the tires.

However, it is understood that the tires should not carry more weight than that specified for their maximum load capacity. If, with the additional weight in question, this limit would be exceeded, it will be necessary to replace the tires with others of greater load capacity. When fitting additional weight the tire pressure / load table must always be kept in mind.

However, in particular circumstances certain overloads can be permitted.

In principle, when the weight of the tractor rear wheels is increased, whether with water or by weights, it is advisable to increase the weight in the front as well in order to re-establish the correct balance of forces, which otherwise would affect its good operation and proper working conditions. Besides, with excessive indirect ballasting at the back of the tractor (implements etc.) there is a risk that, in certain hung tasks, the front of the tractor may even rise up. The front counterweights can either be attached to the wheel discs or to the support protruding from the front axle.

WATER BALLASTING

Ballasting of the tire with water, which is introduced thro the air tube, is known by the name of water ballasting. It is the simplest and least detrimental way of increasing the weight of the wheels, apart from its low cost, ease and speed with which the operation is carried out, and the possibility of conveniently graduating the required ballast weight. This system, as opposed to ballasting with weights has no influence on the axles, wheels and the sidewalls, as the additional load bears down on the tread and the ground.

Although the ballast water can be fairly easily removed, in general practice this is not done. Therefore, in jobs of a light nature an additional useless weight is being carried, thus increasing the tractor fuel consumption. The water ballast load is located at a very low level, producing a lowering of the center of gravity of the tractor and a reduction in the risk of its overturning on sloping ground.

To prevent the water used in ballasting from freezing in winter, an anti-freeze product must be used. The most common system is to use a mixture of water and calcium chloride. It is best to make the mixture in an open container and wait for it to cool before introducing it into the tire.

Pour the calcium chloride into the water; never pour the water on to the calcium chloride. This anti-freeze should not be used in the engine radiator as it is corrosive to metals. Similarly, the anti-freeze used in the engine cooling system should not be used in the tires as it attacks the rubber.

It is best to dissolve in the water-chloride anti-freeze mixture one kilogram of slaked lime per hundred of chloride, that is 1%, so as to eliminate any possibility of acidity.

NOTE: Do not attempt to add chloride directly to the tire filled with water, as the resultant heat and explosion of the mixture can damage the tire.

Take care to wash with clean water those metal parts which have been splashed, as the anti-freeze solution is highly corrosive.

If, when draining a tire, the water which remains below the level of the inner tube valve, located in its lowest position, is not entirely removed, and anti-freeze when water only has been used, then the pieces of ice that may otherwise form, would damage the tube and the casing.

When introducing the liquid, do not use high pressure pumps such as those used for washing cars; it may be filled from a low pressure fountain, a specially prepared pump, a fluid transfer pump, or simply by gravity from a tank located above the tire. The quantity of water or mixture to be introduced into the tire is regulated by the position of the valve. When this is in its highest position approximately three quarters (75%) will be filled, but if the valve is located on a horizontal plane, only half will be filled.

Water ballasted tires carry the load under air pressure, since one section of the inside of the tire remains to absorb impacts and to protect the carcass of the casing. Therefore the tire will never be totally filled with water as it has been proved that a rear tractor tire, with 90% water ballast, is 30% more resistant to impacts and ruptures than one completely filled with water or mixture.

When travelling fast on the road, if the wheels have water ballast, the water may cause the tractor to sway on sharp turns or bends. The following table shows the approximate capacities of tractor tires for agricultural use, filled to 75% of their volume, and the mixtures of commercial calcium chloride needed to protect them down to a temperature of 10° C below zero.

[illegible]	[illegible]	[illegible]		
		[illegible]	[illegible]	[illegible]
11-28	130	113	23	142
11-32	153	138	26	172
12-28	163	145	30	187
12-32	156	128	40	204
13-28	156	170	46	225
13-32	200	215	50	271
14-28	300	270	58	340

NOTE: The table and method of filling recommended below can be used for every make of tire. Although tires of equal rated size vary slightly in their internal dimensions, according to the manufacturer, the degree of filling we indicate will not affect the performance of the tire. The anti-freeze safety temperature obtained by the addition of calcium chloride varies not only according to the proportion chosen but also with the degree of concentration of the chloride. The following table shows, as a mere guideline, a list of below-zero temperatures in relation to the recommended percentage of calcium chloride to be used by means of two different degrees of concentration, at 74/75% (normal commercial) and at 77/80%.

Temperature °C	[illegible]	
	[illegible]	[illegible]
5	[illegible]	[illegible]
10	20	12
15	25	15
20	30	20
25	42	28
30	50	42

WATER BALLASTING SYSTEMS

To facilitate the introduction of the water into the tire, a number of methods can be used, with or without the aid of special adaptors for water ballasting. If only a hose is available, the following recommendations can be followed:

— Jack up the wheel from the ground. If the wheel is not installed on the tractor, place it in a vertical position. In either case, the valve must be in its highest position.

— Take out the part of the valve that contains the core (B, Fig. 11) so that only the base of the valve remains, allowing all the air to escape.

— Connect the water hose or normal rubber pipe into the body of the valve (C, Fig. 11).

— Turn on the water from the mains supply or from a tank 1.5 to 2 meters above, interrupting this operation from time to time to allow the air in the tire to escape.

— If on withdrawing the hose, the water runs out continuously through the valve, the water has reached the level of the valve and filling should be stopped.

— Connect the valve core and inflate the tire to the prescribed pressure.

Do not use a normal air pressure gauge to measure a water ballasted tire as it goes wrong. There is a special gauge for this purpose.

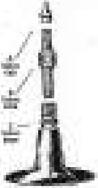


Fig. 3 — Valve

To avoid the trouble of having to interrupt filling several times to let the air escape, when the hose is fitted directly to the body of the valve, some special devices are used which permit the air to escape at the same time as the water is being introduced. One of these is the well-known Schrader number [illegible] adapter which has an air bleeder button on its side. When the water runs out continuously through the bleeder —the valve being closed— the tire case is full up to the level of the valve ([illegible]).

The nozzle or small part No. [illegible], B, fig. [illegible], which accompanies the adapter, can be used to fit to single part valves.

There are other adapters (fig. 4) which, instead of a button type side valve, have a small diameter, plastic or rubber tube which is inserted through the body of the valve and which provides a continuous outlet for the air as it is being dispelled by the water.

On the assumption that an up to 90% filling is desired, proceed as follows:

— Locate the wheel with the valve in the bottom position (this is important because of what will be explained later on).

— Attach to the valve an adapter equipped with a tube or spacer with an extension of:
a) [illegible] mm for tires of 7" to 10".
b) [illegible] mm for tires of 10" to 12".
c) [illegible] mm for tires of 12" to 16".

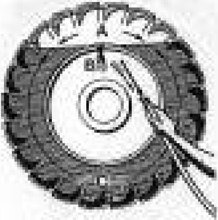
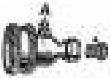


Fig. 4 — Water filling in position
[illegible]



Adapter (A — air bleeder)

It should be attached to the air outlet tube as is illustrated in figure 4.

— Pump the mixture with the aid of hand pump until it runs out through the adapter air removal tube, at which time a quarter of the capacity of the tire will have been filled.

— Block the air outlet with a finger and give the wheel a half turn so as to situate the valve in the top position.

— Continue pumping the liquid until it runs out through the air removal tube.

At this moment approximately [illegible]% of the capacity of the tire will have been filled.

With this reference, turn the wheel slightly to either direction, allowing liquid to run out through the valve until an approximately 90% filling is achieved.

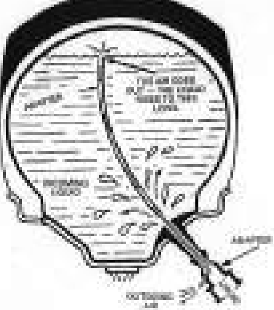


Fig. 4 — Water filling with [illegible]

Fig. 5 — Draining water

NOTE: With respect to what has been previously described, the purpose of starting to fill the tire with the valve in the bottom position is to allow the adapter extension tube to be inserted into the inner tube without obstacles, which would not be easy with the valve in the top position as the inner tube would then be collapsed on the rim.

DRAINING WATER

To remove the water, it is sufficient to locate the valve at the lowest point of the wheel and take out the valve core so that the water runs out through its own weight. If it is wished to remove all the water that remains below the level of the valve in its lowest position, a water ballast adapter is attached, equipped with a bleeder tube, which is inserted downwards through the valve body hole. The pressure of the air delivered through the large hole of the adapter will force the water to run out through the tube. If no water ballast adapter is available, the following procedure can be employed: fit a small rubber tube, like a [illegible] tube, in the bottom end of the valve core and insert it into the tire inner tube through the body of the valve and then screw in the core place. The tire is then inflated and the core removed, letting the residual water run out as it will be expelled by the pressure of air prevailing inside the inner tube. To get out the rubber tube, the core holder part is removed, which is screwed in again — with the core — after taking away the tube. Finally the tire is inflated to the correct pressure.

COUNTERWEIGHTS

Ballasting the tractor with cast iron counterweights has the advantage that they can be quickly removed when the tractor does not require ballast dead weight for some time. Through this advantage, more fuel is saved than in the case of water ballast since often the tractor operates with liquid ballast [illegible].

Front wheel counterweights

These weights weigh approximately [illegible] kg. One counter-weight is attached on the inside of each wheel (fig. [illegible]).

Rear wheel counter weights

Weighing approximately [illegible] kg., one or two weights can be fixed on the outside of each wheel, screwed onto the disc. These weights are only valid for the Model [illegible] equipped with [illegible] wheels (fig. [illegible]).

Fig. [illegible] — Front wheel counter weights

Front counterweights

These weights, of approximately [illegible] kg., fit into the flange formed by the front support, being secured with a rod (A, fig. [illegible]). Up to eight weights can be attached in the space in the above mentioned flange.

Fig. [illegible] — Rear wheel counterweight

Fig. [illegible] — Front counterweights

W H E E L S

TO REMOVE AND INSTALL A FRONT WHEEL (Fig. 9)

To remove a front wheel, proceed as follows:

— Apply brake and for greater security, chock the rear wheels.

— Loosen the six hub bolts.

— Remove the hub cap.

— Jack up the front of the tractor.

— Finish unscrewing the six hub bolts and take off the wheel. To install the front wheel, carry out the above operations in reverse order, tightening up the bolts to a torque setting of 6 to 8 kgm.

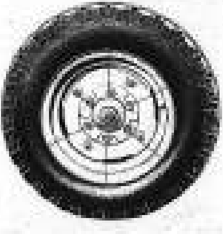


Fig. 9 — Front wheel

TO REMOVE AND INSTALL A REAR WHEEL (Fig. 10)

To remove a rear wheel, perform the following operations:

— Chock the front wheels.

— Partly loosen the eight hub nuts.

— Raise the rear of the tractor with an adequate jack.

— Secure the wheel with the aid of a hoist, which is fit and finish unscrewing the eight nuts.

— Remove the wheel, taking care not to damage the threads of the bolts.

To install the rear wheel, carry out the above operations in reverse order, observing every cleanliness. Apply grease to the bolts before screwing on the nuts. Tighten the nuts in criss-cross order to a torque setting of [illegible] kgm.

NOTE: Do not forget to re-tighten the nuts after the tractor has been operating for a few hours.

Fig. 10 — Rear wheel

REAR TREAD

The wheel tread can be changed in graduations of 100 mm., owing to the fact that the wheel disc is offset in relation to the differential shaft plate and can be reversed in conjunction with the wheel rim, which also has offset spokes. In this way, treads can be obtained of:

Model 300 with 12 x 28 wheels: treads of 1.15 to 1.80 m by means of eight different disc and rim positions (Fig. 11).

Model 400 with 12 x 28 wheels: treads of 1.20 to 1.80 m by means of eight different disc and rim positions (Fig. 12).

NOTE. The torque setting of the disc to rim clamp bolts is 6.2 to 7.4 kg/cm.

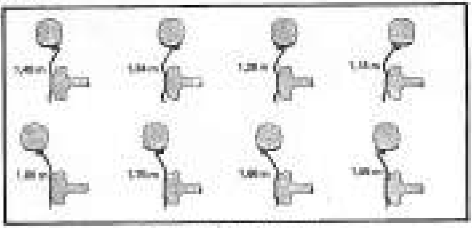


Fig. 11 — Rear wheel widths Model 300

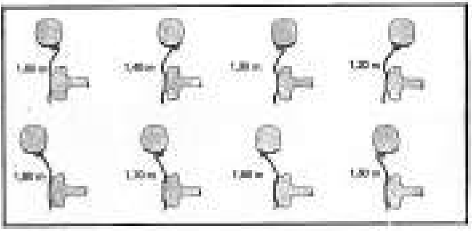


Fig. 12 — Rear wheel tread widths Model 400

TIRES

TO REMOVE A REAR WHEEL TIRE

To remove a rear wheel tire, proceed as follows:

— Place the wheel in position with the convex side towards the ground (fig. 13).

— Deflate the tire by taking out the inside of the valve (fig. 13).

— Loosen the heel from the rim flange and force it so that it slides and becomes lodged in the rim channel on the opposite side from the valve (fig. 14).

— Insert two tire irons at a distance of some 30 to 40 cm from each other; press one of these down towards the the inside of the rim and with the other, begin the operation of removing the heel (fig. 15).

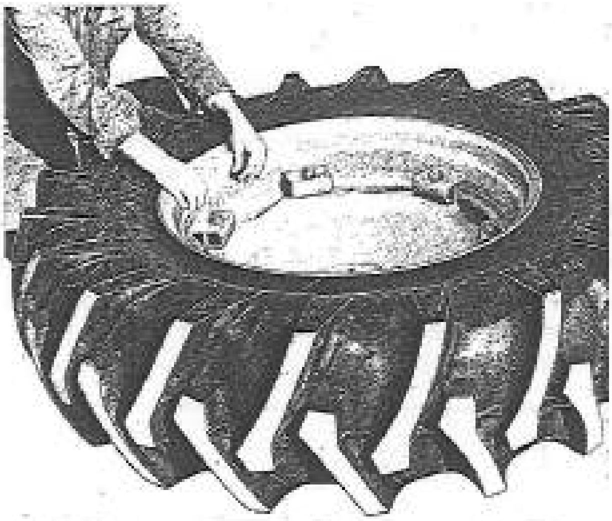


Fig. 13 — Taking out valve internals

Fig. 14 — Loosening heel from rim flange

Fig. 15 — Removing first heel

- Raise the heel of the casing on the valve side and take out the inner tube, pulling it carefully to avoid tearing (fig. 16).
- Having taken out the tube, lift up the case together with the rim; insert a tire iron as far as the inner rim flange, forcing so as to make the heel pass over the flange. Continue the operation with second tire iron until the case is completely clear (fig. 17).

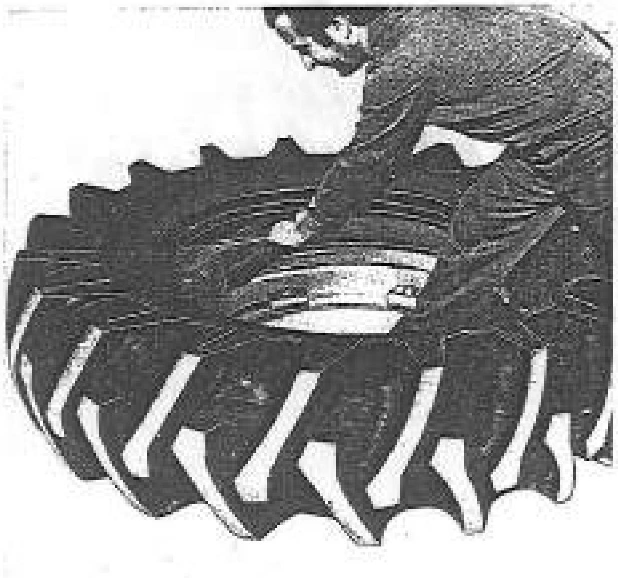


Fig. 16 — Taking out inner tube

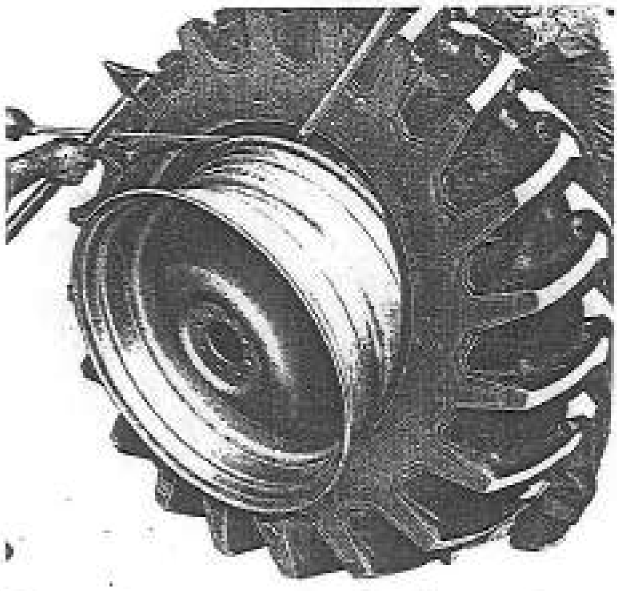


Fig. 17 — Removing second heel

TO INSTALL A REAR WHEEL TIRE

To install a rear wheel tire, proceed as follows:

- Set the cover, slightly inclined, over the rim, setting the tread rotation in the right direction and with the valve correctly placed. Hold the tire cover with the foot and right hand, at the same time pushing with the left hand so that the first heel enters the rim channel. Continue the operation with a tire iron until the heel is totally installed.
- Slightly inflate the inner tube and place it on the tire case. Lift the heel and insert the inner tube, pulling the valve out through the hole in the rim (fig. 19).

Fig. 18 — Installing first heel

– With the aid of two tire irons begin to install the second heel on the side opposite the valve (fig. 20).

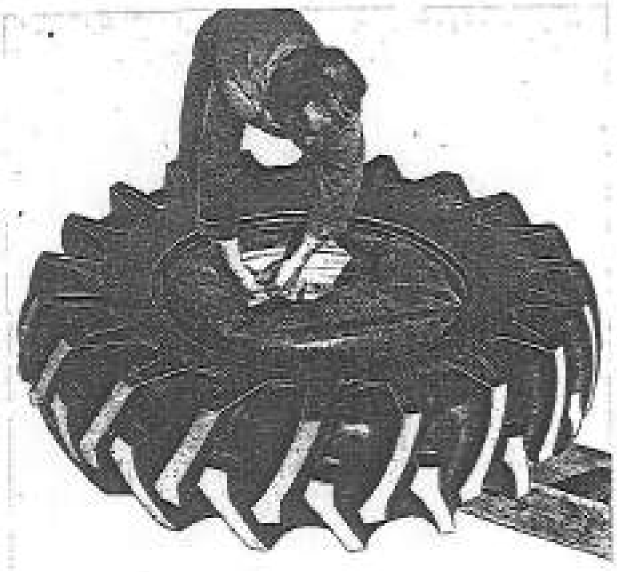


Fig. 19 – Inserting inner tube

Fig. 20 – Installing second heel

– Once part of the second heel has been fitted, continue the operation with one tire iron while exerting pressure on the tire case with the feet until the heel is completely installed (fig. 21).

NOTE: After the tires have been mounted on the rims, inflate them to a pressure of 2.5 kg/cm² so as to seat the casing heels perfectly on the rims. Then deflate the tires completely to allow the inner tube to adopt its normal position and re-inflate to the recommended working pressure.

Fig. 21 – Complete installation of second heel

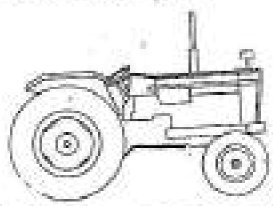
TROUBLE SHOOTING TABLE

Trouble	Possible Cause	Solution
Wheelslip or spinning.	Too low gear selected.	Use highest gear possible in which tractor can work without being forced.
Wheelslip due to load of the tires on ground.	Overinflation.	Adjust pressure to recommended minimum.
	Underinflation.	Increase pressure to correct value according to load or wheels.
	Insufficient weight on front of tractor.	Attach front and front wheel counterweights.
Lateral oscillation of tractor when working on hard soil or road.	Buckling of tire through insufficient pressure.	Increase pressure. This effect can cause damage to tire sidewalls.
Uneven tread wear when the tractor is used a lot on the road.	a) Insufficient pressure. b) Overload.	Increase pressure. This is observed by wear on tread bar edges.

Trouble	Possible Cause	Solution
Uneven wear of pattern	Overinflation.	Adjust pressure to recommended valve. Observed by wear limited to the center of the pattern bars.
	Wheels off-center.	a) Jack up wheels, loosen and retighten wheel nuts. b) Check correct position of tire rim.
Sliding of tire on rim.	Underinflation.	a) Increase pressure. b) Check rim and seat position; replace if necessary.
Slit tire sidewall.	Underinflated tire collided with sharp object.	Small slits may be repaired. Very large slits require tire replacement.

SECTION 13: ELECTRICAL EQUIPMENT AND INSTRUMENTS

CONTENTS



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DESCRIPTION

The EBRO 350 and 460 tractors have a 12 V. battery with grounded negative and control by voltage compensation regulator. Fig. 1 shows the arrangement of all the components and wiring of the system.

The regulator, horn, battery and headlights are installed in the front part of the tractor in front of the radiator. Access can be gained to all these units by removing the tractor's front grille.

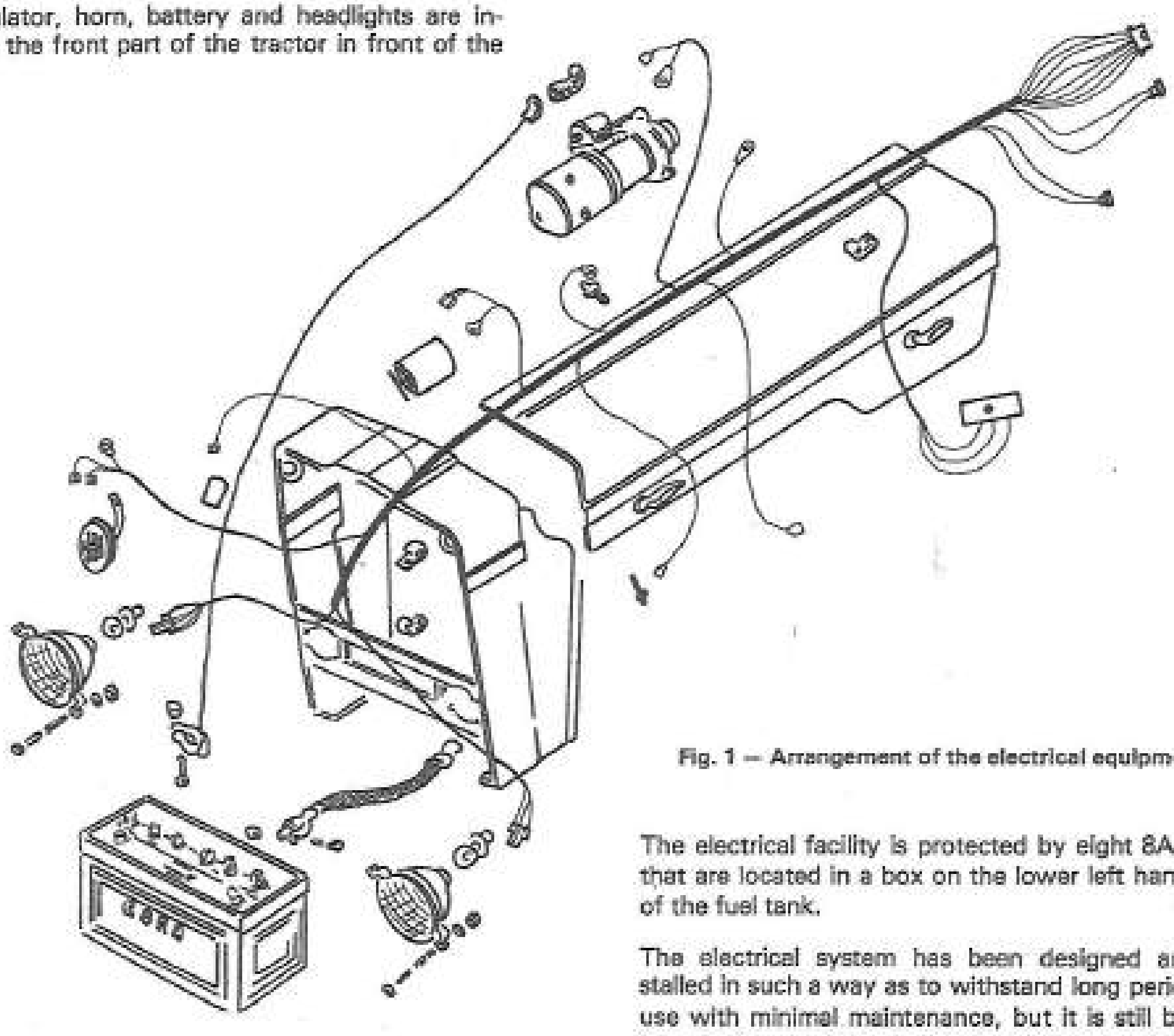


Fig. 1 — Arrangement of the electrical equipment

The alterriator is installed on the right hand side of the engine and is driven by a V-belt that is connected to the crankshaft pulley. The alternator assembly is adjustable to maintain correct belt tension.

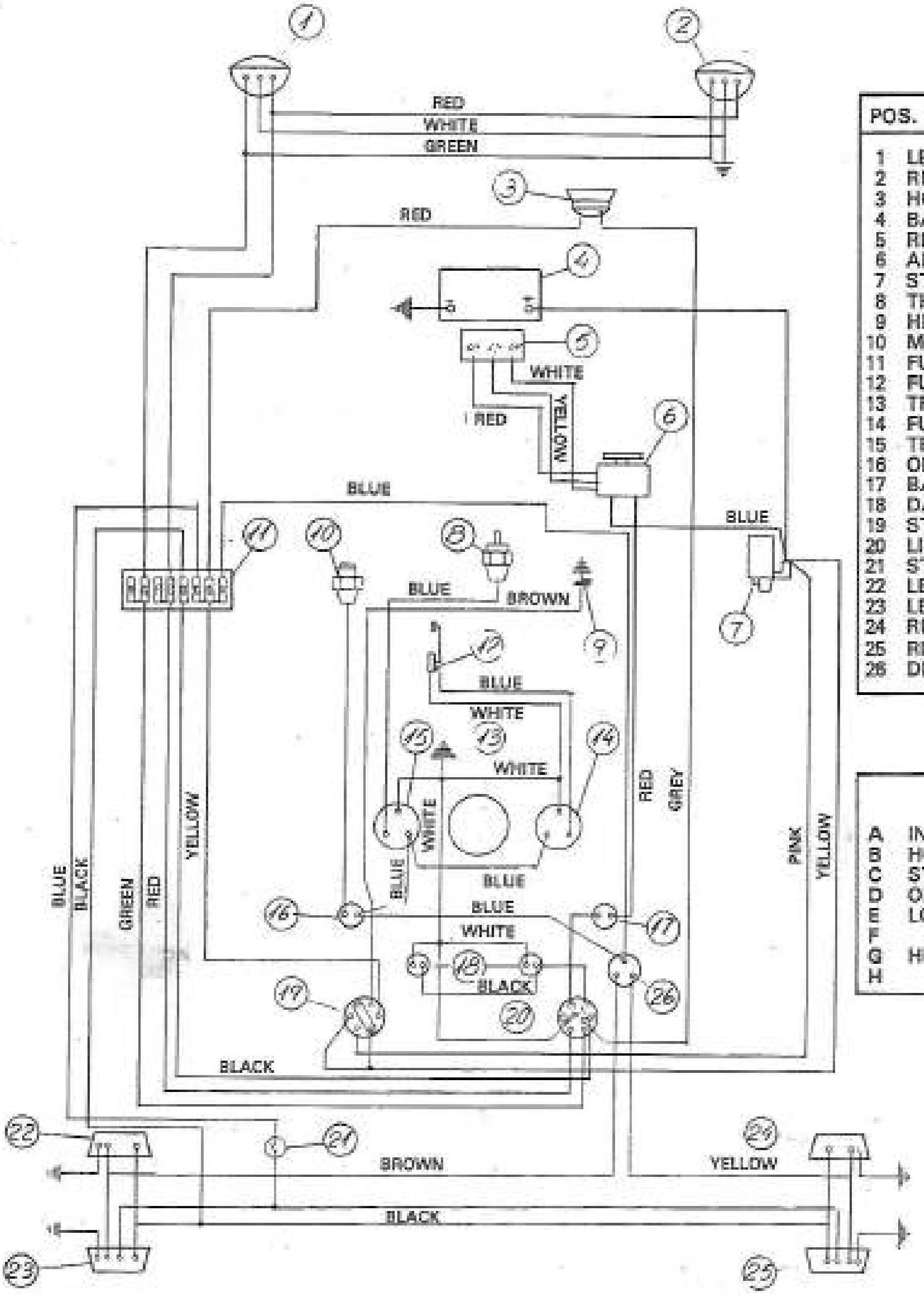
The starter is secured in place on the right hand side of the engine by means of three nuts that screws onto the three pins installed on the block.

The electrical facility is protected by eight 8A fuses that are located in a box on the lower left hand side of the fuel tank.

The electrical system has been designed and installed in such a way as to withstand long periods of use with minimal maintenance, but it is still best to keep it clean and check that the battery terminals are correctly tightened.

This section deals with the way in which to remove and install all of the components of the system, and how to check their operation when any trouble is observed. Directions are also provided for disassembling and assembling the starter and alternator according to the relevant manufacturers' instructions.

Note: Make sure to disconnect the battery terminals before handling the electrical system.



POS.	DESIGNATION
1	LEFT HEAD LIGHT
2	RIGHT HEAD LIGHT
3	HORN
4	BATTERY
5	REGULATOR
6	ALTERNATOR
7	STARTER
8	THERMISTOR
9	HEATER
10	MONOCONTACT
11	FUSE BOX
12	FUEL LEVEL FLOAT
13	TRACTOMETER
14	FUEL GAUGE
15	TEMPERATURE GAUGE
16	OIL PRESSURE LIGHT
17	BATTERY CHARGE LIGHT
18	DASHBORD LIGHT
19	START SWITCH
20	LIGHT AND HORN SWITCH
21	STOP SWITCH
22	LEFT FRONT FENDER LIGHT
23	LEFT REAR FENDER LIGHT
24	RIGHT FRONT FENDER LIGHT
25	RIGHT REAR FENDER LIGHT
26	DIRECTION (TURN) LIGHT

FUSES	
A	INSTRUMENTS
B	HORN
C	STOP LIGHTS
D	ORDINARY LIGHTS
E	LOW BEAMS
F	
G	HIGH BEAMS
H	

Fig. 2 — Electric system diagram

REMOVAL AND INSTALLATION OF THE SYSTEM COMPONENTS

Instrument Panel

The following instruments are found on the panel:

a) Temperature gauge.

b) Fuel level gauge.

c) Tractometer.

d) Low oil pressure warning light.

e) Battery charge control light.

f) Electric circuit and starter switch (ignition switch).

g) Light switch (with horn button).

h) Direction (turn signal) switch.

The instrument panel is secured to the dashboard by six screws. In order to gain access to any of the fore-mentioned instruments, the instrument panel must be removed. To do so, follow the procedure described below:

— Remove the steering wheel with the help of an extractor.

— Remove the throttle lever.

— Loosen the six set screws which secure the panel to the dashboard.

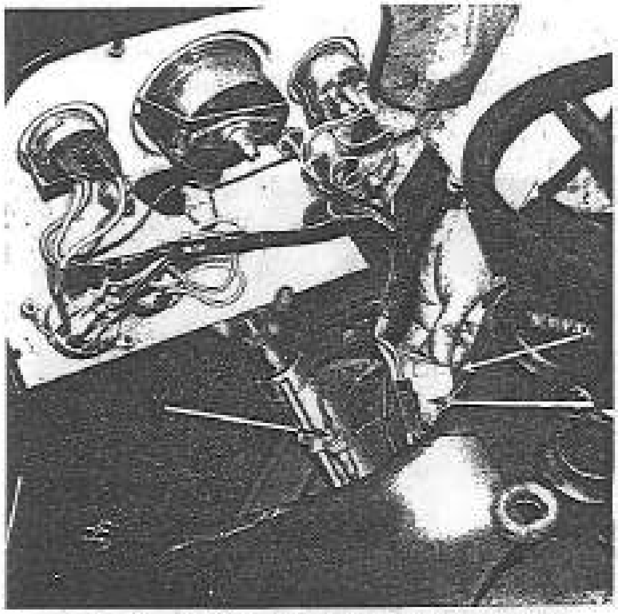


Fig. 3 — Removal of the instrument panel

— Pull the instrument panel upwards and out, disconnect the electrical system sockets and tractometer control wire (fig. 3).

When installing the instrument panel, reverse the foregoing procedure.

Battery, horn and regulator (fig. 4)

In order to remove the battery, horn or regulator, proceed as follows:

— Remove the front grille of the tractor, thereby gaining access to the forementioned components. Then follow this procedure.

a) Battery:

— Disconnect the battery terminals.

— Disconnect the plugs of the head lights.

— Disassemble the lock support of the lights.

— Loosen the nuts of the lock pins and remove the battery.

b) Horn:

— Disconnect the battery gound cable.

— Disconnect the horn unit cables.

— Loosen the lock nut and remove the ground cable and horn.

c) Regulator:

— Disconnect the ground cable of the battery.

— Disconnect the plug of the regulator unit.

— Loosen the two set screws and remove the regulator (be careful when loosening the right hand screw since it also secures the horn).

When re-installing these components, just reverse the foregoing removal procedures.

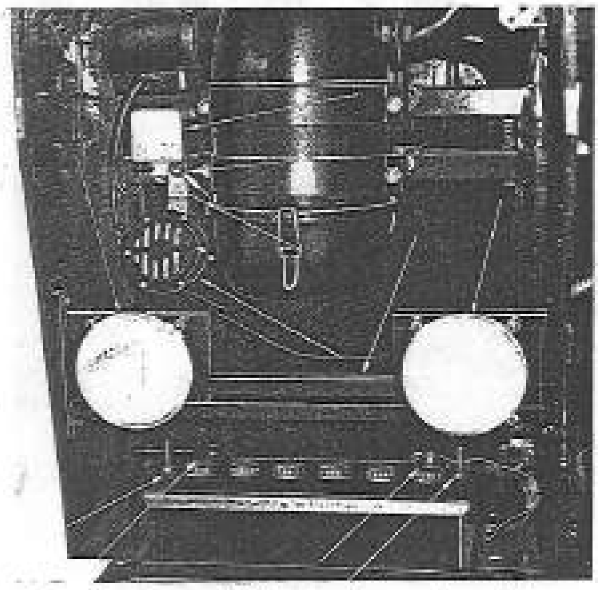


Fig. 4 — Removal of battery horn and regulator

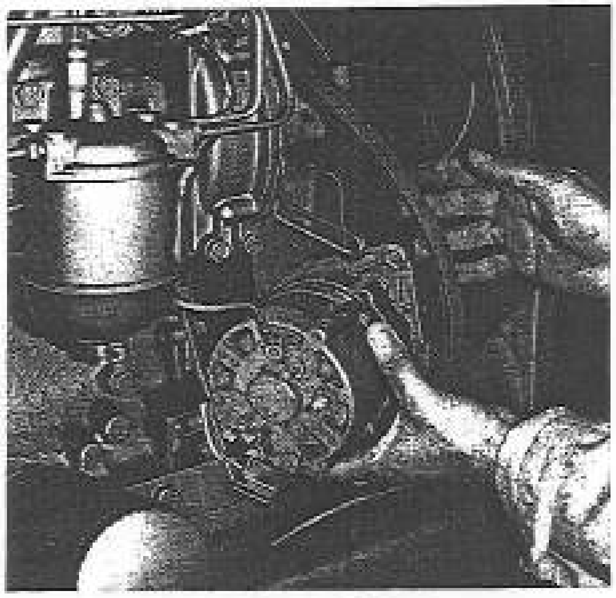


Fig. 5 — Removal of alternator

Alternator (fig. 5)

In order to remove the alternator, carry out the following procedure:

— Disconnect the battery ground cable.

— Disconnect the plug and cable of the alternator unit.

— Loosen the adjustment arm screw.

— Rock the alternator toward the block and remove the belt.

— Loosen the screw that secures the alternator to the attachment support and remove the screw and the alternator.

When re-installing the alternator, reverse the foregoing procedure.

Note: The deflection of the drive belt is approximately 10 mm.

Starter (fig. 6)

In order to remove the starter, proceed as follows:

— Disconnect the battery ground cable.

— Disconnect the positive cable between the starter and the battery.

— Disconnect the starter unit wiring.

— Remove the lock nuts and take out the starter.

When re-installing the starter, just reverse the foregoing procedure.

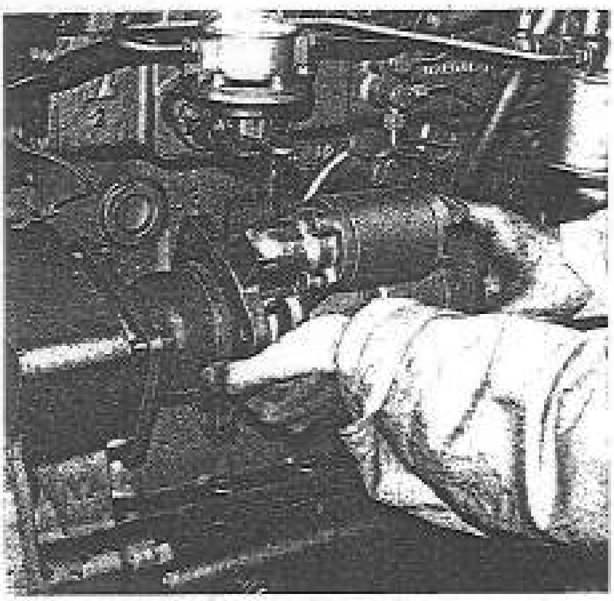


Fig. 6 — Removal of starter

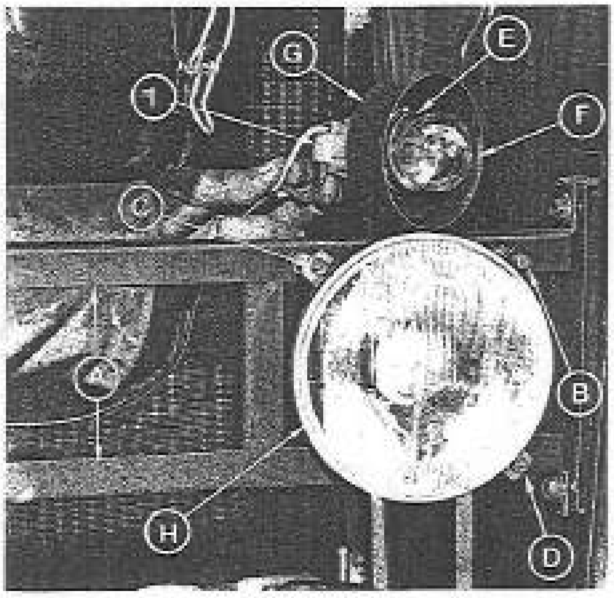


Fig. 7 — Headlights

Headlights (fig. 7)

The headlights are assembled on the lock support (A) by means of the screws (B, C and D), which also serve to adjust the lights.

These lights are composed of a bulb holder (E), a bulb (F), dustguard (G), reflector and lens. The lights are of the half-sealed type, that is, the lens and the reflector form a unit called the optical assembly (H). The terminals of the electrical wiring are located in a plug (I), which only allows one connection position for the bulb holder. When removing a front light, carry out the following procedure:

— Remove the front grille.

— Separate the bulb holder from the plug in the space found between the lock support and the radiator.

— Push the dustguard rearwards.

— Release the two elastic clamps connected to the reflector which secure the bulb holder, and remove the bulb holder together with the bulb.

— Loosen the three set screws, procuring not to lose the compression springs that are mounted on them. Next remove the optical assembly.

Just as can be seen from the description of the foregoing procedure, it is not necessary to dissasemble the head light assembly in order to replace a bulb.

When re-installing the head light, simply reverse the fore-going removal procedure.

Once the head light has been re-installed, it should be adjusted as follows: (fig. 8).

a) Place the tractor at a right angle and a distance of 80 cm. from a wall or screen.

b) Draw a vertical line (1) on the wall or screen, which should concur with the axis of symmetry of the tractor.

c) Draw a horizontal line (2) through the vertical line (1) at the height of the center of the lights (4).

d) Mark two points (3) on the horizontal line which shall be equidistant from the vertical line (1). The distance between the two shall be equal to the distance between the centers of the lights.

e) Check one light while covering the other so that the point (3) that is marked on the wall is in the center of the beam of light.

f) Adjust the position of the light as required, using the forementioned adjustment screws to do so.

g) Check and adjust the other light in the same way.

The vertical focus adjustment, that is, the raising or lowering of the beam of light, is carried out by means of the screws C and C (fig. 7). For horizontal adjustment, that is, in order to regulate the direction of the beam of light towards one side or the other, tighten or loosen screws B and D as required (fig. 7).

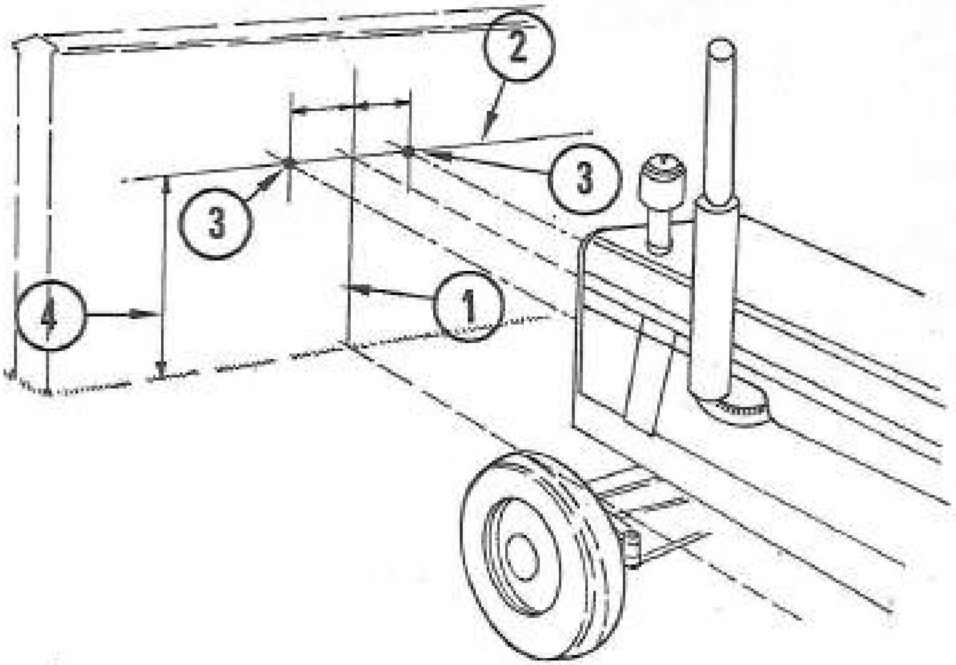


Fig. 8 — Head light focusing

Parking and Direction (Turn Signal) Light Assembly (fig. 9)

This light assembly is mounted on the fenders and equipped with two lights, namely: the direction (turn signal) light and the parking light. They are easily accessible by removing the screws that secure the lens. In order to remove a front assembly, proceed as follows:

— Loosen the two lock nuts which are located on the inside of the fender.

— Take out the assembly far enough to be able to disconnect the two terminals that are connected to the lights.

When re-installing this front turn-parking light assembly, just reverse the foregoing removal procedure.

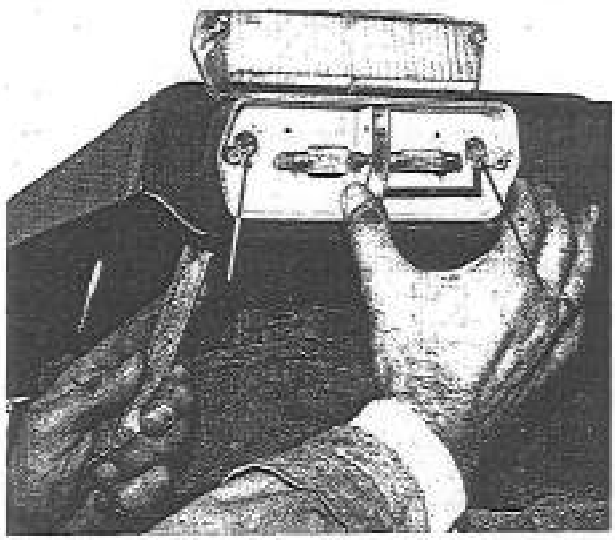


Fig. 9 — Removal of a front turn-parking light assembly

Rear light assembly comprising parking, brake, direction (turn signal) and license lights (fig. 10).

This light assembly is mounted on the rear part of the fenders and has a double divider component that separates it into two compartments. One compartment is for the direction (turn signal) light while the other one contains the brake and parking lights. The left rear light assembly, which can be seen in the picture, also has a transparent white plate through which the parking light shines in order to illuminate the license plate.

When removing the rear light assembly, proceed as follows:

— Loosen the two lock nuts that are located on the inside of the fender.

— Remove the light assembly far enough to be able to disconnect the three terminals that are connected to the lights.

When re-installing the rear light assemblies, simply reverse the foregoing removal procedure.

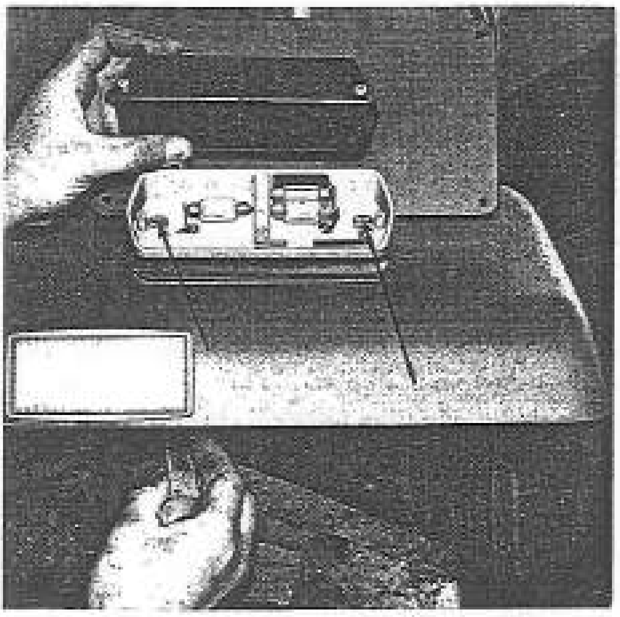


Fig. 10 — Removal of a rear light assembly

BULBS

The following table shows the characteristics (part number, quantity, location and power consumption) of the bulbs that are used in the electrical system.

Part Nr.	Quantity	Description	Watts
205-E-13007-A	2	Front light bulb. EUROPEAN type. Twin-filament:	45/40
1.830.243-M1	4	Parking light bulb. Vacuum, «Plafoniers» base.	7
1.830.244-M1	4	Direction (Turn Signal) bulb. Gas. «Plafoniers» base.	18
1.830.244-M1	2	Brake light bulb. Gas, «Plafoniers» base.	18
969.616-M1	2	Dashboard illumination bulb.	2
SP-13466	1	Working light bulb. Single filament, Bosch base, pear shaped.	35

Main electrical facility

In order to disassemble the main electrical facility, proceed as follows:

— Remove the front grille.

Disconnect:

— The battery.

— The front light unit plugs.

— The two horn wires and the ground cable.

— The regulator unit plug.

Once the front connections have been disconnected, the front cowling must be partially removed (and subsequently, the hood as well) before proceeding to disassemble the rear electrical system.

— The alternator unit plug and the ground cable (right-hand side).

— The two starter cables (right-hand side) and the gound cable.

— The cold weather heat cable (right-hand side).

— The thermistor wire (left-hand side).

— The mono-contact wire (left side).

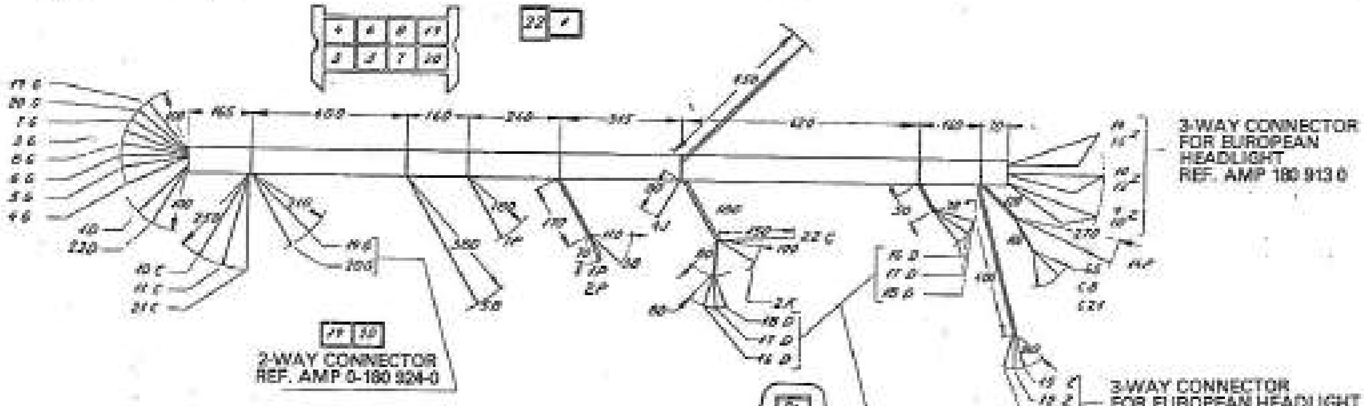
— The fuse terminals (left side).

— The rear light unit plug.

— Remove the instrument panel in order to disconnect the two plugs of the panel's instrument assembly.

— Remove the facility.

Note: Remove the elastic clamps as the wires and plugs are disconnected. When assembling the main facility, just reverse the foregoing disassembly procedure.



Circuit	Wire Color	Sheath Color	Sect.
1 Battery positive	Yellow	Brown	4
2 Alternator-starter positive	Blue	Blue	4
3 Solenoid	Pink	Pink	1.5
4 Heater	Brown	White	1.5
5 Mono-contact	Purple	Purple	0.75
6 Thermistor	Blue	White	0.75
7 Instrument panel ground	White	White	0.75
8 Button-horn ground	Grey	Grey	1
9 Right low beam	Red	Red	1.5
10 Right high beam	Green	Green	1.5
11 Left low beam	Red	Red	1
12 Left high beam	Green	Green	1
13			
14 Right headlight ground	White	White	1.5
15 Left headlight ground	White	White	1
16 D Alternator positive	Red		1
17 DF Alternator	White		1
18 D Alternator negative	Yellow		1
19 Left direction (turn signal) lights	Brown	Brown	1
20 Right direction (turn signal) lights	Yellow	Yellow	1
21 Horn positive	Red	Black	1
22 Battery charge control	Red	Red	0.75

Fig. 11 — Main electrical facility diagram

Rear light facility

In order to disassemble the rear light facility, proceed as follows:

Disconnect the following:

- The plug connecting the main facility to the rear lights facility (behind the fuse box).
- The rear light facility wires connected to the fuse box (left side).
- The wiring between the facility and the stop switch (beneath the left-hand step plate).
- The wiring in the connection box (left side).
- The wiring of the rear lights, disassembling the light assemblies.
- Disassemble the elastic clamps and remove the wires together with their casings.

In order to reassemble the rear light facility, just reverse the foregoing procedure.

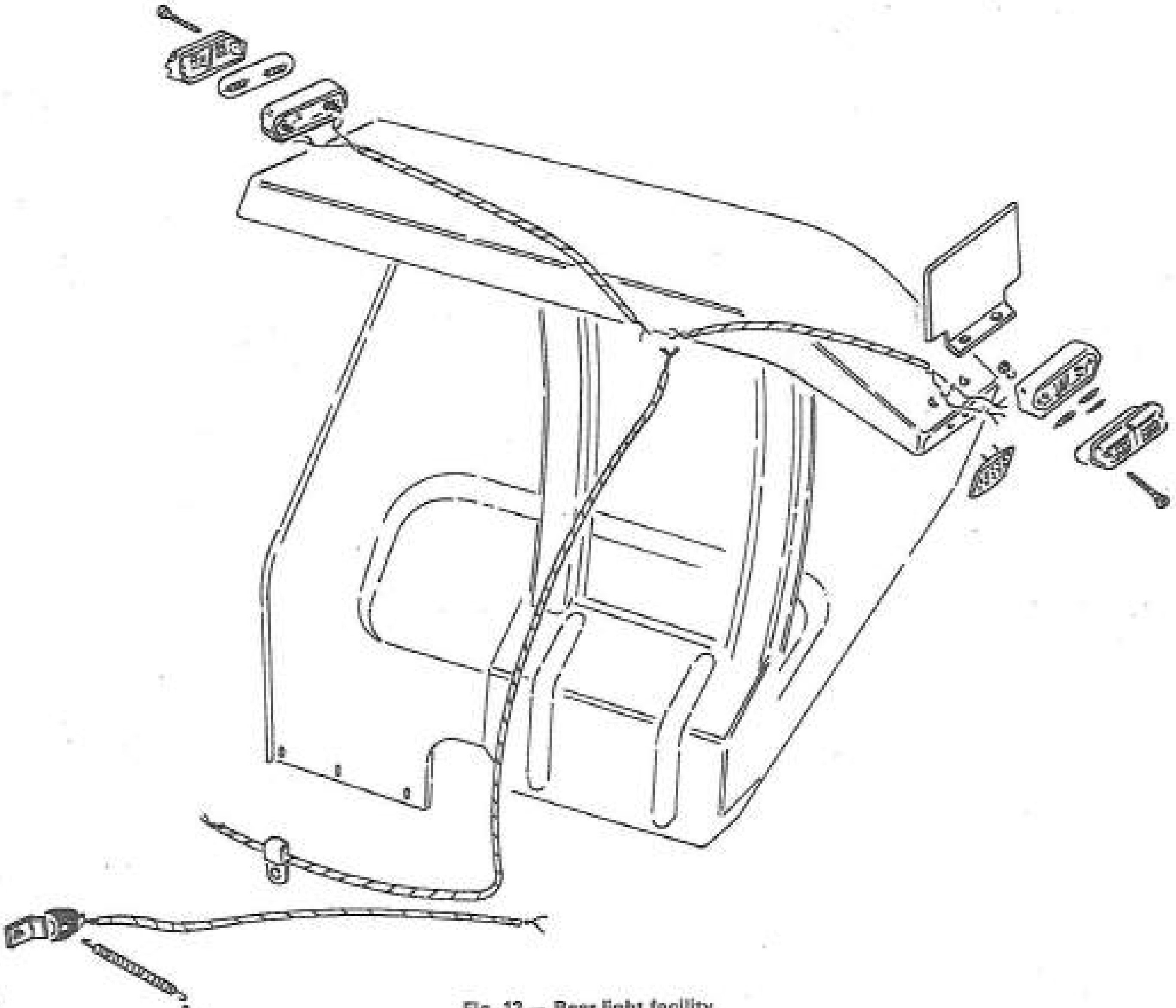


Fig. 12 — Rear light facility

Fuses

The fuse box is located on the lower left-hand side of the fuel tank. In order to gain access to the fuses, remove the cover of the box by taking out the set screw which secures it.

The fuses may be easily replaced by simply removing them from their supports. Check that both the support and the new fuse to be installed have clean contacts and that the fuse is of the same capacity.

In the event that, after replacement, a new fuse should burn out immediately, do not replace it with any object that allows a greater current capacity to pass than the one specified for the fuse, since this would result in an overload and endanger the facility.

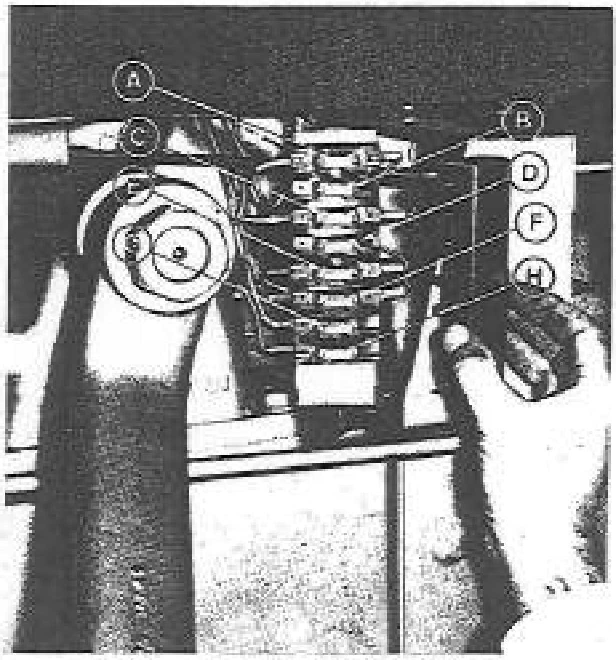


Fig. 13 — Fuse box

Identification of fuses (fig. 13)

A — Direction (turn signal) lights
B — Horn
C — Brake lights
D — Parking lights
E — Low beams
F — Reserved
G — High beams
H — Reserved

Electrical circuit and starter switch (ignition switch)

This switch, which is actuated by the ignition key, is located on the lower right-hand side of the instrument panel. Its operation is as follows: (fi. 14).

- When the key is in position (A), the electrical circuit is disconnected.
- When the key is turned to the right to point (B), the circuit is connected.
- When the key is turned further to the right, to point (C), the cold weather starting heater device is connected.
- When the key is moved still further to the right, to point (D), the starter is actuated.

In position (C) or (D), the ignition key will be returned to point (A) unless held in place by hand, tanks to a spring mechanism. The key must be held in the «connected heater» position for cold weather starting for a period of 15-20 seconds in order for this device to operate correctly. Once this time is up, the key should be turned to point (D) against the spring resistance in order to actuate the starter.

The starter stops operating as soon as the key is released. The key then returns to the initial «connected circuit» position by spring action.

Under normal weather conditions, the starter should be actuated without stopping the key at point (C), that is there should be a continuous movement of the key from point (B) to point (D).

When the operation of the switch is rough or defective, check it according to the following procedure:

- Remove the switch from the instrument panel.
- Connect the positive terminal of a battery to the BAT terminal of the switch.
- Place three high-Wattage lamps in series, connecting them to each other with the ground terminal.

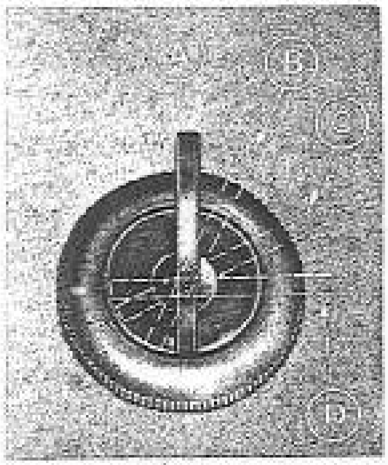
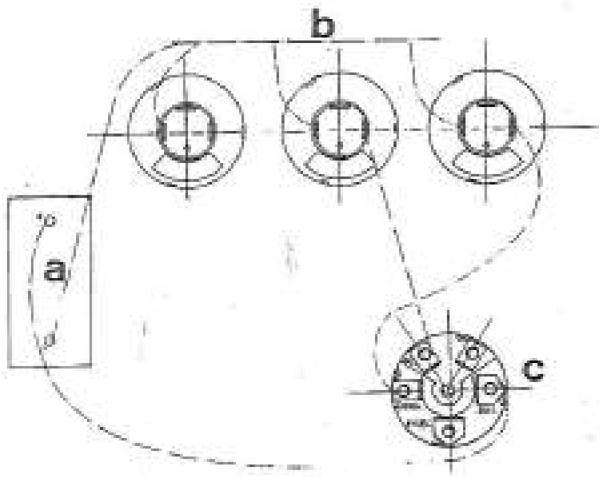


Fig. 14 — Ignition key positions



(a) BATTERY
(b) GROUND
(c) START-BAT-PREHEAT

Fig. 15 — Ignition switch check

- Connect the negative terminal of the battery to the ground of the lamps.
- Connect each of the lamps to the terminals of the switch: START, PREHEAT and ACT respectively.

According to the three positions of the key in the switch, the circuit of each lamp should be connected. If the switch does not operate correctly, replace it with a new one without handling the one that is removed (in the event a claim is to be filed). If on the other hand, the switch operates correctly, search for the cause of the trouble in some other point.

Light Switch

This switch is located in the lower right-hand side of the instrument panel and has the following four positions: (fig. 16).

— Pointer in a vertical position (B): lights off.

— Pointer to the right in position (D): parking lights and low beams.

— Pointer to the right in position (E): parking lights and high beams.

— Pointer to the left in position (A): parking lights.

The horn button (C) is located in the center of the light switch. The horn is actuated when this button is depressed.

When the switch does not operate correctly, check it according to the following procedure:

— Remove the switch from the instrument panel.

— Connect the positive terminal of a battery to the positive terminal of the switch.

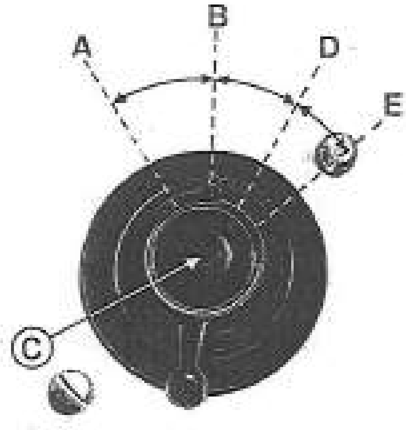


Fig. 16 — Light switch positions

— Place threee high-wattage lamps in series, connecting them to each other with the ground terminal.

— Connect the negative terminal of the battery to the ground of the lamps.

— Connect each of the lamps to terminals 56A, 56B and 58 of the switch, respectively.

Direction (Turn Signal) light switch

This switch is located in the lower left-hand part of the instrument panel, and has the following three positions:

— Pointer to the right: right direction indicator (turn signal) lights.

— Pointer to the left: left direction indicator (turn signal) lights.

— Pointer in the center: direction (turn signal) lights off.

The three positions of the switch pointer connect each of the three lamp circuits, respectively.

In order to check the operation of the horn button, proceed as follows:

— Disconnect all the wiring of the switch.

— Connect the positive terminal of the battery to terminal 30 of the switch.

— Place a wire between one of the lamps and terminal 85 of the switch.

The circuit should be connected when the horn button is depressed.

In order to check the correct operation of this switch, proceed as follows:

— Connect the positive terminal of the battery to the positive terminal of the switch.

— Place two wires between the lamps in series and terminals 58 and 58 of the switch.

The respective circuit should be connected when the switch pointer is set in each position.

Tractometer

This is a combined instrument which comprises a tachometer (rpm-counter), a speedometer and an operation-hour counter (fig. 17).

The four calibrated scales (A) on the lower part of the dial indicate tractor speed in km/hr on long runs.

The upper scale (B) indicates the rpm of the engine in hundred revolutions per minute.

The windows (C) in the middle of the dial show the total operation time in units equivalent to operation-hours at 90,000 rpm, which represents an average rating of 1,500 rpm.

If the engine is operated at over 1,500 rpm, the instrument tabulates a higher number of hours than the real time, and a lesser number in the case of operation below that rating. This value indicates the real work of the engine and is very useful in determining when to carry out maintenance operations.

When the operation of the tractometer is defective, check the following fluctuations, return or seizing of the needle and the rpm and operation-hour counter with a comparative test bench clock. To do so, proceed as follows:

- Set up a connection with the corresponding wire of the model on a test bench.

When carrying out these bench tests, remember that the tractometer has a gear ratio of 2:1, for which it will indicate twice as many revolutions as the bench engine.

- Check the fluctuations or seizing of the needle.
- Allow the needle to rise slowly up to 800 rpm, stabilize it for a few seconds, and then allow it to rise progressively to 2,000 and 2,400 rpm, respectively.
- Stabilize the needle at 1,500 rpm in order to check the operation-hour counter. Every 6 minutes the red roll gauge of the hour counter should mark a fraction until one hour is reached.

In the event in which there is no test bench available, the foregoing checks may be carried out in the following way:

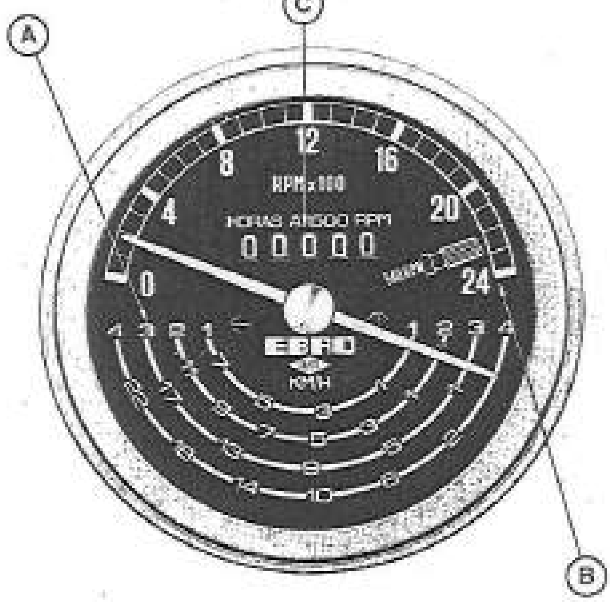


Fig. 17 — Tractometer

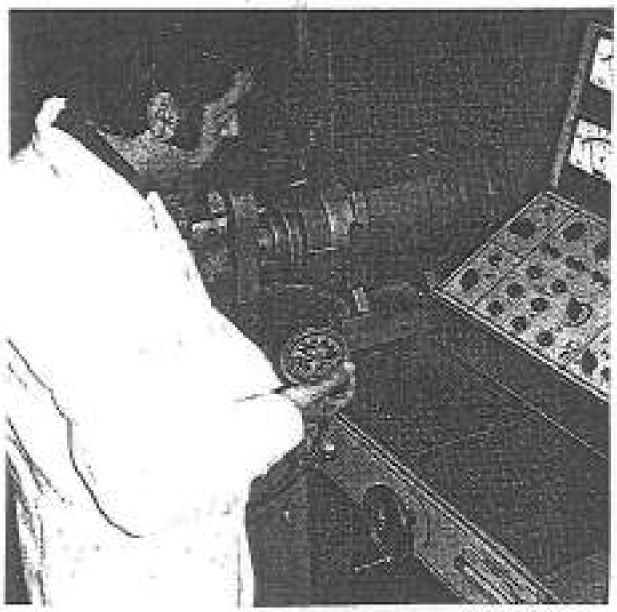


Fig. 18 — Checking tractometer rpm

- Connect the tractometer on the outside with a new wire in the housing located in the upper rear part of the cylinder block, and then carry out the engine speed tests.

If the fluctuations of the needle are quick and the same as those of the wire, the trouble is located in the wire itself or its casing.

Fuel level gauge

This gauge (fig. 19) is located in the upper right-hand part of the instrument panel and indicates the fuel tank lever. The slope of the green scale (A) which runs from upper right to lower left, marks the progressive drop in the fuel level from full to empty.

This instrument is made up of two components: the gauge on the instrument panel and the float in the fuel tank. The gauge is connected to the electric circuit and only operates when the circuit is connected.

It the gauge stops recording the fuel level or does so incorrectly, examine all of the relevant wiring connections to make sure that they are tight and clean.

— Connect a wire from the positive terminal of the battery to the red terminal of the gauge.

— Connect the negative terminal of the battery to one of the two ground terminals of the gauge.

— Make a bridge between the other ground terminal of the gauge and the ground terminal of the float.

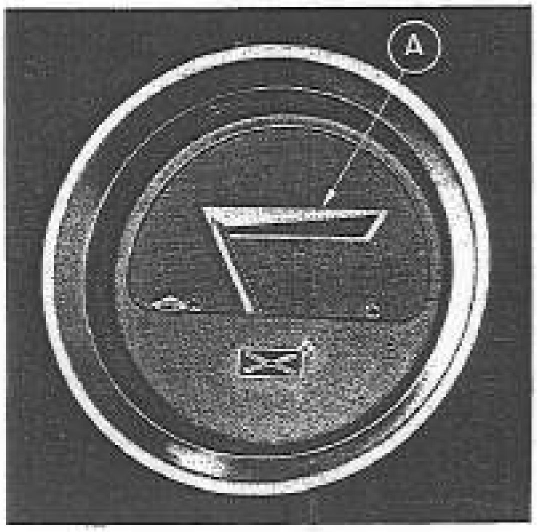


Fig. 19 — Fuel level gauge

— Make another bridge between the blue terminal of the gauge and the «Faston» terminal of the float.

Temperature gauge

This instrument (Fig. 20) indicates the cooling water temperature at the engine outlet.
When the engine reaches operating temperature after running for a few minutes, the needle should move into the green area (B) of the scale. The red area (C) indicates engine overheating.
If the fluctuations of the needle are intermittent or uneven, the trouble is located in the instrument.

Actuate the float arm all along its travel, observing the gauge to see if it is recording this change correctly. If not, carry out the following test:

— Disconnect the wire that goes to the «Faston» terminal of the float and make contact with the float ground with the tip of this wire.

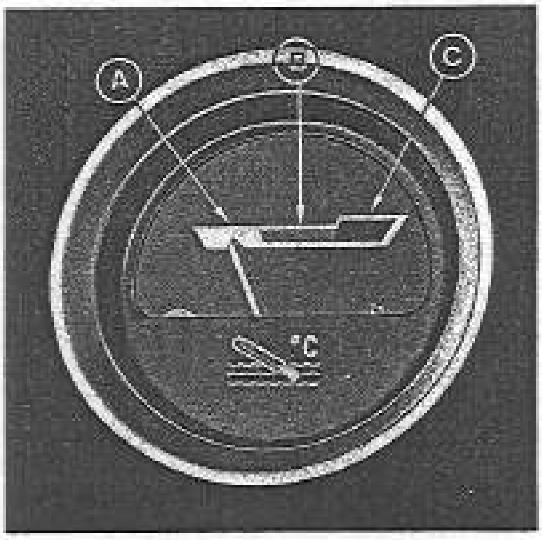


Fig. 20 — Temperature gauge

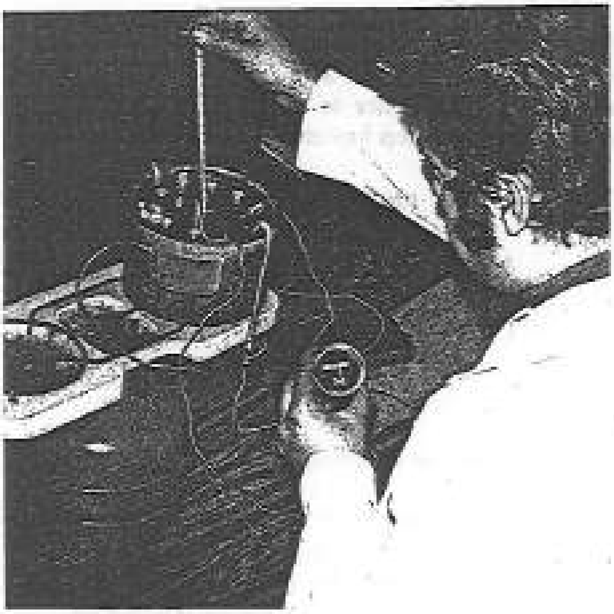


Fig. 21 — Checking the temperature gauge

The needle of the gauge should indicate the maximum when this contact is made. If not, the trouble is in the float. Do not attempt to repair these components, for they can only be replaced.
The white area (A) means that the engine is cold.
This instrument is made up of two components: the gauge on the instrument panel and the thermistor, which is located in the upper front part of the cylinder head.
The gauge is composed of two interconnected coils, one with fixed resistance and the other with variable resistance.
The current that comes from the battery through the ignition switch is divided between the two coils (the fixed one and the one with the variable resistance addition of the thermistor), to which it is connected. The needle of the gauge is connected to a revolving armature that responds to a fixed magnetic field and a variable one. In this case the gauge is calculated so that the needle indicates five different points between Cold, Normal and Danger, according to be real temperature of the coolant liquid in the front pan of the cylinder head. If the gauge does not operate correctly, examine the connections and wiring. If it continues to operate incorrectly after carrying out this inspection, perform a practical test on the gauge and thermistor. To do so, proceed as follows:

— Remove the gauge and the thermistor.

— Heat a receptacle with liquid glycerin or some other liquid with a boiling point that is higher than that of the water (fig. 21).

— Place a thermometer with capacity for indicating over 100° C in the receptacle.

— Connect the positive terminal of the battery to the positive (red) terminal of the gauge.

— Connect the thermistor terminal to the blue terminal of the indicator.

— Place the thermistor in the receptacle.

— Connect two ground wires, one to the receptacle and the other to the gauge.

When placed in the receptacle that is being heated, the gauge should begin to move out of the white area between 65° and 70° C and enter the red area at the temperature of 100° C. A tolerance of 1/4 needle should be taken into account.

Check of the ohmic value with a tester:

From 65° to 70° C equal to 470 and at 100° C equal to 145 in approximate terms. These tests are to be carried out at 13 to 13.5 V.

Stop switch

The rear light assemblies of the tractor are equipped with a brake light which acts in conjunction with the brake pedals. In order to assure their actuation, a spring-equipped stop switch has been installed.

One side of this switch is secured beneath the left step plate, while the other side, where the spring is found, is attached to the left brake control rod.

When the brake pedals are depressed, the left brake control rod stretches the spring, which connects the switch circuit, turning on the brake lights.

Low oil pressure warning light

This red light is located in the middle left part of the instrument panel and under normal operating conditions it lights up when the ignition key is turned on to start the engine. Once the engine has started, the light should go out and stay out while the engine is in operation.
Engine lubrication is correct as long as this light does not go on.

If the ignition key is turned without starting the engine, and yet the warning light does not come on, the bulb is burnt out, loose or has a disconnected wire. Change or tighten the bulb and inspect the wire.

If the warning light comes on while the engine is in operation, quickly turn off the engine. Check the oil level in the engine, and if it is correct, remove the pressure switch that is installed in the left-hand side of the cylinder block. Start up the engine and if the switch does not flow, it may be due to one of the following causes.

— Break-down of the shaft or trouble in the oil pump.

— Loose or obstructed suction pipe.
— Obstruction in the suction strainer, oil filter or lubrication ducts.

If there is an abundant flow of oil, the pressure switch is damaged and requires replacement.

Battery charge control light

This is a red light that is located in the right central part of the instrument panel and turns on when the electrical circuit is connected. The light goes out once the alternator begins to charge, that is shortly after the engine exceeds idling speed.

If the two lights do not go on at the same time when the tractor is braked, check the operation of the switch in the following way:

— Inspect the relevant fuse and determine whether there is a correct supply of current.

— Make a bridge between the two terminals of the switch.

If the switch is operating normally, the lights should go on. If not, replace the switch. Check the condition of the spring before carrying out the replacement.

If the light does not go out, this means that the battery is not receiving any charge, in which case the causes of the trouble should be sought in the alternator or regulator.

BATTERY CHARGE SYSTEM

BATTERY

Specifications

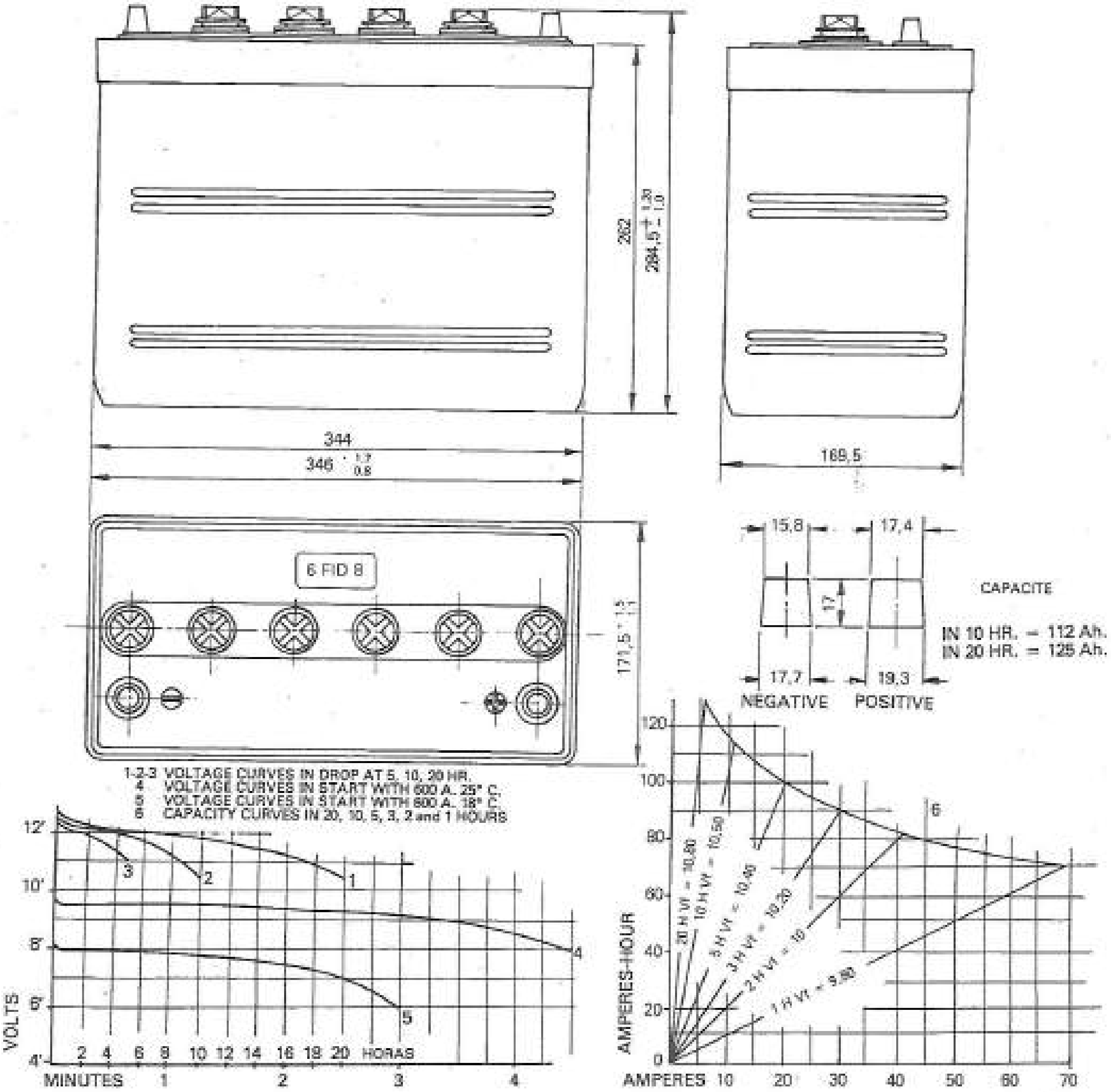


Fig. Fig. 22 — Battery characteristics diagram

Battery care, cleaning and maintenance rules

The following instructions are some practical and easy-to-follow advices for always giving the battery adequate care.

Considering the important functions which the battery has in the different components of the electrical system (start, horn, lighting, etc,), it is of prime importance to always keep it in the best possible service conditions and assure that it will have a long life.

Always keep the battery clean -

Dirt, regardless of its origin, together with moisture go to form conductive sludges that discharge the battery and corrode the metal parts in contact with them.
When installing a battery in the tractor, dry it completely first; this is especially important with regard to the positive and negative terminals. Clean these wire terminals periodically, scraping them with a file to remove the solid crust formed by corrosion.

Battery placement

Check that the battery is well secured on its support to prevent it from moving while the tractor is in operation. This is necessary in order to avoid any possible breakage of the receptacle and to prevent any false contacts from coming about and impeding the normal flow of electrical current due to loose installation.

Connect with the right polarity

When installing the battery, be careful to make a good connection or coupling between the positive (+) and negative (−) poles and the positive and negative poles of the facility. First connect the current pole (insulated wire) with the terminal, and then the gound wire (bare wire). Whenever it is necessary to remove the battery, proceed in reverse order in relation to the terminal removal process. This precaution prevents a mistake from causing a short-circuit.

A battery that is connected with the opposite polarity deteriorates quickly and irreversibly.

The life of the battery is greatly influenced by its correct installation and the care that is given to it. By following the advice and instructions presented on these pages, you will obtain a high yield from the battery in terms of both service and long life. This will be the benefit obtained from the small cares given to the battery and negligence in this maintenance will only be to the detriment of the unit.

Clean the top of the battery, removing the dust that has accumulated there and then drying the covers well if they should be soaked with fluid.

The plugs of the battery elements should always have clean breather holes to assure gas outlet. An obstruction due to dirtiness may even be so harmful as to cause an explosion that would break open the cover and the receptacle of one or more elements.

When tools are to be used over the battery, protect its top with a sheet of rubber or foam rubber which should only be removed after the job is finished.

When two batteries are installed and connected in series or in parallel, both of them must be exactly the same in terms of voltage and capacity. The wires used to join the poles of the two batteries must also be of exactly the same cross-section.

The clamps or terminals of the wires must be adjusted on the corresponding terminals of the battery and well tightened to avoid false contacts. All these components should have clean contact surfaces, for which it is advisable to have the terminals and inside cone of the terminals scraped with sandpaper or a file. The clamps should be well covered with a layer of petroleum jelly in order to prevent their corrosion which would subsequently lead to a reduction in battery yield due to the hindering of electric current supply. The wires must be of sufficiently large cross-section and be suitably flexible and long in order to avoid a tension or stress that might break the terminals of the battery.

Periodically fill with distilled water

The battery loses water, but no acid, by evaporation, decomposition and while charging. For this reason the water that is used up must be restored, more or less frequently according to the work of the battery and the temperature of the season (summer or winter). The fluid level of the battery must be checked at least once a month although, as a general rule, refills should be carried out whenever necessary in order to prevent the plates from being left exposed, which would quickly make the battery useless.

The abnormal drop in fluid level in one or more of the battery elements which makes it necessary to refill it unusually often, above all after using the tractor at full output, calls for a careful inspection. If there are no recent signs of corrosion or moisture on the support, the receptacle is probably not broken, for which the cause of this abnormal evaporation should be sought in the charge circuit.

The high charge rate of a maladjusted regulator is the most frequent cause of this problem. In such a case, quickly carry out the required adjustment of the regulator to prevent the battery from becoming useless in a short time.

It is indispensable that the fluid level in each element cover the upper edge of the separators by about 10 mm. When filling, only use distilled or deionized water. Rain water is not suitable and should not be used to fill the battery. Periodic filling with electrolyte (sulfuric acid solution) leads to excessive sulfatation of the plates and their early destruction. A common mistake is to think that low acid density is corrected and improved by refilling with acid. Low acid density in a battery in service is a sympton of discharge, for which the best remedy is to charge the battery correctly in order to raise this density.

The ground wire should be well tightened on the end that makes contact with the tractor chassis. Loose contacts impede the passage of current. This defect may be detected in light fluctuations and starting trouble.

Only in the case in which the battery is tipped over or something else happens to cause a loss of electrolyte, should a densimeter by used to measure the concentration of the fluid remaining in each well of the battery. Then prepare a solution of acid and distilled water, slowly adding the acid to the water (NEVER ADD WATER TO ACID), of the same density and use it to fill the wells, replacing the lost fluid. Under no other circumstances should the electrolyte concentration in the wells be changed, since if more acid were to be added, not only would the plates be damaged, but the readings of the densimeter would become incorrect and this means of determining the charge condition of the battery would no longer be valid.

Distilled water refills can be made at any time in the summer. This is not the case, however, in winter, since in that season of the year the battery should preferably be refilled while the tractor is in service. If winter filling is carried out while the tractor is closed up in very cold buildings or outside with only partial shelter, there is a dangerous possibility of the water freezing and bursting the battery receptacle before it has the time to mix completely with the acid.

Never use solid or liquid products (more or less «miracle-working» additives) which are purposed to have virtues and plate-regeneration or battery capacity increase properties. The only sure thing is that distilled water is not harmful and the most practical procedure is to refill the battery correctly and on time to prevent abnormal sulfating.

The fluid level can be measured with a piece of glass tubing. Insert the tube until it touches the separators, then cover the outside end with your finger and take the tube out to check.

Check the density

Check the acid density of the battery at least once a month. It should be within a range of 1.28 ± 0.01 at an ambient temperature of approximately 25° C. A density that exceeds the maximum specified value, in the case in which the electrolyte level in the wells is correct, may be due to the previous addition of acid on some occasion instead of distilled water. In order to correct the density, charge up the battery and then empty the fluid from the wells. After that, fill the wells with electrolyte having the correct density.

High density may also be due to systematic overloading caused by poor adjustment of the regulator. The electrolyte level is usually low in such cases.

Density values that are repeatedly below 1.28 may be due to the addition of water in the wake of a loss of acid in the wells. It may also be due to a systematic charge deficiency caused by using the tractor only at low rpm or because of regulator misadjustments.

The results of density checks will be inaccurate if the check is carried out immediately after filling the battery with distilled water. The water must first be allowed to mix with the acid, for which the battery should be subjected to a charge period lasting approximately two hours.

The density of each of the elements of a battery are not often identical, even when it is in perfect condition. Small differences are not important as long as they do not exceed 0.01. For example, densities of 1.275, 1.280 and 1.285 are considered to be normal were they to be found at the same time in three different cells of the battery, since the differences lie within the tolerable limits.

Charge the battery correctly

The alternator should charge only as much as necessary to compensate discharge. Overloads are as harmful to the battery as excessive discharges.

The ideal alternator charge rate is the one that normally allows the electrolyte density to remain within the limits of 1.28 ± 0.01 at an ambient temperature of approximately 25° C. Given the great importance of balancing the battery charge and discharge according to the service of each tractor, give maximum attention to correcting, when necessary, the charge rate of the alternator and to adjusting the regulator.

In any case, if the charge rate of the alternator, because of some irregular service, does not compensate the power consumed by the starter, headlights, horn, etc., it will be necessary to charge the battery outside of the tractor, as long as the electrolyte density is less than 1.18 e.p. and before it drops to the limit of 1.12 e.p. which is the point of total discharge.

Fig. 22 b — Checking the electrolyte density

The acid density lowers in proportion to battery discharge. With densities of 1.12 to 1.15 e.p., the battery is considered to be completely discharged. This situation whose causes are explained in the following section, must be avoided. Check to see if the alternator and the regulator are operating correctly in case they do not maintain an adequate charge rate.

If the battery is completely discharged during the cold season, there is a danger of the electrolyte freezing and bursting the receptacle.

Overloading should be checked when the electrolyte density is habitually over 1.28 + 0.01 and there is excessive fluid evaporation, making it necessary to keep up the level with unusually frequent refills of distilled water.

The foregoing care is especially important if the tractor is operated only a few days each month, carrying out short jobs with frequent stops.

If the battery is not given supplementary charges outside of or disconnected from the tractor, it will become totally discharged and ruined in a short time.

Winter care

At colder times and places in winter, tractors increase their current consumption. On one hand, the engine requires more power for starting because of the higher resistance entailed by the increased density of the engine and gearbox oil. This increased current consumption is also brought about by the headlights, which need to be on for longer periods of time because of the reduction in the number of thours of light per day.

Store the battery when not in use

If the tractor is not to be used for two or three months, the battery must be stored away. If it is simply left unattended, it will deteriorate until it is ruined. This is because the battery loses capacity by self-discharge which constitutes a progressive loss that is more pronounced the greater the duration of the period of idleness. This self-discharge leads to the abnormal sulfating of the plates, bringing about their destruction.

Just as has been previously mentioned, this problem can be solved by carrying out an inspection on the electrical equipment. The opposite case, that is when an increase in the charge rate is called for, denotes low electrolyte density, which is always below 1.28 ± 0.01.

Do not habitually resort to the so-called «quick-charging» apparatus or procedures since they are always harmful for the battery. The more often this charge system is used, the quicker the battery will be ruined.

On the other hand, since the capacity of the battery is reduced at low temperatures, it is much more difficult for the alternator to produce enough current to keep it charged, since the tractor jobs are usually shorter than during other seasons of the year. For these reasons, the battery must be more carefully checked in the winter and charged outside the tractor as after as necessary to keep it in perfect condition.

The remedy for these drawbacks lies in periodically charging the battery. It should be charged at least once a month with the normal rating, and always previously filled with distilled water, if necessary. The duration of these charges will vary, depending on the charge condition of the battery and will generally fluctuate between 4 and 12 hours. The charge should not be concluded until the electrolyte density reaches 1.28 ± 0.01.

ALTERNATOR

Specifications

Type of alternator	G1 (R) BOSCH
Rated voltage	14 V.
Maximum current	28 A.
Polarity	Negative ground.
Rectification	By 6 diodes.
Power tests	
Maximum charge current	10 A. from 1,500 rpm 18 A. from 2,200 rpm 28 A. from 7,000 rpm
Resistance values (short circuit tests between loops)	
Stator	0.4 + 10% (between phase outlets).
Rotor	4.0 + 10%.
Test voltages (short circuit to ground)	
Stator	40 V (approx.).
Rotor	40 V. (approx.).
Friction rings	
Setting	3.7 ± 0.1 mm.
Outside machining length	20 mm.
Maximum eccentricity	0.03 mm.
Minimum diameter	26.8 mm.
Brushes	
Maximum length	10 mm.
Minimum length	5 mm.
Torque values	
Cylindrical head screws	35 — 55 kg. cm.
Pulley lock nut	3.5 — 4.5 kg. m.
Bearing lubricant	
Molykote grease	Type Ft 70 v. 1.

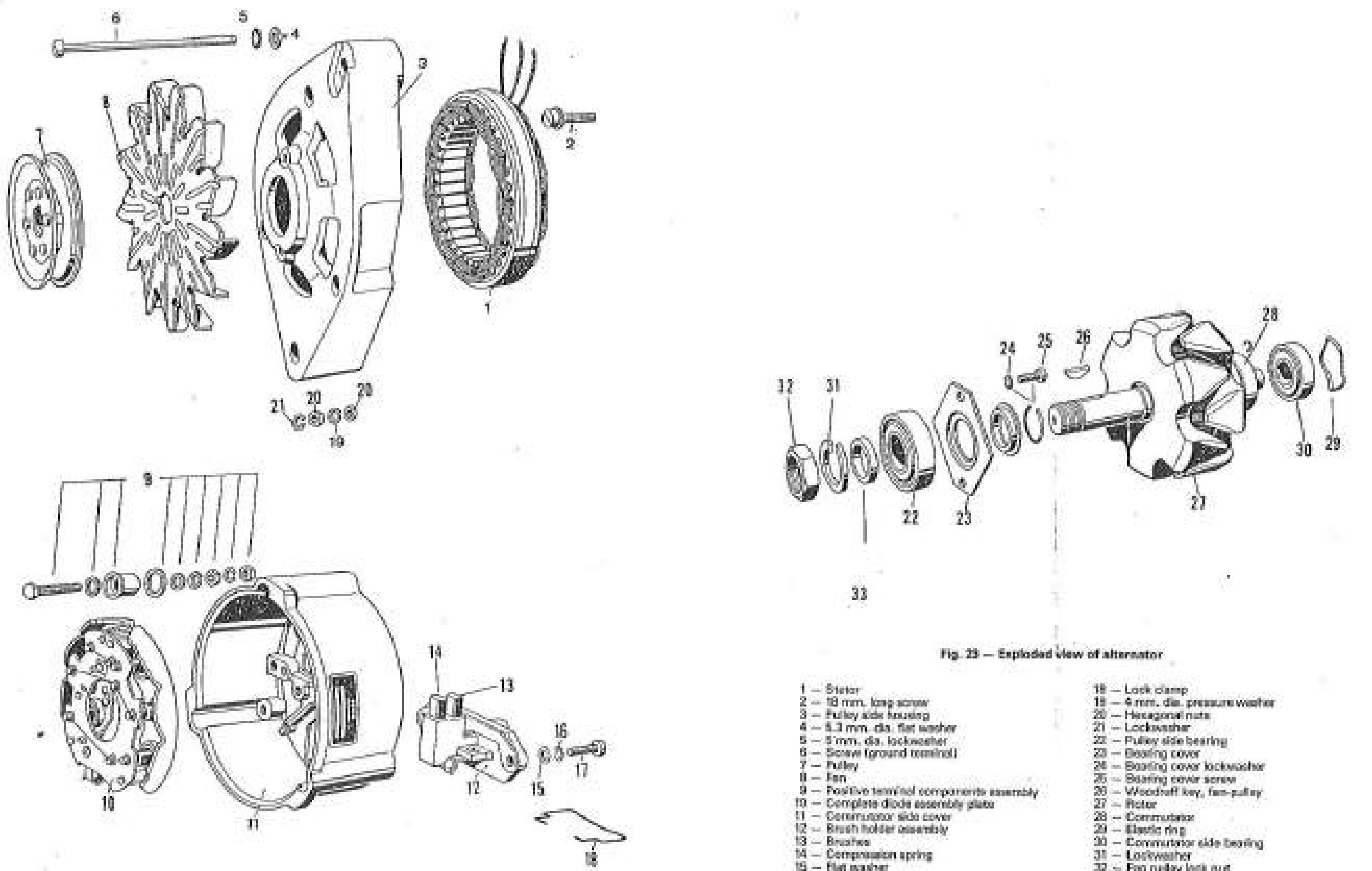


Fig. 23 — Exploded view of alternator

1 — Stator
2 — 18 mm. long screw
3 — Pulley side housing
4 — 5.3 mm. dia. flat washer
5 — 5 mm. dia. lockwasher
6 — Screw (ground terminal)
7 — Pulley
8 — Fan
9 — Positive terminal components assembly
10 — Complete diode assembly plate
11 — Commutator side cover
12 — Brush holder assembly
13 — Brushes
14 — Compression spring
15 — Flat washer
16 — 4 mm. dia lockwasher
17 — M x 18 screw
18 — Lock clamp
19 — 4 mm. dia. pressure washer
20 — Hexagonal nuts
21 — Lockwasher
22 — Pulley side bearing
23 — Bearing cover
24 — Bearing cover lockwasher
25 — Bearing cover screw
26 — Woodruff key, fan-pulley
27 — Rotor
28 — Commutator
29 — Elastic ring
30 — Commutator side bearing
31 — Lockwasher
32 — Fan pulley lock nut
33 — Spacer

General

The alternator comprises the following components:

- Two supports housing the rotor shaft by means of bearings. The stator is located between these two supports. One of these supports locates the brush holders which ensure the electrical connection to the induction coil or to the stator. It also houses the hexa-diodes and the alternator terminals.

  The other end support lets the rotor shaft through to fit the drive pulley.

- The stator is made up of a series of steel plates cut into circular crown shape. Slots in the crown inner diameter house the stator coils.
- The spring inducer or rotor is made up of a single coil fitted between the two commutators. The coil is fed through the slip rings and the coil ends are soldered to them. All components are mounted on one shaft thus built into a rugged unit to overcome the centrifugal force.

Operation

The rotor coil is fed through the brushes and slip rings so producing a magnetic field within the rotor. Due to the lay out of commutators the rotor break-in device presents a series of North and South poles.

When the alternator is in operation the rotor faces these magnetic poles against the stator teeth thus creating induced alternate current.

The current generated is of the three-phase type due to the lay out and connections of the inducers.

The alternator is self-fed, that is to say that the inducer coil uses part of the current generated.

The tractor contact key switches off the battery-inducer coil circuit through the regulator which means that the alternator will start to generate current just as the engine has started.

Operation of the rectifier assembly

The rectifier assembly is basically made up of silicon diodes. These components offer a high resistance to the passage of current in one direction while no resistançe is opposed when the current flows in the opposite direction.

Its operation can be compared to a valve which opens when the flow goes in one direction but blocks the passage in the opposite direction.

The diodes are classified as listed below as per the diode end tip contacting the metal casing in which it is contained and which holds it onto the rectifier support.

a) cathode base
b) anode base

These names also apply to the direction in which the current is let through.

Rectifier assembly for three-phase alternators

Three-phase alternators are fitted with six diodes to rectify the three phases in «full wave» that is to say that each diode rectifies half a wave, the pair covering the full wave, the negative and the positive halves. This provides a constant flow of current pulses.

Fig. 24 shows the diode connections. Straight line arrows show the path covered by one phase during the positive half-wave and the dotted line arrows show the path covered during the negative half-wave.

Fig. 25 shows the rectified wave. The continuous line curves show the positive half-waves and the dotted line curves show the negative half waves. The thicker line shows the rectified current waves.

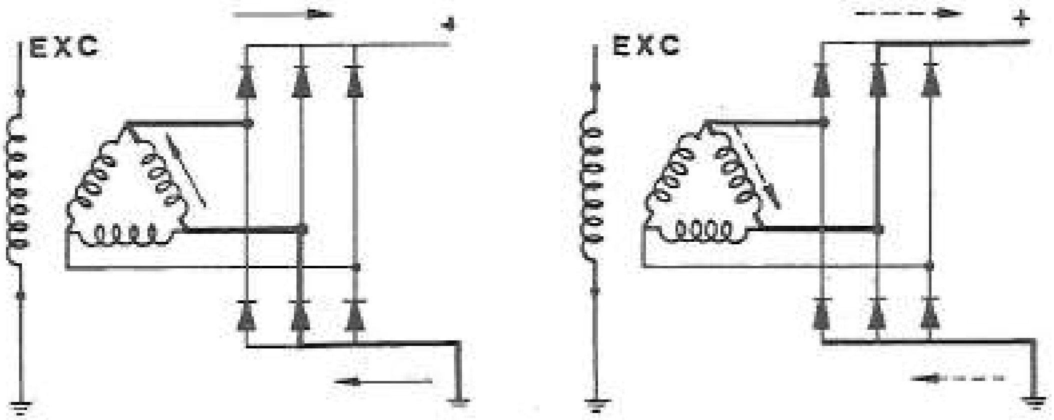


Fig. 24 — Diode connection

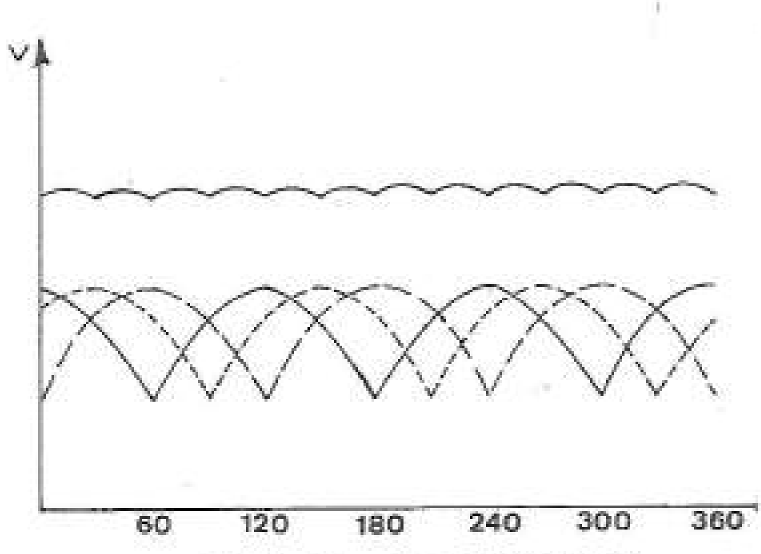


Fig. 25 — Three-phase alternator voltage

Alternator drive system

The drive system used in the alternator is as follows:

By V-belt. To assure the correct drive of the alternator, the use of belts with the following characteristics is indispensable: Neoprene rubber belt with polyester fiber. The maximum deflection of the belt is 10 mm.

Precautions

In tractors that are equipped with an alternator, a series of precautions must be kept in mind which, if not heeded, may lead to irreparable damage in the alternator or regulator.

— Check the polarity of the battery before connecting it to the tractor. If the terminals of the battery are reserved, the rectified diodes may be damaged.

— In the event in which an auxiliary battery is used to start the tractor, take the precaution of correctly connecting the cables of the auxiliary battery to the terminals of the tractor battery in this: positive terminal to positive terminal and negative terminal to negative terminal.

— When a charger is used, check the correct connection of its terminals to those of the battery. In such cases disconnect the battery from the rest of the tractor circuit.

— Prevent short-circuits from coming about between the diode holder plates or between the positive «Ex» and ground terminals in the alternator.

— The alternator should not be operated without load or with the circuit disconnected. Also avoid disconnecting the battery or regulator while the alternator is turning.

Periodic maintenance

The alternator does not practically require any periodic maintenance. However, it is advisable to follow certain maintenance rules in order to assure the maximum life of the apparatus.

— The regulator should always be connected to the alternator. Whenever possible, directly connect the positive terminals, and connect the ground of both apparatus in the same way.

— Never supply the alternator directly with battery voltage. If it should prove necessary to do so, first connect a 3 — 4 W bulb with suitable voltage (12 V) in series between the battery terminal and the alternator excitation terminal.

— When removing the alternator, first disconnect the battery.

— Provide means of insulation and never use testers with built-in generator.

— In ground bridging tests, place a resistor in series that limits the current to approximately 0.05 A.

— When spot or arc welding jobs are carried out on the tractor, first disconnect the alternator.

— The charge indicator light found in the tractor should never be short-circuited, even if another contol component should be installed.

The maintenance rules and schedule for the alternator are set forth in the relevant chapter of this manual. The maintenance periods mentioned there are merely for illustrative purposes and will actually depend on the service of each tractor.

Checking operation of alternator mounted on tractor

In order to check the operation of the alternator while it is mounted on the tractor, proceed as follows:

— Check the charge condition of the battery.

— Place voltmeter with an adequate scale between the positive and negative terminals of the alternator. In the case in which there is ground return, place the boltmeter between the insulated terminal and the ground being careful with the polarity.

— Connect an ammeter with an adequate scale in the connection joining the alternator with the battery, and bear in mind the polarity of the metering apparatus.

— Actuate the ignition key without starting the tractor engine. The ammeter needle should indicate discharge. Should it remain stationary on the zero point of the scale, the aparatus is not operating correctly.

— Disconnect all of the tractor's accessories.

— Start the engine and let it idle. In the case in which the ammeter should indicate discharge with the engine idling, accelerate a little until the ammeter indicates a charge.

— Slowly raise the engine speed and check that the needle of the voltmeter remains fairly still, indicating the regulator is operating correctly. If it is found that the voltmeter reading increases with the speed of the alternator, immediately stop, since this is a sign that the regulator is operating incorrectly.

— **Do not accelerate the engine until the correct operation of the regulator has been checked.**

— Stop the engine and discharge the battery a little, turning on the tractor lights for approximately five minutes. Accelerate the engine and check that the alternator is charging the battery. The current supply value should be the one set forth in the relevant specifications.

Checking operation of alternator on the test bench

Before carrying out the alternator tests on the test bench, the following precautions should be observed:

— The conductors connecting the alternator and the regulator, or the test bench, must have well-made connections. Do not set up temporary type connections, since the release of a conductor from one of them during the test would lead to voltage peaks in the alternator which could damage the diodes.

— Do not operate the alternator with the battery disconnected. Do not take off the terminal connections of the battery until the alternator has stopped.

— In order to check the diodes, use direct current of 24 V. maximum voltage. Higher voltages than this will damage the diodes.

— The check of the insulation and grounding of the windings with higher voltages may be carried out if the diodes are first disconnected before testing.

— When the alternator is in operation, do not release the battery cable since this might lead to deterioration of the diodes as a result of the voltage peaks that would be produced.

In order to carry out the test bench tests on the alternator, proceed as follows:

— Secure the alternator on the test bench.

— Set up the connections between the alternator and the regulator.

In facilities with «Bendix» plugs, an adequate plug connection must be used.

- Connect the positive cable of the bench battery with terminal B + of the alternator.
- Connect the ammeter for supply to cable «DF» between the alternator and the regulator, being careful that the connection cannot come loose during the testing process.

For pre-excitation, connect a 2.0 W control bulb (charge indicator) between terminal B + (the test bench battery terminal) and terminal D +/61 of the alternator.

Power test

- Connect the battery.
- Connect the charge resistor.
- Adjust the rotation speed to the specified value and simultaneously increase the charge until it reaches the value set forth in the specifications, as a minimum.

If the values indicated in the specifications are not attained in the power test, or if the control bulb flashes or lights up, there may possibly be trouble with the alternator, assuming that the connections and the regulator are in perfect conditions.

The alternator trouble can later be determined with the help of a BOSCH alternator tester model AW 192. When doing so, release the drive-side bearing set screws in order to gain access to the commutator points and proceed as indicated in the chapter entitled «Disassembly and Assembly of the Alternator and Check of its Components».

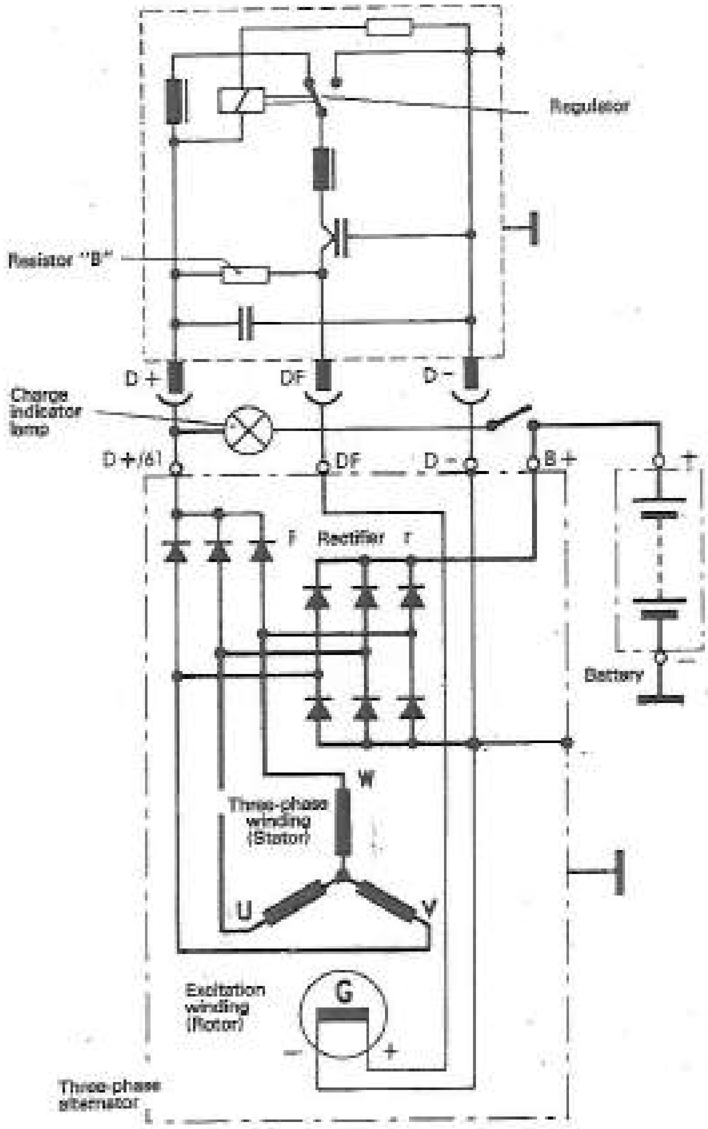


Fig. 28 — Alternator-regulator diagram

DISASSEMBLY OF THE ALTERNATOR AND CHECK OF ITS COMPONENTS

In order to disassemble the alternator and check its components, proceed as follows:

— Block the pulley with a suitable tool and loosen the lock nut with a star wrench (fig. 27).

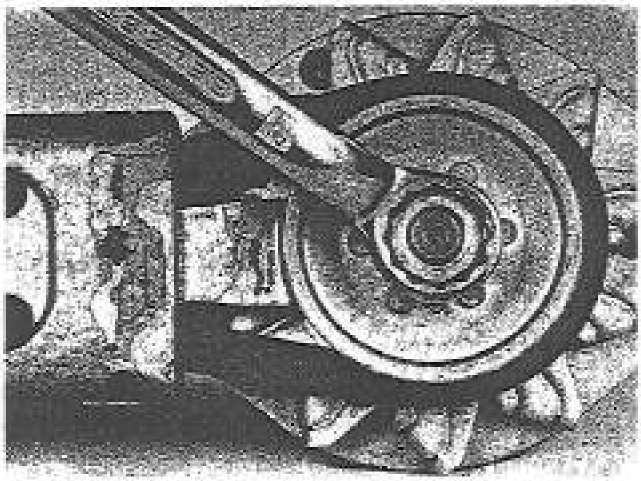


Fig. 27 — Disassembly of the pulley

Disassemble the brush holder plate, loosening the set screws very carefully (fig. 28).

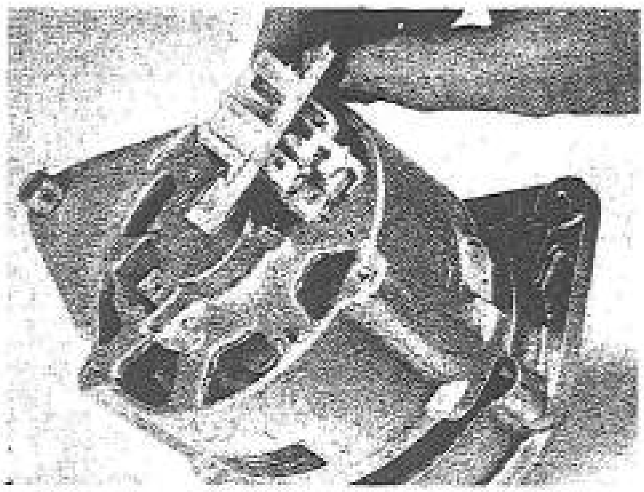


Fig. 28 — Removal of the brush holder plate

— Mark the position of the stator drive side support and the friction ring side support (fig. 29). These marks should match up when reassembling the apparatus.

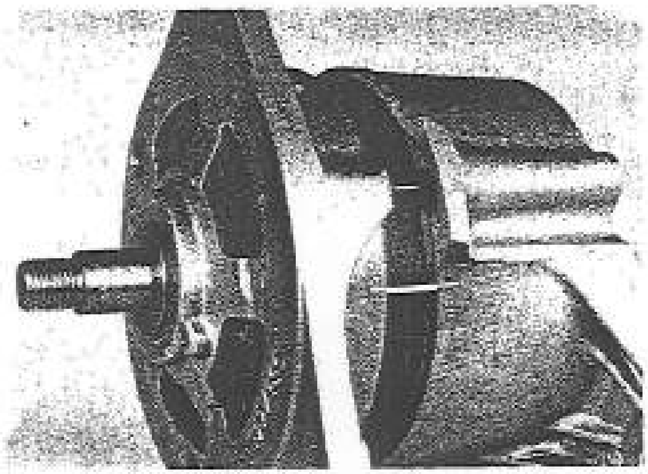


Fig. 29 — Marking the parts

— Loosen the set screws in the drive side support. Carefully remove the stator and the friction ring side support (fig. 30), and the rotor together with the drive side support.

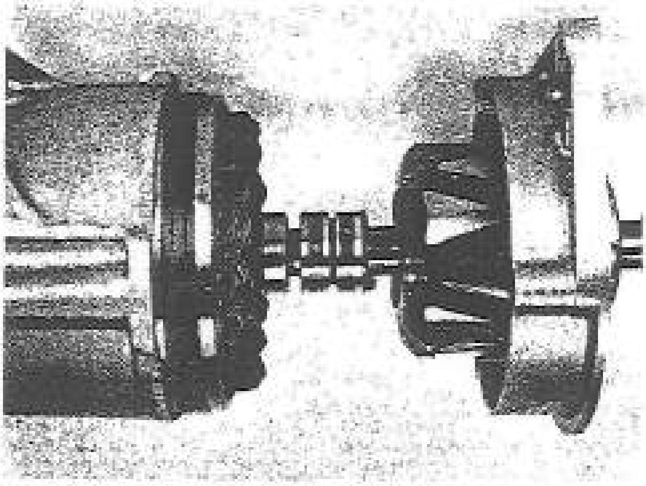


Fig. 30 — Disassembly of the alternator

Checking the diodes

In order to check the diodes with the help of the BOSCH alternator tester model AW 192, proceed as follows:

— Place the metering selector in the position indicated in fig. 31. If the diodes are in good condition, the needle will move indistinctly to the left or right within the green area.

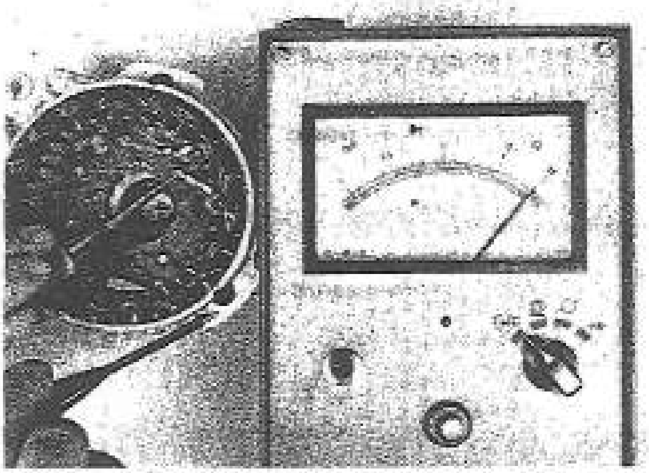


Fig. 31 — Checking the mounted diodes

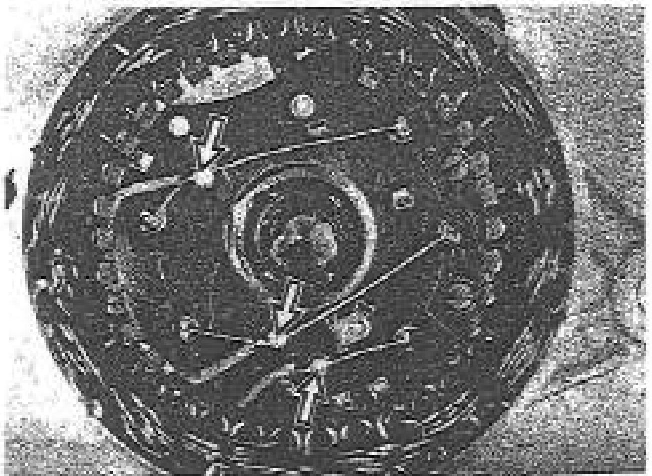


Fig. 32 — Separate check of the diodes once the stator winding connections have been unsoldered

Positive diodes

— Apply the test point to the cooling element of the positive diodes or to the B + plug tab and to the commutator points.

Negative diodes

— Apply the test points to the cooling element of the negative diodes or else to the friction ring support side and to the commutator points.

— Apply the test points to the contact bar and to the commutator points.

In order to separately check the diodes when they have been disassembled, the stator winding must be unsoldered.

— Release the stator winding connections with a soldering iron as indicated by the arrow in fig. 32.

— Take the precaution of bending the phase outlets as little as possible.

— Then remove the stator from the friction ring support and check the diodes separately after having cleaned them with a suitable liquid.

If any diode is found to be defective when carrying out these tests, the whole diode plate must be replaced.

Power diodes

— Place the metering selector of the tester in the position that is indicated in Fig. 33 and apply the testing points to the cooling element and to the commutator points.

The needle will indicate the passage direction, moving to the left within the green area. The blocking direction should show a maximum value of 0.8 mA.

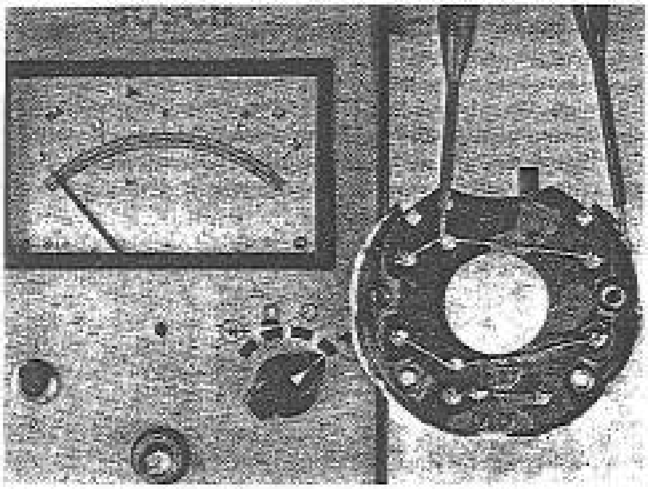


Fig. 33 – Checking the passage direction of the power diodes

– When checking the blocking direction of the power diodes, place the metering selector in the position indicated in fig. 34. Apply the testing points to the cooling element and to the commutator points.

The needle should move indistinctly to the left or the right within the green area of the tester.

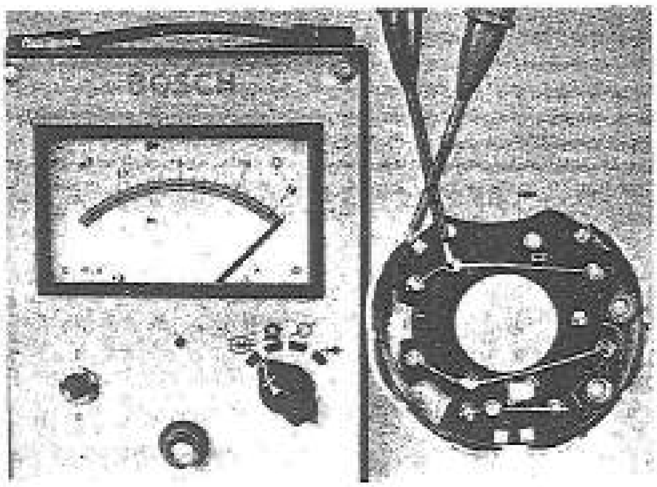


Fig. 34 – Checking the blocking direction of the power diodes

Excitation diodes

– Move the metering selector to the position indicated in fig. 35 and apply the testing points to the contact bar and to the commutator points.

The needle of the tester will indicate the passage direction, moving to the left within the green area.

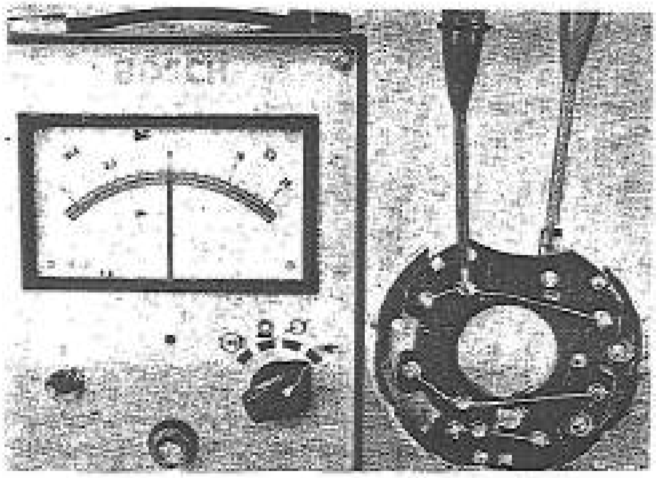


Fig. 35 – Checking the passage direction in the excitation diodes

– When checking the blocking direction, turn the tester selector to the left until it is located according to fig. 6. Apply the testing points to the contact bars and to the commutator points.

The indicator needle of the tester will move to the left or right, indistinctly, within the green area and its maximum value will be 0.8 mA.

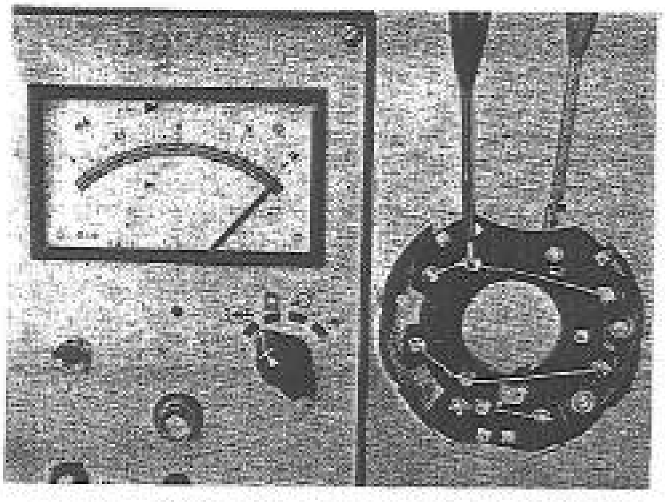


Fig. 36 – Checking the blocking direction of the excitation diodes

— Remove the rotor drive side support using a press with a suitable seat base as indicated in fig. 37.

While carrying out this operation, take the precaution of securing the rotor so that it does not fall and get damaged.

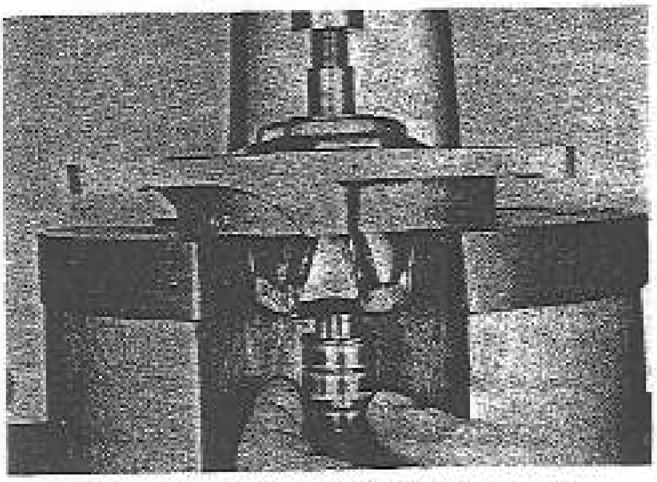


Fig. 37 — Disassembly of the drive side support

— Next remove the ball bearing with a suitable tool as indicated in fig. 38.

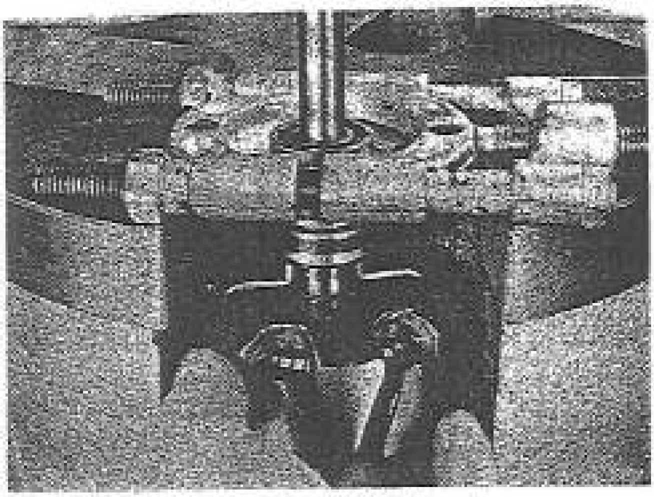


Fig. 38 — Removing the ball bearing

— Then remove the friction ring side ball bearing, which is inserted by pressure. To do so, use a press with a suitable base and a tool as indicated in fig. 38.

Any ball bearing that is disassembled must be replaced with a new one.

Checking the rotor

Two electrical checks should be carried out on the rotor:

a) Ground short-circuit.
b) Short-circuit between loops.

— In order to carry out the first mentioned check, install the rotor on an insulated spot on the test bench; take the testing points and place of of them on any metal part of the rotor. The other testing point should be placed on the surface of the friction rings (one each time) (fig. 39), while the control bulb connected in series with the testing points is observed.

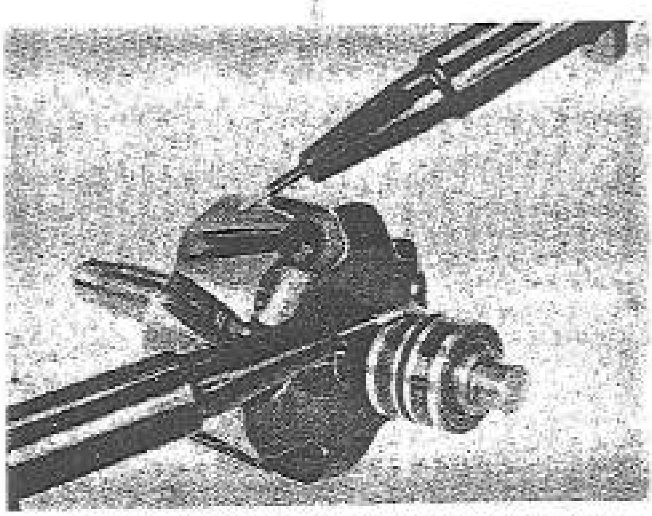


Fig. 39 — Checking ground short circuit of the rotor

The control bulb should not light up during this check.

A voltage of approximately 40 V. should be applied during this test.

— Use an ohmmeter to carry out the second test. Measure the resistance of the excitation winding in the rotor of interleaved poles, applying the testing points to both friction rings as indicated in fig. 40.

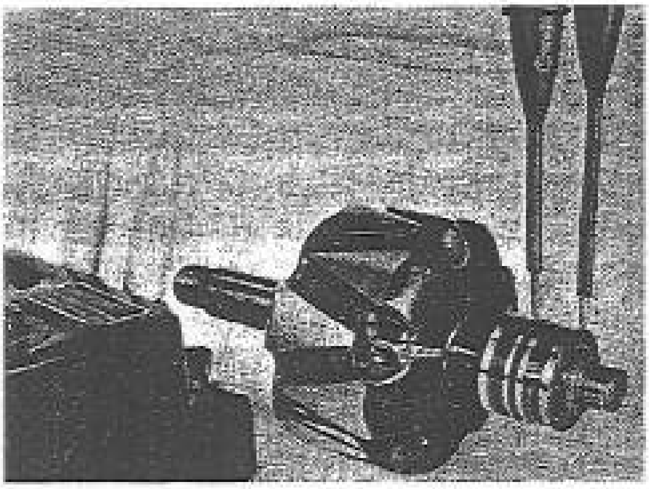


Fig. 40 — Checking short-circuit between rotor loops

The resistance value that should appear in the ohmmeter is 4.0 + 10%.

Checking the stator

The same as with the rotor, two tests should be carried out on the stator: the ground short-circuit one and the short-circuit between loops test.

— In order to control the ground short-circuit, use the testing points with a bulb connected in series, put one of the points on any metal part of the stator, and apply the other point successively to the winding outlet terminals (fig. 41).

The test lamp should not light up during this test. Apply a voltage of approximately 40 V. to the windings.

— For the second test, use an ohmmeter and measure the resistance of the stator windings between the outlets of the three phases (fig. 42).

The resistance value that should appear in the ohmmeter is 0.4 ohms + 10% between phases.

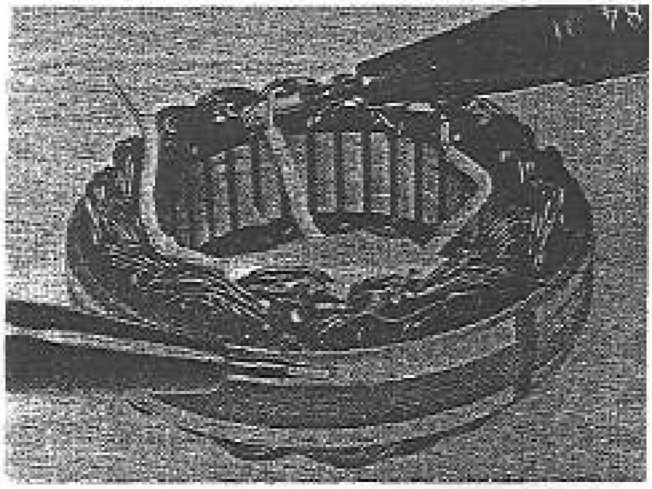


Fig. 41 — Checking stator ground short-circuit

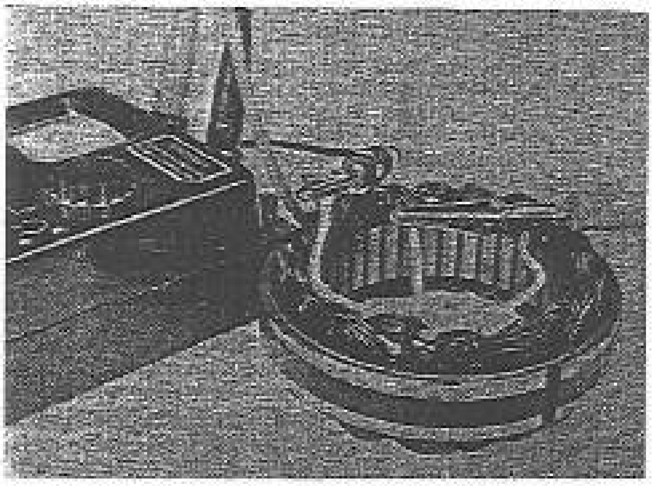


Fig 42 — Checking stator short-circuit between loops

Repair or replacement of the friction rings of the alternator

— Secure the rotor on a support with a surface composed of two inclined planes to prevent it from turning. Unweld the two winding ends from the friction ring with a soldering iron, also using needle-nosed pliers to help out with (fig. 43).

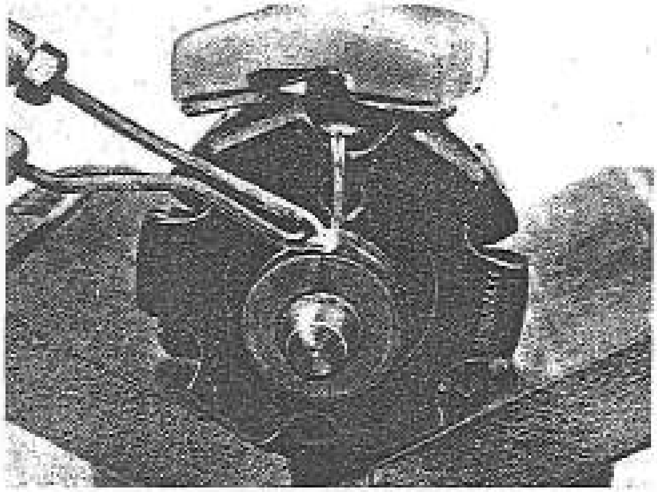


Fig. 43 — Applying the soldering iron to the friction ring

— Remove the friction ring from the rotor shaft with the help of a twin-prong extractor, just as can be seen in fig. 44.

Be very careful about removing the friction ring in such a way that there is no damage done to the contact point where the extractor prongs exert a pressure.

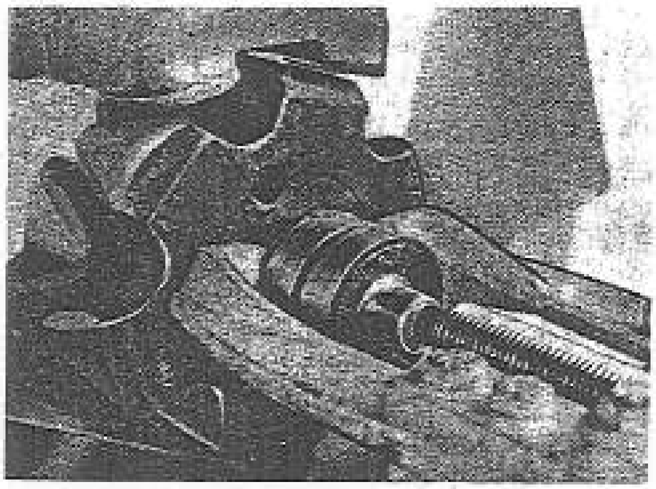


Fig. 44 — Removal of the friction ring with an extractor

— Install a new friction ring on the rotor shaft, matching up the closed grooves with the ends of the winds as can be seen in fig. 45.

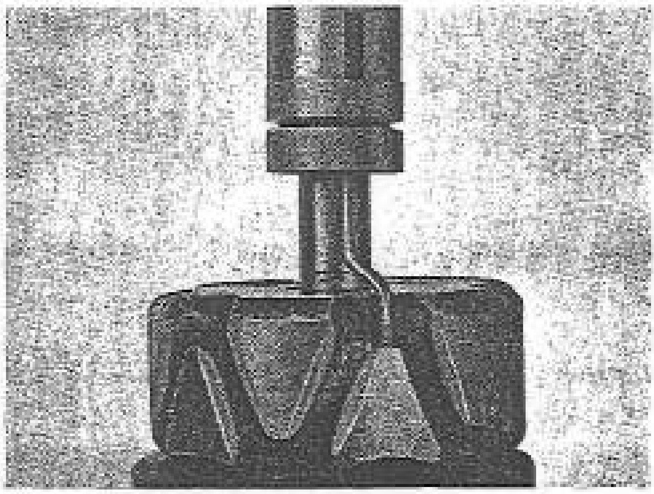


Fig. 45 — Inserting the friction ring on the rotor shaft

— Insert the long end of the winding a little on the friction ring.

Install a grooved shaft on the friction ring so that the groove matches up with the point in which the connection wire is located when pressing on the friction rings.

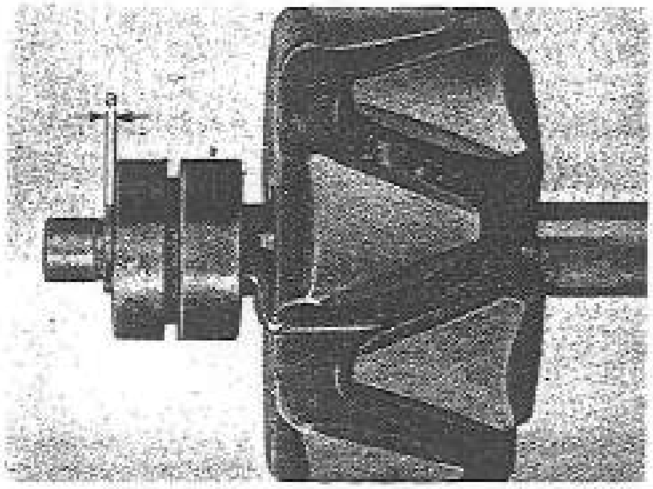


Fig. 46 — Setting point of the friction rings

— Next press on the friction rings until they stop on the shaft projection.

As shown in fig. 46, check the setting point «A», whose length is 3.7 — 0.1 mm.

– Secure the ends of the winding in the two slots of the friction ring and solder them (fig. 47). The insulating cover over both ends of the windings should not be damaged or worn in any way, since such deterioration might lead to ground short-circuits.

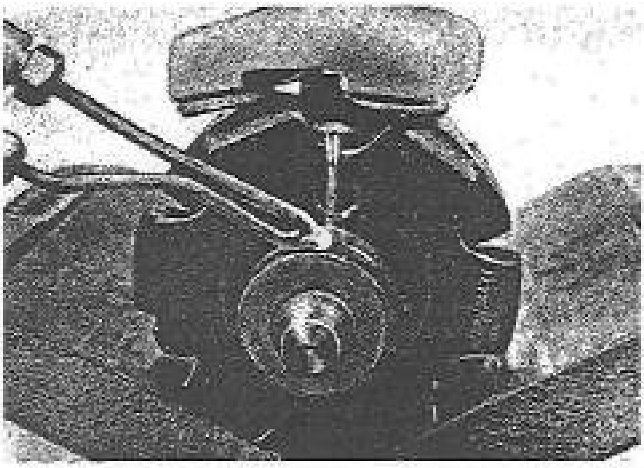


Fig. 47 – Soldering the ends of the windings to the friction rings

– Once the ends of the winds have been soldered, the friction rings must be turned on the outside for a length of 20 mm (fig. 48). In order to do this, use a hard metal blade or a diamond blade.

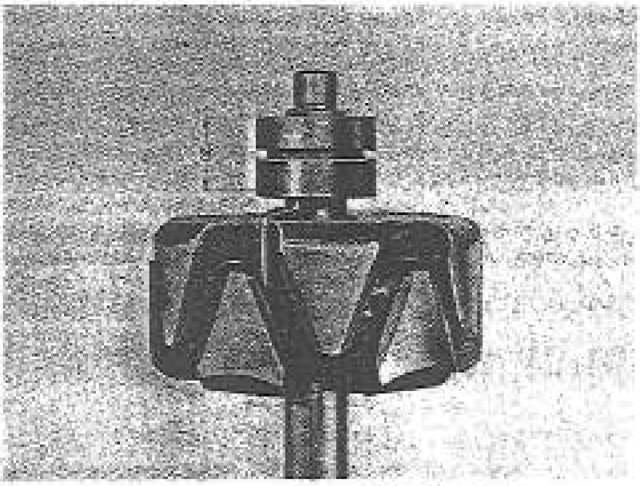


Fig. 48 – Outside turning of the friction rings

– Next install the rotor on two «V» supports (fig. 49) in order to check the concentricity of the friction rings and the rotor.

– The maximum admissible eccentricity for the friction rings is 0.3 mm. and for the rotor, it is 0,5 mm.

The minimum admissible diameter of the friction rings is 26.8 mm.

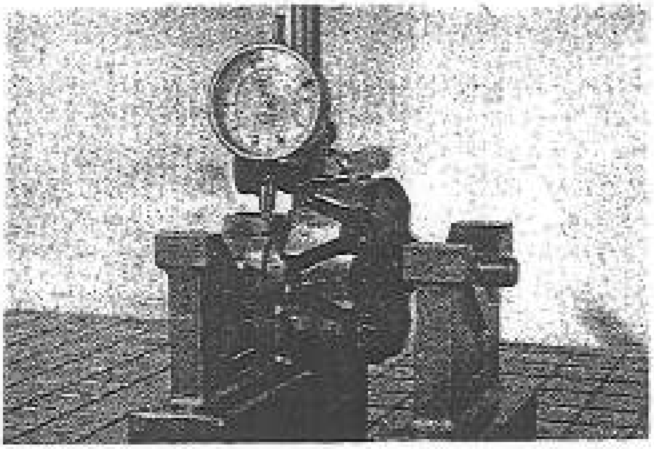


Fig. 49 – Checking the eccentrity of the friction rings

Assembly of the ball bearings

– Press the ball bearing onto the friction ring side rotor with the help of a press.

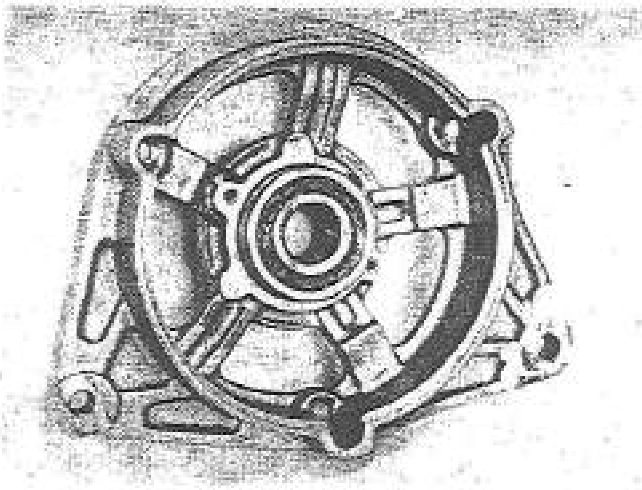


Fig. 50 – Press-on assembly of the drive side support ball bearing

— Assemble the ball bearing of the drive side support (fig. 50), after first lubricating it with grease. Press to insert with the closed side facing down and then screwing onthe lock plate.

Note: In some cases the lock plate is secured with through bolts, in which cases such bolts should be secured with shellac.

Remplacement of brushes

— Check the length of the brushes; when the projecting length is 5 mm. or less, the brushes should be changed.

When installing new brushes, the projecting length (fig. 51) should be 10 mm. Be careful when soldering so that the solder does not penetrate into the braided copper cable of the brush, and carefully set the flexible tube that covers the braided cable at the soldering point.

— Check that the brushes slide easily on the brush holder.

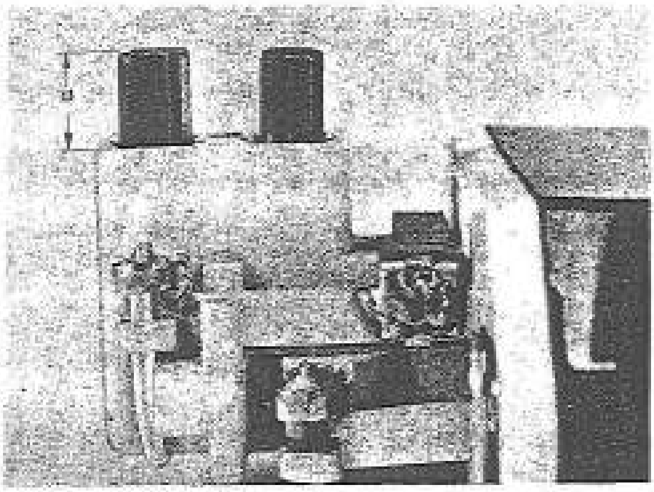


Fig. 51 — Replacement of the brushes

ASSEMBLY OF THE ALTERNATOR

When assembling the alternator, proceed in the following way:

— With the help of a press, press on the drive side support and pressure ring on the rotor shaft (fig. 52).

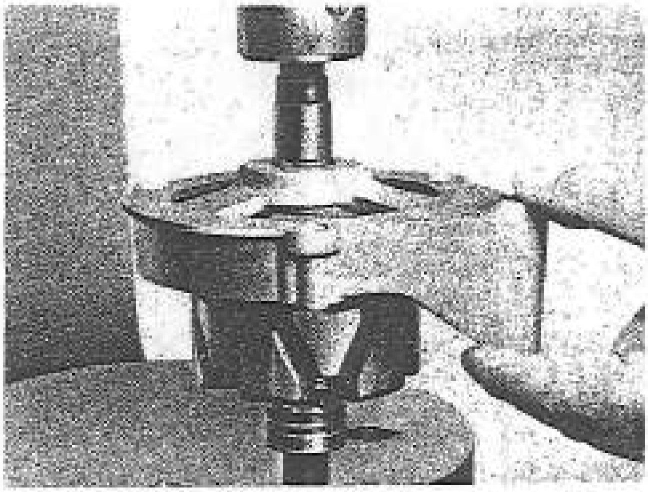


Fig. 52 — Assembly of the support and pressure ring on the rotor shaft

Use a bushing to carry out this operation in order to allow the rotor shaft to come through. The bushing or tube should only be set on the inside ring of the ball bearing or else on the pressure ring. Never exert any pressure on the drive side support.

— Next install the rotor friction rings side ball bearing.

— Screw on the friction ring side support, the diode plate and assemble the stator.

— Solder the stator windings to the commutator points of the diode plate (fig. 53). Be very careful not to overheat the diodes and not to let any drops of solder fall inside the diode plate when soldering. Do not bend the plug connections.

— Lubricate the seat of the friction ring side support and assemble the metal washer. Carefully insert the rotor together with the drive side support and screw on the different alternator components so that the marks that were made before disassembling match up (fig. 54).

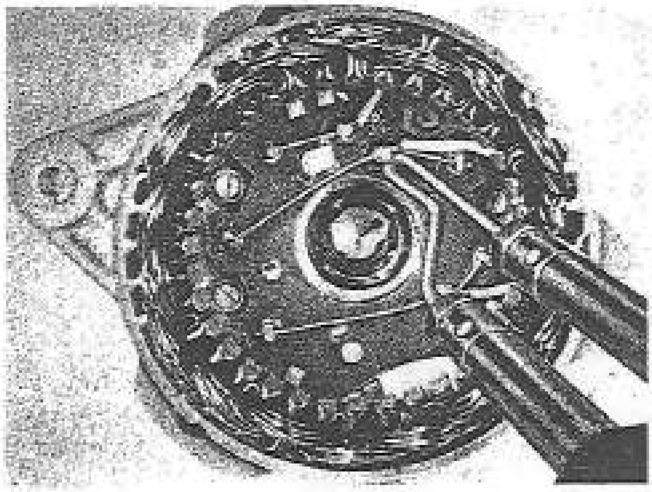


Fig. 53 – Soldering of the stator windings to the commutator points of the diode plate

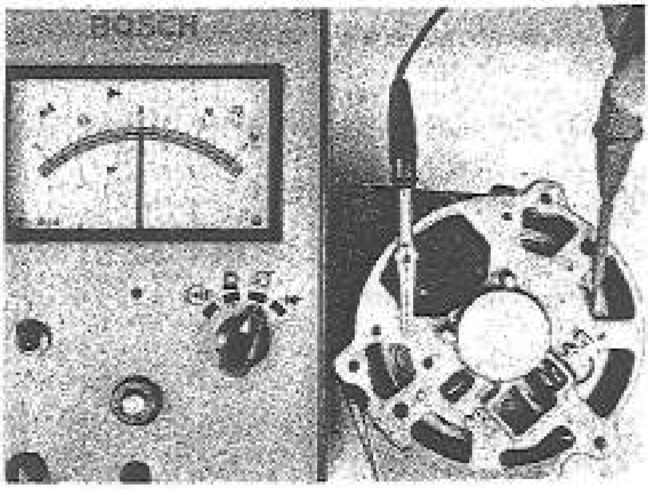


Fig. 55 – Testing the connection of the negative diodes with the housing

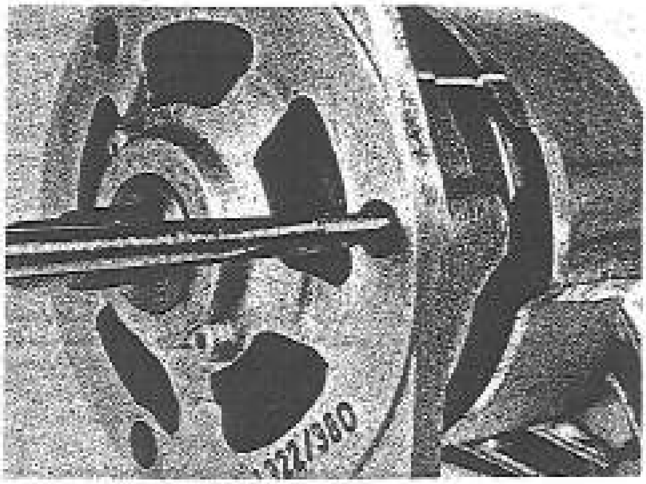


Fig. 54 – Even tightening of the screws and matching up of the marks when assembling

The cylindrical head screws should be evenly tightened at a torque value of 38 to 55 kg. cm.

– Once again use the alternator tester with the metering selector control in the position indicated in fig. 55. Put the testing points in the position shown in the same figure to test whether the cooling element of the negative diodes has a good connection with the housing.

If this connection is correct, the movement of the needle of the indicator will be very small.

Install the brush holder plate being careful that the contact spring of the diode plate has a good contact with the brush holder.

REGULATOR

Specifications

Regulator	Type AD 1 — 13 V.
Regulation voltage	13.9 — 14.8 V.
Regulation amplitude	0 — 0.45 V.
Alternator rpm	4,000 rpm.
Charge current for testing regulation amplitude	—20% (24 A.)
Charge current for testing the regulation voltage	3 ... 8 A.
Position of the terminals for testing	Downwards.

Important Note

Regulators cannot be repaired since they lack replacement and parts lists, for which the whole unit must be replaced when necessary.

Description

This regulator is of the double contact type with negative ground. It is independent of the alternator.

Checking the regulation voltage

The regulation voltage can be checked and adjusted with charge only. The regulator contacts must be pointed downwards. Both the alternator and the regulator must be at a temperature of approximately 20° C.

The alternator must be connected to the battery through a retainer resistance and the charge resistor must also be connected.

Connections on the test bench

— Connect the terminals D +, DF and D— of the alternator with those of the same designation on the regulator; connect the negative conductor of the test bench to terminal D— of the alternator. In the case in which there is no alternative, connect the threaded terminal of the plate.

— Connect the positive conductor of the test bench to terminal B + of the alternator through a retainer resistor.

— Connect a voltmeter to terminals B + and D— of the alternator. Be very careful of assuring that this polarity is correct and do not connect the negative conductor of the voltmeter to the threaded terminal of the regulation plate.

— Connect the conductor that goes from the charge control bulb to terminal D + of the alternator or of the regulator.

During the testing time it is not wise to recharge the battery since the values might not be valid if such action were to be taken.

Be very careful about not endangering the alternator or regulator semi-conductors by not connecting or disconnecting the terminals of the regulator until the alternator has stopped. Also make sure that the regulator is always tested together with the alternator if the battery is connected in parallel. The battery should always be disconnected after having stopped the alternator.

Testing process

— Connect the charge resistor and operate the alternator at 4,000 rpm. Adjust the charge current of the alternator (1 max—20%), varying the charge resistance. Reduce the number of revolutions and then increase it again in order to prevent errors due to hysteresis. If necessary, readjust the charge current.

— Read the regulation voltage in a one minute interval. Reduce the charge now from 3 ... 8 A, and the difference between the voltage that is indicated and the regulation voltage that was previously metered with charge current constitutes the regulation amplitude.

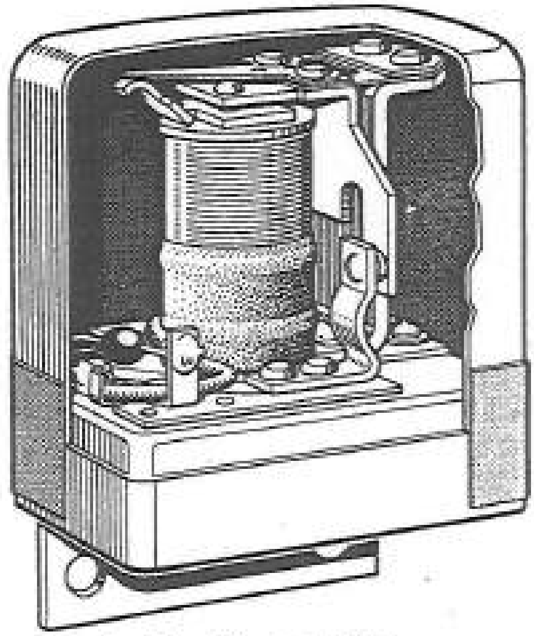


Fig. 56 — Voltage regulator

Trouble shooting

After carrying out the tests on the tractor, on the basis of the charge condition of the battery and the charge current observed, check tables 1 and 2 for the possible troubles found in the regulator-alternator.

On the basis of the values obtained in the test bench test, check table nr. 3 for the possible trouble found in the alternator.

Trouble control

The numbers of the following sections correspond to the ones in the trouble shooting tables.

Check to find if there is continuity in the different circuits and that there are no broken or loose wires and then check the three following readings:

a) In the alternator terminals or between the positive terminal and ground.

b) In the regulator terminals or between the positive terminal and ground.

c) In the battery terminals.

In order to carry out this metering procedure, start the engine and run it at a moderate speed, and then turn on the headlights so that there will be current throughout the circuit.

Control nr. 1

Check the regulator and repair or change if necessary.

Control nr. 2

Remove the alternator from the tractor and check it on

Control nr. 3

Check that there is not excessive voltage drop in the wiring, checking to see if there are any noticeable differences between the different connections and the ground.

Control nr. 4

Check the tension of the drive belt. If this tension is low, tighten it correctly. In the case in which the belt is very worn or deteriorated, change it.

Control nr. 5

Check with the tractor diagram to see if the connections have been changed in the terminals of the different apparatus.

Before carrying out the inspection, the different parts must first be thoroughly cleaned, eliminating all grease, sludge, etc, which may be adhering to them.

TABLE NR. 1

Tractor-mounted Apparatus Test

Control lamp of with ignition key on	Defective regulator	Control nr. 1
	Defective ignition key	Control nr. 3
	Defective lamp	Control nr. 3
	Lack of ground in alternator	Control nr. 3
	Defective lamp connection	Control nr. 3
	Regulator connections changed	Control nr. 5
	Loose or broken connections	Control nr. 3
Control lamp on with engine running	No charge	See Table 2
	Defective regulator	Control nr. 1
	Lack of ground in regulator	Control nr. 2
	Loose or broken connections	Control nr. 5

TABLE NR. 2

Tractor-mounted apparatus test

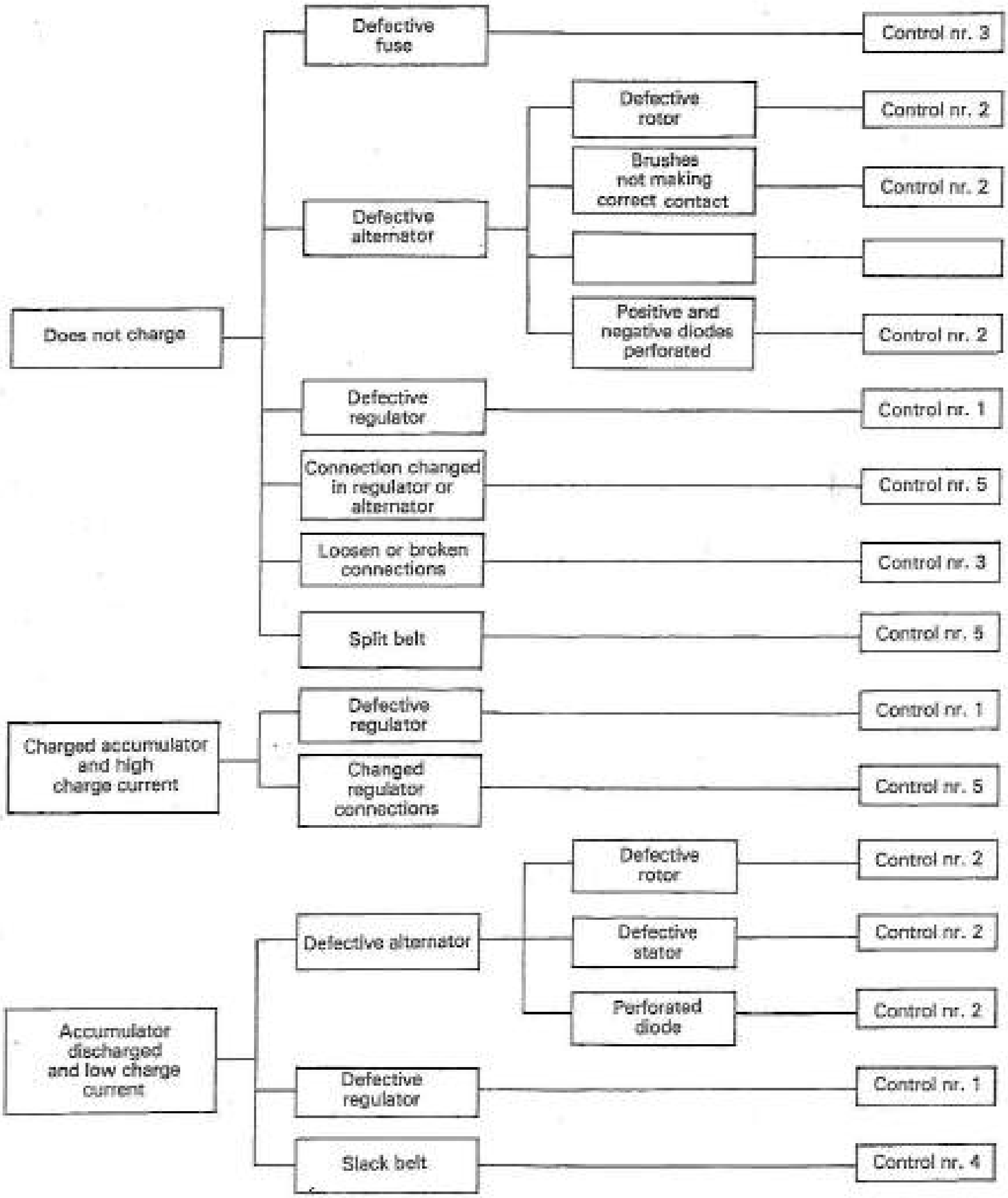
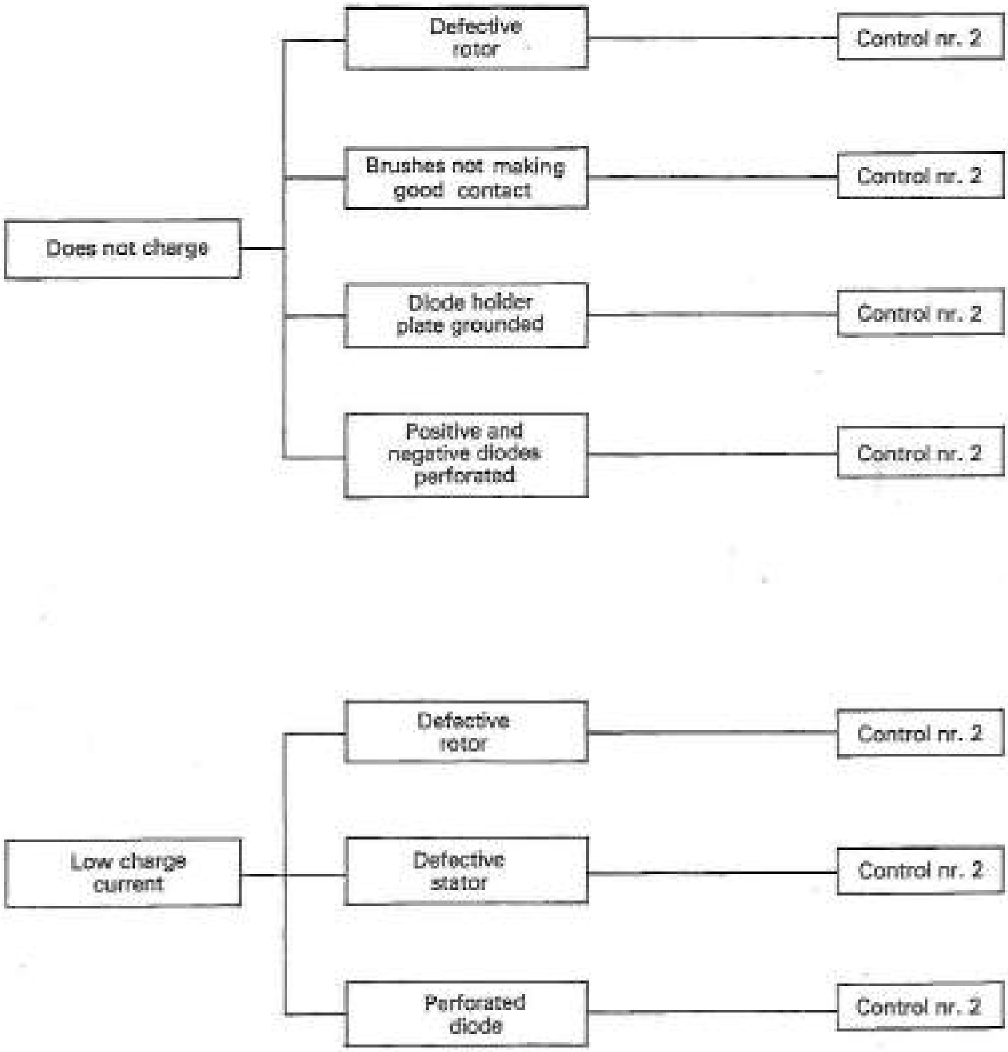


TABLE NR. 3

Test bench tests



START SYSTEM

STARTER

Specifications

Type	JF-12 (BOSCH)
Voltage	12 V.
Power	2.5 Hp.
Minimum commutator diameter	39.5 mm.
Brush pressure	1,500 to 1,300 gr.
Minimum brush length	15.5 mm.
Longitudinal armature play	0.1 to 0.3 mm.
Maximum armature plate package ovalization	0.05 mm.
Armature brake torque	4.5 to 7.5 kg. cm.
Separation torque	1.2 to 3.2 kg. cm.
Torque moment	3.7 to 4.5 kg. cm.
Minimum contactor drive voltage	7.5 V.
Distance between gear and ring gear	2.5 to 3.0 mm.
Play between tooth sides	0.35 to 0.5 mm.

Unloaded test

Voltage	11.5 V.
Current	65 to 95 A.
rpm	6,500 to 8,500 (for 1 min).

Short-circuit test

Current	530 to 880 A.
Voltage	3.5 to 4.5 V.

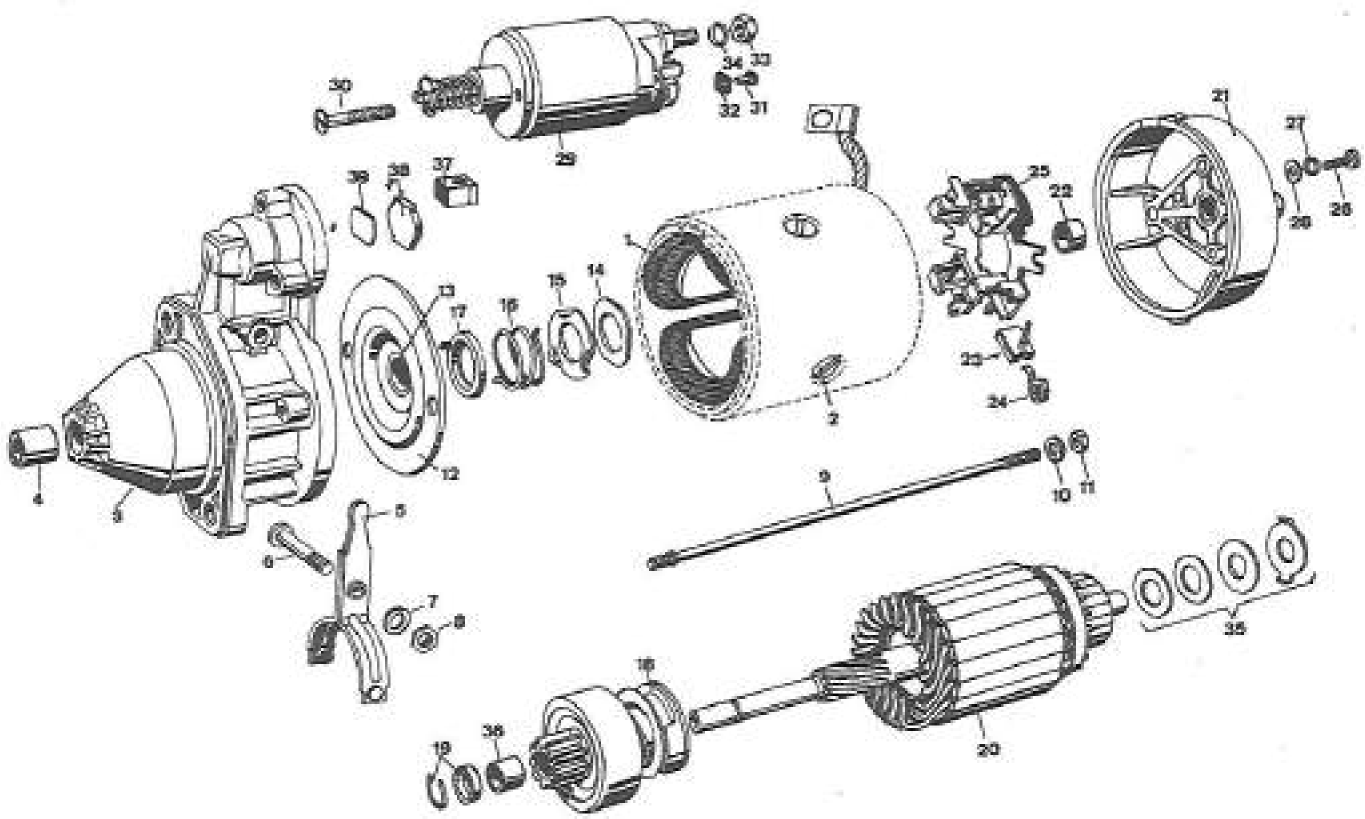


Fig. 57 — Exploded view of starter

1 — Field coils
2 — Screw
3 — Bushing side cover
4 — Bearing bushing
5 — Clutch lever
6 — Screw
7 — 8 mm. dia. lockwasher
8 — Nut
9 — Screw
10 — Washer
11 — Nut
12 — Middle cover
13 — Bearing bushing
14 — Insulations washer
15 — Brake plate
16 — Helical spring
17 — Guide washer
18 — Gear
19 — Bearing bushing
20 — Armature
21 — Commutator side housing
22 — Bearing bushing
23 — Brush set
24 — Brush lock spring
25 — Brush holder plate
26 — Screw
27 — 5 mm dia. lockwasher
28 — Flat washer
29 — Contactor
30 — Screw
31 — Screw
32 — Connection terminal
33 — Nut
34 — 10 mm. dia. lockwasher
35 — Armature washer set
36 — Gear bushing
37 — Rubber connection protector
38 — Rubber seal
39 — Sealing plate

NOTE: Numbers 19-35-37-38 and 39 are only supplied as replacement parts in the form of a complete assembly.

DESCRIPTION

An internal combustion engine cannot start by itself, as opposed to other engines, which start by simply connecting the supply circuit in order to begin operation. This type of engine, however, calls for an outside component supplied with a source of auxiliary power. This function is carried out by an electric motor that is supplied from the tractor battery.

When starting a Diesel engine, the resistances must be overcome which arise from cylinder compression, piston ring and bearing friction, flywheel inertia, etc. These resistances vary according to the quality of the lubricants used and the ambient temperature at which starting is carried out, and are larger in cold weather due to the fact that the frictions and lubricant viscosity are higher at that time.

Furthermore, an internal combustion engine will not start unless a minimum rpm is attained.

The minimum rpm at which the Diesel engine should turn depends on factors such as the engine temperature when starting, the type of combustion chambers and the preheating assist components.

The function of the starting system is to crank the thermal engine at sufficient speed so that it can start up. The system is composed of an electric motor with a solenoid mounted on the housing, a moveable start pinion (bendix), a battery and a remote control switch.

The amount of resistance in the circuit should be kept to a minimum in order to provide maximum current to the circuit and motor while it is in operation, for which it should be checked that the connections are not close, contacts are not sulfated and wires not partially broken or with excessively small cross-section, which would cause overheating in these points and reduce the rpm of the engine.

Test bench test

The electrical test value depend on the condition of the test (starter heating, battery discharge). These values are only valid for the test bench and may not be used for starters that are mounted on the tractor. The battery that is mounted on the test bench subjects a small starter to larger stress, while on the other hand, in the case of larger starters, the capacity of the test bench battery is not enough to obtain maximum power from the unit.

The test bench conductors, which are unavoidably longer, also exert an influence on the power of the starter. The duration of the test should thus be as short as possible and the battery should be in good condition and charge to a minimum of three fourths total capacity.

Testing should be performed at an ambient temperature of 20° C.

In the case in which the starter is damaged, the mean values will differ a good deal from the specified ones.

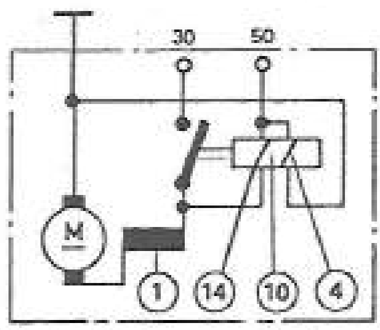


Fig. 58 — Starter connection diagram

1 — Winding in series
4 — Retainer winding
10 — Gear relay
14 — Thrust and reactive winding

In the case of doubt, check the field windings and armature winding to detect any possible ruptures or short circuits between loops or ground.

The inside connection of the starter is shown in fig. 58.

Unloaded operation test

In order to carry out the unloaded operation tests, proceed as follows:

— Secure the starter on the test bench so that the pinion being set forward, cannot mesh with the gear.

— Connect the starter (fig. 59).

The electrical connection for the test bench test can be seen in fig. 59.

— Measure the absorbed current, voltage and rpm of the starter.

The following table sets forth the possible causes of trouble in the case in which the mean values should differ from the test (specification) values.

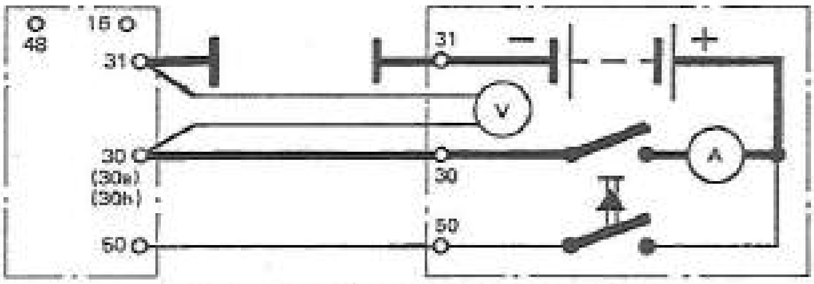


Fig. 59 — Connection of starter on test bench

TEST VALUE TROUBLESHOOTING CHART

Trouble	Cause
rpm and absorbed current too low.	Battery discharged-large voltage drops in the relay contacts, connection terminals or passage through commutator — armature winding is unsoldered — armature rupture — brushes seized or worn.
rpm too low, absorbed current too high (strong heating).	Short-circuit between field or armature winding loops — mechanical friction due to seizing of bearing retainers or armature brake, or high pressure in brushes.
Strong sparking in brushes.	Ovalized commutator — insulation between the segments in projecting commutator is unsoldered.
Voltage too low.	Battery discharged — resistance due to contact in supply conductors; set up a ground connection between the test bench and the starter if necessary.

Short-circuit test

When carrying out the short-circuit tests, proceed as follows:

— Connect the starter and brake it until it stops; read the absorbed current and the voltage. Perform the test for only a short time (from 1 to 2 seconds as a maximum).

In order to carry out this operation, the ring gear of the test bench and the pinion of the starter must have the same toothing (same modulus). If not, change the ring gear.

Carefully check the play between the tooth sides and the distance between the pinion and the ring gear.

When checking the mesh conditions, make the pinion mesh several different times. It should easily mesh with the ring gear, without blocking or making sharp noises.

The current and voltage values indicated in the specifications are valid if the battery that is used is charged to a minimum of 75% total capacity.

The following table sets forth the possible causes of abnormal current absorption.

Trouble	Cause
Current absorption.	Short-circuit between loops or to ground.
Current absorption too low.	Rupture of a coil branch, seized brush, unwelded armature winding, broken commutator connection, discharged battery.

Load test

It is enough to carry out this test as an operation check.

—Start the motor and brake it without stopping it.

— Secure the starter and connect it the same way as for the short-circuit test.

The following table sets forth the possible causes of incorrect starter operation.

TROUBLESHOOTING CAUSES OF INCORRECT INCORRECT STARTER OPERATION

Defect	
Strong sparking of brushes.	Ovalized commutator, short-circuit between loops in the field winding or armature, rupture in the armature.

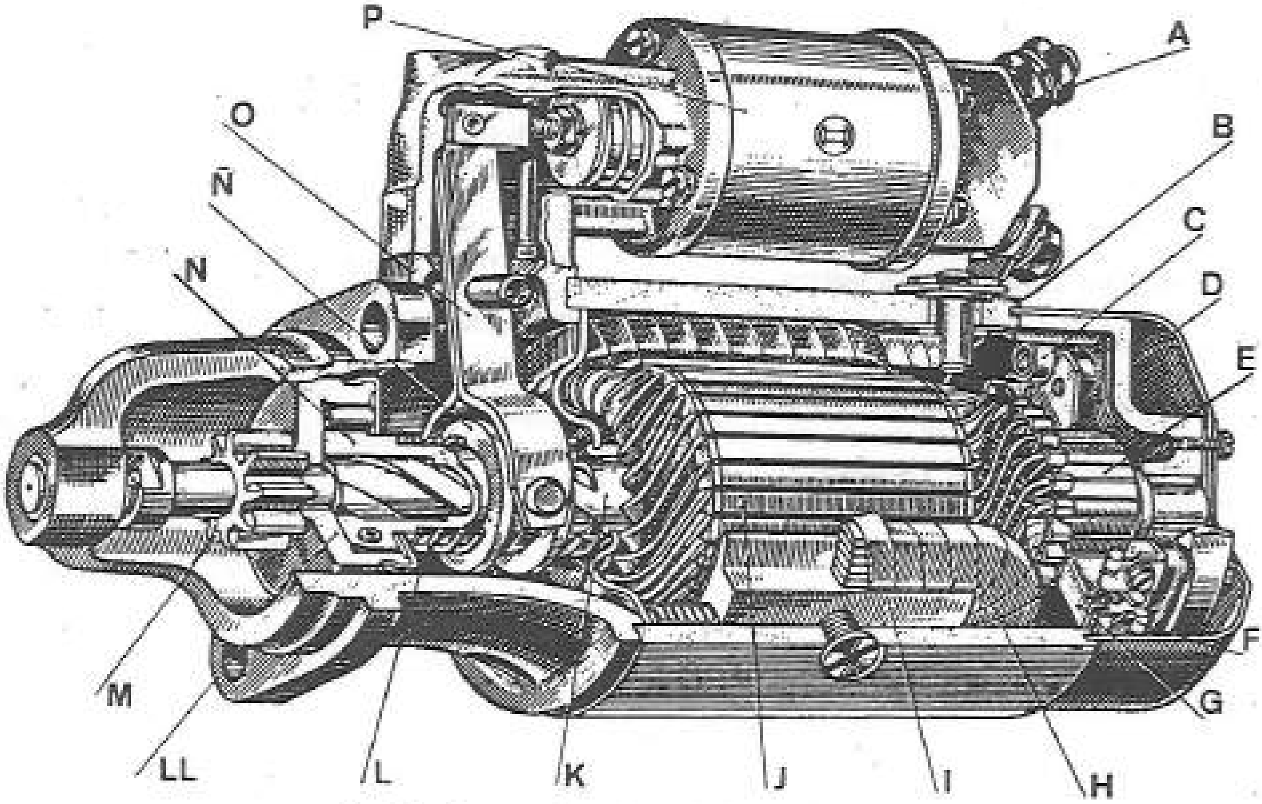


Fig. 60 — Cross section view of the mixed system starter with thrust gear and bendix

A — Connection terminal
B — Housing
C — Brush spring
D — Housing
E — Commutator
F — Brush
G — Brush
H — Field winding
I — Pole ground
J — Armature
k — Armature shaft
L — Helical spring
M — Freewheel mechanism
N — Pinion
O — Drag
P — Guide ring
Q — Gear lever
R — Contactor

DISASSEMBLING THE STARTER AND CHECKING ITS COMPONENTS

In order to disassemble the starter and check its components, proceed as follows:

- Secure the starter on a suitable support so that it cannot be moved.
- Remove the brush lock cover (fig. 61), raising the brush lock springs with a hook and remove the brushes from their housings.
- Release the connection between the field winding and the brush holder.

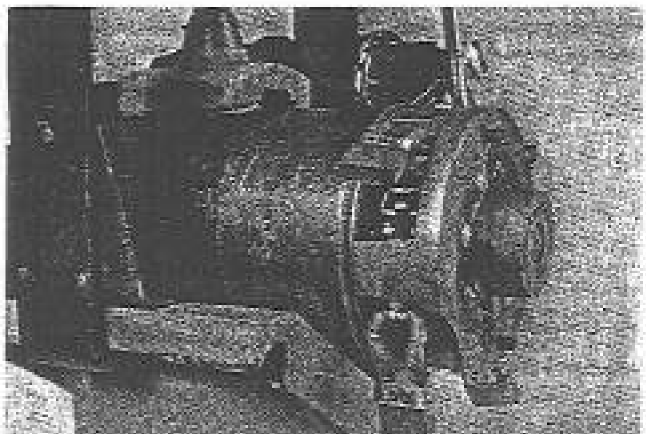


Fig. 61 — Removal of brushes

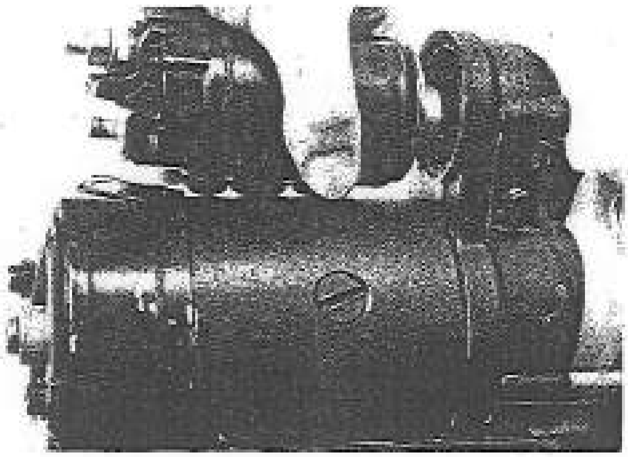


Fig. 62 — Disassembly of contactor

— Release the contactor connection and remove the gear lever bolt.

— Unscrew the drive lever contactor and remove it, pulling on the pinion (fig. 62).

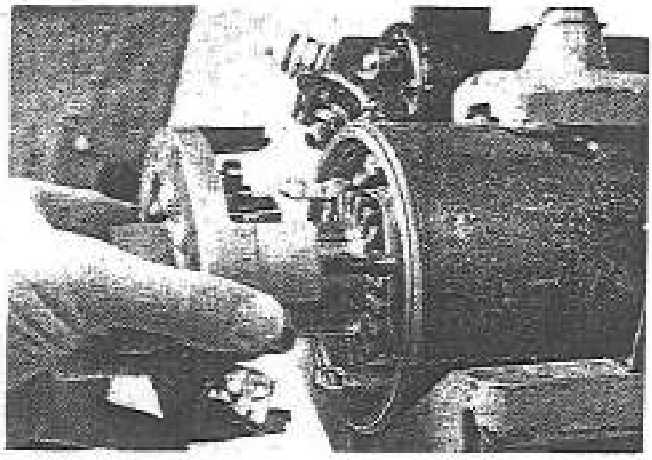


Fig. 63 — Disassembly of the rear housing

— Remove the lock nuts and take off the rear housing (fig. 63) (being careful with the metal washers which act to correct the axial play of the armature, and the insulation washer).

— Remove the armature housing with the drive bearing.

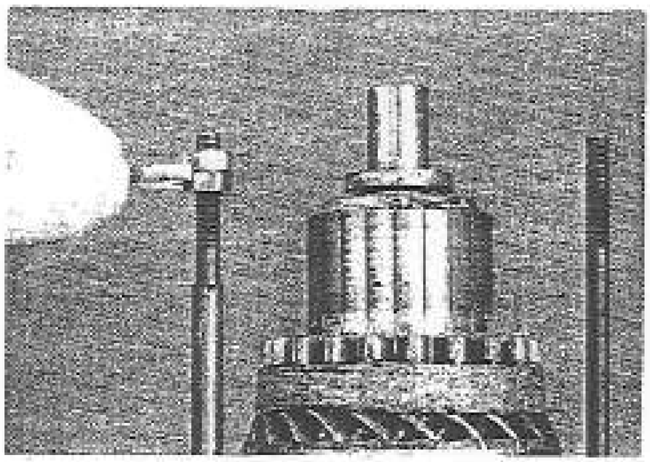


Fig. 64 — Removing the stud bolts

Unscrew the stud bolts attaching the front support to the rear housing.

They can be unscrewed by loosening the two nuts that are tightened together (Fig. 64).

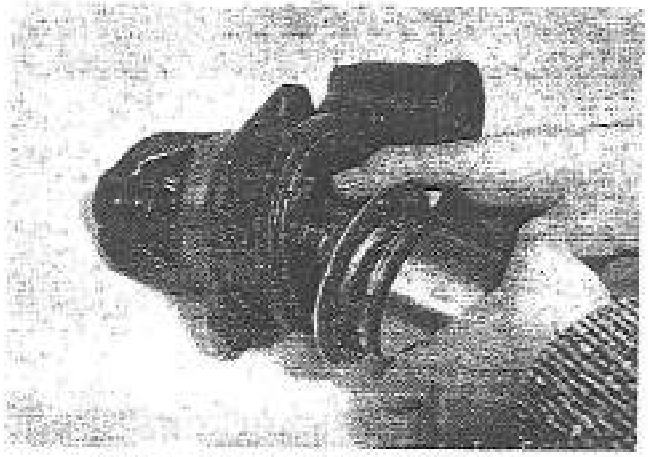


Fig. 65 — Removal of the control lever

— Set the drive support to one side and draw the drive lever to one side of the gear (fig. 65).

— Keep the armature inclined downwards and slide the control level upwards until the lever drag pistons can be removed from the guide sleeve.

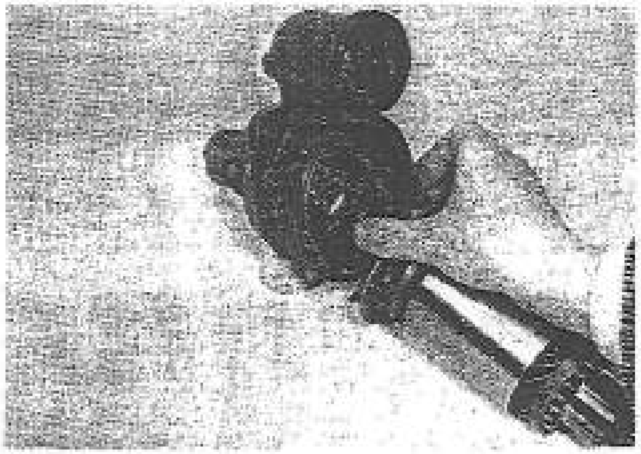


Fig. 66 — Removing the armature from the front support

— Pull the steering control lever to the intermediate bearing while moving the armature even lower at the same time.

— Pull out the control lever and the armature shaft of the drive bearing together (fig. 66).

— Secure the armature on a support, remove the through bolt of the castellated nut and unscrew the nut (fig. 67). If the motor spins to right, the thread will be to the left, and vice versa.

— Next remove the gear (fig. 68), the intermediate bearing and the armature brake of the armature shaft.

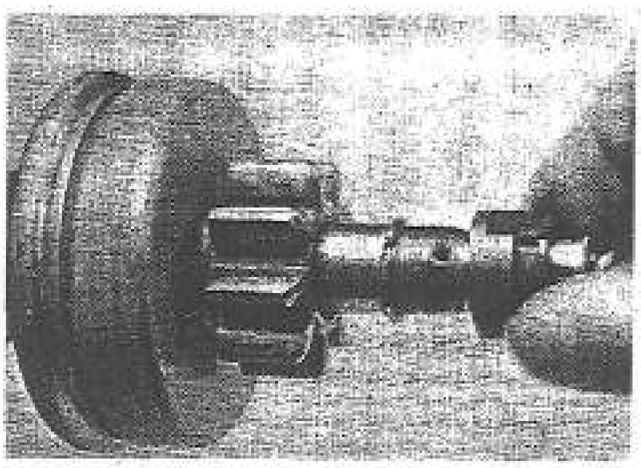


Fig. 67 — Removing the castellated nut

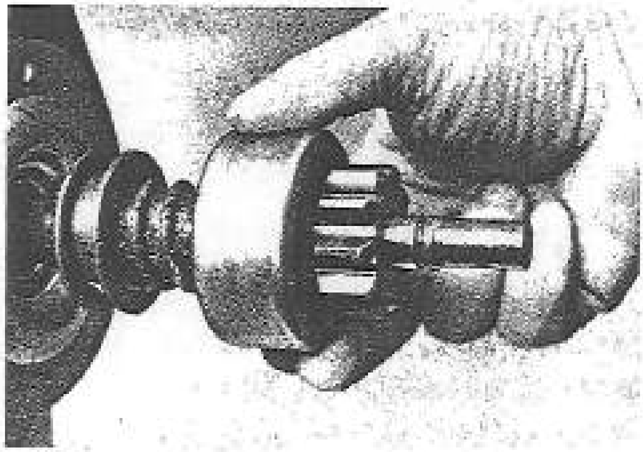


Fig. 68 — Removing the bendix

Visual check and cleaning of components

Clean the grease off the different components with some type of solvent liquid, and then dry them with compressed air at a pressure of not over 5 kg/cm².

The armature, the windings of the armature coils and the gear should not come into contact with the cleaning fluid.

Check all of the components thoroughly to determine whether they are considerably worn or contain any mechanical fault.

Once the surface have been cleaned of grease and dried, they should be applied a thin layer of oil to prevent rust.

Checking the armature

Two electrical tests should be carried out on the armature to check the condition of the winding:

a) Ground short-circuit.

b) Short-circuit between loops.

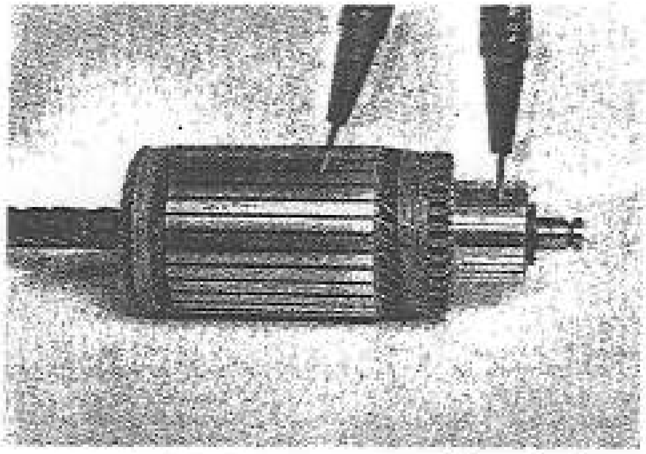


Fig. 69 — Checking the armature ground short circuit

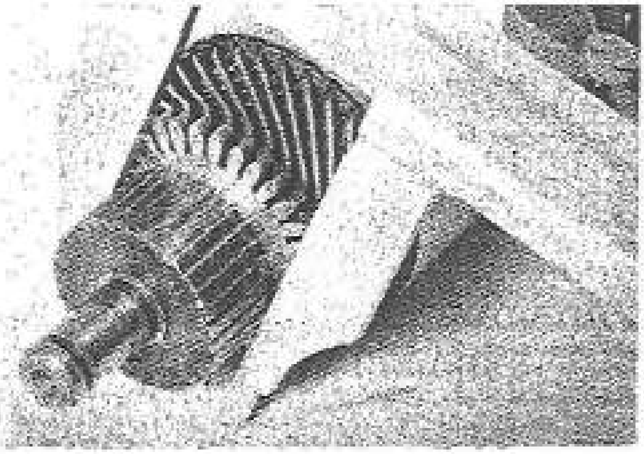


Fig. 70 — Checking the ovalization of the commutator

In the first test, use testing points connected in series with a bulb. A single phase current of 40 V. shall be applied to these points. One of the testing points should be applied to any metal part of the armature, while the other should be applied to the commutator (fig. 69). Under these conditions, the bulb should stay off.

In order to carry out the second test for a possible short-circuit between loops, install the armature in a magnetic tester. Place a metal lamina on it and slowing turn the armature. Each time that the metal lamina meets one of the winding insertion slots, it should be stabilized, which indicates that the armature is operating correctly.
If it should, on the other hand, begin to vibrate, this is a sign of a short-circuit between loops.

Also check that the armature does not rub the pole grounds or the field windings. The maximum admissible ovalization for the lamina package is 0.05 mm.

Also check the friction surface of the commutator in the area where the brushes rest (fig. 70). This area should have an even blue-grey colour and not be dirty or stained with oil.

Check that the commutator connections are well soldered and that the commutator shows no signs of burning due to sparks. Likewise, check for a possible lack of roundness, a maximum eccentricity of 0.03 mm. being admissible.

The minimum diameter of the commutator is 39.5 mm.

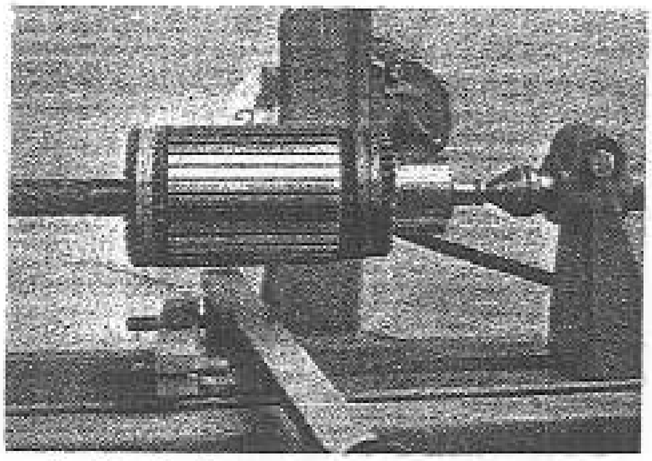


Fig. 71 — Machine reduction of the insulation between commutator segments

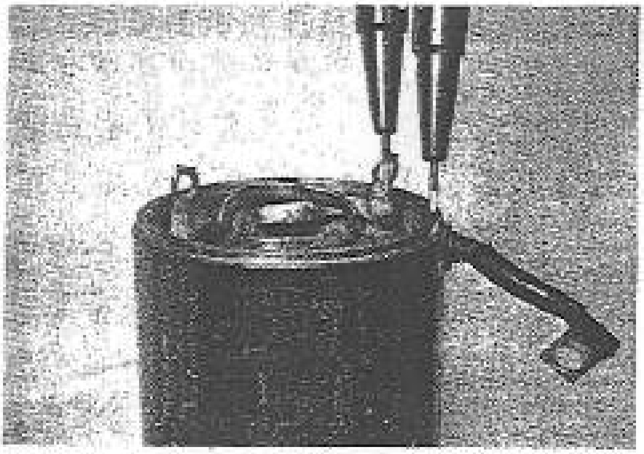


Fig. 72 — Checking ground short-circuits of the field coils

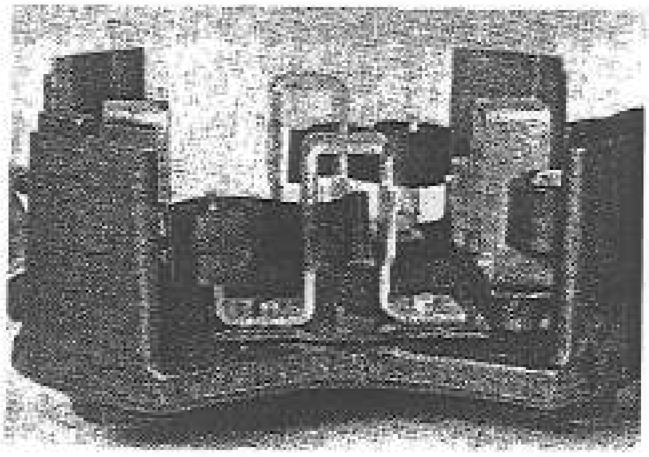


Fig. 73 — Checking the insulated brush holder

If necessary, turn the commutator. Once this operation has been performed, check that the diameter does not lie below the minimum acceptable value.

Once the commutator has been turned, reduce the insulation between segments to a length of approximately 0.5 to 0.8 mm. with a commutator saw. Eliminate the edge of the segments and then check again to determine whether there is ground short-circuit or short-circuit between the loops in the armature.

Check the field windings in the pole housing. They should not be burnt, unwelded or projecting from the pole grounds.

Check all the field windings to detect any possible ruptures. To do so, first disconnect all the coils that are connected in parallel. For this test use testing points to which a voltage of 6 V. direct current is applied. The bulb connected in series with the testing points should go on to indicate the continuity of the winding.

Also check all the windings to see if there are gound short-circuits. To do so, release all the ground connections, and apply a voltage of 40 V./ single phase alternating current to the testing points (fig. 72). The bulb connected in series should stay off.

Check that the brushes slide easily on their guides and that the lock springs are not retracted or damaged (fig. 73). Also check the pressure that these springs exert with a dynamometer. The correct pressure is 1,150 to 1,300 gr.

Check the length of the brushes. It should not be less than the value indicated as the minimum according to specifications. If the length is shorter than specified, a strong sparking will be produced in the commutator and endanger the operation of the starter.

Check the condition of the self-lubricating bearing (fig. 74). If it shows considerable wear, replace it.

Whenever the starter is disassembled, it is wise to replace the toric rings of the front support (fig. 75).

Check the condition of the self-lubricating bearing of this support and replace it if they show considerable wear.

Replace the gear (fig. 76) when the freewheel mechanism is worn or the teeth are worn or otherwise damaged.

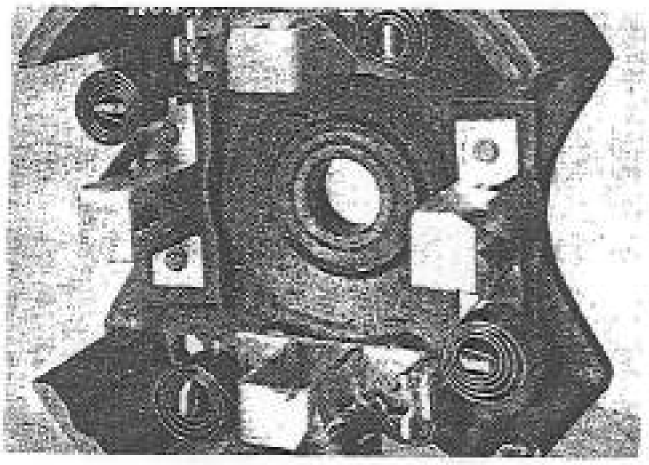


Fig. 74 — Self-lubricating bearing

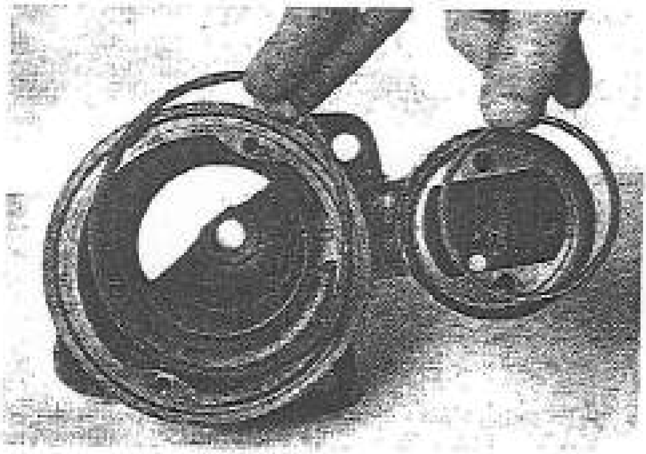


Fig. 75 — Position of the toric rings in the front support

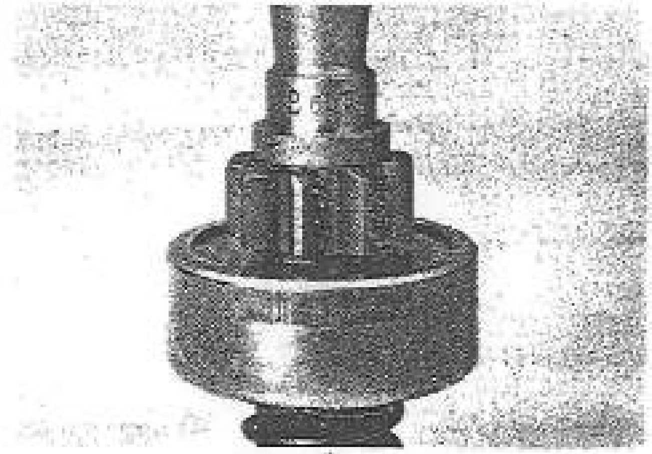


Fig. 76 — Bendix pinion

Assembly of the starter

Once the pinion assembly has been assembled on the armature shaft, without neglecting to install the intermediate washer and the helical spring, slide the drive support over the armature gear and set the control lever in place (fig. 77).

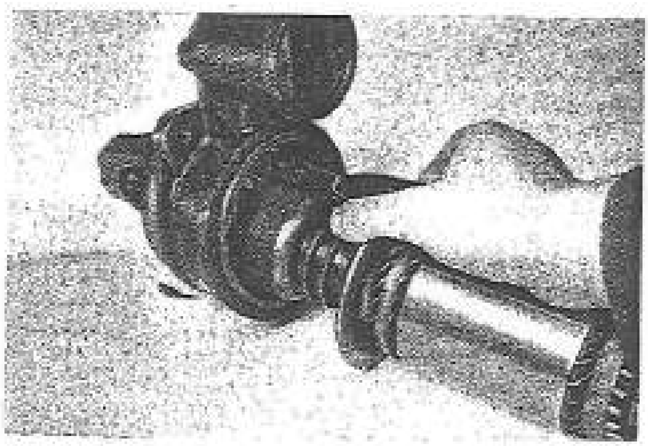


Fig. 77 — Assembly of the front support

The drag studs of the control lever should fit into the guide ring of the two parts of the gear.

Screw on the lock rods of the front support assembly and correctly insert the slightly lubricated rubber gasket in its housing in the support.

Contactor

Change the joint and the rubber gasket if they are worn or damaged. Completely replace the contactor if it has been affected by water. Check that there is good contact and firm seating of the connection terminals.

The positions of the locks slots of the drive end intermediate bearings should match up.

Insert the insulation tubes on the fork rods of the assembly and install the housing (Fig. 78). Check the rubber gasket slot and fork projection.

Fig. 78 — Installing the housing

— The end play of the armature is adjusted by means of compensator washers that are placed on the armature shaft (Fig. 79).

Fig. 79 — Assembly of the washers for end play adjustment of the armature.

— The correct longitudinal play of the armature is 0.1 to 0.3 mm.

Draw the control lever downwards and hook up the contactor plate fork on it. Screw on the contactor with the three pan head screws.

Screw on the nut and the winding connecting of the contactor (Fig. 80).

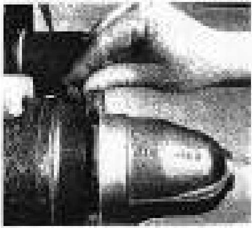


Fig. 80 — Assembly of the contactor

Insert the brushes (Fig. 81) in their guides and secure the their connection wires so that they are not rubbing or touching any metal part.

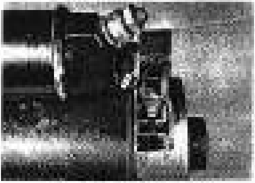


Fig. 81 — Assembly of the brushes

Next assemble the coupling plate inside the housing and then screw on the housing itself.

— Varnish all of the spaces in the connections of the starter.

Armature braking torque

The armature braking torque is composed of the friction of brushes, bearings and of the armature brake, which is assembled on an additional part.

— An excessively large braking torque creates wear and additional heating of the armature brake. If the torque value is too low, the time which the starter operates on its own inertia until stopping is too large. Likewise, when it is surpassed by the thermal engine, starting is dragged out to an rpm that is too high.

Advance torque

Advance torque means the torque that is necessary to turn the pinion in the direction of rotation of the starter, while the starter is mounted and the armature stationary.

— If the advance torque is too low, under certain circumstances the coupling does not transmit power. On the other hand, if the advance torque is too high, when the start is surpassed by the traction engine, it is dragged to an unacceptable high rpm which may even ruin it.

Play between tooth sides

This play means the clearance between the sides of the pinion teeth and those of the ring wheel while the pinion is meshed.

— When the play is too small there will be a large noise and high wear on the teeth. If the play is too large, the load on the teeth will be excessive and may cause them to break.

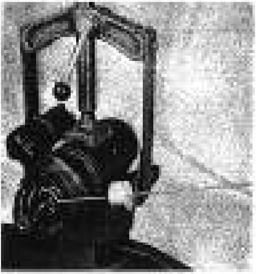
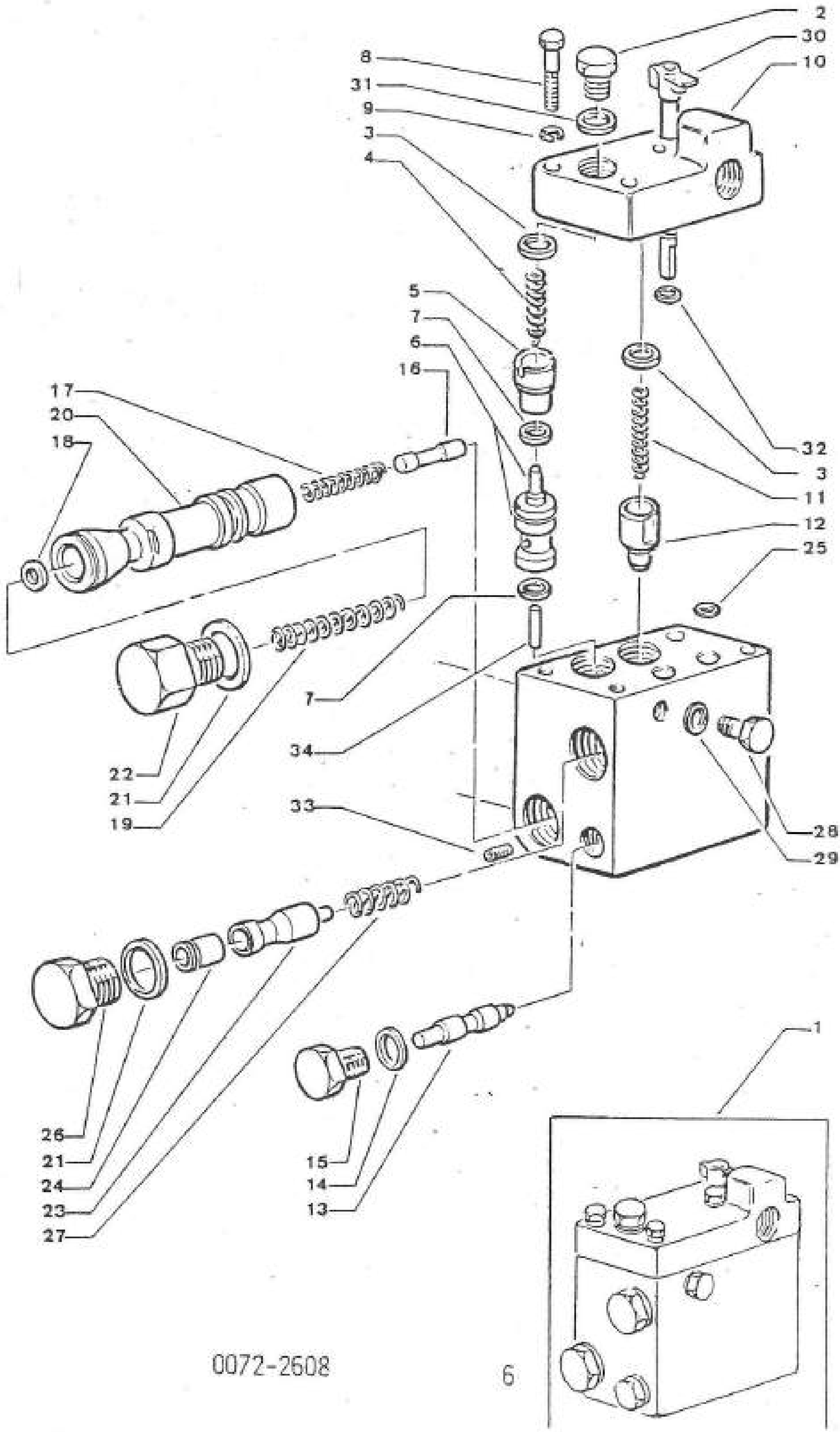


Fig. [illegible] — Checking the braking torque

LUBRICATION TABLE		
Lubricant	Lubrication point	Lubrication instructions
	Bearing Bushings	Before assembling new bushings submerge them in oil for at least a half an hour.
	Armature shaft	Slighty lubricate the bearing points on the drive and commutator side, the slide surface and the clutch flanges, as well as the large thread of the gear.
	Armature brake	Lubricate all brake discs and their separations well. Slightly lubricate the spring.
	Commutator and drive side washers	Slightly lubricate.
	Contactor	Lubricate the inside surface of the joint fork and bolt lightly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0072-2608

ELEVADOR HIDRAULICO / STD.
HYDRAULIC LIFT / STD.
RELEVAGE HYDRAULIQUE / STD.

DISTRIBUIDOR
DISTRIBUITOR
DISTRIBUTEUR

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6

0072-2608

1		-207024-0	1	CJTO.DISTRIBUIDOR ENS.DISTRIBUTEUR	DISTRIBUITOR ASSY	
2	1	SS-18-0028C	1	TAPON BOUCHON	PLUG	
3	1	-1441698-X1	2	JUNTA ALOJ. JOINT TORIQUE	O'RING	
4	1	SS-11-0018B	1	MUELLE RESSORT	SPRING	
5	1	-377181-0	1	SEPARADOR ENTRETOISE	SLEEVE	
6	1	-379094-0	1	VALVULA CLAPET	VALVE	
7	1	SS-16-0082A	2	JUNTA JOINT TORIQUE	O'RING	
8	1	-339009-X1	4	TORNILLO VIS	SCREW	
9	1	-339374-X1	4	ARANDELA RONDELLE	WASHER	●○ -353446-X1
10	1	-377034-0	1	TAPA SUPERIOR COUVERCLE	COVER	
11	1	SS-11-0012B	1	MUELLE RESSORT	SPRING	
12	1	-377039-0	1	VALVULA CLAPET	VALVE	
13	1	-377042-0	1	VALVULA PILOTO CLAPET	VALVE	
14	1	SS-16-0085A	1	JUNTA TAPON JOINT	GASKET	
15	1	SS-18-0027C	1	TAPON BOUCHON	PLUG	
16	1	-377134-0	1	VALVULA CLAPET	VALVE	
17	1	SS-11-0007B	1	MUELLE RESSORT	SPRING	
18	1	-339024-X1	1	ARANDELA RONDELLE	WASHER	
19	1	SS-11-0022B	1	MUELLE RESSORT	SPRING	
20	1	-377040-0	1	TIRADOR TIROIR	VALVE HOUSING	
21	1	SS-16-0087A	2	JUNTA TAPON JOINT	GASKET	
22	1	SS-18-0013B	1	TAPON BOUCHON	PLUG	
23	1	-377041-0	1	COMPENSADOR COMPENSATEUR	COMPENSATOR	
24	1	SS-08-0033B	1	SEPARADOR ENTRETOISE	BUSH	
25	1	SS-16-0065A	2	JUNTA JOINT	GASKET	
26	1	SS-18-0029C	1	TAPON BOUCHON	PLUG	

27	1	SS-11-0013B	1 MUELLE RESSORT	SPRING	
28	1	SS-18-0030C	1 TAPON M10 BOUCHON	PLUG	
29	1	SS-16-0083A	1 JUNTA TAPON JOINT	GASKET	
30	1	-377035-1	1 VALVULA CLAPET	VALVE	
31	1	SS-16-0086A	1 JUNTA TAPON JOINT	GASKET	
32	1	SS-04-0085C	1 ANILLO JOINT TORIQUE	O'RING	
33	1	SS-18-0010G	1 TAPON M10 BOUCHON	PLUG	
34	1	-377116-0	1 AGUJA AIGUILLE	PIN	⌀ 22,2 ÷ 22,148
34	1	-377118-0	1 AGUJA AIGUILLE	PIN	⌀ 22,1 ÷ 22,048
34	1	-377120-0	1 AGUJA AIGUILLE	PIN	⌀ 22,0 ÷ 21,948
34	1	-377122-0	1 AGUJA AIGUILLE	PIN	⌀ 21,9 ÷ 21,848
34	1	-377124-0	1 AGUJA AIGUILLE	PIN	⌀ 21,8 ÷ 21,748