ELECTRICAL SYSTEM

DESCRIPTION

1. The 370 electrical system (fig. 1) is a 12 V negative earth system, and it can be broken down into a number of simple interrelated circuits:

(1) **Starting**
(2) **Charging**
(3) **Controls and accessories**

These are dealt with in Sections 4 B1, 4 C1 and 4 D1 respectively.

2. Electricity is generated by a dynamo and stored by the battery.

3. The system consists of the following components:

(1) **Engine mounted.** Dynamo; starter motor; starter solenoid; voltage regulator; oil pressure switch; water temperature sender; battery.

(2) **Cabin mounted.** Instrument panel; windscreen wipers; cabin heater; horn button; light switches.

(3) **Mainframe mounted.** Horn; road and working lights; fuel level sender.

4. The wiring comprises several looms which are attached to the structure. All the connections are of the crimped terminal end type.

5. The standard system of wire colour coding is as follows:

R – red	B – black	V – blue	N – brown
W – white	Y – yellow	P – purple	O – orange
G – green	S – slate	LG – light green	K – pink

6. Where two colours are given, e.g. R W, the first colour is the dominant colour of the wire, and the second is the tracer colour. In this case – a red wire with a white line running the length of the wire. Any colours running across the wires should be ignored as these are manufacturer's codes and are unrelated to the circuit.

SPECIAL TOOLS AND EQUIPMENT

Â 12 V/4 W test lamp or an avometer or a suitable multimeter. (See also paragraph 8.)

REMOVAL

N.A.

REPLACEMENT

N.A.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

7. The following notes give some of the basic techniques to be used when fault finding on electrical circuits. They should be used with the relevant paragraphs in Sections 4 B1, 4 C1 and 4 D1.

8. Many of the faults in an electrical circuit can be located by two simple pieces of equipment:

(1) A lamp-holder with two flexible leads attached. A 12 V lamp of the required wattage (usually 4 W) is fitted in the holder, and probes/clips are attached to the ends of the leads. It is used to check for a live supply between points in a circuit.

(2) A lamp with similar connections to those described in (1), but also with its own battery supply. The lamp will be one suited to the battery. This is used to check continuity between points in a circuit.

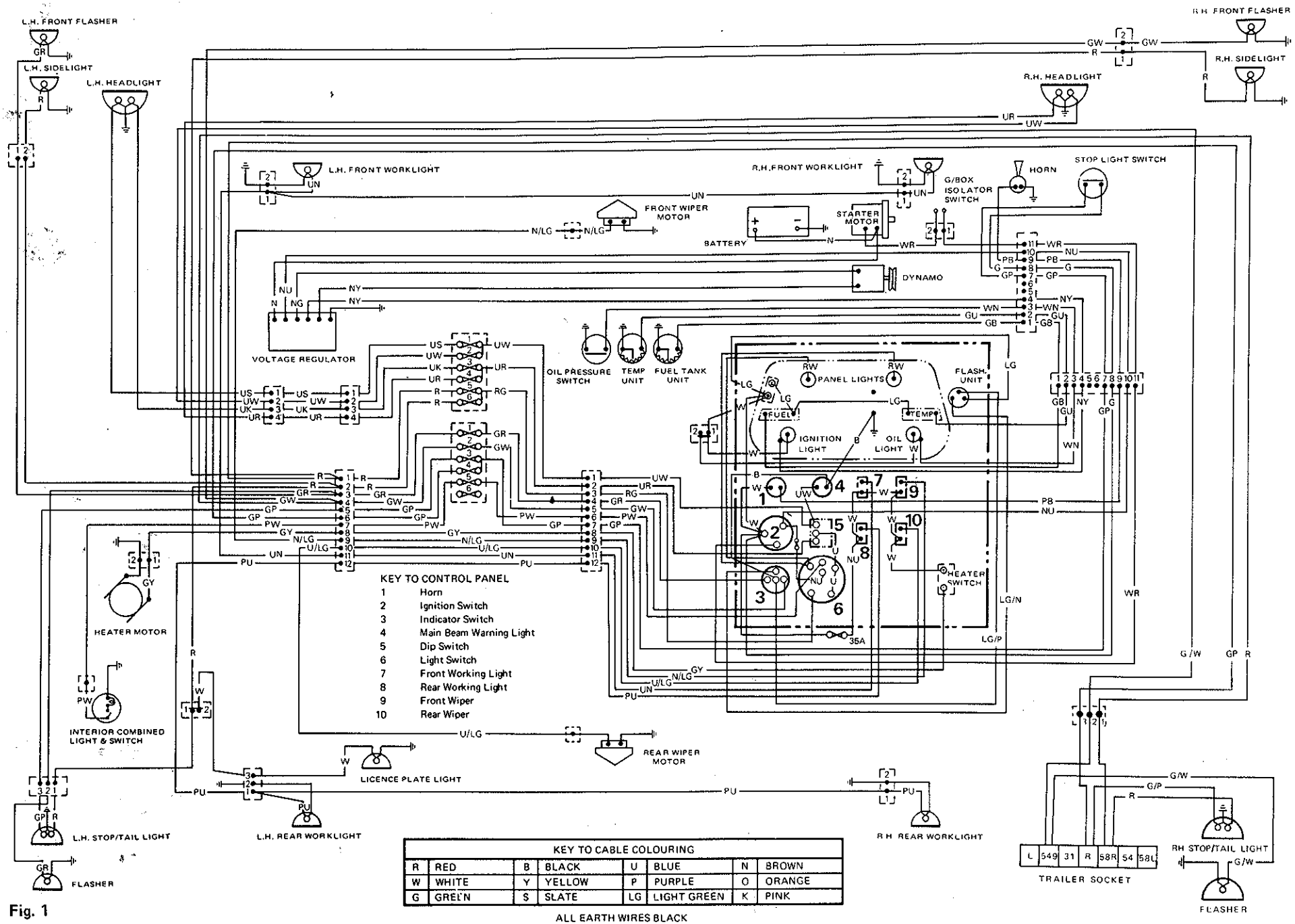
9. The more common faults to be found in electrical circuits are as follows:

(1) **Blown fuse.** A visual check can often prove the fuse faulty. If not, then the test lamp with the battery can be used. If a fuse has blown, the circuit to which it is connected should be checked for short circuits before the fuse is replaced. It is unusual for a fuse to blow unless an overload has occurred.

CAUTION:
Never uprate a fuse.

(2) **Faulty bulb.** If a bulb is burnt out, this can easily be seen by the broken filament and the scorch marks on the inside of the glass. A bulb can develop a short or broken circuit inside the glass or cap, which may cause the fuse to blow. A test lamp and battery test will prove if the bulb is faulty.

(3) **Bad connections.** By bridging suspect connections with the test lamp leads, broken connections can be isolated and corrected. If the test lamp lights, but the light is dim on any circuit compared with another, then a high resistance joint exists in that circuit. Internal breaks can often be detected in this manner. Cleaning or correcting the joint or replacing with new wiring will eliminate the problem.



KEY TO CABLE COLOURING							
R	RED	B	BLACK	U	BLUE	N	BROWN
W	WHITE	Y	YELLOW	P	PURPLE	O	ORANGE
G	GREEN	S	SLATE	LG	LIGHT GREEN	K	PINK

ALL EARTH WIRES BLACK

Fig. 1

HYMAC

(4) **Faulty switch.** By connecting the test lamp across the terminals of a switch, it can be isolated in the on/off positions and thus checked for correct operation. Switches, as with other components, are more easily replaced than repaired.

(5) **Dead circuit.** This can be due to battery connections not being made properly. Check that the terminals are clean and that they are mating securely on the battery itself. Also check that the earth lead is clean and securely connected to the machine. Also check that the battery is charged.

10. **Maintenance of the battery.** Always keep the level of the electrolyte (acid) in the battery above the top of the plates. Top up with distilled water as necessary. Ensure that the terminals are kept clean and free of corrosion. Keep them lightly coated with petroleum jelly. Ensure that the leads on the battery and earth terminals are clean and secure. Never short out the two terminals of a battery. To put two 6 V batteries in parallel, connect the positive terminals together and use in the ordinary way.

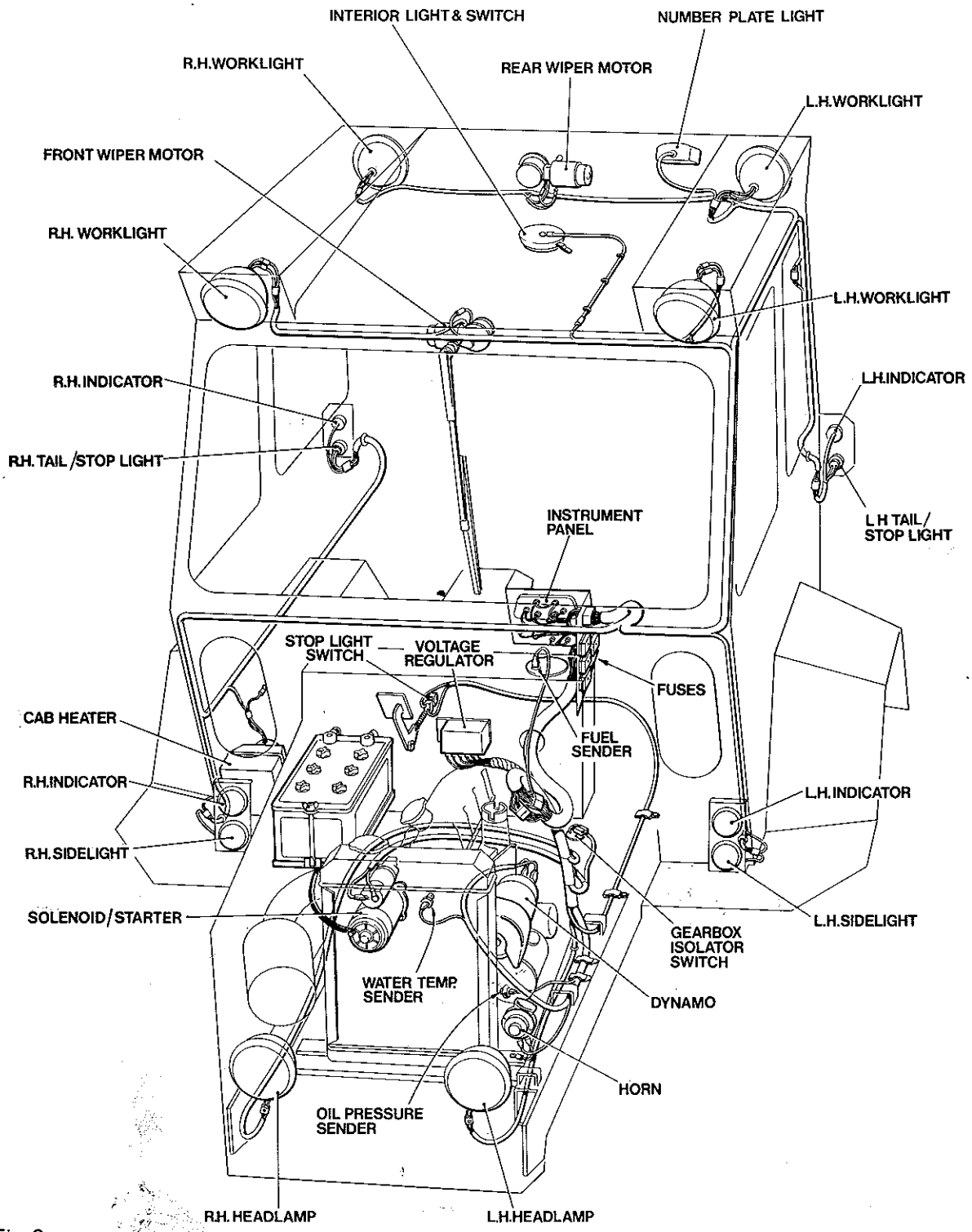


Fig. 2

STARTING (ELECTRICAL)

DESCRIPTION

1. The starter motor is a conventional heavy duty 12 V series motor. It is permanently connected on the negative side to earth, and a heavy duty lead connects the battery positive to the motor via solenoid operated contacts. The solenoid is energised from the battery via contacts 1 and 3 of the ignition switch. The starting circuit is shown in fig. 1.

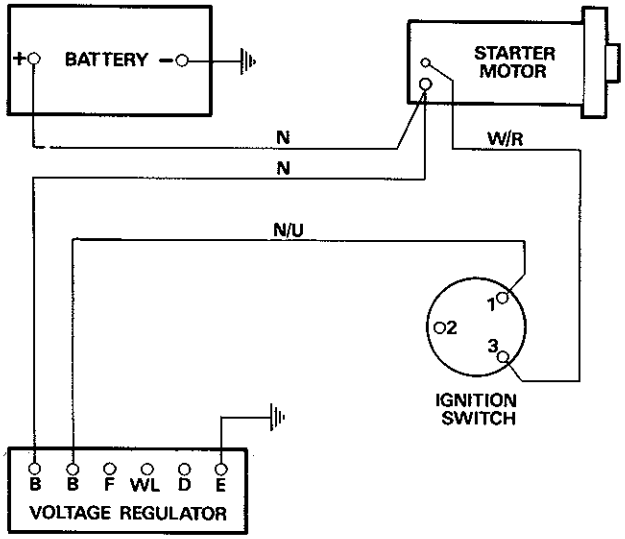


Fig. 1

SPECIAL TOOLS AND EQUIPMENT

See Section 4 A1.

REMOVAL

CAUTION:
Before removing any electrical component, ensure that the power is switched off.

2. **Ignition switch. Remove.** Remove the instrument panel by releasing six self-tapping screws. Remove the nut which secures the switch to the panel. Take the electrical connections from the switch. It is important to identify which contacts connect to which leads.

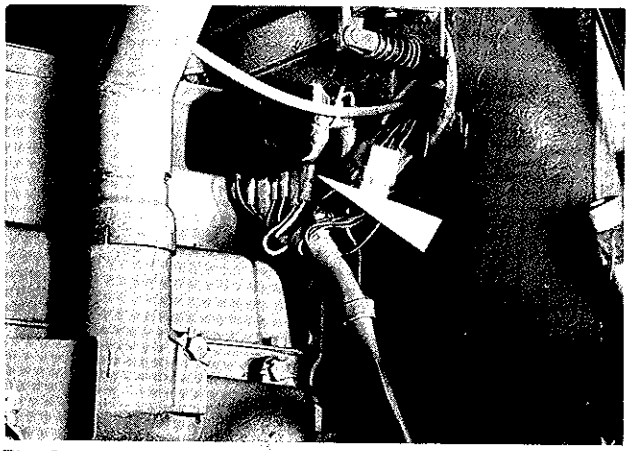


Fig. 2

3. **Voltage regulator. Remove** Disconnect and identify the leads to the regulator. Remove the fixing screws attaching the regulator to the mainframe. Remove the regulator (fig. 2).

NOTE:
As far as the starting circuit is concerned, the voltage regulator only acts as a terminal. It functions as a regulator for the charging circuit. (See Section 4 C1).

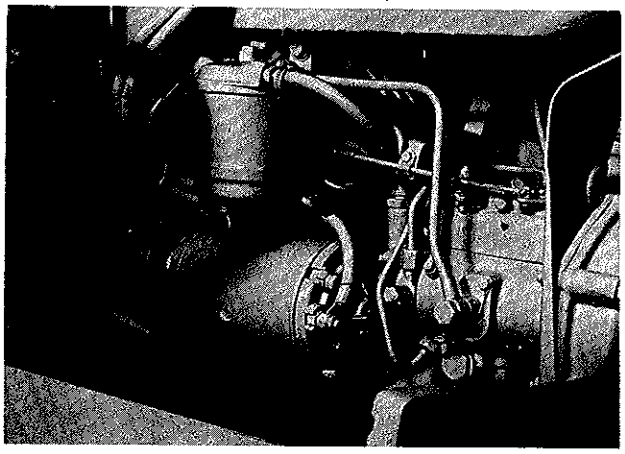


Fig. 3

4. **Starter motor. Remove.** Remove the leads from the starter motor and identify them. Remove the starter mounting bolts. Withdraw the starter motor from the engine (fig. 3).

5. **Battery. Remove.** Disconnect the leads, slacken the wingnuts on the retaining clamp, swing the clamp aside and remove the battery.

NOTE:
Remember negative earth on re-assembly.

REPLACEMENT

6. Replacement is a reversal of paragraphs 2 to 5.

DISMANTLING

7. It is recommended that for the regulator and the starter motor reference is made to the appropriate manufacturer's manual.

INSPECTION

8. Ensure that all the components are free of corrosion and other damage. Ensure that all connections are clean and secure.

RE-ASSEMBLY

9. See paragraph 7 above.

ADJUSTMENTS

10. See paragraph 7 above.

SERVICING

11. Check the level of the electrolyte in the battery, and top up with distilled water if necessary. Lightly coat all heavy duty cotacts with petroleum jelly.

FAULT FINDING

12. Basic fault finding is also given in Section 4 A1, paragraph 9.

13. **Starter circuit not working.** There are many possible causes of this failure. The first step in locating the fault is to isolate the component causing the trouble.

NOTE:
There may be more than one.

(1) Ensure that the battery terminals are tight and that the battery is fully charged.

(2) Connect one lead of the test lamp (described in Section 4 A1) to a good earth (bare metal on the machine), and the other to the ignition switch terminal (lead wires). If the lamp lights, then the supply is reaching the switch. Move the test lead to the output side of the switch, and hold the switch in the starting position. If the bulb lights up, then supply is passing through the switch. This test eliminates the switch and the wiring up to it.

(3) With one end of the test lamp terminal connected to a good earth, take the other lead to the solenoid terminal. Hold the starter switch in the on position. If the bulb lights, then the power is reaching this point. If the solenoid does not click in (the click should be clearly audible), then the solenoid is faulty and should be changed. If the solenoid is heard to be making and breaking correctly, connect the test lead to the output side of the solenoid, and operate the starter switch again. The solenoid should close and the lamp should light. If it does not, then the solenoid contacts or switching are faulty, and the solenoid should be changed.

(4) If the circuit is sound as far as this point, only the starter motor is left. After checking the connections to make sure that the supply is reaching the motor and that the motor is properly earthed, there is little to be done without stripping the motor down, and for this it is recommended that the user refers to the appropriate manufacturer's manual.

(5) The following is a summary of the above procedures:

Symptom	Cause	Remedy
Starter motor fails to turn.	Battery flat	Put known good battery in parallel.
	Faulty connections	Check all connections are clean and secure.
	Solenoid not operating	Using test lamp check supply at solenoid and listen for audible 'click' when ignition switched on. Change solenoid if 'click' is not heard.
	Solenoid operates but starter does not turn	Connect 12 V/60 W (min) lamp across battery. Turn ignition to start. If light dims and motor does not turn, check battery earth lead for good connection. If connection is good, change motor.
	Broken cables or leads	Check continuity of cables by means of test lamp.

CHARGING (ELECTRICAL)

DESCRIPTION

1. The dynamo, in conjunction with the voltage regulator, supplies the power for charging the battery. With the ignition switch in the on position, a warning light next to the switch goes out, to signify that the output from the dynamo is sufficient to charge the battery, i.e. when the output voltage is higher than that of the battery. The charging circuit is shown in fig. 1.

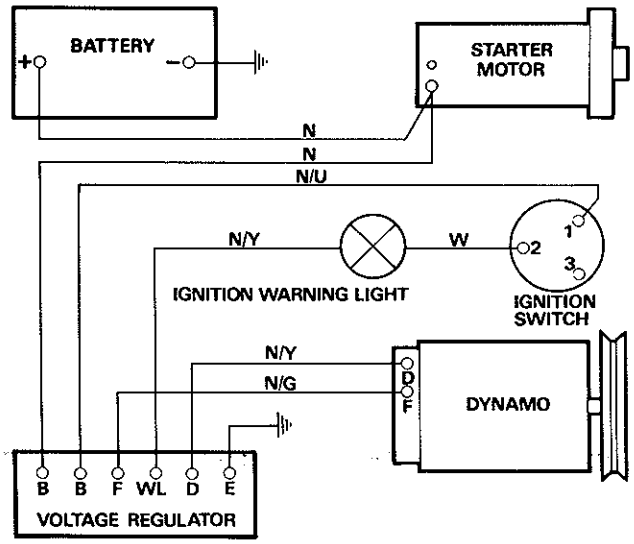


Fig. 1

SPECIAL TOOLS AND EQUIPMENT

See Section 4 A1.

REMOVAL

2. **Ignition switch. Remove.** See Section 4 B1.

3. **Voltage regulator. Remove.** See Section 4 B1.

4. **Starter motor. Remove.** See Section 4 B1.

5. **Battery. Remove.** See Section 4 B1.

6. **Warning light. Remove.** Remove the six self-tapping screws securing the instrument panel, and remove the warning light lead and bulb holder. Remove the bulb.

7. **Dynamo. Remove.** Loosen the dynamo support bracket and remove the fan belt from the dynamo pulley. Identify and remove the electrical leads. Remove the fixing bolts and remove the dynamo (fig. 2).

REPLACEMENT

8. Replacement is a reversal of the removal procedures above.

NOTE:
Fan belt adjustment is shown in fig. 2.

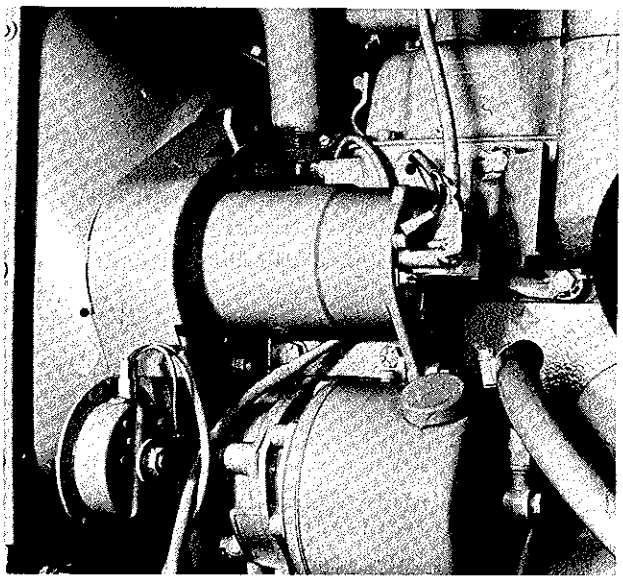


Fig. 2

DISMANTLING

9. It is recommended that for the dynamo, starter and regulator, reference is made to the appropriate manufacturer's manual.

INSPECTION

10. Ensure that all the components and connections are free from corrosion and are securely located.

RE-ASSEMBLY

11. See paragraph 9 above.

SERVICING

12. See Section 4 B1 for servicing of the battery.

FAULT FINDING

13. Basic fault finding is given in Section 4 A1, paragraph 9.

14. **Dynamo not charging.** This is indicated by:
    (a) a flat battery, and
    (b) the warning light permanently on.

First isolate the faulty component or components.

(1) *Dynamo.* This can be tested by connecting a test lamp lead to earth (bare metal), and the other lead to the dynamo output terminal. When the engine is running, the lamp should light up very brightly. If it does not, then the dynamo is faulty and should be replaced. A check should be made to ensure that the fan belt is not slipping, and that the connections are clean and tight. Also check that the battery is not worn out.

(2) *Warning light.* Turn on the ignition switch to check that the warning light is illuminated. If it is

not, then first check the bulb. Then, using the lamp test equipment, check the circuit through to the warning light. By connecting one lead to earth and the other to the lamp holder contact, if the test lamp bulb lights up with the ignition is on, then power is reaching the warning light side of the system. If it does not light up, then retrace all the steps in the system as follows: either side of the ignition switch – point 2 (output) and point 1 (input); the two positions B on the regulator; the starter terminal; the battery. At each point, take care to check that all connections are clean and secure. If the warning light illuminates but fails to extinguish when the engine is running at high revs, then see (1) above.

(3) *Other components.* For fault finding in other components of the charging circuit, see Section 4 B1.

SERVICES (ELECTRICAL)

DESCRIPTION

1. The services may be broken down under the following headings:

(1) Fuel level, engine temperature and oil pressure.
(2) Headlights.
(3) Indicator lights.
(4) Side and tail lights.
(5) Working lights, wipers, heater and horn.
(6) Interior lights.

Fuel level, engine temperature and oil pressure:

DESCRIPTION

2. When the ignition switch makes contacts 1 and 2, the charging circuit is completed between the battery and earth (fig. 1). The oil pressure sender and water temperature sender are located on the engine. The fuel level sender is mounted on the fuel tank. The ignition switch and voltage regulator are mounted in the control panel.

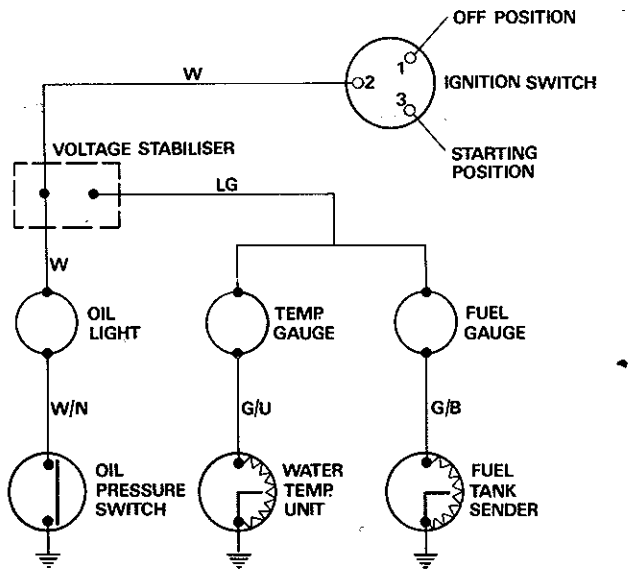


Fig. 1

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

REMOVAL

WARNING:

(1) Ensure that the engine is switched off.
(2) When removing the temperature sender, ensure that the coolant is cool and the pressure is relieved.

3. **Instrument panel. Remove.** Remove six securing screws and remove the instrument panel from its housing.

4. **Temperature gauge, fuel gauge and oil warning light. Remove.** Disconnect the leads from the gauges and the bulb-holder, making sure that they are carefully identified. Remove the gauges and the bulb from the instrument panel. (See Section 3 G1.)

5. **Temperature sender. Remove.** Identify and disconnect the lead from the temperature sender, and unscrew it from the engine (fig. 2). Either fit a new temperature sender immediately or plug the hole, to prevent coolant loss and dirt ingress.

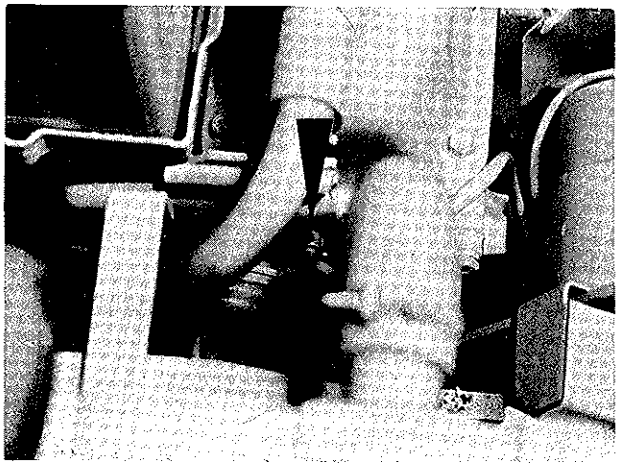


Fig. 2

6. **Fuel sender. Remove.** Identify and disconnect the lead from the fuel sender. Remove it from its location on the fuel tank by removing three screws and removing the sender and float assembly complete.

7. **Oil pressure sender. Remove.** Identify and disconnect the lead from the oil pressure sender, and unscrew it from its location on the engine (fig. 3). Fit a new sender immediately or plug the hole, to prevent oil loss and dirt ingress.

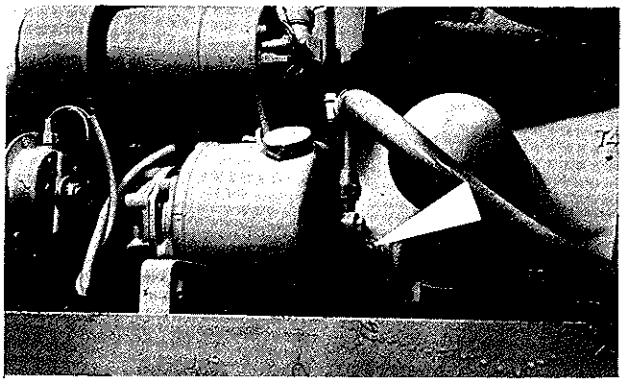


Fig. 3

REPLACEMENT

8. Replacement of these components is a reversal of the procedures described in paragraphs 3 to 7.

NOTE:
Ensure that the oil and coolant levels are correct before

starting the engine. If antifreeze has been used, ensure that the radiator is topped up with the same mixture of water/antifreeze.

DISMANTLING

N.A.

INSPECTION

9. Check all the components and connections visually to ensure that they are all clean and secure.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

10. Basic fault finding techniques are to be found in Section 4 A1.

11. The following hints may also be useful in trying to discover the cause of a faulty gauge:

(1) To check the sender units, connect the sender terminal directly to earth. The needle in the fuel level or water temperature gauge will rise to maximum. If this occurs and the gauges previously did not register, then either the senders are faulty or else they are not making a good earth contact in their location.

(2) To check the gauges, use the test lamp described in Section 4 A1. First connect one lead to earth, and the other to the input side of the gauge. If the bulb lights up, then this proves that supply is reaching the gauge. Then test the output side of the gauge. If the bulb lights up, then supply is passing through the gauge.

Headlights

DESCRIPTION

12. The headlights are supplied from the battery via the ignition switch positions to the main light switch. The switch is of the on/off type, and it makes contacts 1 and 7 on the switch. The supply passes through a dipswitch for main beam or dip, as selected by the operator by means of the control on the instrument panel. A fuse is located between the ignition switch position 1 and the main light switch position 1. The circuit is shown in fig. 4, and it can be seen that each light is protected by fuses 1, 2, 3 and 4.

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

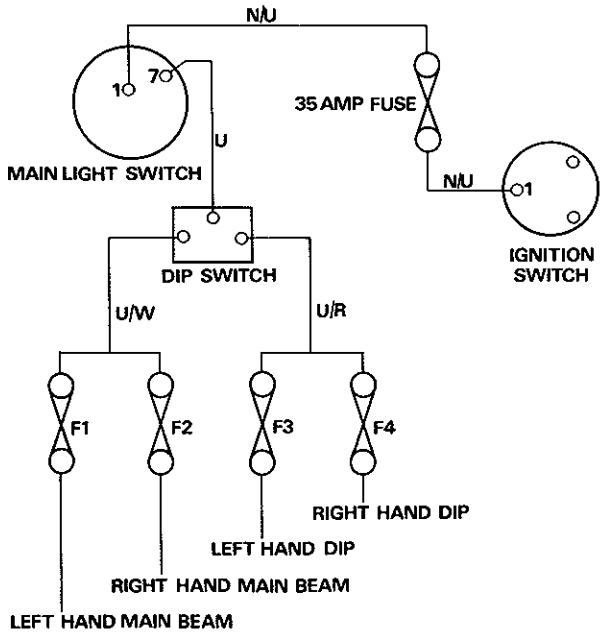


Fig. 4

REMOVAL

13. Before removing any component, remove the fuse. Remember to identify all leads before disconnecting them.

REPLACEMENT

14. Ensure that all leads are correctly fitted, and that all connections are clean and secure.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

15. If headlamps have been removed and replaced, check them for correct alignment.

SERVICING

N.A.

FAULT FINDING

16. Basic fault finding techniques are described in Section 4 A1.

Indicator lights

DESCRIPTION

17. The indicator lights are supplied from the battery via the ignition switch. When contacts 1 and 2 are made, the indicators are then supplied via the indicator switch – either left-hand front and rear (fuse 1) or right-hand

front and rear (fuse 2). The flasher unit is located between the ignition switch and the indicator switch. The circuit is shown in fig. 5.

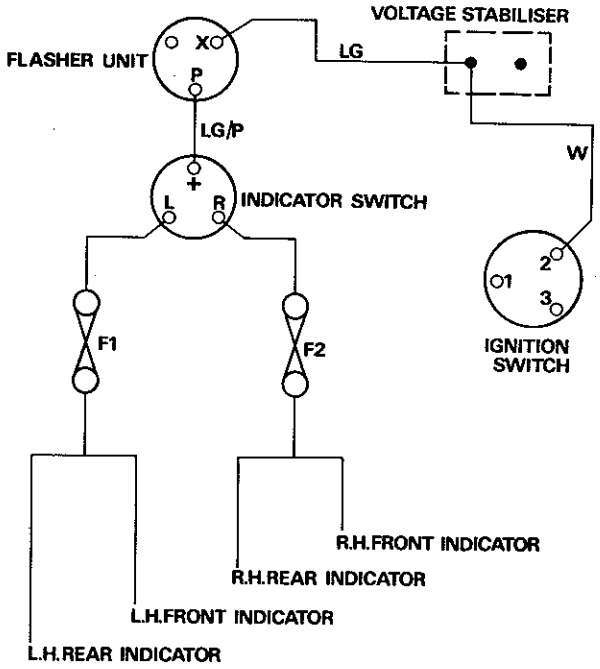


Fig. 5

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

REMOVAL

18. Before removing any components, remove fuses 1 and 2. Identify all leads before disconnecting them.

REPLACEMENT

19. Ensure that all the leads are correctly fitted and that the connections are clean and secure.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

20. For basic fault finding techniques, see Section 4 A1.

Side and tail lights

DESCRIPTION

21. The side and tail lights use position 1 of the ignition switch and positions 1 and 4 of the main light switch, with a fuse located between them. From the main light switch the circuit is made complete by passing through fuse 5 to the right-hand tail light and the right-hand side light, and through fuse 6 to the left-hand tail light, the number plate light and the left-hand side light. The circuit is shown in fig. 6.

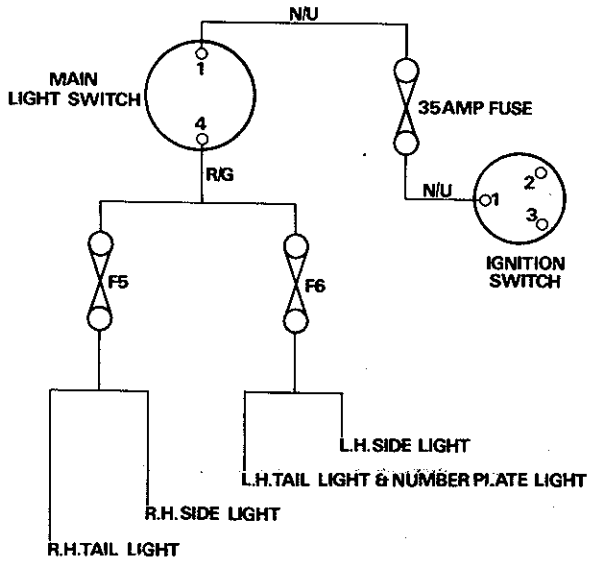


Fig. 6

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

REMOVAL

22. Before removing any components, remove the fuses. Always identify leads before disconnecting them.

REPLACEMENT

23. Make sure that all leads are correctly fitted before replacing fuses. Ensure that all connections are clean and secure.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

24. See Section 4 A1 for basic fault finding techniques.

Working lights, windscreen wipers, heater and horn.

DESCRIPTION

25. All these components are supplied via position 2 on the ignition switch. The circuits for the working lights, the windscreen wipers and the heater are fused between the ignition switch and the individual switches: 7 and 8 working light switches, 9 and 10 wiper switches, and the heater switch. The circuit for the horn passes from the control button direct to the horn. The circuits are shown in fig. 7.

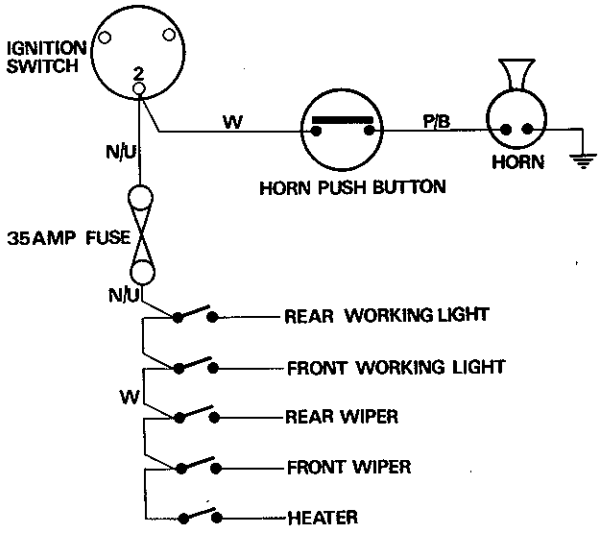


Fig. 7

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

REMOVAL

26. Before removing the components, remove the associated fuses. All leads should be identified before they are disconnected.

REPLACEMENT

27. Make sure that all leads are correctly fitted before fuses are replaced. All connections must be clean and secure.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

28. Basic fault finding techniques are to be found in Section 4 A1.

Interior light

DESCRIPTION

29. The interior light is supplied via position 1 of the ignition switch and passes through positions 1 and 2 of the main light switch. A fuse is located between the two switches and the circuit is completed via fuse 5 to the light. See fig. 8.

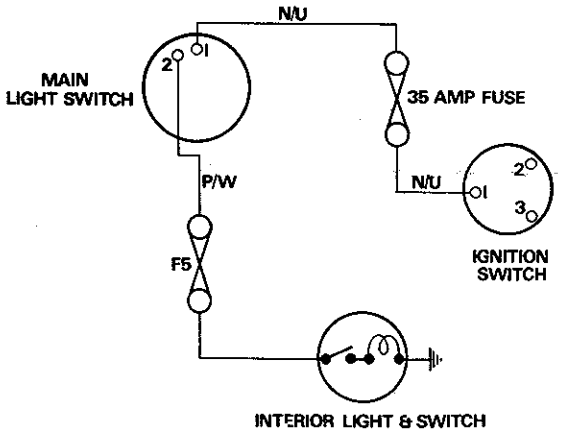


Fig. 8

SPECIAL TOOLS AND EQUIPMENT

See Sections 4 A1 and 4 C1.

REMOVAL

30. Before removing components, always remove the associated fuses. Also remember to identify leads before disconnecting them.

REPLACEMENT

31. Ensure that all leads are correctly fitted before fuses are replaced, and that all connections are clean and secure.

DISMANTLING

N.A.

INSPECTION

N.A.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

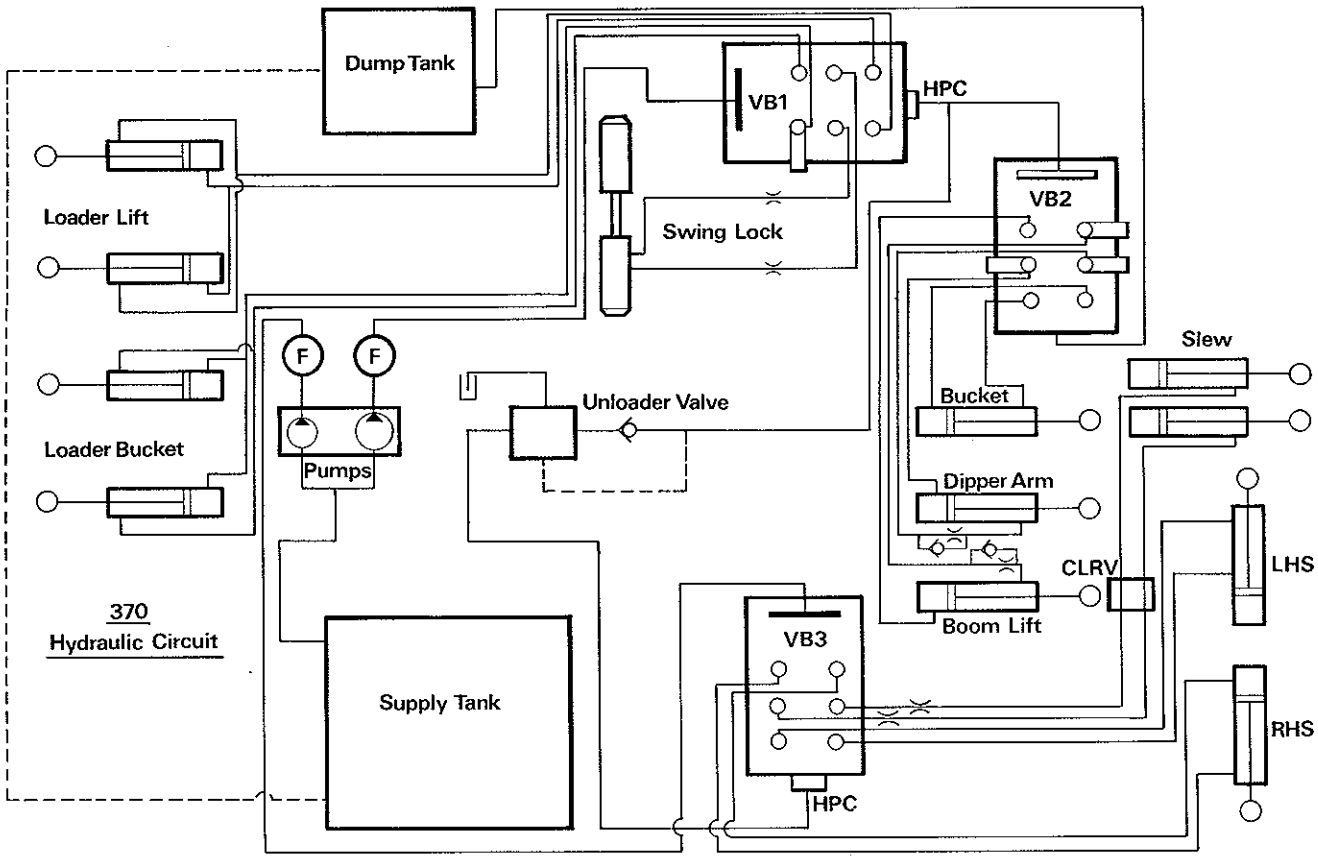
N.A.

FAULT FINDING

32. A guide to basic fault finding is given in Section 4 A1.

1/370/1

HYDRAULIC SYSTEM



DESCRIPTION

1. All the hydraulic services of the machine are powered by rams, and they are controlled through manually operated valves. There are six aspects of the hydraulic circuit to be considered:

(1) Basic Circuit
(2) Front Loader Circuit
(3) Offset Swing Lock Circuit
(4) Excavator Circuit
(5) Stabiliser Circuit
(6) Slew Circuit

2. A set of two hydraulic pumps joined in tandem, are driven directly through a flexible coupling drive arrangement by the prime mover. With the prime mover running, hydraulic oil is continuously taken from a suction tank, and made available for any service. When no services are in use, the hydraulic oil is directed to a return manifold and from there back to the main tank. The main tank is connected to the suction tank and will enable hydraulic oil to be re-used in a continuous cycle.

BASIC CIRCUIT

3. The basic circuit is illustrated in fig. 1, which shows that each pump takes its hydraulic oil from the suction tank and forces the fluid through its associated filter to its own valve block. The valve blocks contain three spools which individually relate to a service ram or motor. With no service selected, all spools will be in the neutral position and will allow the fluid to pass straight through the open centre type valve blocks to the dump tank. The valve blocks are bolted to the mainframe. Hoses lead directly from the pumps to the input sides of VB1 and VB3, and they are connected by means of a high pressure carryover plug to VB2 and the unloader valve respectively. The outlet sides of the valve blocks are connected to a tank return manifold.

4. Hydraulic oil is thus flowing continuously around a closed system, and the course it takes is as follows: main tank; suction tank; pumps; filters; valve blocks; return manifold; main tank. There will be some pressure in the system, but it will be low.

FRONT LOADER CIRCUIT

5. Control of the front loader is by means of the directional control valve VB1 (fig. 2).
The spool locations are as follows:

VB1 1st spool – loader bucket
3rd spool – loader lift

6. It should be noted that if any spool in VB1 is selected, then all oil supply from the large pump will be directed to return and will not supply VB2. (See also Excavator Circuit.)

7. **OPERATION.** Displacement of a valve block spool by operation of the appropriate manual control, will stop the flow of hydraulic oil through the open centre of

the valve block, and redirect the pump flow to the associated ram. As the ram moves, hydraulic oil will be displaced, and will be directed in the valve block to the output side, from where it will return to the tank manifold. Reversing the movement of the manual control will reverse the operation of the ram, as the pump delivery is now connected to the other side of the ram. The return passages in the valve block are symmetrical, and its return route is therefore always the same to the tank manifold.

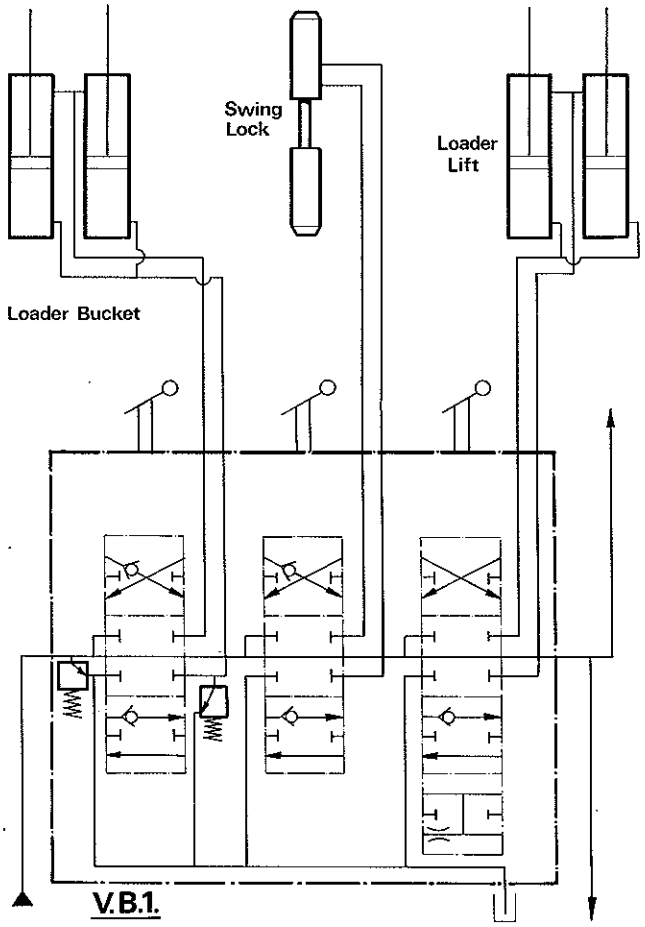


Fig. 2

8. Both services are controlled from the same lever (see also Operator's Handbook), using the joystick principle. Forward and rearward movement of the lever gives lift and lower of the loader arm. Side to side movement opens and closes the bucket.

9. Routing of the fluid to the loader services is by a combination of rigid and flexible pipes to adaptors, and can be traced on the machine.

10. **Main Relief Valves (MRV).** Various circumstances can lead to high pressure in both the service lines, the ram, and part of the valve block. One example is when a particular service has reached the limit of the ram stroke and the control is not returned to neutral. A main relief valve in the valve block will then open to release fluid to the return manifold, whilst still maintaining system pressure. Two of these are fitted, one on the inlet side of VB1, and the other on the inlet side of VB3. In the case of VB2, a sealed blank plug is fitted, since any system pressures generated on the services of this valve block will be relieved by the MRV of VB1.

11. **Service Line Relief Valves (SLRV).** In some instances, when any one service has reached the required position and neutral has been selected, the associated valve block spool will have moved to its neutral position and so have locked the fluid in a closed circuit, which will include the ram, the service lines and the passages in the valve block. It is possible, when another digging service is brought into use, to cause an effort to be exerted on the original service. The high system pressure which could result is guarded against by the fitting of an SLRV in those locations considered to be appropriate. These are:

(1) Loader bucket – full bore side
(2) Excavator lift – annular side
(3) Dipper arm – full bore side
(4) Dipper arm – annular side.

The units are screwed on to or into the valve block body and are connected to the service port. In the event of excessive pressure in the system, the valve lifts to displace hydraulic oil to the return manifold.

12. **Load Hold Check Valves (LHCV).** Load hold check valves are fitted in the spool for the service. They hold the pressure in that service when the spool is selected from neutral. The pump delivery is directed towards the valve, which will lift only when the pump pressure exceeds that existing in the service. Back pressure caused by the service load is thus prevented from suddenly being imposed on the pump.

OFFSET SWING LOCK SERVICE

13. Control of the offset swing lock is by means of the direction control valve VB1 (fig. 2).
The spool location is: VB1, 2nd (or middle) spool. (See also paragraphs 5 and 6.)

14. **Operation.** The operation of the swing lock is similar to that of the front loader, described in paragraph 7. The ram, in this case, is the swing lock pin itself, and it is therefore a two-directional ram, as the rod locates in both upper and lower points on the slew post/mainframe connection.

15. **Protection.** The service is protected by the MRV in VB1.

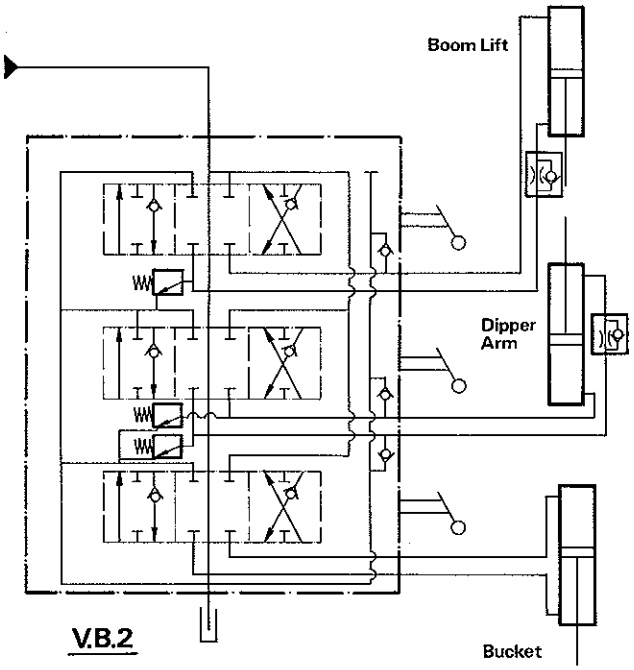
EXCAVATOR CIRCUIT

16. The excavator circuit is controlled by all the services on VB2 (fig. 3). The spool locations are as follows:

VB2 1st spool – excavator boom
2nd spool – dipper arm
3rd spool – bucket

17. It should be noted that, when any service in VB1 is selected, supply is restricted to that from VB3 via the

high pressure carryover. Therefore, if any service is selected in VB3, then no fluid is available for excavator services. (See also paragraphs 6 and 22.)



18. **Operation.** Operation of the services are as laid down in paragraph 7. The controls are of the joystick type, and they link the following services:

(1) Excavator boom and slew
(2) Excavator bucket and dipper.

19. **Protection.** The protection of the excavator circuit varies. Under conditions of less than 88 kgf/cm^2 (1,250 lbf/in^2), both pump outputs (large and small) are connected just before they enter VB2, and in these conditions protection is not required. Above this pressure, the unloader valve operates and allows the small pump to circulate the fluid back to the return manifold without any resistance. The large pump is able to use the energy given up by the small pump by operating at higher pressures. When the pressures are reached which are the same as the setting for VB1, then the MRV of VB1 will protect the service, as described in paragraph 10.
The SLRV's and their locations are given in paragraph 11.

20. **Anticavitation Valve.** An anticavitation valve is one which allows a flow of hydraulic oil from the return manifold into the service line, when the pressure in the service line is reduced below that of the return line. Three anticavitation valves are fitted to VB2. The locations are as follows:

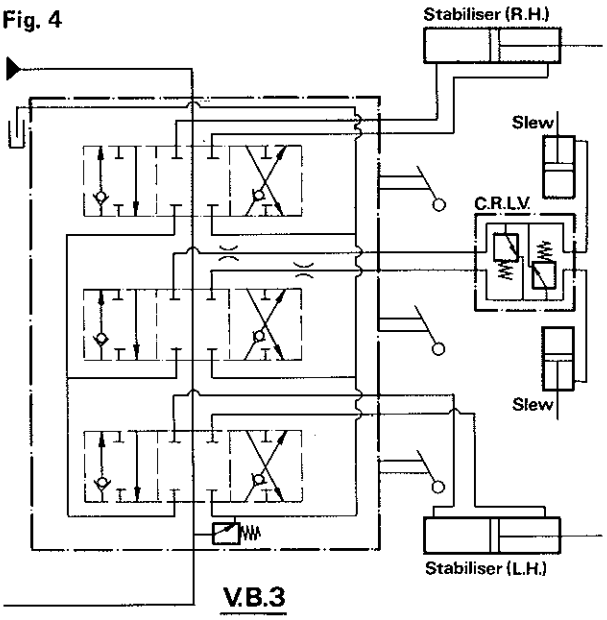
Excavator boom — full bore side.
Dipper arm — full bore side.
Dipper arm — annular side.

STABILISER CIRCUIT

21. The stabiliser circuit is controlled by means of a directional control valve VB3 (fig. 4).
The spool locations are as follows:

VB3 1st spool — R H stabiliser
3rd spool — L H stabiliser

Fig. 4



22. It should be noted that, if any spool in VB3 is selected, then there is no oil available for any further upstream services, e.g. VB2. (See also paragraphs 6 and 17.)

23. **Operation.** The operation of the stabiliser services is the same as that for the front loader, described in paragraph 7. The services are controlled by independent levers, next to the excavator joystick levers.

24. **Protection.** Protection for the stabiliser service on VB3 is by means of the MRV of VB3.

SLEW CIRCUIT

25. The control for the slew circuit is by means of the control valve VB3 (fig. 4). The spool location is: VB3, 2nd (or middle) spool. (See also paragraphs 6, 17 and 22.)

26. **Operation.** Whilst the operation for the slew is similar to that for the front loader, described in paragraph 7, some additional information is needed for a complete understanding. The slew rams are only connected hydraulically to the annular side, and selection of the spool in one position will connect: left-hand ram to pump delivery; right-hand ram to return manifold. Selection of the spool in the other position will connect: right-hand ram to pump delivery; left-hand ram to return manifold.

27. **Protection.** The protection for the slew service is the MRV in VB3.

28. **Cross Line Relief Valve (CLRV).** When neutral is selected, from a slewing motion, momentum can cause the ram to act as a pump. The circuit is a closed one, and there would be a build-up of pressure on one service line, and a reduction on the other. This pressure is utilised to effect a steady retardation of the slewing motion. Two CLRV's (housed in one block) are connected in opposite directions between the two service lines. Hydraulic oil is thus re-directed from the service line being pressurised to the line acting as a suction line. The effect is to act as a brake and, at the same time, to reduce cavitation. In the opposite direction, the other CLRV will come into use.

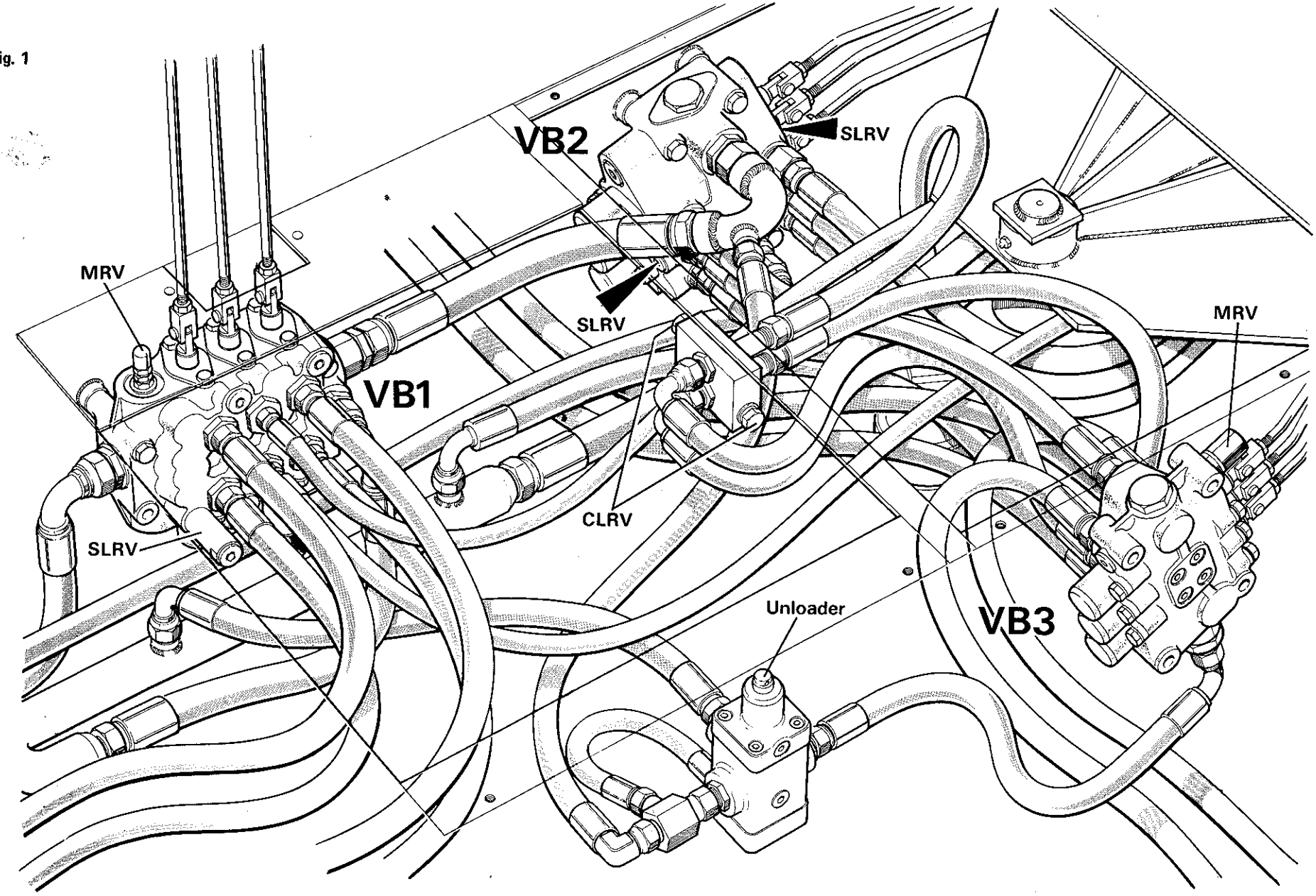
ADJUSTMENTS

29. For the reasons given under the description, and because incorrect setting of the various protective devices could result in serious damage to the machine, too much emphasis cannot be placed on the need to follow the pressure setting procedures given in Section 4 F1.

FAULT FINDING

30. Incorrect or unsatisfactory operation of the system should be investigated and rectified as soon as the symptoms are apparent. Reference should be made to the fault finding procedures given in Section 4 G1.

Fig. 1



DESCRIPTION

Introduction

1. The method to be employed in setting up the various protection valves in the hydraulic system is to fit a reliable pressure gauge to a suitable test point, restrict the motion of the service concerned and, using the power pack as a power source, check the pressure generated and adjust the appropriate valve setting.

WARNING
DO NOT REMOVE TEST POINT PLUGS OR GAUGES FROM ANY SERVICE WITH THE ENGINE RUNNING. ALWAYS OPERATE THE CONTROLS A FEW TIMES AFTER THE ENGINE HAS STOPPED TO RELIEVE ANY PRESSURE REMAINING IN THE CIRCUIT.

2. The machine is designed to operate on the figures given in this section and valves should be set strictly to within the tolerances specified.

CAUTION
The setting of valves to operate at higher values than those specified to overcome operating difficulties must never be undertaken as this can lead to dangerous conditions, damage and premature failure of components. Only test gauges which have recently been checked against a master gauge should be used since use of inaccurate equipment can lead to the same dangerous results.

3. The schematic layout of the valves to be tested is shown in fig. 1, and the valve settings are given in Table 1.

Pre-test checks

4. Before commencing the tests, prepare the machine on level ground, as follows:

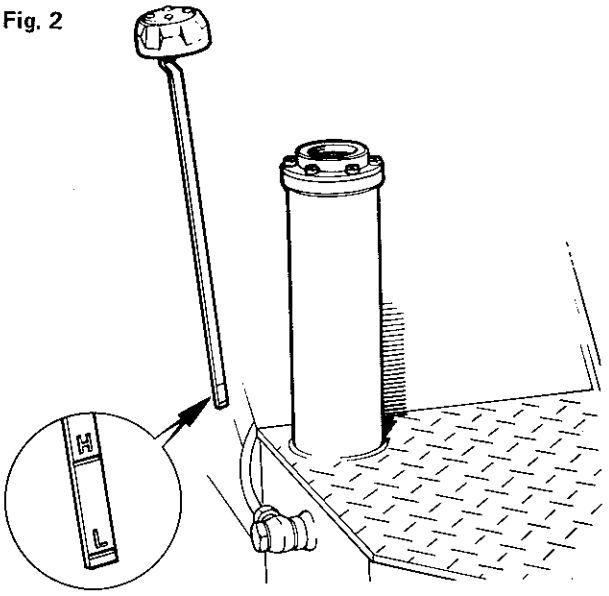
5. **Fluid. Obtain working temperature.** Operate the machine until the fluid temperature is 30°C to 50°C (86°F to 122°F).

6. **System. Free of air.** When the machine is at working temperature, operate all services of the machine at reduced engine speed, to allow the air in the hydraulic tanks time to release to atmosphere.

7. **Fluid level. Check.** (fig. 2) The hydraulic reservoir fluid level should be checked with the excavator in the parked position (as shown in General Data, fig. 2). This is also the position in which the machine should be left at any time when unattended.

The excavating arms should be laid out rearwards of the machine at full reach with the bucket teeth resting on the ground. This is with the bucket ram and dig ram nearly closed and the lift ram opened sufficiently to allow the bucket to rest on the ground. The loader

Fig. 2



bucket should be resting on the ground with the loader lift cylinders closed and the bucket crowd cylinders nearly closed.

In this position the hydraulic fluid level can be checked on the dipstick located in the combined filler, strainer, air breather unit on the reservoir.

The level should be up to the high mark on the dipstick.

8. **Main tank. Top up as necessary.**

(1) Remove the oil filler cap from the top of the hydraulic oil tank.
(2) Using a clean funnel, top up with clean approved hydraulic fluid to the required level.
NOTE: Dirt ruins hydraulics.
(3) Replace the oil filler cap.

SPECIAL TOOLS AND EQUIPMENT

9. The following will be required:

(1) Pressure gauges: 0-350 kgf/cm^2 (0-5,000 lbf/in^2) and 0-700 kgf/cm^2 (0-10,000 lbf/in^2).
(2) Hand operated pump, 0-700 kgf/cm^2 (0-10,000 lbf/in^2) capacity.
(3) Set of A/F. spanners.
(4) Screwdriver.
(5) Special extractor for the removal of the Service Line Relief Valve (S.L.R.V.)
(6) Tee adaptor, 1in BSP male/female. ½in BSP tee. (Hydraulic filters).
(7) Tee adaptor, 3/8in BSP male/female. ½in BSP tee. (Steering pump relief valve.)

10. Fig. 3 illustrates a pressure guage fitted to the tee piece, ready for the Main relief Valve (M.R.V.) and unloader test. Fig. 5 shows the arrangement for the Cross Line Relief Valve (C.L.R.V.) test. Fig. 7 shows the arrangement for the Service Line Relief Valve (S.L.R.V.) test. Fig. 8 shows the arrangement for the steering pressure test.

TABLE 1

Valve	Qty.		Service	Setting	Tolerance
MRV	1		VB1	158 kgf/cm^2 (2,250 lbf/in^2)	± 3.5 (50)
MRV	1		VB3	158 kgf/cm^2 (2,250 lbf/in^2)	± 3.5 (50)
SLRV*	1	VB1	Loader Bucket Full Bore	130 kgf/cm^2 (1,850 lbf/in^2)	± 3.5 (50)
SLRV*	1	VB2	Excavator Boom Annular	316 kgf/cm^2 (4,500 lbf/in^2)	± 3.5 (50)
SLRV*	2	VB2	Dipper	316 kgf/cm^2 (4,500 lbf/in^2)	± 3.5 (50)
CLRV*	1		Slewing	162 kgf/cm^2 (2,300 lbf/in^2)	± 3.5 (50)
Unloader	1		From VB3	88 kgf/cm^2 (1,250 lbf/in^2)	± 3.5 (50)
Steering	1		Steering Pump	66 kgf/cm^2 (950 lbf/in^2)	± 3.5 (50)

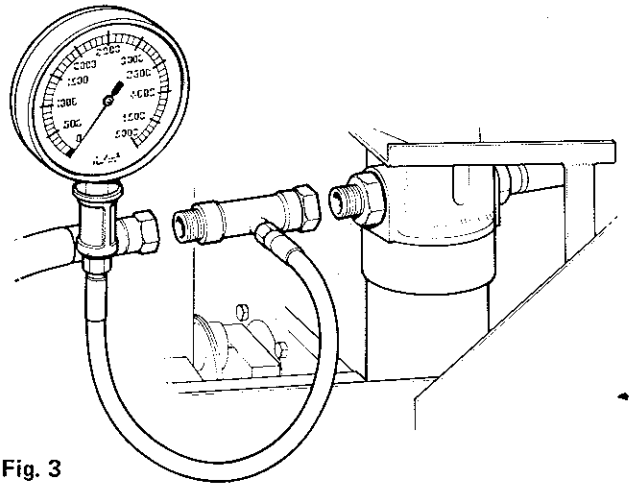


Fig. 3

ADJUSTMENTS

SETTING THE MRV's

Valve Block VB1 (fig. 1)

11. **Pre-test checks. Carry out.** Carry out the procedures in paragraphs 4 – 8. if this has not already been done.

12. **System. Relieve.** Operate the controls a few times to relieve any pressure, with engine switched off.

13. **Tee piece. Fit.** Remove the hose from the pump to the large filter at the filter end. Fit the tee piece. Use temporary blanks to reduce hydraulic oil spillage.

14. **Pressure gauge. Fit.** (fig. 3) Connect 0 – 350 kgf/cm^2 (0 – 5,000 lbf/in^2) gauge to the tee piece.

15. **Engine. Start.** Run only at idling speed.

16. **Control. Select.** Select the loader bucket control, annular side, i.e. closing the bucket.

17. **Engine. Increase speed.** If the gauge reading is near normal or below, then bring the engine to the normal full speed.

18. **MRV. Set.** (fig. 1) Set the MRV as follows:

(1) Remove the cap nut.
(2) Slacken the locknut.
(3) With a screwdriver, turn the adjusting screw anti-clockwise until the pressure gauge reading is at least as low as the lower tolerance figure given in Table 1 for the MRV of VB1.
(4) Turn the adjusting screw clockwise to bring the gauge reading **upwards** to the normal figure given in Table 1.
(5) Tighten the adjuster locknut.
(6) Replace the cap screw.

19. **Gauge. Re-check reading.** If the reading altered while the locknut was being tightened, repeat paragraph 18.

20. **System. Relieve.** With the engine switched off, operate the controls a few times to relieve the pressure.

21. **Tee piece. Remove.** Remove the pressure gauge and the tee piece.

22. **Pump/Filter. Reconnect.** Reconnect the hose between the pump and the filter at the filter end.

Valve Block VB3 (fig. 1)

23. Repeat the procedures given in paragraph 11 – 22 for VB3, but fitting the gauge to the small filter and selecting the R.H. stabiliser, annular side, i.e. closing the ram to raise the pressure.

SETTING THE UNLOADER VALVE (fig. 1)

24. Repeat the procedures in paragraphs 11 – 14, but connect the gauge to the small filter using the small tee piece.

25. **Engine. Start.** Run only at idling speed.

26. **Control. Select.** Select the excavator bucket service until the ram piston is at the limit of its stroke. Observe the highest gauge reading. The needle will rise to a maximum and then fall.

27. **Unloader valve. Set.** If the pressure is high, turn the adjusting screw anti-clockwise. If the pressure is low, turn the adjusting screw clockwise. Rewire the adjusting screw to prevent turning.

SETTING THE CLRV

28. **System. Relieve.** Operate the slew control a few times with the engine stopped.

NOTE:
Operate the control gradually.

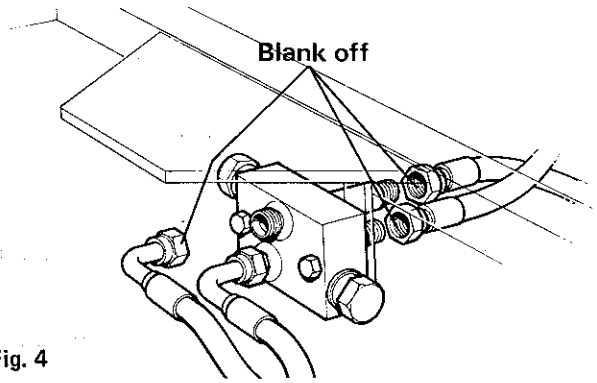
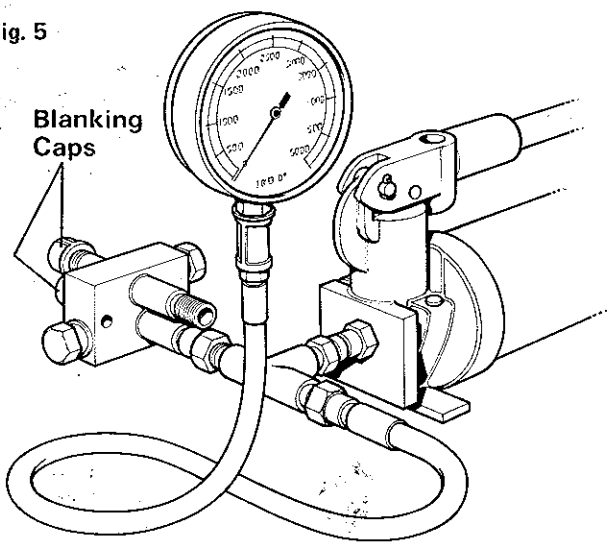


Fig. 4

29. **Hoses. Remove.** (fig. 4). Remove four hoses from the same side of the CLRV, and blank them off to reduce oil spillage. Raise the hoses and secure them.
NOTE
Identify the connections to ensure correct re-assembly.

Fig. 5



30. **Test pump. Fit.** (fig. 5) Connect the hose of the test pump to one of the ports on the CLRV, using a 0 – 350 kgf/cm^2 (0 – 5,000 lbf/in^2) gauge.

31. **CLRV. Pressure test. One side only.** Use a hand pump to generate pressure until the valve relieves. Note the pressure.

32. **Pressure gauge. Read off.** Check whether the gauge reading is within the tolerance given in Table 1.

33. **CLRV. Adjust.** If the gauge reading is not with tolerance, adjust as follows:

(1) Remove the appropriate valve plug assembly
(2) Add a shim between the spring and the plug to increase the pressure.
(3) Remove the shim between the spring and the plug to decrease pressure.

NOTE
Ensure cleanliness. Dirt ruins hydraulics.

(4) Refit the plug assembly.
(5) Repeat paragraphs 31 and 32.

34. **CLRV. Pressure test. Opposite side only.** Remove the hose connection of the test pump from the port on the CLRV, and connect it to the other port.

SETTING THE SLRV'S

Loader Bucket Service (full bore side) VB1 (fig. 1)

35. Repeat the procedures described in paragraphs 31, 32 and 33.

36. **Test pump. Remove.** Disconnect the hose between the CLRV and the test pump at the CLRV.

37. **Hoses. Reconnect.** Reconnect the hoses to the CLRV, ensuring correct re-assembly.

38. **System. Relieve.** Operate the controls a few times with the engine stopped.

39. **SLRV assembly. Remove.** Remove the complete SLRV assembly, taking care to fit a blanking cap, to reduce oil spillage.

40. **SLRV. Remove.** (fig. 1) Remove the cap (61) from the body (63). Extract the SLRV (64), using the SLRV extractor.

41. **SLRV test block. Fit.** Fit the SLRV in the test block (fig. 6), and connect the hose to the block.

42. **SLRV. Pressure test.** (fig. 7) Use the pump to generate pressure until the valve relieves. Note the pressure.
NOTE: Ensure cleanliness. Dirt ruins hydraulics.

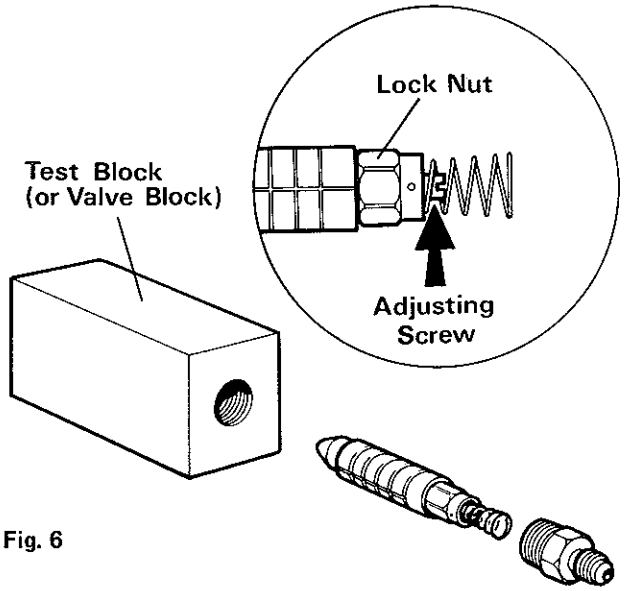


Fig. 6

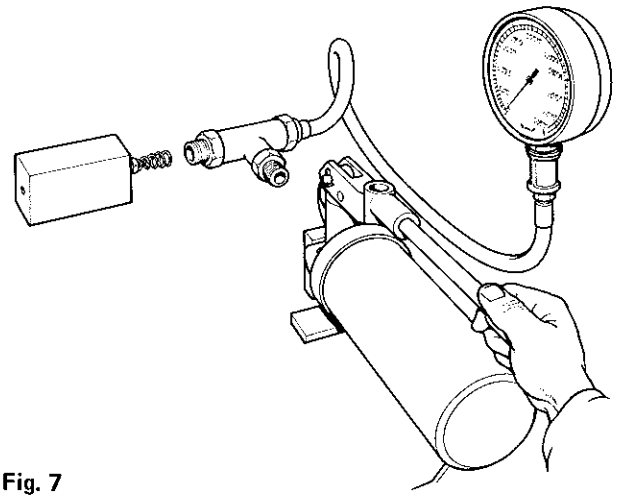


Fig. 7

Table 2

Cartridge code	Valve seat diameter	Operating pressure on machine	Pilot setting
B8	5mm (.197in)	130 kgf/cm^2 (1,850 lbf/in^2)	105 kgf/cm^2 (1,420 lbf/in^2)
E5	4mm (.156in)	316 kgf/cm^2 (4,500 lbf/in^2)	285 kgf/cm^2 (4,050 lbf/in^2)

43. **Pressure gauge. Read off.** Check whether the gauge reading is within the tolerance given in Table 2, for the appropriate pilot setting.

44. **SLRV. Adjust.** (fig. 6) If the pressure gauge reading is not within tolerance, adjust as follows:

(1) Remove the SLRV from the test block.
(2) Slacken the locknut.
(3) Using a screwdriver, turn anti-clockwise to the lower pressure, and clockwise to raise the pressure. Adjust to suit the appropriate pilot setting shown in Table 2.
(4) Tighten the locknut.
(5) Replace the SLRV in the test block.
(6) Repeat paragraphs 41 – 43.

45. **Pressure gauge. Recheck reading.** If the reading altered while the locknut was being tightened, repeat paragraph 44.

46. **SLRV test block. Remove.** Remove the SLRV from the test block. Fit the SLRV into the valve body. Tighten the locknut.

47. **SLRV. Fit.** Fit the SLRV in location on the valve block.

BOOM AND DIPPER SERVICES VB2

Excavator Boom, full bore
Excavator Dipper, full bore
Excavator Dipper, annular

NOTE
The following procedure is common to all three locations above (see Table 1). The boom, full bore side, has been used to describe this procedure.

48. **System. Relieve.** Operate the boom control a few times with the engine stopped.

49. **SLRV assembly. Remove.** Remove the complete SLRV assembly using the special extractor tool, and taking care to refit the plug to valve block VB2.

NOTE
Oil spillage can effectively be reduced by adopting the following practice: Using a standard SLRV spares container with the blanked end cut off, and an 'O' ring for the outside diameter of the tube and the inside bore of the plug end of the valve block, remove the plug and insert the tube, pushing the 'O' ring into the recess. The special tool can then be used with minimum oil loss to remove the SLRV.

50. **SLRV. Check and adjust.** Carry out the procedures in paragraphs 41 – 44.

51. **SLRV. Test Block. Remove.** Remove the SLRV from the test block.

52. **SLRV. Fit.** Remove the plug on VB2. Insert the SLRV in the housing, ensuring that the plug diameter is in accordance with the requirements of Table 2.

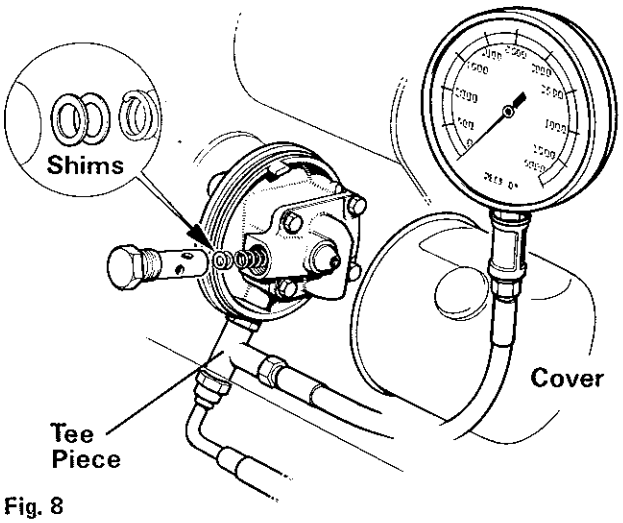


Fig. 8

STEERING PUMP PRESSURE CHECK

53. **Engine. Stop.**

54. **Tee piece. Fit.** (fig. 8) Remove the delivery hose from the steering pump unit. (Refer also to Section 3 F1 Steering). Fit the small tee piece between the pump and the hose. Use temporary end caps to reduce oil spillage.

55. **Pressure gauge. Fit.** Fit a 0 – 350 kgf/cm^2 (0 – 5,000 lbf/in^2) gauge to the tee connection.

56. **Engine. Start.** Run only at idling speed. Increase the engine revs to 2,000 rpm.

57. **Pressure. Test.** Turn the steering wheel to full lock in either direction and hold. Note the pressure.

CAUTION

Do not hold full lock for longer than 10 seconds at any one time.

58. **Pressure gauge. Read off.** Check whether the gauge reading is within tolerance given in Table 1.

59. **Steering pump relief valve. Adjust.** If the gauge reading is not within tolerance, reset as follows:

STEERING PUMP PRESSURE. SET

60. **Engine. Stop.** Switch off engine.

61. **Pump. Remove.** Refer to Section 3 F1.

62. **Relief valve. Remove.** Refer to Section 3 F1.

63. **Relief valve. Dismantle.** Grip the body of the valve in a soft-jaw vice. Unscrew the head from the body. Extract the valve and the spring.

64. **Pressure. Adjust.** Shims are fitted between the spring and the body (fig. 8). Add shims to increase the pressure. Remove shims to reduce the pressure. The following tables gives approximate adjustments to pressures:

0.25mm (0.01in) 4.6 – 5.2 kgf/cm^2 (66 – 74 lbf/in^2)
0.38mm (0.015in) 7 – 7.7 kgf/cm^2 (99 – 110 lbf/in^2)
1.52mm (0.06in) 27.8 – 30.9 kgf/cm^2 (396 – 440 lbf/in^2)

65. **Relief valve. Re-assemble.** Adjust with shimming requirement. Re-assemble the spring and the valve to the body, and tighten the head to 0.83 – 1.38 kg/m (6 – 10 lb/ft).

66. **Relief valve. Fit.** Refer to Section 3 F1.

67. **Pump. Fit.** Refer to Section 3 F1.

68. **Relief valve. Check.** Follow the procedures described in paragraphs 53 – 59.

FAULT FINDING: HYDRAULICS

The charts in this section summarise some of the possible causes of faults which may arise in the hydraulic system, and provide guidelines for their correction.

The following references and explanations of terms and abbreviations are intended to assist the operator in making the best use of the charts:

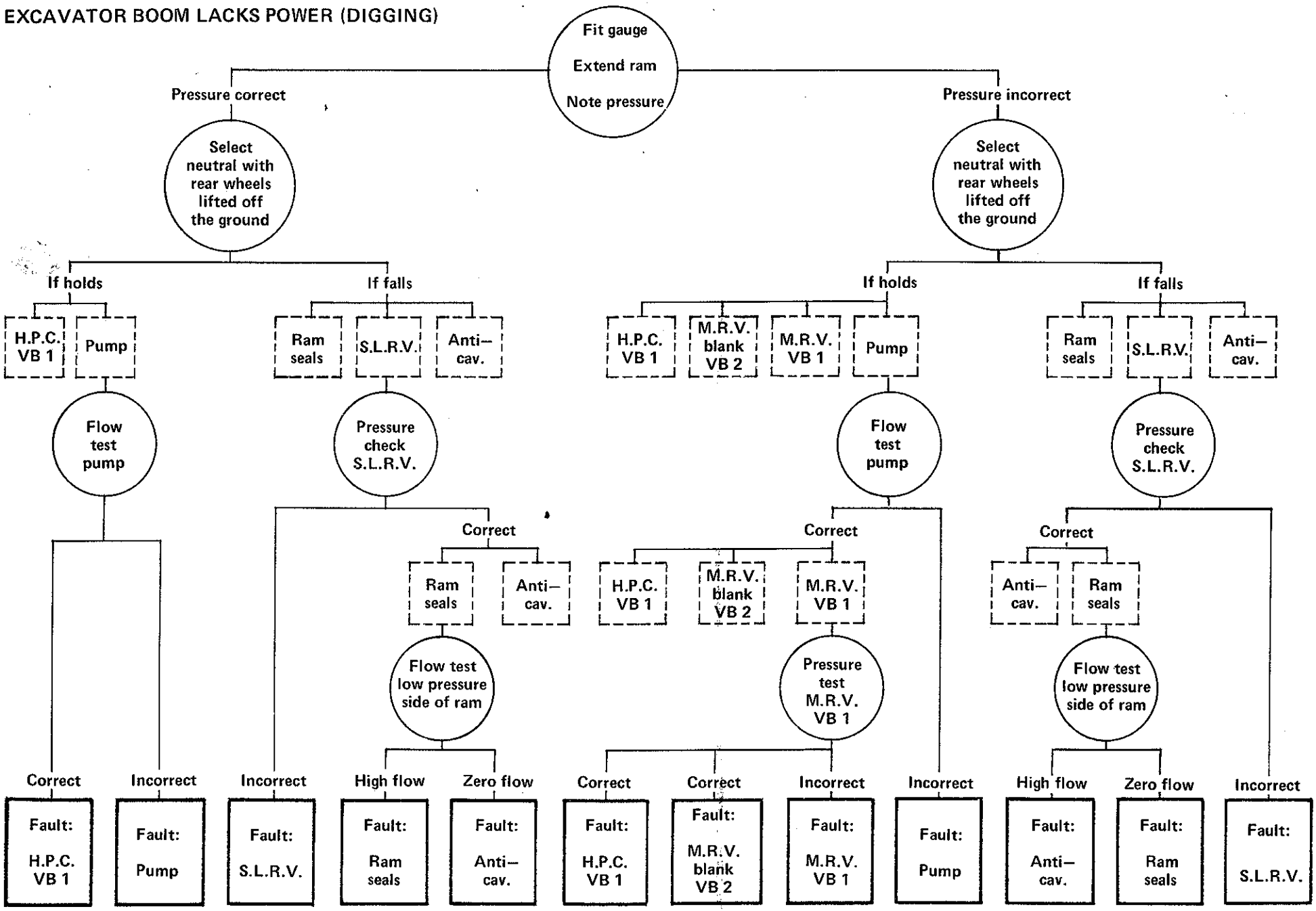
Anticav.	Anticavitation valve. See Section 3 C1.
C.L.R.V.	Cross line relief valve. See Section 3 D1.
Flow: High flow	In excess of 1.15 litre/min J (0.25 UKgal/min)
Low flow	Below 1.15 litre/min (0.25 UKgal/min)
H.P.C. VB 1	High pressure carryover in valve block 1. See Section 3 C1.
M.R.V. VB 1	Main relief valve in valve block 1. See Section 3 C1.
M.R.V. blank VB 2	Main relief valve blank in valve block 2. See Section 3 C1.
M.R.V. VB 3	Main relief valve in valve block 3. See Section 3 C1.
Pump	See Section 2 B1.
Ram Seals	For steer ram, see Section 1 B1. For all other rams see Section 5 F1.
S.L.R.V.	Service line relief valve. See Section 3 C1.

CAUTION:

1. **It is important that the figures and procedures are strictly adhered to.**

2. **When meters and gauges are used to carry out tests, it is essential that their accuracy has recently been checked against a master instrument.**

EXCAVATOR BOOM LACKS POWER (DIGGING)



HYMAC

Excavator boom lacks power (Digging)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (See Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

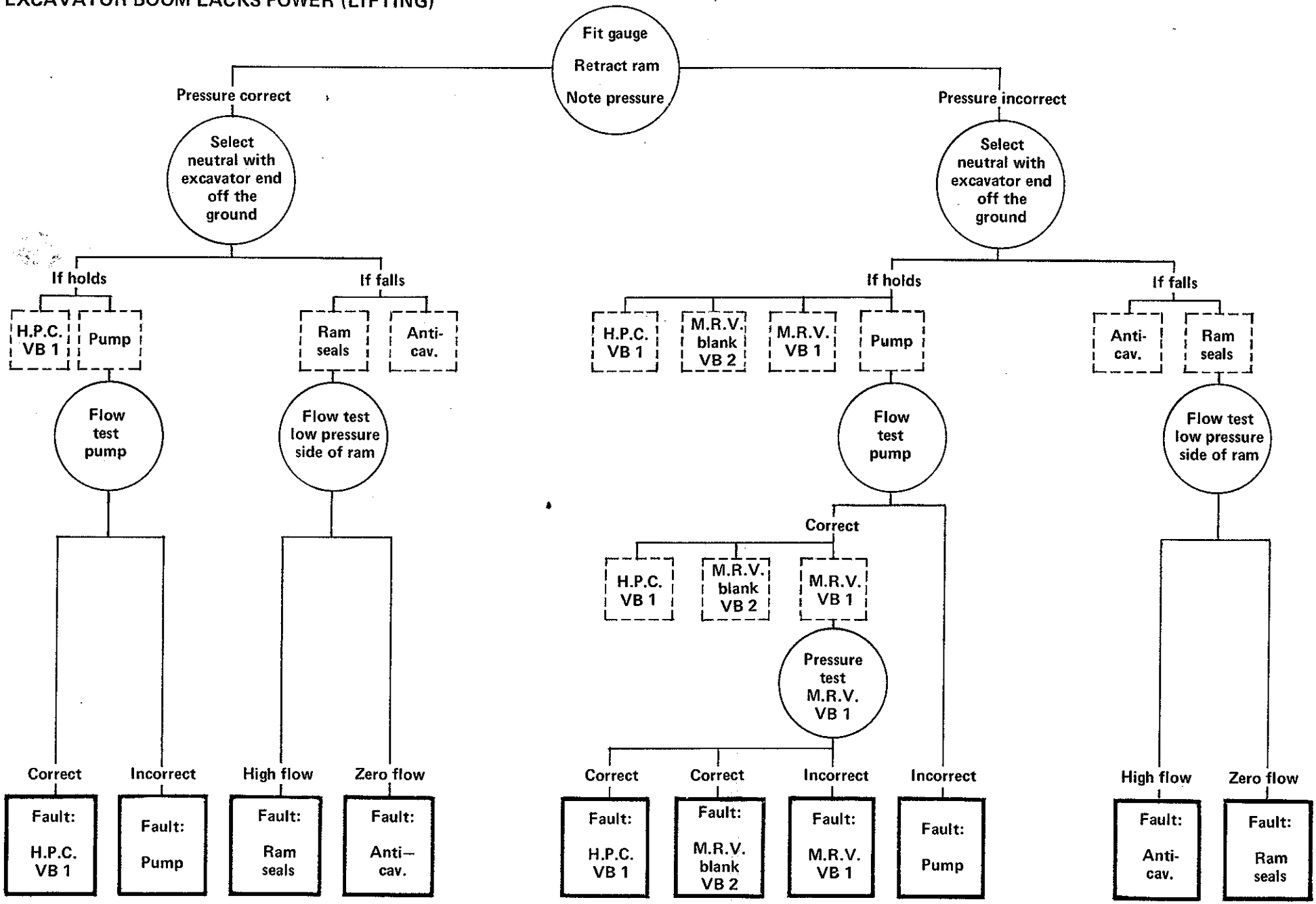
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. dipper and bucket. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

EXCAVATOR BOOM LACKS POWER (LIFTING)



Excavator boom lacks power (Lifting)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (See Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

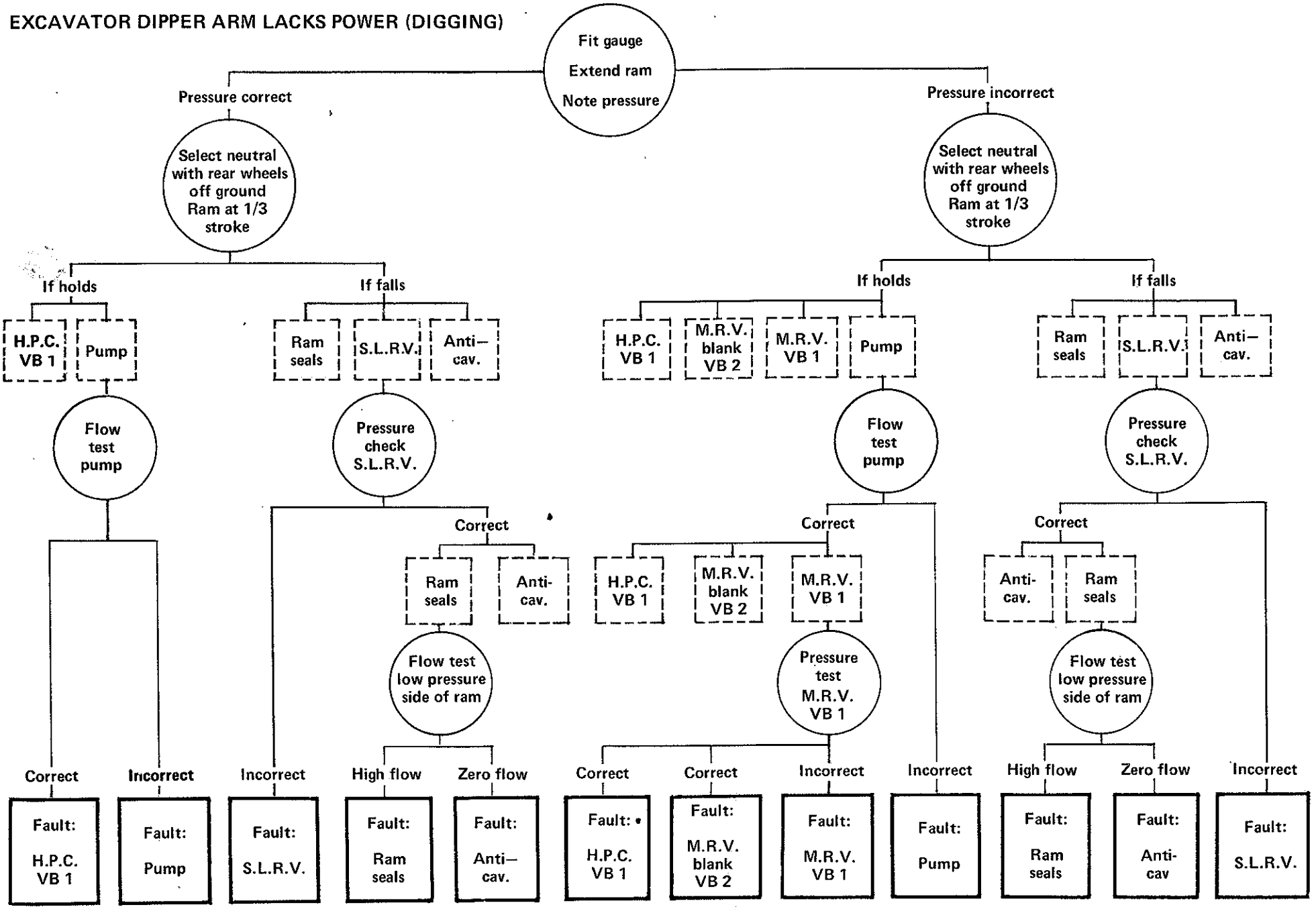
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. dipper and bucket. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. with the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

EXCAVATOR DIPPER ARM LACKS POWER (DIGGING)



HYMAC

Excavator dipper arm lacks power (Digging)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (See Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

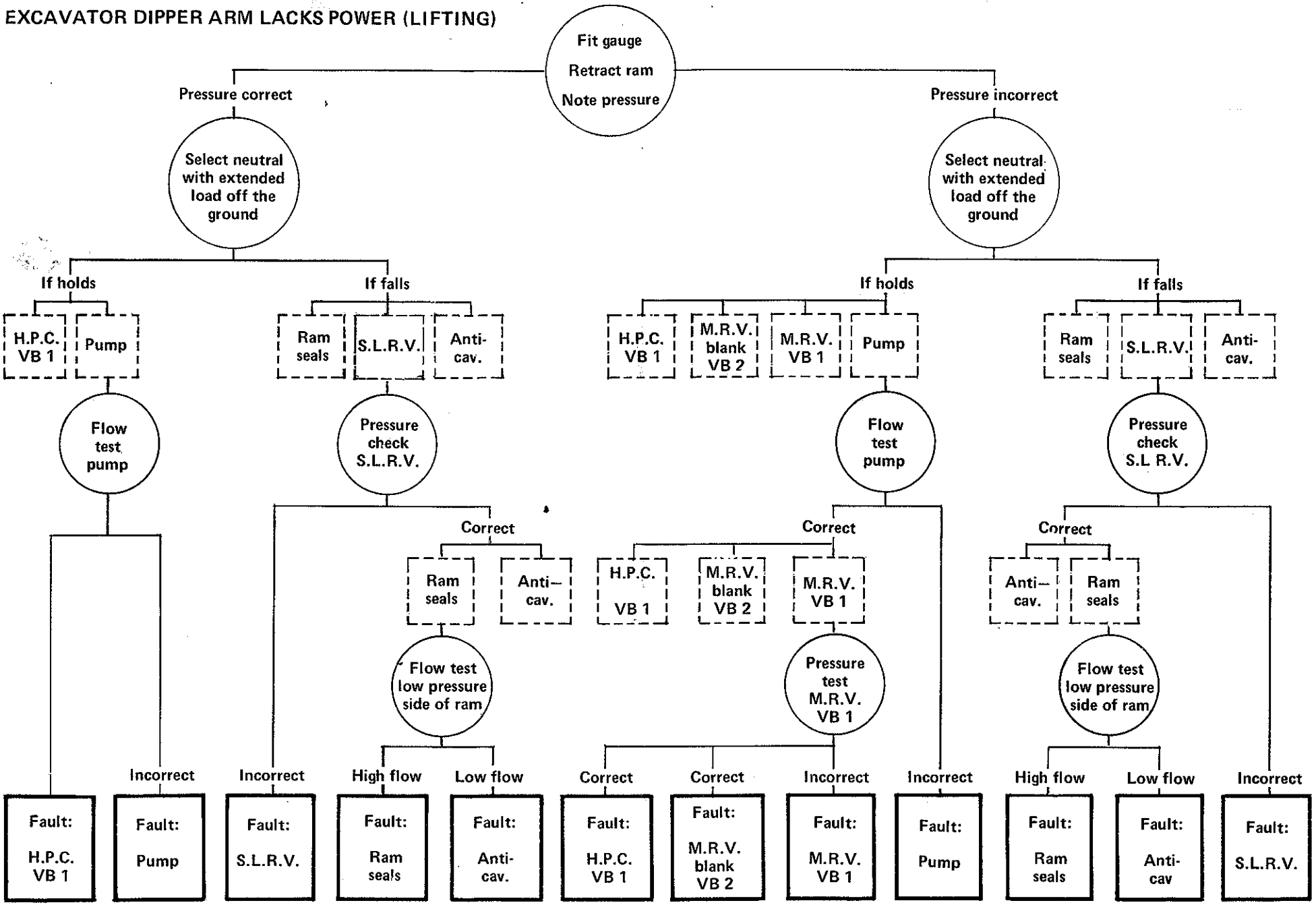
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V, use another service on the same valve block, e.g. boom and bucket. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

EXCAVATOR DIPPER ARM LACKS POWER (LIFTING)



Excavator dipper arm lacks power (Lifting)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

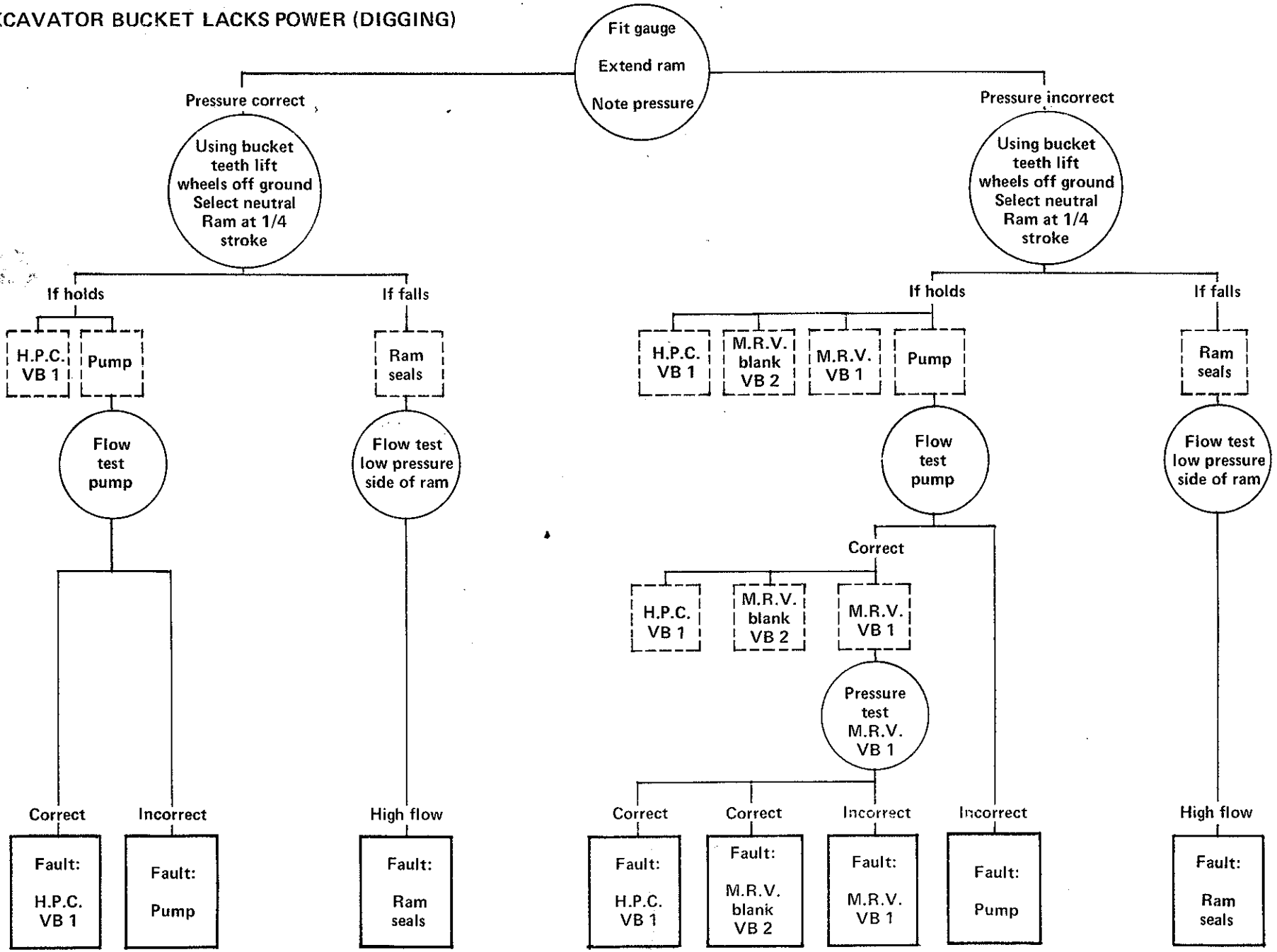
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) the engine is switched off, and
   (b) the pressures are removed (as described in Caution 1. above).

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. boom and bucket. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

EXCAVATOR BUCKET LACKS POWER (DIGGING)



Excavator bucket lacks power (Digging)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

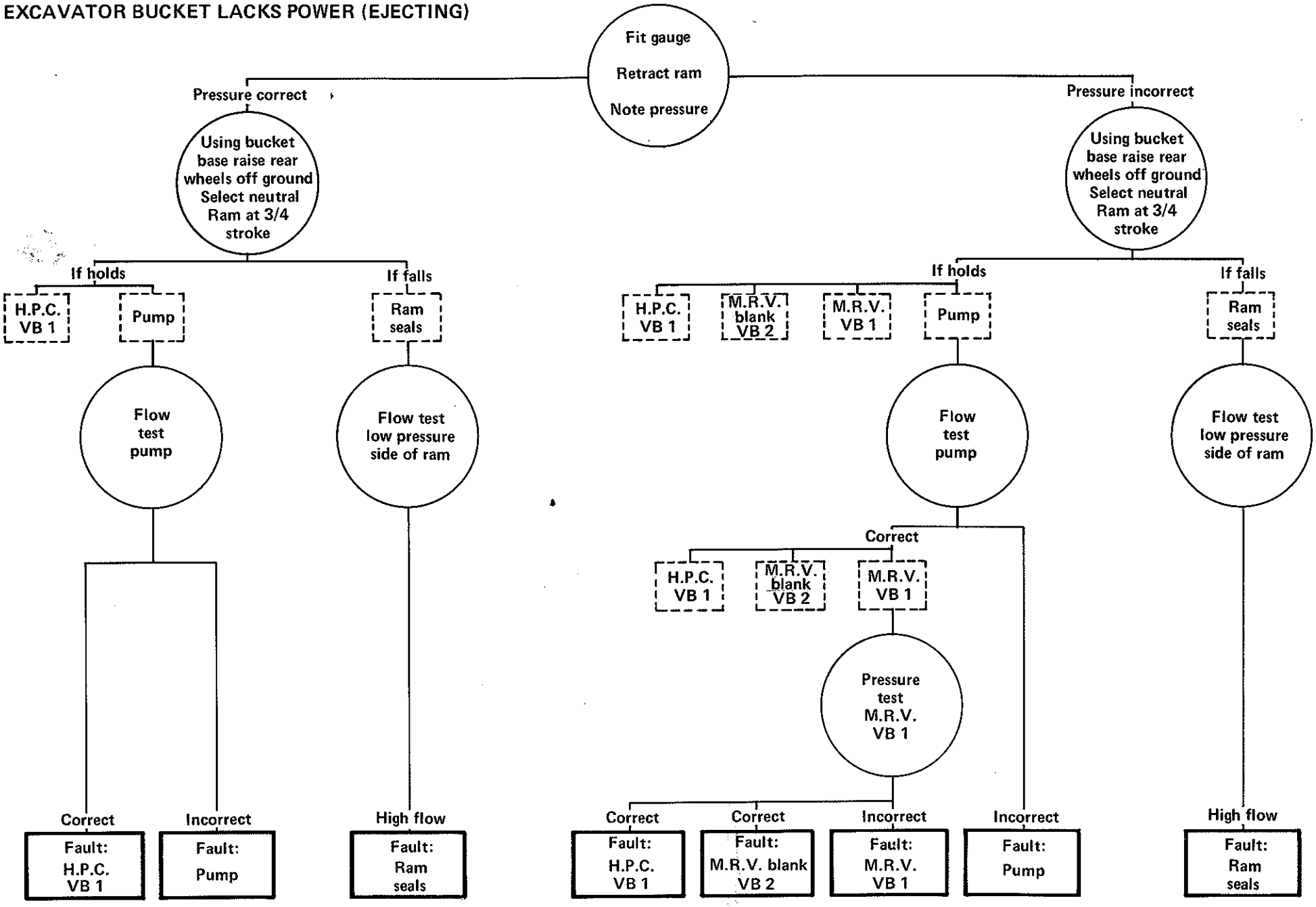
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) the engine is switched off, and
   (b) the pressures are removed (as described in Caution 1. above).

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. boom and dipper. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

EXCAVATOR BUCKET LACKS POWER (EJECTING)



Excavator bucket lacks power (Ejecting)

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

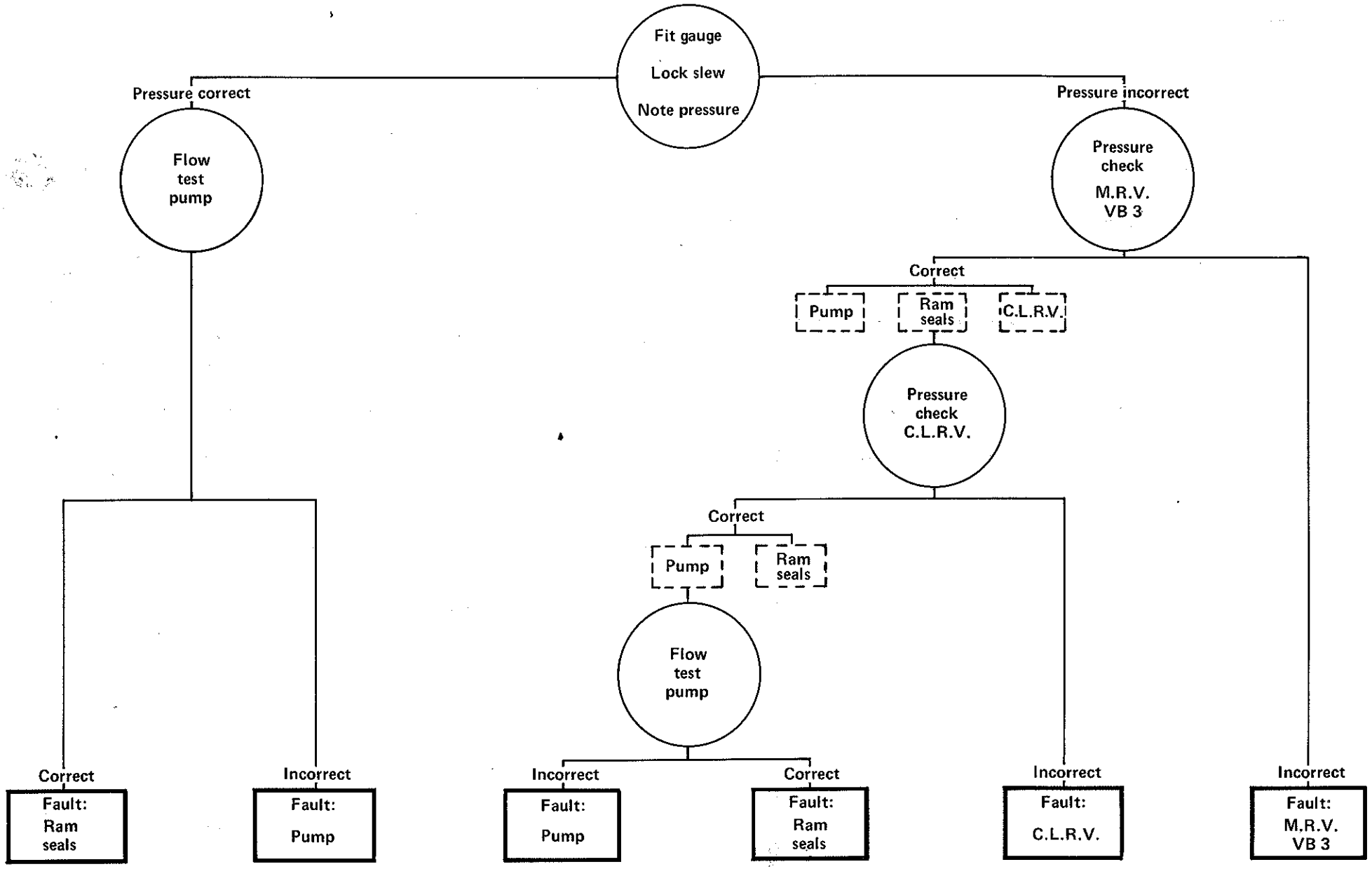
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. boom and dipper. If there is power in the other service, then the pump and M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

SLEW LACKS POWER



Slew lacks power

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

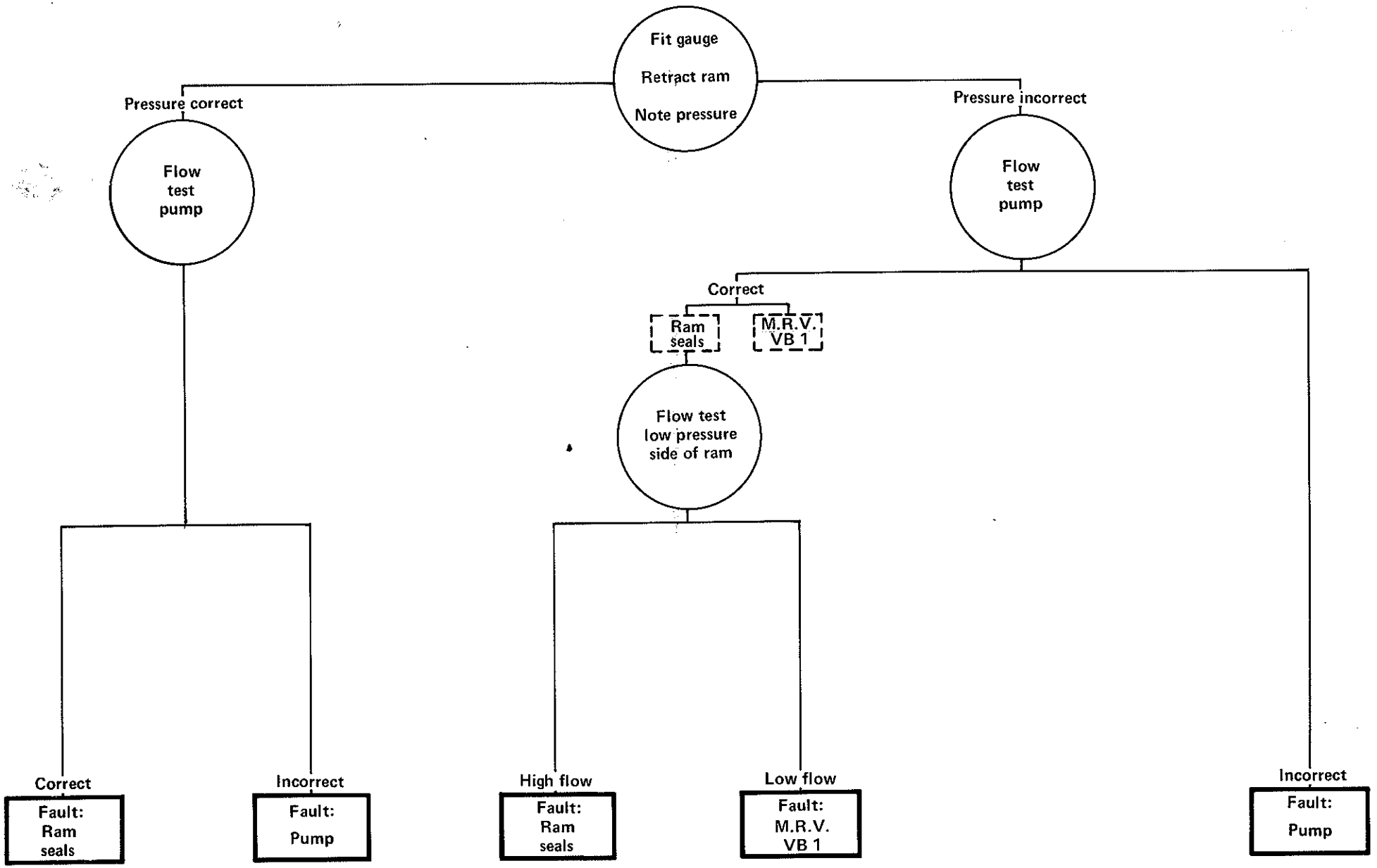
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

To check the pump and M.R.V., use another service on the same valve block, e.g. the stabilisers. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.

LOADER BOOM LACKS POWER



Loader boom lacks power

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

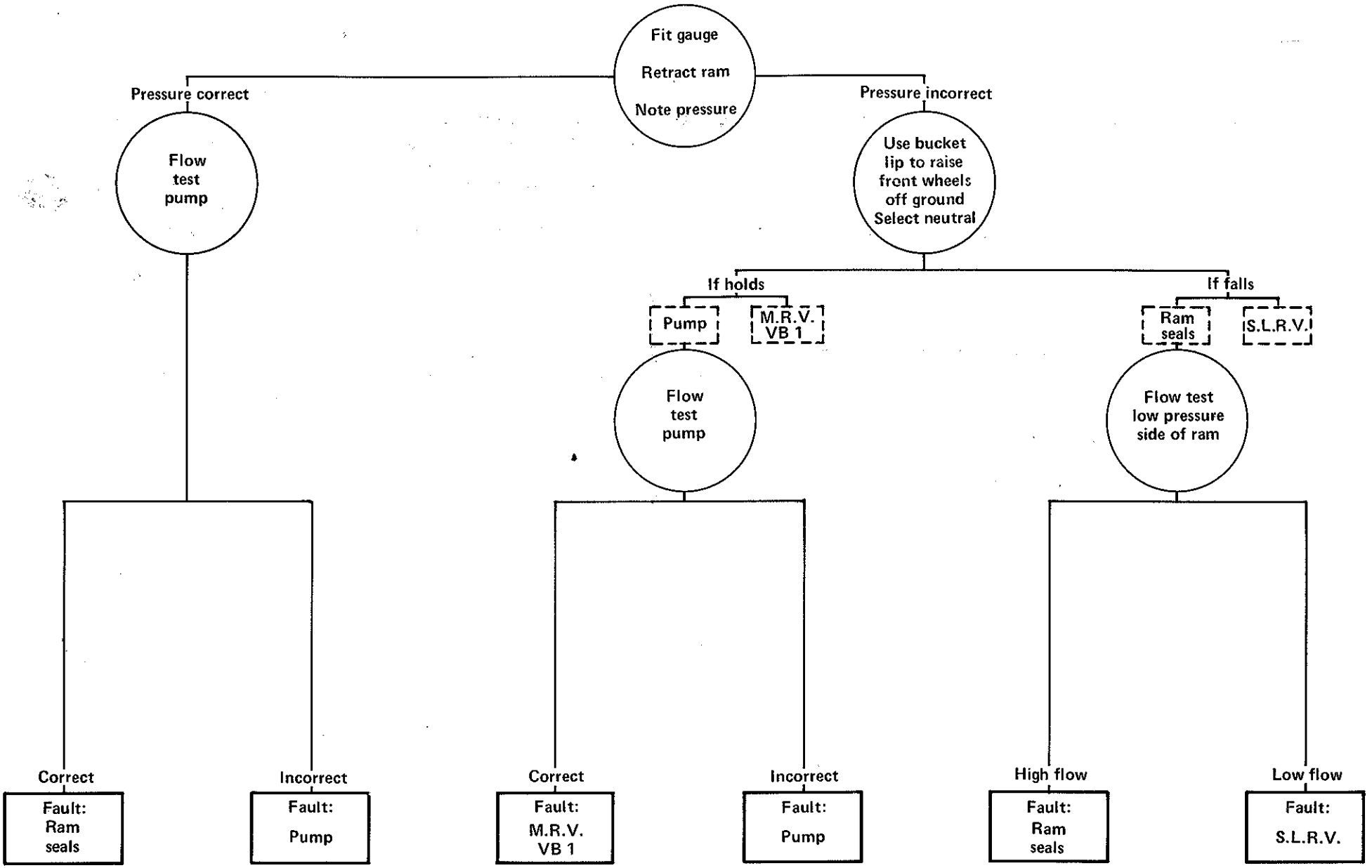
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. loader bucket. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

LOADER BUCKET LACKS POWER



Loader bucket lacks power

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

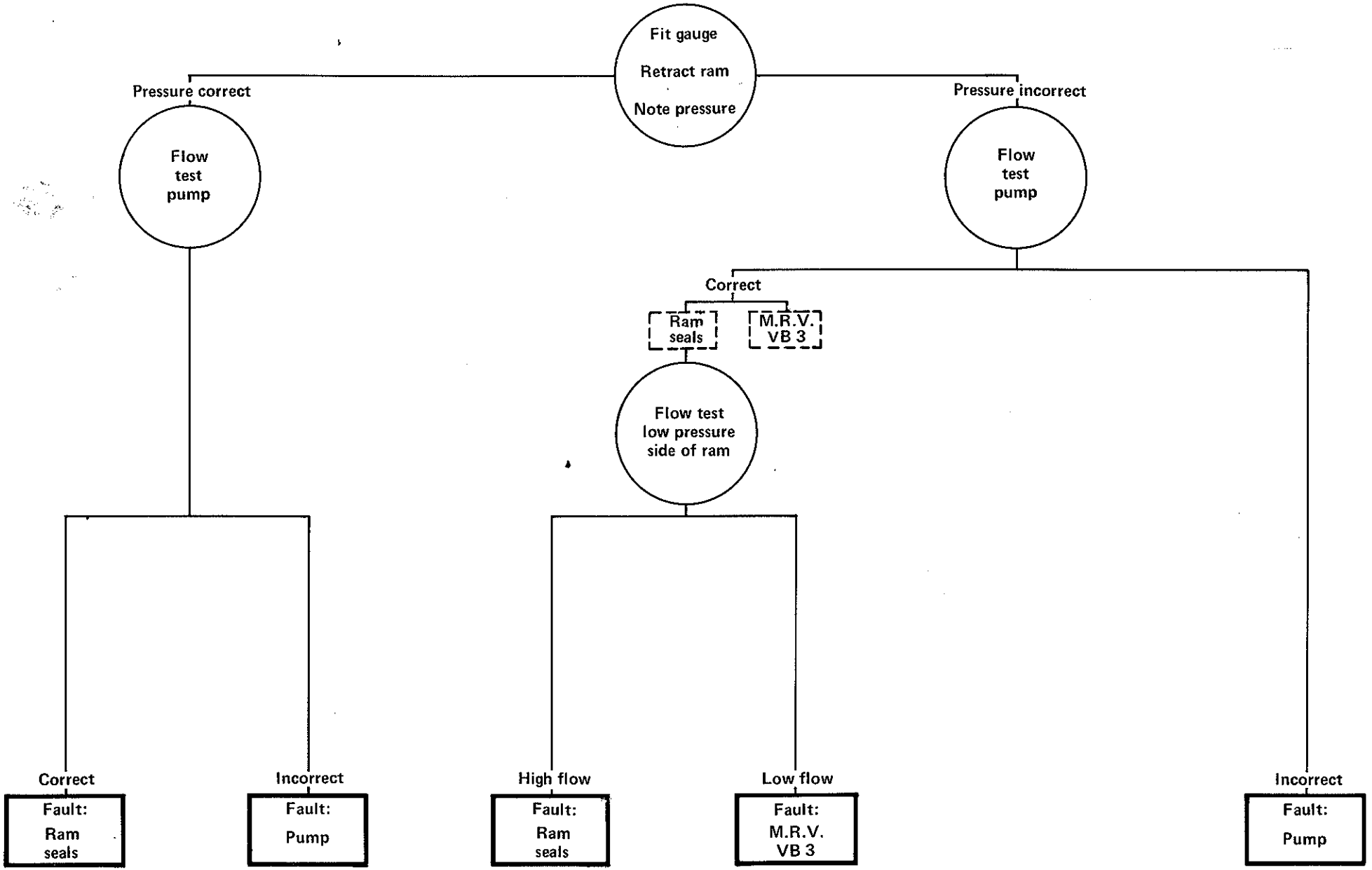
CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. loader boom. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

STABILISERS LACK POWER



Stabiliser lacks power

The above chart does not exhaust the list of possible sources of this type of defect, but it provides a logical procedure for detecting some of the major causes.

Other possible causes

1. Incorrect engine revs and setting (see Section 4 F1).
2. Insufficient hydraulic fluid in the system (see Section 4 F1).
3. Too much air in the hydraulic system (see Section 4 F1).
4. Failure of mechanical linkage between the control rod and the valve block (visual examination).
5. Incorrect spool movement (visual examination).

CAUTION:

1. **When fitting test equipment, stop the engine and remove all pressures in the system by operating the levers slowly several times, with the machine in a stable condition.**
2. **Whenever a break in the hydraulic system is required (e.g. when a hose is disconnected), make sure that the system is protected by fitting end caps to all hoses and pipes.**
   DIRT RUINS HYDRAULICS.
3. **Before breaking into the hydraulic system, ensure that:**
   (a) **the engine is switched off, and**
   (b) **the pressures are removed (as described in Caution 1. above).**

Useful hints

1. To check the pump and M.R.V., use another service on the same valve block, e.g. slew. If there is power in the other service, then the pump and the M.R.V. are unlikely to be at fault.
2. If flow test facilities are not available, it is possible to flow test rams by:
   (a) selecting the ram to the end of its stroke,
   (b) removing the plug from the test point on the ram (or hose connection),
   (c) blanking off the return line with metal blanking caps to prevent spillage. With the service selected in this position, any excessive flow from the ram will indicate ram seal failures.

BUCKET AND LINKAGE (EXCAVATOR)

DESCRIPTION

1. The bucket is of the conventional back hoe type, which is supplied in a variety of sizes, and can be fitted with different types of teeth according to the user's requirements. Further details of sizes and uses of buckets are given in the sales brochures.

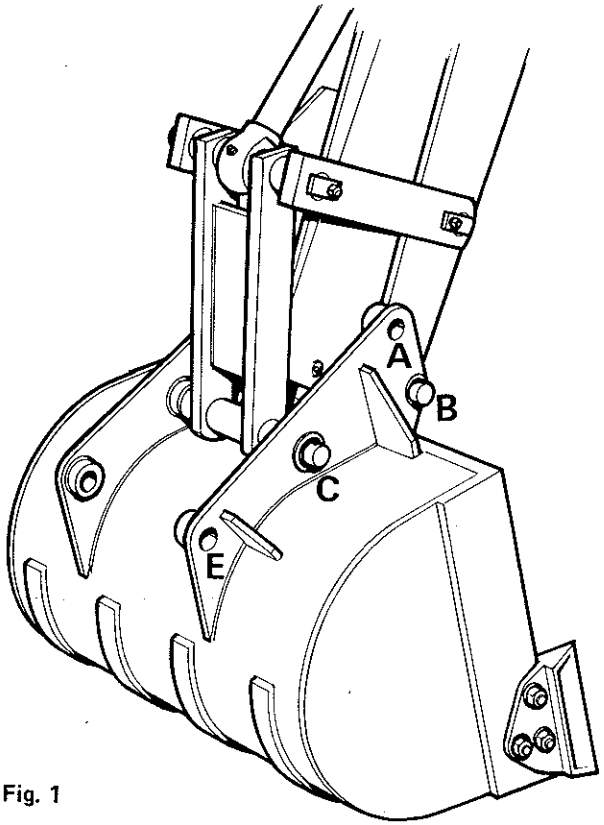


Fig. 1

2. The linkage (fig. 1) consists of two tipping levers, which pivot at one end, on either side of the dipper arm, at a point just above the bucket pivot point and a one-piece steel tipping link. At the other end, the tipping levers connect to the outsides of the upper end of the tipping link arms. The eye of the bucket ram piston rod is sited between the arms of the tipping link. The tipping levers, the tipping link and the piston rod are all mounted on the same pin to form a floating pivot point. The lower end of the tipping link is connected to the bucket, and movement of the piston rod is therefore transmitted to the bucket.

3. Pins on which the linkage is mounted are restrained either by headed locking pins secured by setscrews, or, as in the case of the bucket pivots, by headed pins secured with quick release pins. Grease nipples are fitted at all moving points.

4. Fig. 1 also illustrates alternative positions for the tipping lever, the tipping link and the bucket pivot points, to give the following requirements:

(1) Normal trenching.
Tipping link at pivot point C on bucket.
Dipper arm at pivot point B.

(2) Square back trenching.
Tipping link at pivot point C on bucket.
Dipper arm at pivot point A.

(3) Forward shovelling.
Tipping link at pivot point C on bucket.
Dipper arm at pivot point E.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL

5. **Boom and Dipper. Extend.** With boom and dipper extended, rest the bucket on the ground.

6. **Tipping link. Bucket end. Disconnect.** (fig. 2)

(1) Remove the quick release pin (14) from the headed locking pin (12) at the bucket.
(2) By adjusting the position of the excavator dipper exactly, it should be possible to draw the pin by hand. If not, use a hammer and suitable drift to drive the pin (12) through the tipping link and bosses in the bucket. Retain the spacers (13).

7. **Bueket pivot pin. Dipper end. Remove.** Repeat the procedure in paragraph 6 to disconnect the link from the bucket.

8. **Bucket. Remove.**

9. **Excavator. Lower.** Start the engine. Slew away from the bucket and lower the excavator to the floor fully extended.

10. **Ram. Support.** (fig. 3) When extending the rod to raise the ram on the pivots, position a suitable block of wood under the cylinder to support the ram when moving pin (23).

11. **System. Relieve.** Stop the engine and operate all the controls to relieve any pressure within the system.

12. **Tipping levers and Tipping link. Remove.** (fig. 2)

(1) Remove the setscrews (24) and the washers (25) from the headed pins (23).
(2) Use a hammer and suitable drift to drive the pin (23) through the levers, the link, the ram and the dipper. Retain any spacers (9) that are fitted.

13. **Bucket ram. Remove.** (fig. 3)

(1) Start the engine.
(2) Retract the ram.
(3) Stop the engine.
(4) Operate all the controls to relieve any pressure within the system.

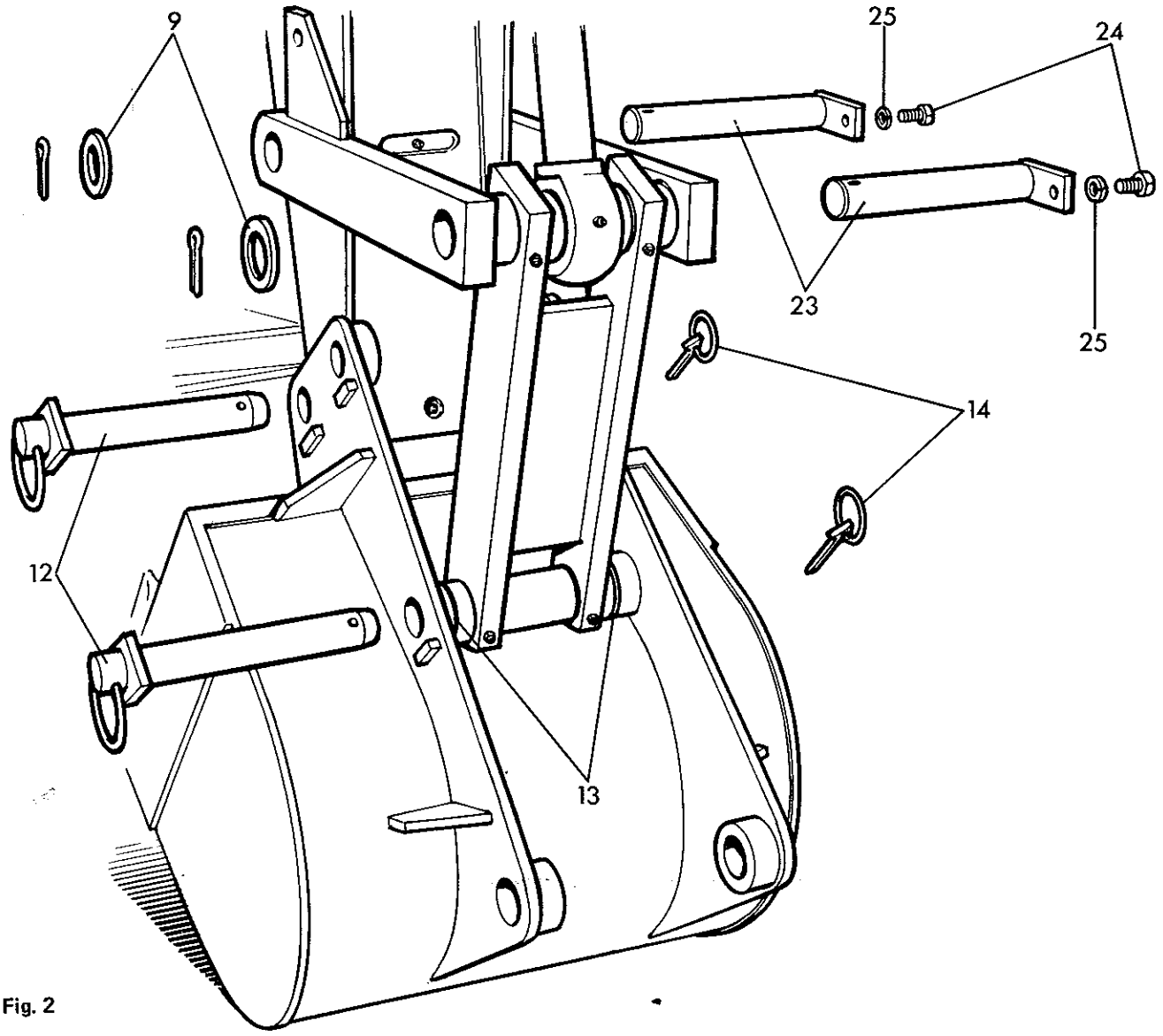


Fig. 2

(5) Support the weight of the ram, using a suitable sling.

(6) Disconnect the two flexible hoses at the ram adaptors.

(7) Fit blanking caps to the hose ends and the ram connections.

(8) Remove the setscrews (24) and washers (25) which secure the ram pivot pin (19).

(9) Use a hammer and suitable drift to drive out the ram pivot pin (19).

(10) Remove the ram from the dipper arm. Retain spacer (9).

REPLACEMENT

14. Replacement is the reversal of the procedures listed in paragraphs 5 — 13. All pivot pins and locking pins should be cleaned and greased (refer to Lubrication Chart) before being fitted. The spacers retained at paragraphs 6, 12 and 13 should be fitted in their original places, except when, as a result of fitting a new component, there is too much, or too little, end float. The spacers should be adjusted to give minimum clearance between moving surfaces consistent with free movement.

INSPECTION

15. The bucket and linkage should be examined generally for defects, and damaged parts should be repaired as necessary. The side cutters, if worn or damaged, may be removed, by unscrewing the nuts and bolts on each one, and replaced by new cutters. Similarly, worn teeth should also be renewed.

DISMANTLING

N.A.

16. The four pins and associated bushes should be examined generally for damage and excessive wear. In the event of doubtful serviceability of any pin or bush, both items should be renewed. An acceptable degree of wear cannot be laid down. This is a matter for judgement by the engineer, and he must bear in mind the severity of the work which the machine will encounter. There should not, however, be any slop or radial movement of the pin in its bushings. One method of estimating the degree of wear is to make a comparison, by inserting a new pin. If this results in an appreciable improvement in the fit, both pin and bushings should be replaced.

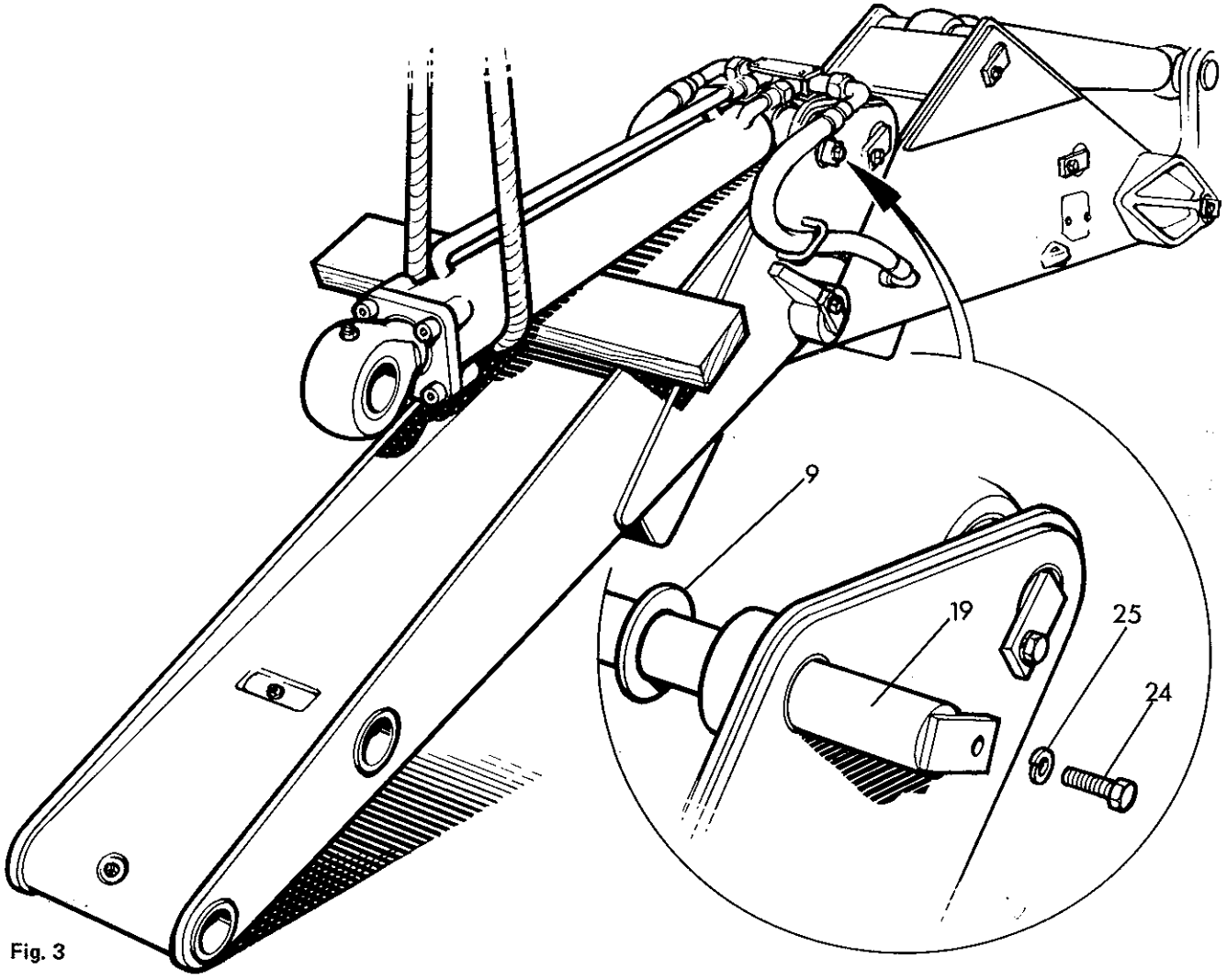


Fig. 3

17. Grease ways should be checked, while the linkage is dismantled, by applying a grease gun and ensuring that a free flow is available. The opportunity should be taken to remove all the old grease and to re-pack with new grease, in accordance with the Servicing and Lubrication section of General Data.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

18. Servicing is confined to greasing at the following six points (fig. 4) using the Servicing and Lubrication section of General Data:

(a) Tipping link, lever end — 2 grease nipples,
(b) Ram, both ends — 2 grease nipples,
(c) Underside of Dipper arm — 2 grease nipples.

FAULT FINDING

N.A.

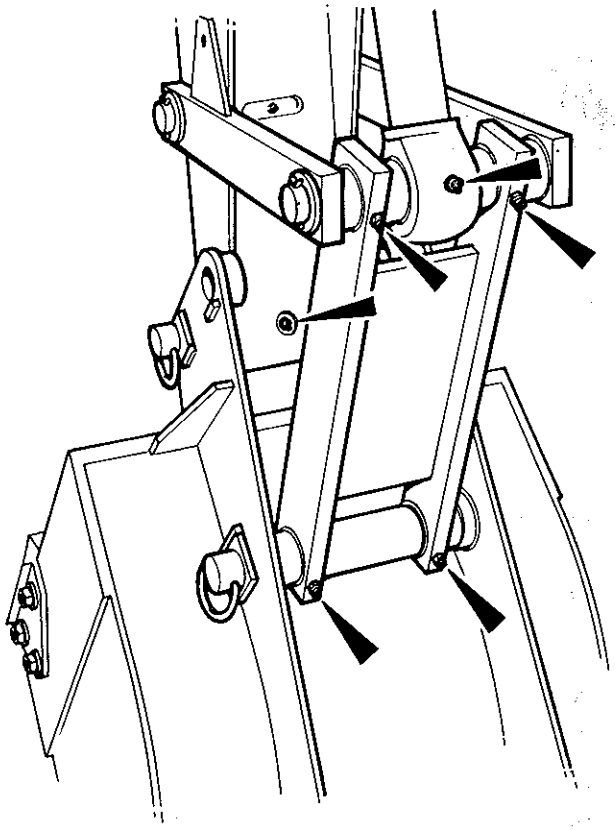


Fig. 4

DIPPER: EXCAVATOR

DESCRIPTION

1. The dipper arm is pivotted at the end of the boom and is operated by a ram which is attached to the boom.

2. Fixed to the lower end of the arm is the linkage for attaching the bucket. The bucket ram is attached to the top side of the arm.

SPECIAL TOOLS AND EQUIPMENT

Hoist capable of lifting 200 kg (4cwt) and a suitable rope.

REMOVAL

3. The dipper can be removed in either of two ways:
   (1) By supporting it in situ, as on the machine.
   (2) By lowering it directly to the ground.

In either case, complete removal of the attaching parts is optional.

METHOD (1)

4. **Excavator bucket and linkage. Remove.** See Section 5 A1. Secure the bucket ram to the dipper if not removed.

5. **Excavator end. Raise.** Start the engine and raise the boom to lift the dipper arm free of the ground.

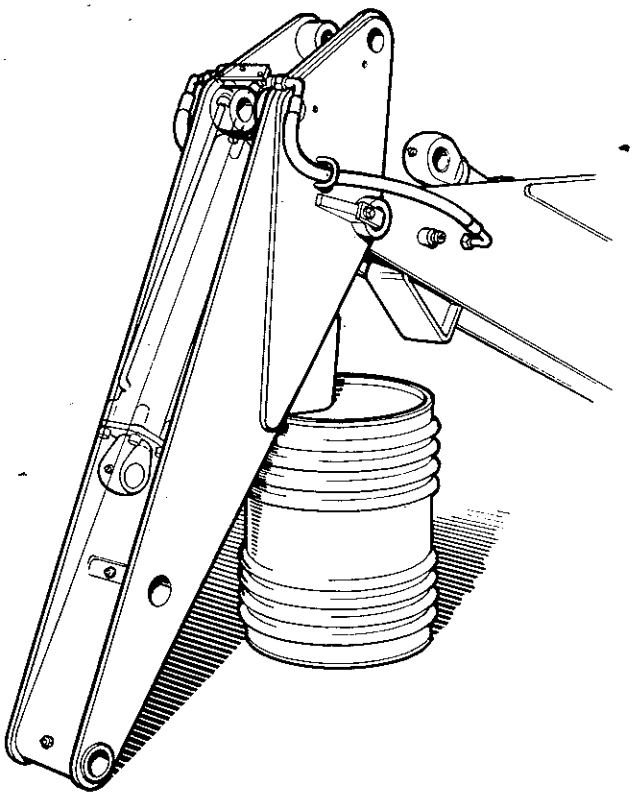


Fig. 1

6. **Dipper arm. Support.** Using a 40 gallon drum, support the dipper arm under the clapper plate, with the end of the dipper touching the ground (fig. 1).

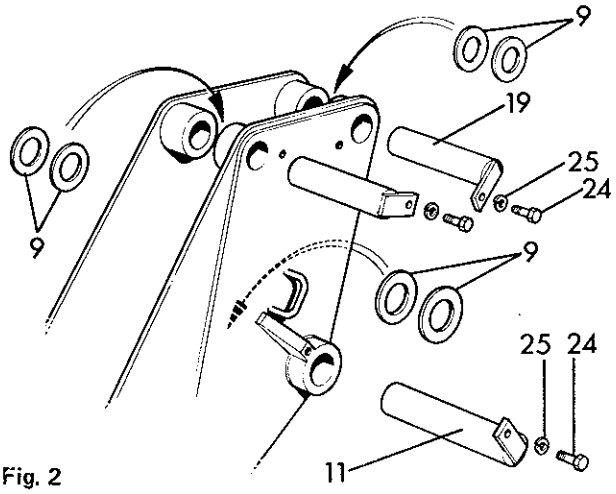


Fig. 2

7. **Dipper ram, rod end. Disconnect.** (fig. 2) Remove the setscrew (24) and the washer (25), securing the pivot pin (19). Using a suitable drift, remove the pin. Retain the washer (9). Start the engine and retract the piston.

8. **Engine. Switch off.** Switch off the engine and operate the controls to release the pressure.

9. **Bucket ram hoses. Disconnect. (fig. 1).** Disconnect the bucket hose connections at the rigid pipes on the boom. Fit blanking caps.

10. **Dipper ram. Remove.** See Section 5 C1.

11. **Dipper pivot pin. Remove.** (fig. 2). Remove the setscrew (24) and the washer (25) which are securing the pivot pin (11), and, using a suitable drift, remove the pin. Retain the washer (9).

12. **Machine. Remove.** Gently remove the machine, leaving the dipper supported on the drum.

REPLACEMENT

13. Replacement is a reversal of paragraphs 3 - 12.

METHOD (2)

14. **Bucket and linkage, excavator. Remove.** See Section 5 A1.

15. **Excavator end. Raise.** Start the engine and raise the boom to lift the dipper arm free of the ground.

16. **Dipper ram piston. Extend.** Extend the dipper ram piston, until the dipper is at right angles to the ground.

17. **Boom. Lower** Lower the boom until the dipper arm touches the ground.

18. Repeat paragraphs 7 - 9.

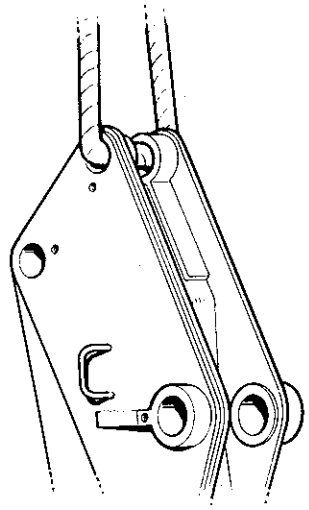


Fig. 3

19. **Dipper weight. Secure.** (fig. 3). Fit the lifting gear to the pivot point for the dipper ram, rod end, and take the weight of the dipper arm.

20. **Bucket ram. Secure.** Attach a rope to the top end of the ram, and secure it over the top of the dipper arm.

21. Repeat paragraphs 10 and 11.

22. **Dipper arm. Remove.** Using the hoist, lift the dipper arm free of the machine and lower it gently to the ground on suitable blocks.
NOTE: Take care not to damage the bucket ram or the associated pipework and hoses.

REPLACEMENT

23. Replacement is a reversal of paragraphs 14 - 22. Grease the pins before inserting them, in accordance with the lubrication data given in the Servicing and Lubrication chart of General Data.

DISMANTLING

N.A.

INSPECTION

24. Examine the pins and associated bushes for damage and excessive wear. If the serviceability of any pin or bush is in doubt, then both should be renewed. The acceptable degree of wear is a matter for the engineer to decide, bearing in mind the severity of the work the machine will encounter.

25. Check the greaseways by applying a grease gun and ensure that a free flow is available

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

26. Grease the dipper arm pivot points in accordance with the lubrication chart given in General Data.

FAULT FINDING

N.A.

BOOM: EXCAVATOR

DESCRIPTION

1. The boom is pivotted on the slew post assembly. Its ram operates at a point above the boom pivot point on the slew post. The dipper arm pivots about the end of the boom, and the dipper ram is attached to the top side of the boom.

SPECIAL TOOLS AND EQUIPMENT

A hoist capable of lifting 300 kg (6 cwt), and a suitable rope.

REMOVAL

2. The removal of the boom can be carried out in either of two ways:

(1) Removing the bucket and linkage and the dipper piece by piece.

(2) Removing the bucket and linkage and the dipper in one piece.

METHOD (1)

3. **Bucket and linkage (excavator). Remove.** See Section 5 A1.

4. **Dipper (excavator). Remove.** See Section 5 B1.

5. **Boom. Lower.** Lower the boom until its end touches the ground, or until it is resting on supports (fig. 1).

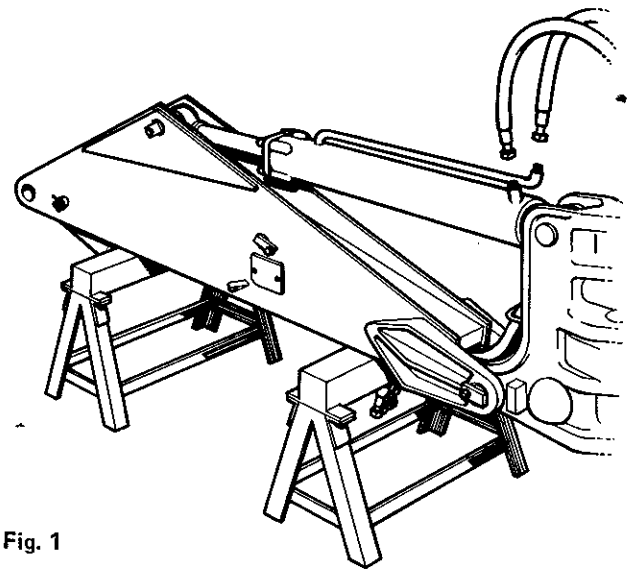


Fig. 1

6. **Boom. Support.** Support the opposite end of the boom.

7. **Engine stop.** Stop the engine and operate the controls a few times to release pressure.

8. **Flexible hoses. Disconnect.** Identify and disconnect the four flexible hoses at the base of the boom. Fit blanking caps.

NOTE. To facilitate the disconnection of the hoses, push the bucket pipe connection in the boom downwards, to expose the lower pipe connections.

9. **Flexible hoses. Disconnect.** Identify and disconnect the two hoses at the boom ram. Fit blanking caps.

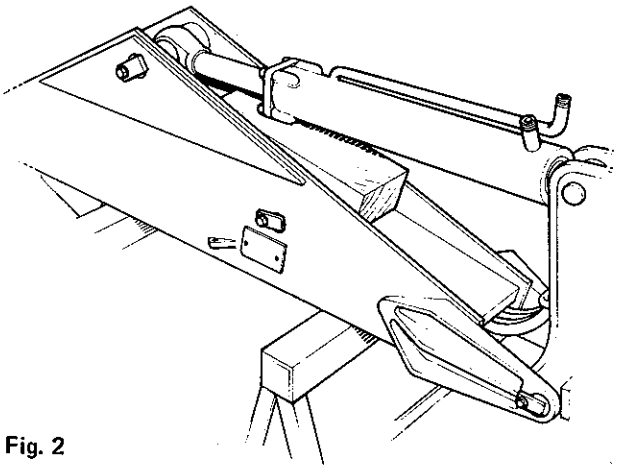


Fig. 2

10. **Boom ram. Support.** (fig 2) Position a suitable block of wood under the cylinder, to take the weight of the ram, when removing the cylinder pin from the slew post location.

11. **Boom ram cylinder pin. Remove.** (fig. 3) Remove the setscrew (24) and the washer (25), and with a suitable hammer and drift, remove the pin (17). Collect the spacers (9).

12. **Boom pin. Remove.** (fig. 3) Remove the setscrew (38) and the washer (37). Remove the split pin (40), collecting the washers (39) and (8). With a suitable hammer and drift, remove the pin (3), collecting the spacer (36) and further washers (8).

13. **Boom ram pin. Remove.** Remove the setscrew (24) and the washer (25) from the pivot pin. Using a suitable drift, remove the pin (34), and collect the spacers (9).

14. **Boom ram. Remove.** Using suitable lifting gear, lift the boom ram from the machine.

15. **Boom. Remove.** Start the engine and carefully remove the machine from the boom. Stop the engine.

16. **Cover plates. Remove.** Remove two screws (5), which secure the cover plate (4), and remove it from both sides of the boom.

17. **Hoses. Remove.** Identify and disconnect the two hoses from the dipper ram. Fit blanking caps.

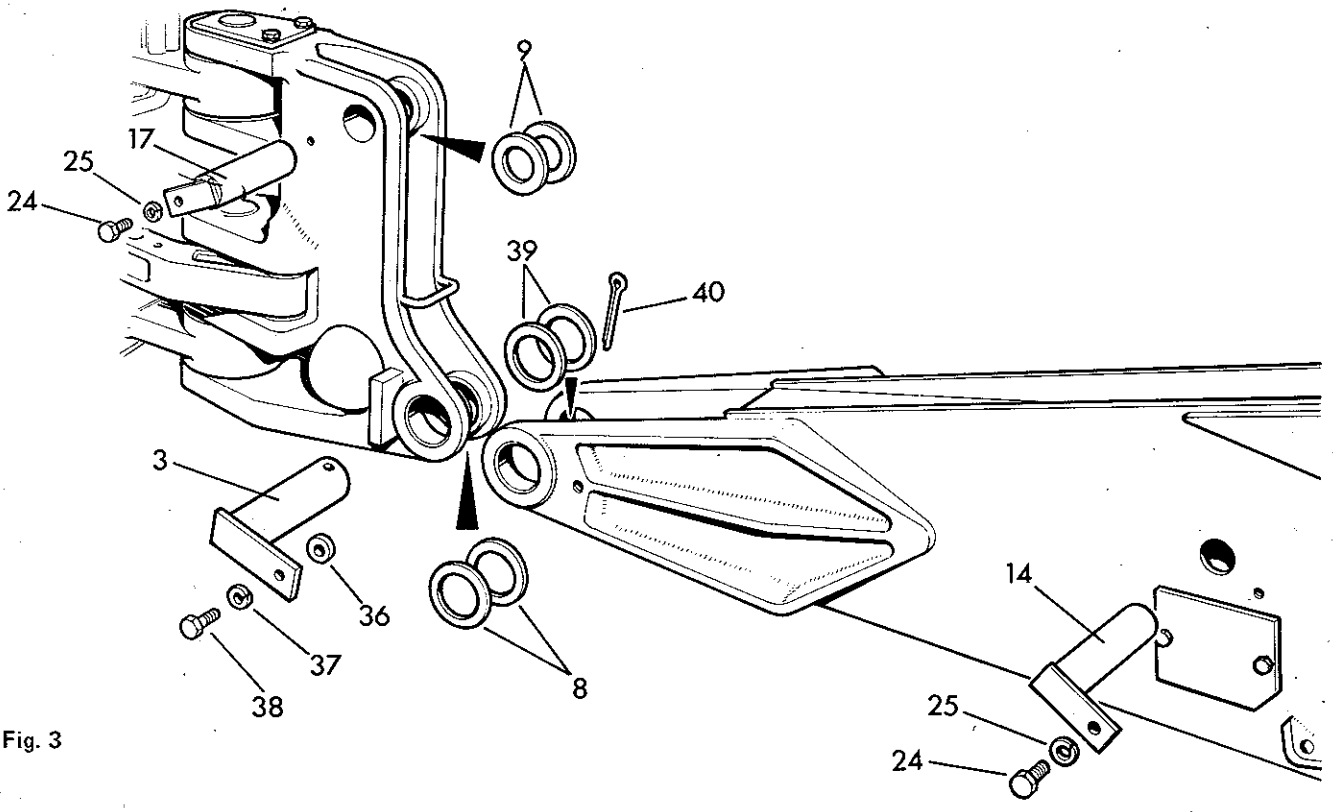


Fig. 3

18. **Dipper ram pivot pin. Remove.** Remove the setscrew (24) and the washer (25). Using a hammer and suitable drift, remove the pin (14). Collect the spacers (9).

19. **Dipper ram. Remove.** Using suitable lifting gear, lift the ram from the boom.

REPLACEMENT

20. Replacement is a reversal of paragraphs 3 - 19. Grease the pins before inserting them, in accordance with the lubrication chart in General Data.

METHOD (2)

21. **Excavator. Position.** Position the excavator, as shown in fig. 1 of Section 5B1.

22. **Dipper. Support.** Support the dipper under the clapper plate, as shown.

23. **Dipper ram pin. Remove.** See Section 5 B1.

24. **Dipper pivot pin. Remove.** See Section 5 B1.

25. **Boom. Remove.** Repeat paragraphs 5 - 15.

REPLACEMENT

26. Replacement is a reversal of the above procedures (paragraphs 21 - 25). Grease the pins before insertion, as specified in the lubrication chart (General Data).

DISMANTLING

N.A.

INSPECTION

27. Examine the pins and associated bushes for damage or excessive wear. If the serviceability of any bush is in doubt, both should be renewed. Bearing in mind the heavy work to be done by the machine, it is up to the engineer to decide upon an acceptable degree of wear. The standards are difficult to specify.

28. Check the greaseways by applying a grease gun, to ensure a free flow.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

29. Grease the excavator pivot points in accordance with the lubrication chart given in General Data.

FAULT FINDING

N.A.

LOADER BUCKET AND LINKAGE

DESCRIPTION

1. The bucket has been designed to extend to the full width of the wheels for site stripping duties. The top face of the bucket is flat and can be used as a visual bucket level indicator when site stripping. When stockpiling rock or compacted materials, provision has been made for bucket teeth to be fitted.

2. The parallel lift linkage to the bucket ensures a constant sole plate angle relative to the ground, when the arms are raised or lowered. It is not necessary to "correct" the bucket service to prevent spillage. (See also Section 3 C1: loader lift service.)

3. The bucket is actuated by means of the bucket rams, which are connected to the mainframe pivot at the cylinder end, and to the tipping lever at the rod end. One end of the tipping lever is connected to the loader arm. The third pivot point on the tipping lever is connected to a tipping link, which connects to a pivot on the bucket. The other bucket pivot is connected to the end of the loader arm.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL

4. **Bucket. Position.** Lower the loader arm to the ground, so that the bucket is upturned and facing the ground.

5. **Engine. Stop.** Stop the engine and operate the controls to relieve the pressure.

6. **Bucket tipping link pivot pin. Remove.** (fig. 1) Remove the setscrew (16) and the washer (17) from the pivot pin. Using a hammer and suitable drift, remove the pin (7), collecting any washers (15). Repeat this procedure on the other tipping link.

7. **Bucket pivot pin. Remove.** (fig. 1) Remove the setscrew (16) and the washer (17) from the pivot pin (8), retaining the washer (15). Repeat this procedure on the other bucket pivot position.

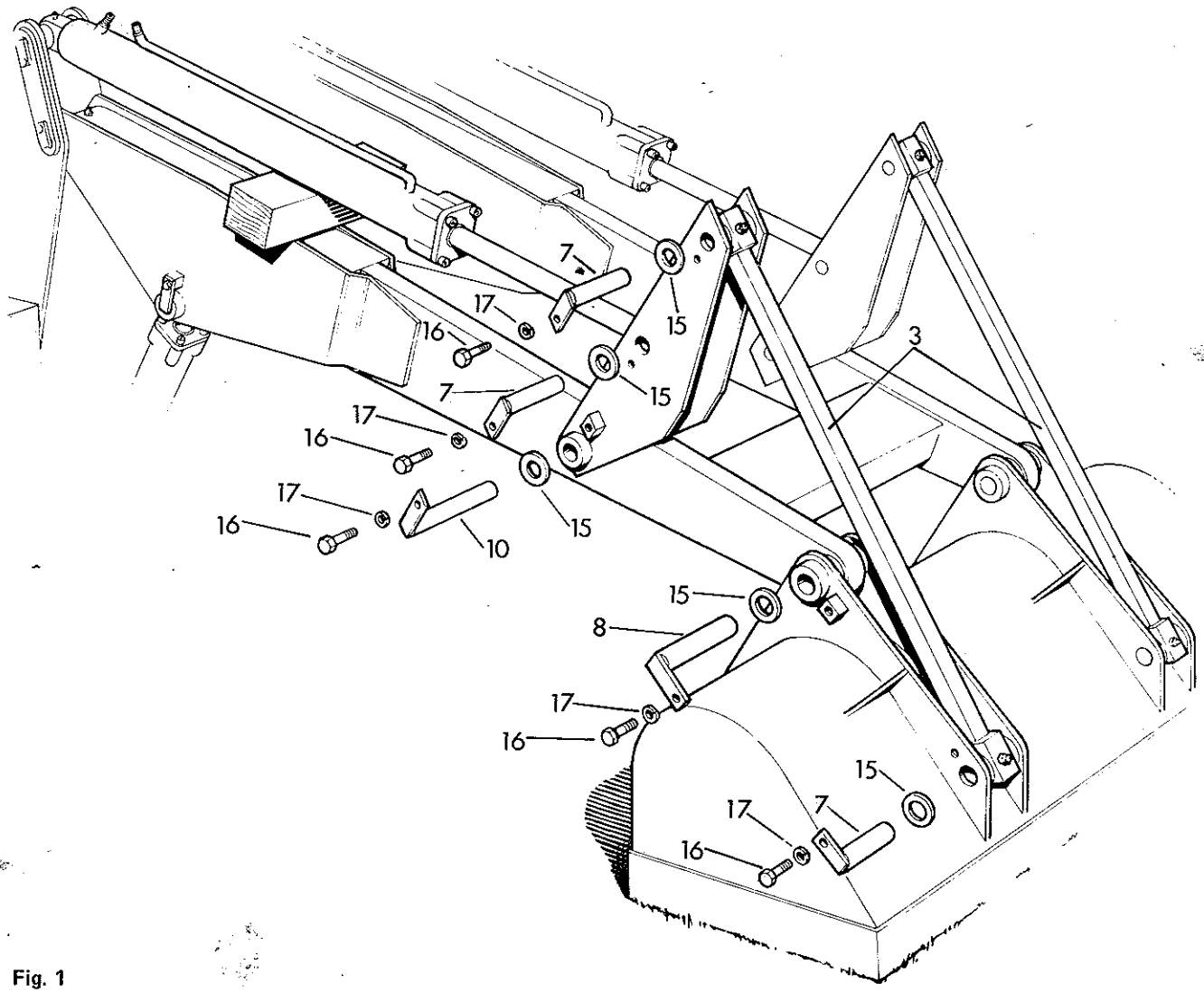


Fig. 1

8. **Machine. Remove.** Start the engine and reverse the machine from the bucket. Place the loader arm on the ground.

9. **Engine. Stop.** Stop the engine and operate controls a few times to relieve the pressure.

10. **Tipping link. Remove.** (fig. 1) Repeat paragraph 6 and remove the tipping links (3).

11. **Bucket rams. Extend.** Extend the bucket rams until the tipping lever is resting on the loader arm.

12. **Bucket ram. Support.** Use a suitable block of wood under the cylinder to take the weight of the ram, when the pivot pin is removed on the rod side of the ram.

13. **Pivot pin. Remove.** Repeat paragraph 6.

14. **Ram. Retract.** Start the engine and retract the ram.

15. **Engine. Stop.** Stop the engine and operate the controls a few times slowly to relieve the system pressure.

16. **Tipping lever. Remove.** (fig. 1) Remove the setscrew (16) and the washer (17) from the pivot pin (10). Using a hammer and suitable drift, remove the pivot pin, collecting the washers (15) and lift the tipping lever from the machine.

17. **Hoses. Remove.** (fig. 1) Remove two hoses from the bucket ram. Fit blanking caps. Repeat the procedure on the other ram.

18. **Bucket ram. Remove.** Using suitable lifting gear, take the weight of the bucket ram. Repeat paragraph 7, and lift the ram from the machine.

REPLACEMENT

19. Replacement is a reversal of the procedures listed in paragraphs 4 - 18. Grease the pins before inserting them, in accordance with the lubrication chart in General Data.

INSPECTION

20. Examine the pins and associated bushes for damage and excessive wear. In the event of doubtful serviceability of any pin or bush, both should be renewed. An acceptable degree of wear is difficult to specify. This is a matter of judgement for the engineer, bearing in mind the severity of the work to be encountered.

21. Check the greaseways by applying a grease gun and ensuring that a free flow is available.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

SERVICING

22. Grease the loader bucket pivot points in accordance with the lubrication chart shown in the Servicing and Lubrication section of General Data.

FAULT FINDING

N.A.

1/307/1

LOADER ARM

DESCRIPTION

1. The loader arm is pivotted from the mainframe at a point above the lift ram pivot, and below the bucket ram pivot, both of which are also on the mainframe. The parallel linkage and the bucket are pivotted from the loader arms.

SPECIAL TOOLS AND EQUIPMENT

Hoist capable of lifting 300 kg (6 cwt), and suitable slings.

REMOVAL

2. **Bucket and linkage. Remove.** See Section 5 D1.

NOTE: It is not necessary to remove the bucket and linkage when removing the loader arm. The following procedures apply in both cases.

3. **Loader arms. Position.** (fig. 1) Move the loader arms as near to the horizontal position as possible. If the bucket is fitted, then it should be upturned and facing the ground.

4. **Loader arms. Support.** (fig. 1) Using suitable lifting gear, take the weight of and support the loader arms.
NOTE: Make sure that the method of slinging does not give any side load effects, but merely supports the weight of the arms.

5. **Lift ram pivot pin. Remove.** (fig. 1) Remove the setscrew (16) and the washer (17) from the pivot pin (10), in two locations. Using a hammer and suitable drift remove the pin and collect any washers (15).

6. **Lift ram. Lower.** Swing the lift ram down to its lowest point pivotting from the rod eye end pivot.

7. **Lift ram. Extend.** Select the control to extend the ram to ground level.

8. **Engine. Stop.** Switch off the engine and operate the controls a few times slowly, to relieve the system pressure.

9. **Lift ram hoses. Disconnect.** (fig. 1) Disconnect two hoses on each ram (5), and fit blanking caps.

10. **Lift ram pivot pin, rod eye end. Remove.** (fig. 1) Remove the setscrew (16), and the washer (17) from the pivot pin (10) in two locations. Using a hammer and suitable drift, remove the pin, and collect any washers (15).

11. **Lift ram. Remove.** The lift ram is now free, and may be lowered gently to the ground.

12. **Loader arm pivot pins. Remove.** (fig. 1) From two locations, remove the setscrew (16) and the washer (17)

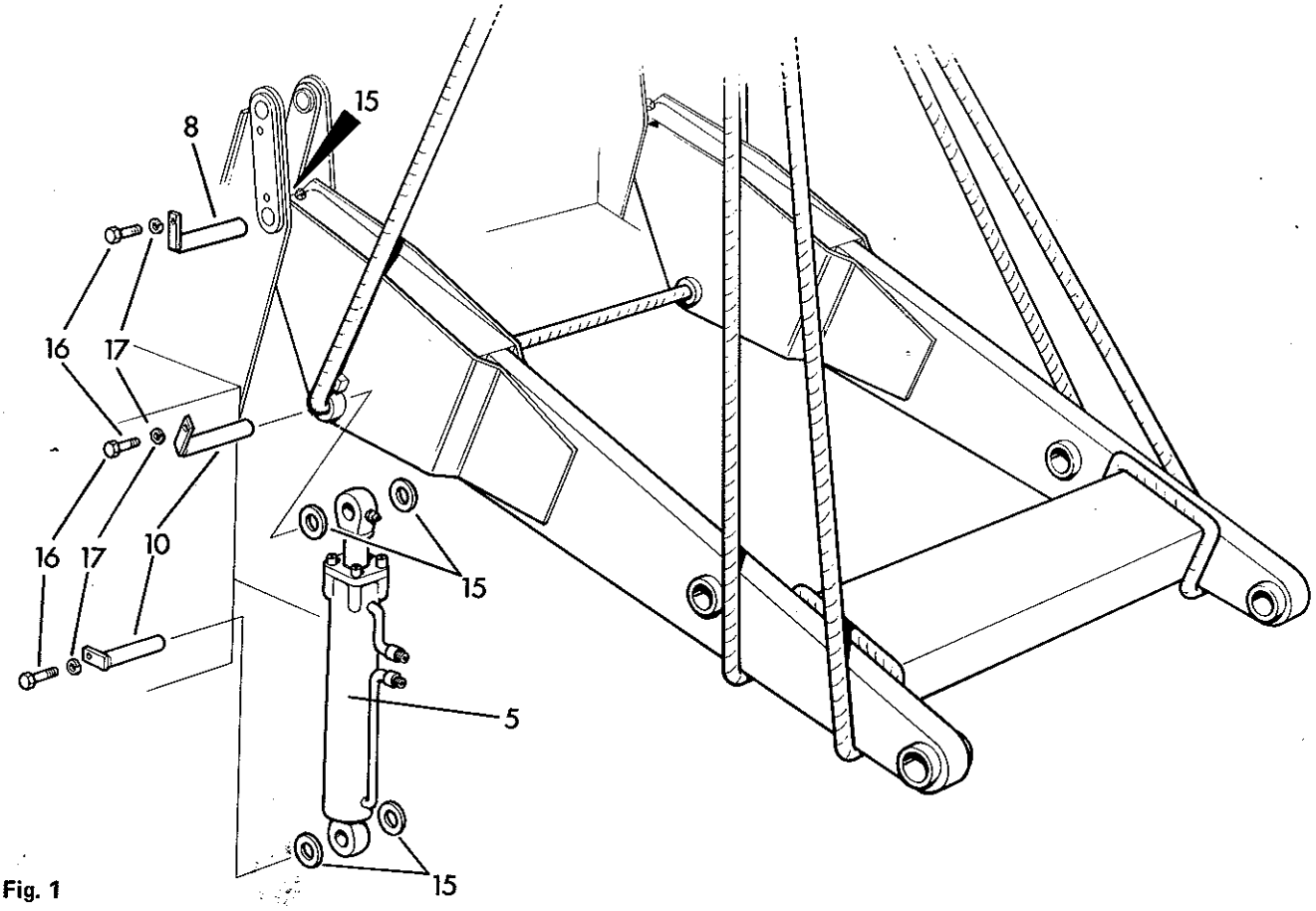


Fig. 1

from the pivot pin (8). Using a hammer, remove the pivot pin, collecting any washers (15).

NOTE: If a bucket ram is connected, then the bucket hoses will need to be disconnected. See Section 5 D1.

13. **Loader arm. Remove.** (fig. 1) With lifting gear, gently raise the loader arm from the pivot points, until it is clear of the machine.

14. **Machine. Remove.** Start the engine, and move the machine from the loader arms.

15. **Loader arm. Lower.** Lower the loader arm gently to the ground.

REPLACEMENT

16. Replacement is a reversal of the procedures given in paragraphs 2 - 15.

DISMANTLING

N.A.

INSPECTION

17. Examine the pins and associated bushes for excessive wear. In the event of doubtful serviceability of any pin or bush, both should be renewed. An acceptable degree of wear cannot be specifically laid down. This is a matter of judgement for the engineer, bearing in mind the severity of the work to be encountered.

RE-ASSEMBLY

N.A.

ADJUSTMENTS

N.A.

FAULT FINDING

N.A.

damage. Light scratches may be honed out using a fine carborundum stone, but where damage is excessive, the part should be renewed. Examine all the components of the piston assembly and the gland assembly generally for signs of damage or wear, paying particular attention to all surfaces next to fluid seals. Check that the 'O' ring grooves on the cylinder gland and rod are clear, and that the bores of the gland and the flanged bush are not excessively worn. Renew the parts which are excessively worn, or where damage is likely to cause hydraulic fluid leaks.

15. Check that the threads on the cylinder barrel are clear and not damaged.

16. Examine the bushings at the eye of the piston rod and at the pivot end of the ram cylinder for wear. If they are worn, the bushings should be renewed.

17. Examine the pipe connections for signs of fluid leakage, or thread damage.

18. When inspection is completed, all parts should be thoroughly cleaned and dried, using an approved solvent or kerosene and a lint-free cloth. Then they should be laid aside for re-assembly. It is essential that no strands of cleaning material or any other foreign matter is allowed to remain within the system.

RE-ASSEMBLY

19. Re-assembly consists of replacing the components in the reverse order to which they were dismantled, but each item must be placed on the ram piston rod individually. New seals lubricated with clean hydraulic fluid should be used. Other than those items to be renewed because of wear, the following new items are required:

Wiper ring	1
Gland pack	1
Gland ring	1
Piston seal pack	1
Piston 'O' ring	1

20. The order of component replacement on the piston rod is evident by reference to figs. 5 to 23.

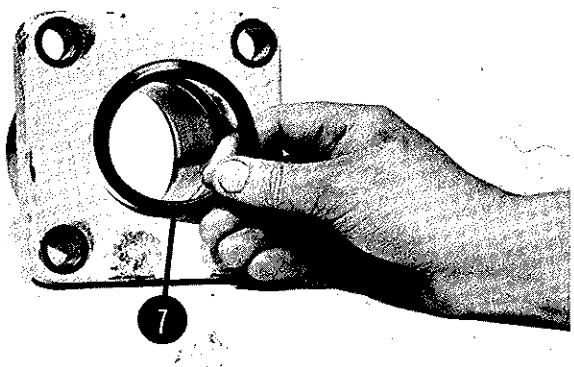


Fig. 5

21. **Gland assembly. Re-assemble.**
Fig. 5 Insert wiper seal (7) in the end cap before replacing the end cap.

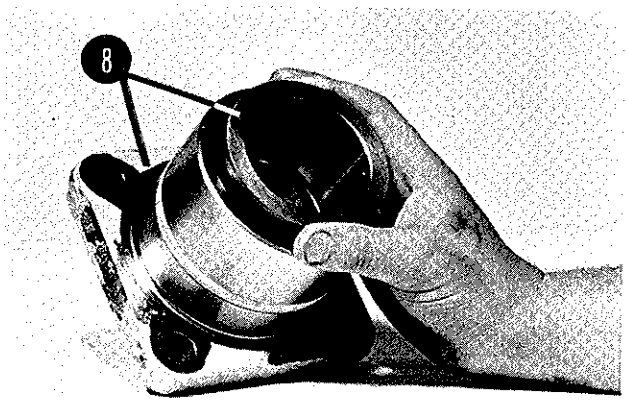


Fig. 6

Fig. 6. Fit the bush (8) to the gland assembly (8).

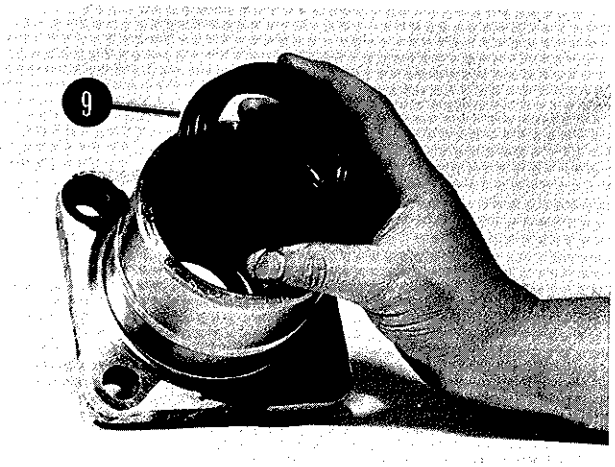


Fig. 7

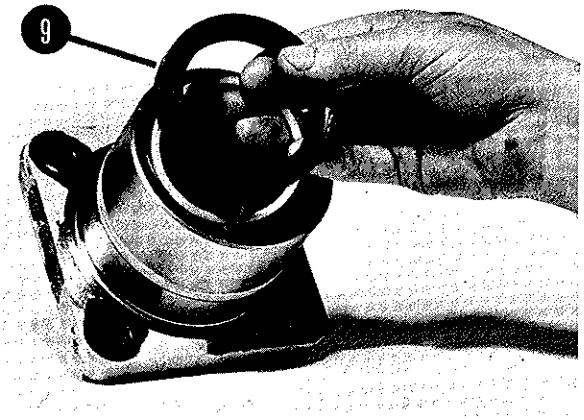


Fig. 8

Figs. 7 & 8. Fit the gland seal (9).

Fig. 9

Fig. 9. Fit the washer (10).

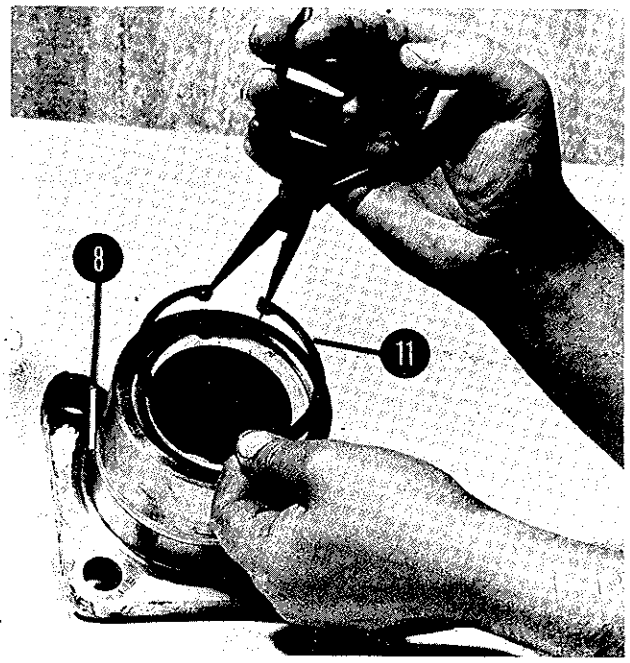


Fig. 10

Fig. 10. Fit the circlip (11).

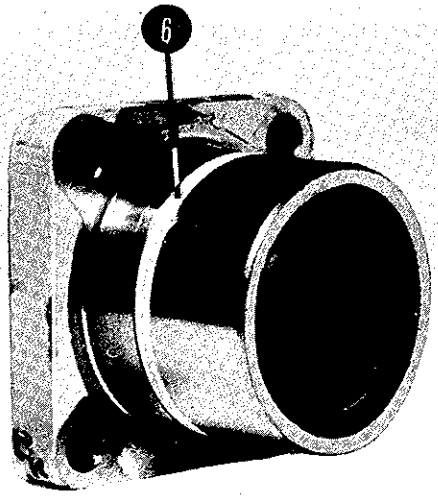


Fig. 11

Fig. 11. Fit the gland ring (6) to the gland assembly (8).

22. **Piston rod assembly. Complete.**

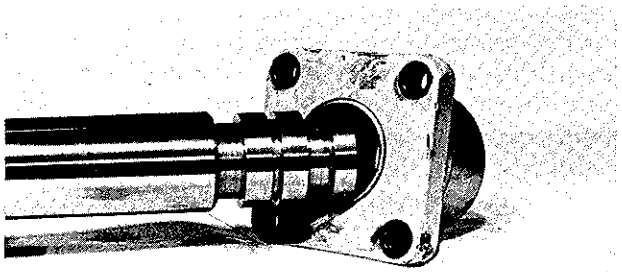


Fig. 12

Fig. 12. Fit the gland assembly to the rod.

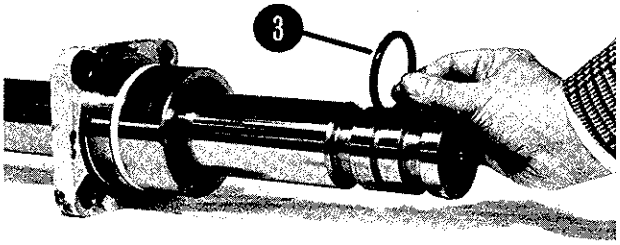


Fig. 13

Fig. 13. Fit 'O' ring (3).

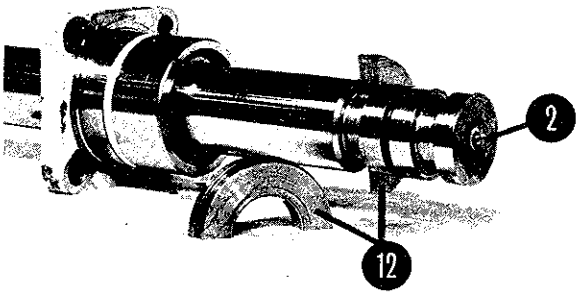


Fig. 14

Fig. 14. Fit the split rings (12) to the rod (2).

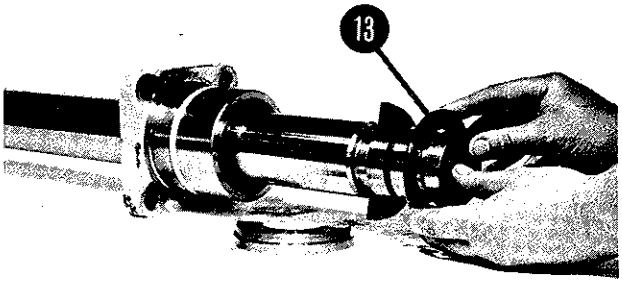


Fig. 15

Fig. 15. Fit the washer (13).

RAMS

NOTE: The ten rams - the bucket ram, the dipper ram and the boom ram on the excavator; two loader arm rams and two bucket rams on the loader; two stabiliser rams; the steering ram; - are similar in general construction and method of operation. The bucket ram on the excavator is described in paragraph 1. The differences between that and the other rams are described in the following paragraphs:

Dipper ram (excavator)	25–31
Boom ram (excavator)	32–38
Bucket rams (loader)	39–49
Lift ram (loader)	46–52
Stabiliser rams	53–59
Steering ram	60–65

BUCKET RAM (EXCAVATOR)

DESCRIPTION

1. The bucket ram is a conventional double acting ram operated by hydraulic fluid, controlled through a remote valve block, and having a full length stroke of 864mm (34.02in).

2. The body, or cylinder, of the ram is pivotted at one end on a pin mounted in brackets on the dipper arm, whilst at the other end a ram piston is attached to the tipping linkage at its mid point. Attachment of the piston to the tipping linkage is also by pin. Renewable bushings, inserted in the eye of the piston rod end and the cylinder pivot point, form bearing surfaces for the pins. The pivot pins are prevented from turning by a retaining keep plate, which is secured by a setscrew.

3. Hydraulic fluid, controlled as described in Section 4 E1, is passed via flexible hoses through pipe connections on the ram cylinder to one side or the other of the ram piston. The resultant piston movement actuates the bucket, and the fluid displaced on the opposite side of the piston is passed on to a return manifold.

4. The internal components are illustrated in fig. 1.

5. Hydraulic fluid is prevented from passing from one side of the piston to the other along the cylinder wall by a piston fluid seal. Seepage along the bores of the piston components is sealed by an 'O' ring fitted to the piston rod.

6. An end cap bolted on to the end of the cylinder comprises a gland and flanged bush with associated 'O' rings, gland seal and wiper ring. These items prevent seepage to the end cap and along the piston rod to the

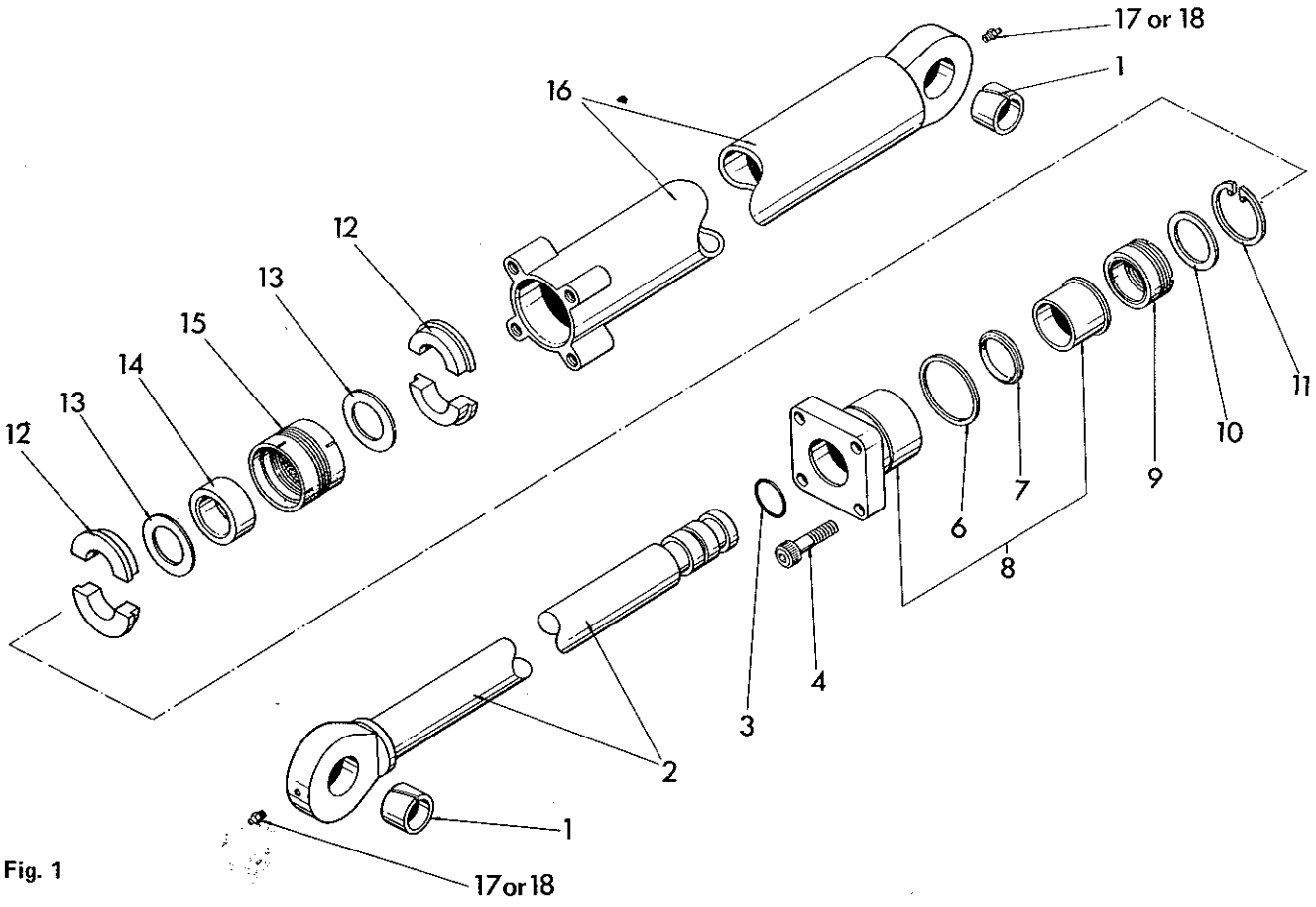


Fig. 1

bore of the end cap, and they contain the fluid pressure. The wiper ring is fitted to an annular groove in the end cap, and it prevents any dirt accumulating on the piston rod from entering the ram.

7. Pipe connectors at each end of the cylinder admit fluid to and from that side of the piston.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

8. The procedure for removal and replacement of the bucket, dipper arm and boom rams (excavator) are covered in Section 5 A1, B1 and C1 respectively, and of the bucket and lift rams (loader) in Section 5 D1 and E1 respectively.

DISMANTLING

9. The procedure for dismantling all rams is the same, although the components parts vary.

CAUTION

Strict cleanliness must be observed at all times when dismantling or assembling hydraulic equipment. Where instructions to lubricate any part of the system are given, only approved hydraulic fluid is to be used, unless otherwise stated.

DIRT RUINS HYDRAULICS

See Servicing and Lubrication section of General Data.

10. **Piston Rod. Remove.**
(1) Remove the blanking caps and drain the fluid.
(2) Remove the four end cap locking set — screws (4) and withdraw the rod piston assembly and gland assembly complete (fig. 2).
(3) Remove excess hydraulic fluid from the piston assembly and rod.

Fig. 2

11. **Piston. Remove.**
(1) Secure the eye of the piston rod and support the weight of the rod.
(2) Remove the plastic split plastic collar (18) from the split rings (12) (fig. 3).
(3) Remove split rings (12) and the washer (13).
(4) Remove the piston seal pack (15) and discard. Remove the spacer (14).

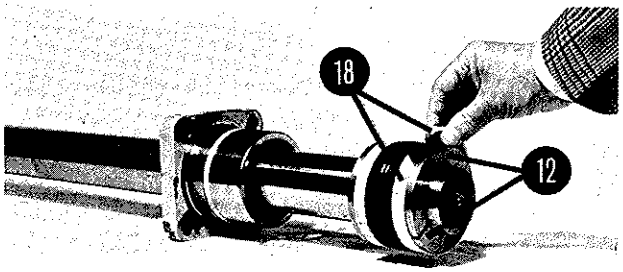


Fig. 3

(5) Remove the washer (13) and the plastic collar (19) from the other split rings (12) and then remove the split rings.
(6) Remove the 'O' ring (3) from the rod (2) and discard.

12. **Gland assembly. Remove.**
(1) Slide the gland assembly complete off the piston rod.
(2) Separate the components of the gland assembly, noting the order of assembly. Discard the gland ring, the wiper ring and the gland seal.
(3) Remove the circlip (11) from the gland assembly (8), (fig. 4).

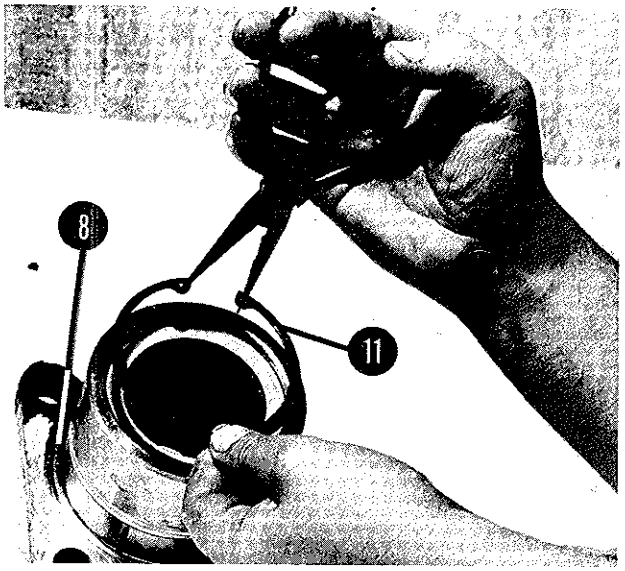


Fig. 4

(4) Withdraw the washer (10) and the seal pack (9).
(5) Remove the bush from the cap (8) and the wiper seal (7).
(6) Remove the gland ring (6) from the gland body (8).

13. **Cylinder. Drain.** Drain all excess fluid from the cylinder.

INSPECTION

14. Examine the surfaces of the piston, piston rod and cylinder for scratches, corrosion or any other signs of

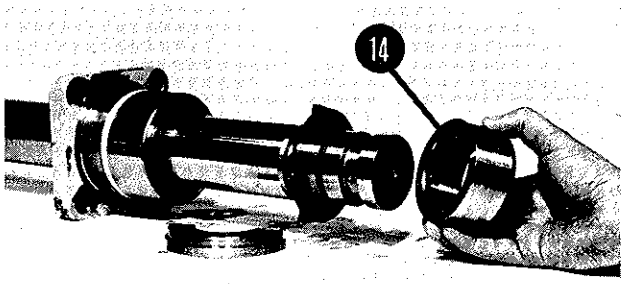


Fig. 16

Fig. 16. Fit the spacer (14).

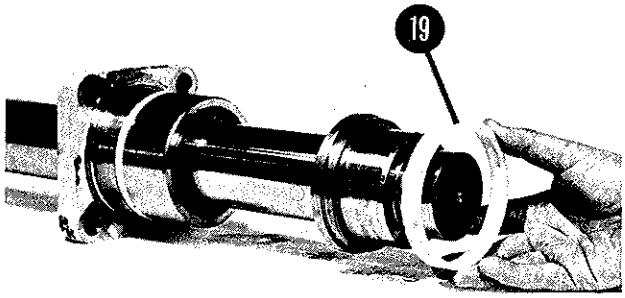


Fig. 17

Fig. 17. Fit the collar (19).

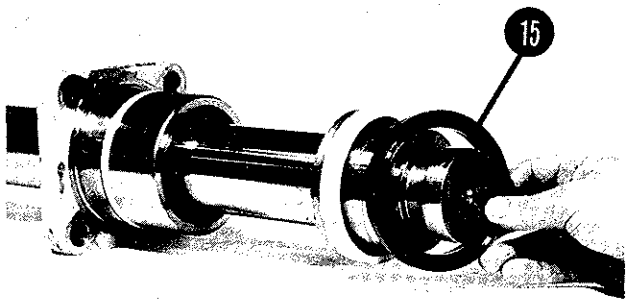


Fig. 18

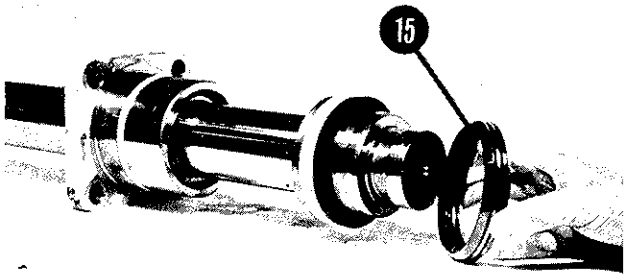


Fig. 19

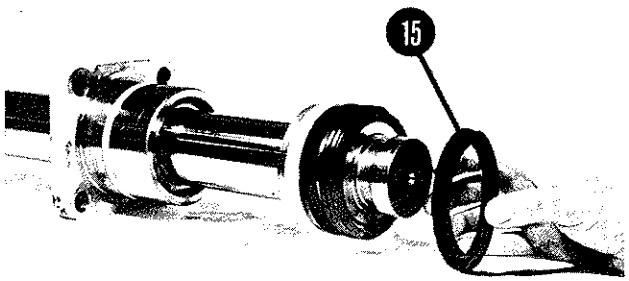


Fig. 20

Figs. 18, 19 & 20. Fit the piston seal pack (15).

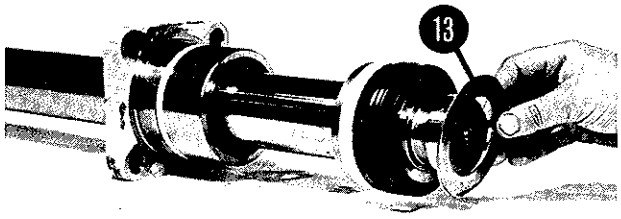


Fig. 21

Fig. 21. Fit the other washer (13).

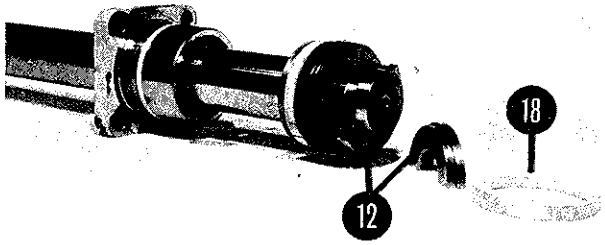


Fig. 22

Fig. 22. Fit the other split rings (12).

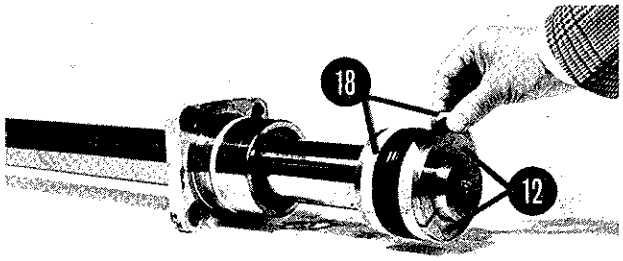


Fig. 23

Fig. 23. Fit the split collar (18).

NOTE: Collars (18) and (19) are a part of the seal pack (15). The split collar (18) must be scarfed at approximately 45°.

23. **Ram. Re-assemble.**

(1) Ensure absolute cleanliness of all components.

(2) Lubricate all parts with clean hydraulic fluid.

(3) Enter the piston into the cylinder and push fully home (fig. 24).

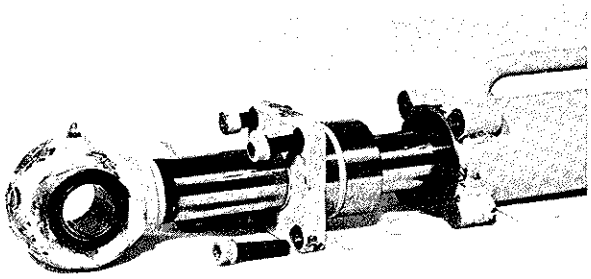


Fig. 24

(4) Operate the piston rod a few times to centralise the gland.
(5) Tighten the end cap in accordance with the torque figure table in the Servicing and Lubrication section of General Data.
(6) Fit temporary blanking caps.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

24. Refer to Section 4 G1.

DIPPER ARM RAM (EXCAVATOR)

DESCRIPTION

25. The construction of the dipper arm ram is identical to that of the bucket ram (excavator). See the preceding paragraphs for internal components and method of operation.

26. The body, or cylinder, of the ram is pivotted at one end on a pin mounted on the boom, whilst, at the other end, the piston rod is connected to the upper end of the dipper arm. Bushings are again used at both points to house the pivot and dipper arm connecting pins, and, in each case, the pins are prevented from sliding out of their housing by a retaining keep plate, which is secured by a setscrew.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

27. The procedure for removal and replacement is given in Section 5 B1.

DISMANTLING

28. The procedure for dismantling the dipper ram is the same as that for the bucket ram (excavator). (See paragraphs 9 - 13).

INSPECTION

29. The same inspection procedure as for the bucket ram (excavator) should be carried out. (See paragraphs 14 – 18.)

RE-ASSEMBLY

30. Re-assembly is the same as for the bucket ram (excavator). (See paragraphs 19 – 23). Take special note of which parts must be renewed.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

31. Refer to Section 4 G1.

BOOM RAM (EXCAVATOR)

1/307/6

DESCRIPTION

32. The boom ram is similar in general construction to the bucket ram (excavator), to which reference may be made for the method of operation and the arrangement of the internal components.

33. The lower end of the ram is pivotted about a pin mounted on the slew post above the boom's own pivot point. The pivot point of the cylinder incorporates a bushing, and the pivot pin is restrained from moving in its location by a retaining keep plate, which is secured by a setscrew. At the upper end, the eye of the piston rod is attached to a pin, which passes through and extends beyond the width of the boom at the point of attachment. Connection of the piston rod to the pin is by a bushing, which is fitted within the eye of the rod. The pin is prevented from moving by a retaining keep plate, which is secured by a setscrew.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

34. The procedure for removal and replacement of the boom ram (excavator) is given in section 5 C1.

DISMANTLING

35. The procedure for dismantling the boom ram is the same as for the bucket ram (excavator). (See paragraphs 9 – 13.)

INSPECTION

36. The inspection procedures are the same as for the bucket ram (excavator). (See paragraphs 14 – 18).

RE-ASSEMBLY

37. Re-assembly is the same as for the bucket ram (excavator). (See paragraphs 19 – 23). Take care to renew the corresponding items.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

38. Refer to Section 4 G1.

BUCKET RAMS (LOADER)

DESCRIPTION

39. The construction of the two loader bucket rams is similar to that of the bucket ram (excavator), to which reference may be made for the method of operation and the arrangement of the internal components.

40. The lower end of the ram is pivotted about a pin mounted on the mainframe. The pivot point of the cylinder incorporates a bushing, and the pivot is restrained from moving in its location by a retaining keep plate, which is secured by a setscrew. At the upper end, the eye of the piston rod is attached to the tipping lever. Connection of the piston rod to the pin is by a bushing fitted in the eye of the rod. The pin is prevented from moving by a retaining keep plate, which is secured by a setscrew.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

41. The procedure for removal and replacement of the loader bucket ram is covered in Section 5 D1.

DISMANTLING

42. The procedure for dismantling the loader bucket ram is the same as that for the excavator bucket ram. (See paragraphs 9 – 13).

INSPECTION

43. The inspection procedures are the same as for the bucket ram (excavator), covered in paragraphs 14 – 18.

RE-ASSEMBLY

44. Re-assembly is the same as for the excavator bucket ram. See paragraphs 19 – 23, and ensure that the corresponding items are replaced as instructed.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

45. Refer to Section 4 G1.

LIFT RAMS (LOADER)

DESCRIPTION

46. The construction of the two loader lift rams is similar to that of the excavator bucket ram, to which reference may be made for the method of operation and the arrangement of the internal components.

47. The lower end of the ram cylinder is pivotted about a pin mounted on the mainframe assembly. The pivot point of the cylinder incorporates a bushing, and the pivot is restrained from moving in its location by a retaining keep plate, which is secured by a setscrew. At the upper end, the eye of the piston rod is attached to the loader arm. Connection of the piston rod to the pivot pin is by a bushing, fitted in the eye of the rod. The pin is prevented from moving by a keep plate, which is secured by a setscrew.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

48. The procedures for removal and replacement of the loader lift rams are covered in Section 5 E1.

DISMANTLING

49. The procedure for dismantling the loader lift rams is the same as for the bucket ram (excavator), as described in paragraphs 9 – 13.

INSPECTION

50. The same inspection procedures should be carried out as for the excavator bucket ram. (See paragraphs 14 – 18).

RE-ASSEMBLY

51. Follow the same procedures as for re-assembly of the excavator bucket ram, as detailed in paragraphs 19 – 23, renewing the corresponding items.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

52. Refer to Section 4 G1.

STABILISER RAMS

DESCRIPTION

53. The construction of the two stabiliser rams is similar to that of the bucket ram (excavator), to which reference may be made for the method of operation and the arrangement of the internal components.

54. The cylinder end of the ram is pivotted about a pin mounted in the stabiliser and secured by the mainframe. The pivot is restrained from moving in its location by a retaining keep plate which is secured by a setscrew. At the rod end – the end nearer to the ground – the rod is connected to the inner stabiliser leg and has a stabiliser foot mounted on it. It is secured by means of the pivot pin, which is prevented from turning by a keep plate, secured by a setscrew.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

55. The removal and replacement procedures for the stabiliser ram are covered in Section 3 B1.

DISMANTLING

56. The procedure for dismantling the stabiliser ram is the same as for the bucket ram (excavator), which is covered in paragraphs 9 to 13.

INSPECTION

57. The inspection procedure for the stabiliser ram is the same as for the bucket ram (excavator). See paragraphs 14 to 18.

RE-ASSEMBLY

58. Re-assembly is also the same as for the bucket ram (excavator), given in paragraphs 19 to 23. Take care to replace the seals as appropriate.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

59. Refer to Section 4 G1.

STEER RAMS

DESCRIPTION

60. The construction of the steer ram is similar to that of the bucket ram (excavator). Reference may be made to Section 3 G1, Steering Controls, with regard to the functional aspect of the steer ram. The lower end of the ram is pivotted about a pin, which is mounted on the front axle beam. The pivot in the ram incorporates a swivel ball joint to ensure free movement of the ram. The rod end has a ball joint assembly, which is locked in position by a locknut. The ball joint has a pivot, which is attached to the track rod lever and is located by a washer, nut and split pin.

SPECIAL TOOLS AND EQUIPMENT

N.A.

REMOVAL AND REPLACEMENT

61. The procedure for removal and replacement is covered in section 1 B1.

DISMANTLING

62. The procedure for dismantling the steer ram is the same as that for the excavator bucket ram. (See paragraphs 9 to 13).

INSPECTION

63. The inspection procedures are the same as for the excavator bucket ram, covered in paragraphs 14 to 18.

RE-ASSEMBLY

64. Re-assembly of the steer ram is the same as that of the excavator bucket ram. See paragraphs 19 to 23, and ensure that replacement seals are fitted as instructed.

ADJUSTMENTS

N.A.

SERVICING

N.A.

FAULT FINDING

65. Refer to Section 4 G1.