Chapter 6

RELAY CONTROL VALVE, Mk. 2

LIST OF CONTENTS

APPENDICES

LIST OF ILLUSTRATIONS

CANCELLED

Introduction

1. The Mk. 2 Relay control valve covers a range of Part Numbers all following the basic design but embodying slight variations to adapt them to suit the varying installational requirements. Particulars of the valves are given in Appendix 1.

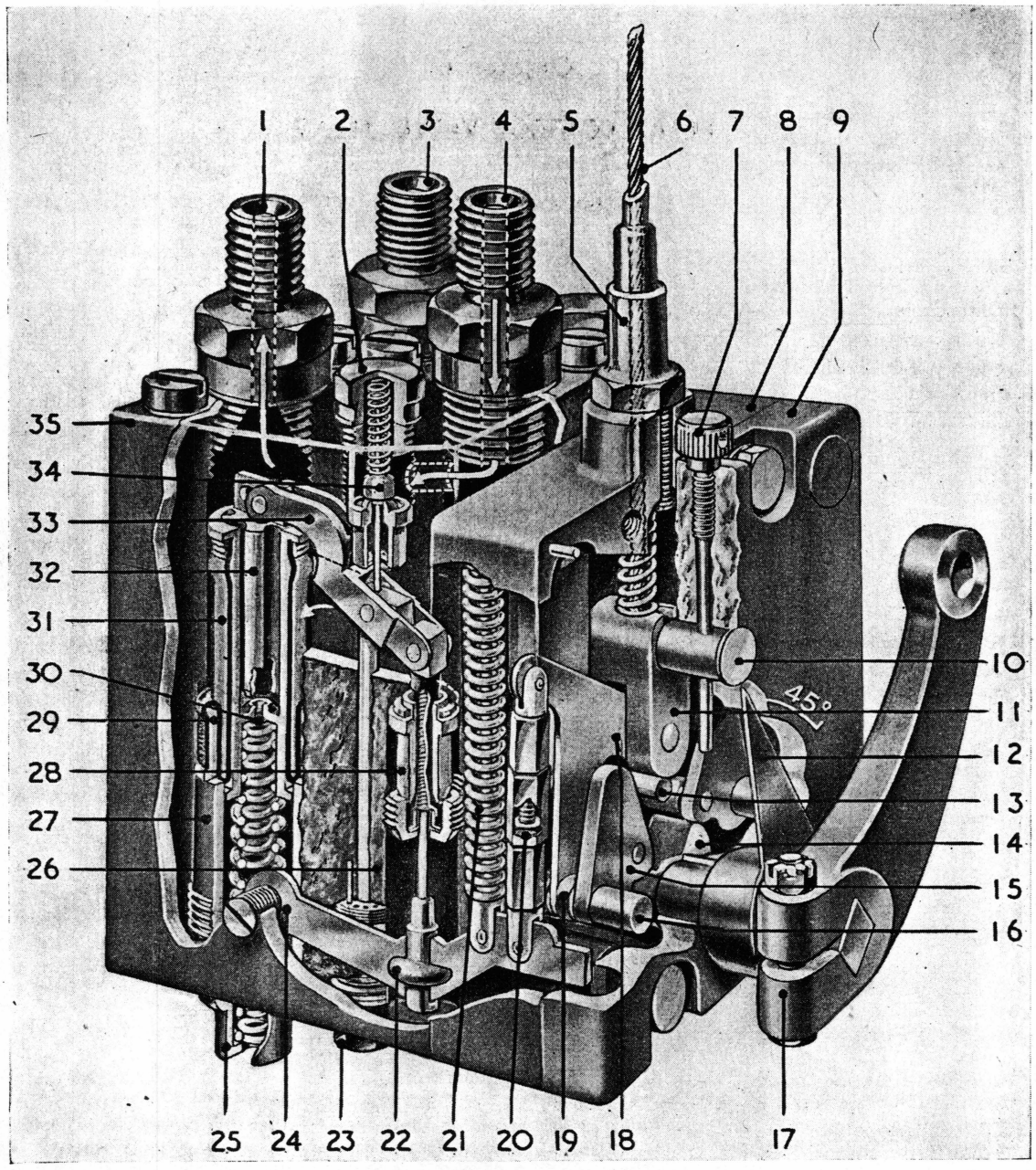
2. The function of the relay valve is to control the pressure applied to the brake units in proportion to the movement of the brake lever and the rudder controls. The relay valve is coupled by cable to the lever which is mounted on the control column, for applying the brakes, and by a connecting rod to the rudder control so that the brakes, when applied, may be used differentially to manœuvre the aircraft on the ground.

3. When the rudder control is central and the brakes are applied, the braking effect on both wheels is equal. Movement of the rudder controls to steer the aircraft moves the steering lever of the relay control. This causes air to be released from the brake unit in the wheel which describes the largest arc during the turn, whilst the pressure in the other brake unit is retained. The release of air is proportionate to the amount of movement imparted to the control.

4. Any degree of pressure up to the maximum setting for the valve may be applied by operation of the control lever, but when the brakes are used for steering purposes the application should never be sufficient to lock the inner wheel.

DESCRIPTION

5. The body of the unit houses two similar assemblies; one for the port brake and one for the starboard brake. Each assembly consists of an inlet valve (34) which controls the flow of compressed air to the brake unit, and an exhaust valve (32) which directs air from the brake unit to atmosphere. These valves are operated through a system



1 AIR OUTLET TO BRAKE UNIT
2 PRESSURE PLUG
3 AIR OUTLET TO BRAKE UNIT
4 AIR INLET
5 PRESSURE ADJUSTER
6 BRAKE OPERATING CABLE
7 SCREW PIN
8 MOVEMENT FACE
9 COVER PLATE
10 CABLE PLUG
11 CABLE BLOCK
12 POINTER
13 STOP PEG
14 STEERING SPINDLE
15 ROCKER ARM
16 ROCKER ARM TRUNNION SPIGOT
17 STEERING LEVER
18 ELBOW LINK
19 ROLLER
20 ADJUSTABLE CONNECTING-ROD
21 RETURN SPRING
22 PUSH ROD
23 ADJUSTMENT CAP
24 TRANSVERSE LEVER
25 EXHAUST CAP
26 ELEVATOR ROD
27 EXHAUST DISTANCE PIECE
28 PUSH ROD GLAND
29 STOCKING RING
30 REGULATOR BARREL
31 RUBBER STOCKING
32 EXHAUST SEAT PLUNGER
33 FLOATING BEAM LEVER
34 INLET VALVE
35 TOP COVER

Fig. 1. Sectional view of Mk. 2 relay valve

of levers which are interconnected, by adjustable links, to the mechanical linkage. The description in para. 6–8 is applicable to both assemblies. A pressure chamber below each inlet valve seat communicates with a supply pipe attached to an adapter (4) fitted in the cover. The adapter embodies a gauze filter disc. When the brakes are OFF, each inlet valve is held on its seat by a spring and the air pressure on the supply side. Two adapters (1) and (3) and two pressure plugs (2) are fitted in the cover. These adapters connect the delivery lines to the brake units with the air chamber above the exhaust valve. This chamber is in communication with the chamber below the inlet valve. Each pressure plug closes the bore in which the inlet valve seat is housed and loads the inlet valve spring.

6. The exhaust valve (32) is an externally fluted plunger with a rubber insert at its lower end which co-acts with a seat in the regulator barrel (30). The regulator barrel is free to slide within the body and has a flange at its lower end which slides in an exhaust distance piece (27) which is secured in the body by an exhaust cap (25). Springs, compressed between the barrel and the cap tend to retain the barrel in the raised position. A reinforced rubber stocking (31) forms an air-tight joint between the sliding regulator barrel and the body.

7. The slotted end of the exhaust plunger is pivoted to a floating beam lever (33) which pivots on the square end of a push rod (22). The push rod is operated by a transverse operating lever (24) which pivots on a screw in the body and is coupled by an adjustable connecting rod (20) to the mechanical linkage system. The push rod is fitted with a gland (28) which permits free movement and prevents leakage.

8. The elevator rod (26), pivoted at a point between the ends of the floating beam lever, opens the inlet valve (34) when the brake control is operated. When the brakes are OFF there must be clearance between the end of the elevator rod and the valve stem. This clearance is adjusted by an adjustment cap (23) which is screwed into the base of the body and forms a seat for the end of the elevator rod when the brakes are OFF.

The mechanical linkage

9. The mechanical linkage, fitted to the movement face (8), consists of two sets of linkage of opposite hand, operating about a cable block (11) to which the operating cable (6) is attached. A central steering spindle, directly attached to the rudder control, regulates the movement of the linkages in relation to each other to provide for equal braking or for differential braking proportional to the degree of rudder movement.

10. The linkage consists of a cable block, two elbow links (18), two rocker arms (15) and two adjustable connecting rods (20).

11. The elbow links are, broadly speaking T-shaped plates. The adjacent ends of the heads are connected to the cable block by a fulcrum pin. The other ends of the heads are connected by adjustable connecting rods to their respective transverse levers. The blade of each link carries a roller (19) at its end which engages a curved slot in the rocker arm. Each rocker arm carries a roller which bears on a cam (14) on the steering spindle. The adjustable connecting rod is an assembly consisting of a screwed rod, 6 B.A. at one end and 4 B.A. at the other, separated by a hexagonal portion at the centre, and two forked nuts to engage the screwed ends. The difference in the pitch of the two right-handed threads on the screwed rod permits fine adjustment to be made to the length of the assembly. When the rod is connected in the linkage, screwing the 4 B.A. end into its nut shortens the assembly 0·005 in. per revolution.

12. The operating levers and the associated parts are held in the inoperative position by compression springs which are fitted between the transverse levers and the body.

Principle of operation

13. The principle of operation is illustrated diagrammatically in fig. 2 to fig. 8.

(1) Fig. 2 shows the position of the components when the aircraft is being brought to rest without turning. The steering spindle is central, the rocker arms are at the same angle, and both elbow links have travelled equal distances. The transverse lever has been raised, causing the exhaust valve to seat, the floating beam lever to pivot about the exhaust valve plunger, and lift the inlet valve from its seat.

(2) When the pilot operates the brake control lever the blades of the elbow links are prevented from moving towards each

other by the bearing faces of the slots in the rocker arms which are equally inclined. The movement imparted to the levers and valves at both sides of the unit is therefore synchronized.

14. Fig. 3 shows the position of the levers and valves when the brakes are OFF. The transverse lever is at its lowest position, the elevator rod is seated in its housing, the floating beam lever, pivoting about the elevator rod has lifted the exhaust valve plunger from its seat in the regulator barrel and the inlet valve is seated, the regulator barrel is at its highest position, and an open duct exists between the brake unit and the atmosphere.

15. Fig. 4 shows the initial movement of the valves and levers when the brakes are applied; the selection is for medium braking. Fig. 5 and 6 show the follow up action. In fig. 4, the transverse lever has been raised; the floating beam lever pivoting about the elevator rod has brought the exhaust valve plunger into contact with its seat, and the floating beam lever now pivots about the exhaust valve plunger and brings the elevator rod into contact with the inlet valve stem.

16. Fig. 5 shows the selection completed; further movement of the transverse lever has increased the movement of the floating beam lever and the elevator rod has lifted the inlet valve clear of its seating. Air enters the chamber below the inlet valve. flows into the chamber above the regulator barrel and through the pipe lines to the brake unit.

17. Fig. 6 shows that the pressure in the chamber above the regulator barrel has forced the barrel down against the pressure of its spring, the exhaust valve plunger remains seated and the floating beam lever now pivoting about the push rod, lowers the elevator rod until the inlet valve seats. If maximum braking is desired the movement of the transverse lever is increased, the inlet valve is lifted further from its seat and in consequence, the regulator barrel has to be depressed further against the increasing pressure of its spring before the inlet valve closes.

18. Fig. 7 shows that when the brakes are released the transverse lever is returned to its lowest position by the pressure of the return spring. The floating beam lever pivots about the exhaust valve plunger until the elevator rod seats in its housing, then the pivot point changes to the elevator rod and the exhaust valve plunger is lifted clear of its seating. Air from the brake units passes through the regulator barrel and drillings in the exhaust head to atmosphere. As the pressure in the chamber above the regulator barrel decreases, the barrel is returned to its highest position by the regulator springs.

19. Fig. 8 shows the position of the steering spindle, rocker arms and elbow links for differential braking. The spindle has been partially rotated and the cam which is travelling upwards imparts no perceptible movement to the rocker arm as the bearing point is on an arc which is concentric with the spindle. The downward travelling cam, bearing on a straight portion of the rocker, permits the rocker arm to move towards the steering spindle. The point of attachment for the adjustable connecting rod is lowered, the transverse lever moves downwards, causes the inlet valve to close and the exhaust valve plunger to leave its seat and exhaust air from the brake until the pressure acting on the upper surface of the regulator barrel is sufficiently low to allow the barrel to be raised by the regulator spring and seat on the exhaust valve plunger.

SERVICING

Diagnosing faults

20. Incorrect functioning of the relay control valve will be indicated by the pressure gauge in the brake circuit. It is essential that during straight line braking, the brake-pressure indicators of the gauge rise and fall at the same rate over the same angular distance when the brakes are applied and released. If the pressure difference between port and starboard brakes exceeds 5 lb. per sq. in., adjustments must be made to equalise the pressures.

21. Leakage from the air bottle will be indicated by the supply indicator of the gauge. The leakage may be from any joint from the air bottle to the relay valve; the possibility of fractured pipes must not be overlooked. If the leakage is traced to the exhaust head of the relay valve a defective or incorrectly adjusted inlet valve is indicated. Loss of pressure when the aircraft is parked with the brakes on may be due to leakage at any point in the system, to faulty seating of the exhaust valve plunger, or to a faulty rubber stocking on the pressure regulator barrel. Movement of the brake-pressure indicators not synchronized when the brakes are applied or released, with the steering lever in the central position,

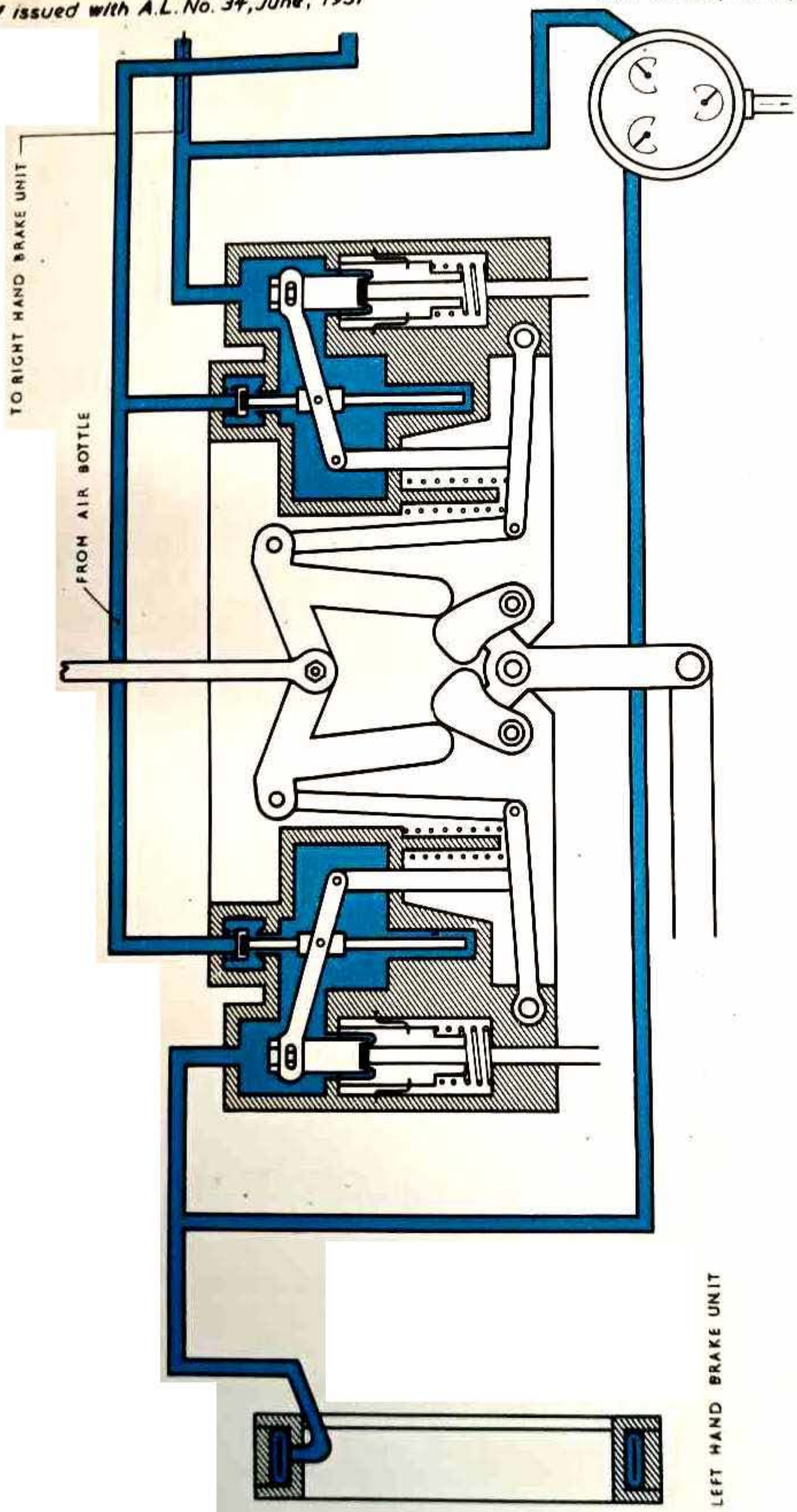


FIG. 2 FUNCTIONAL DIAGRAM OF RELAY CONTROL VALVES – MK. 2

RESTRICTED

PP6640 M35428 G1603 7/51 1680 C & P Gp. 959 (4)

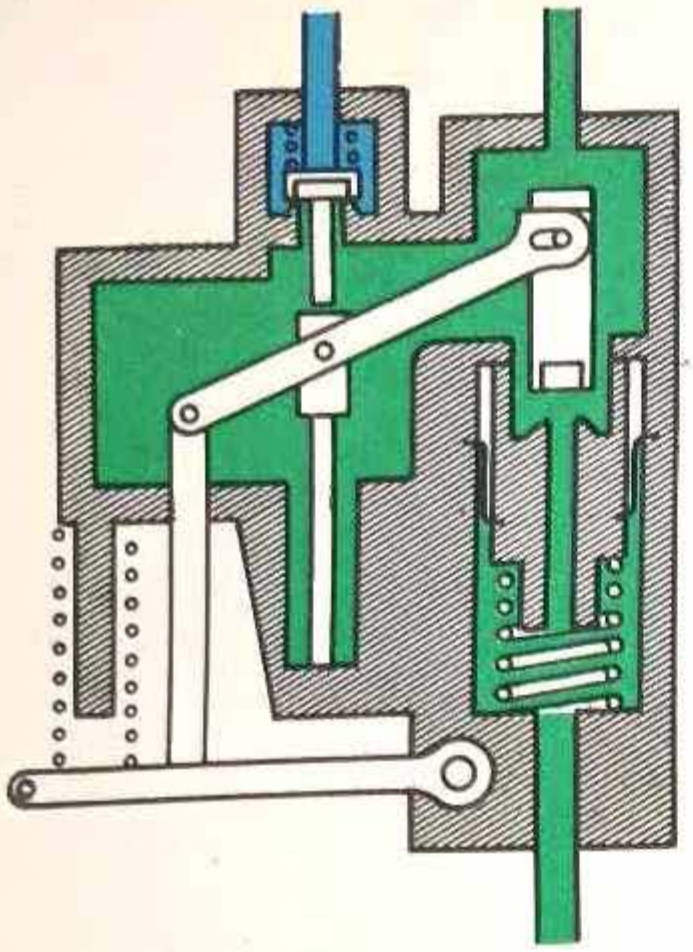


FIG. 3

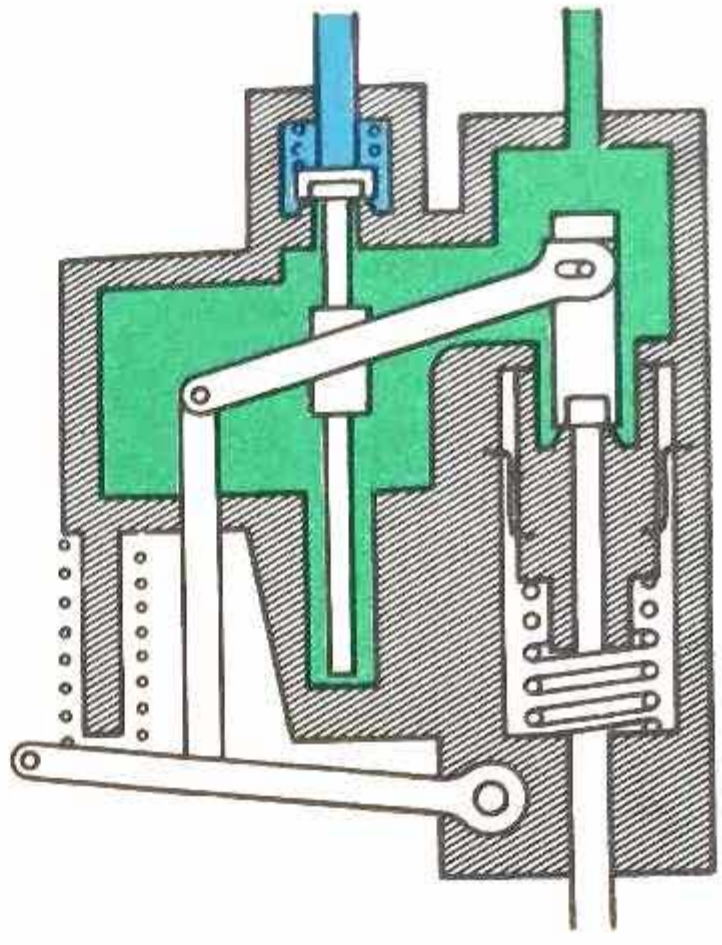


FIG. 4

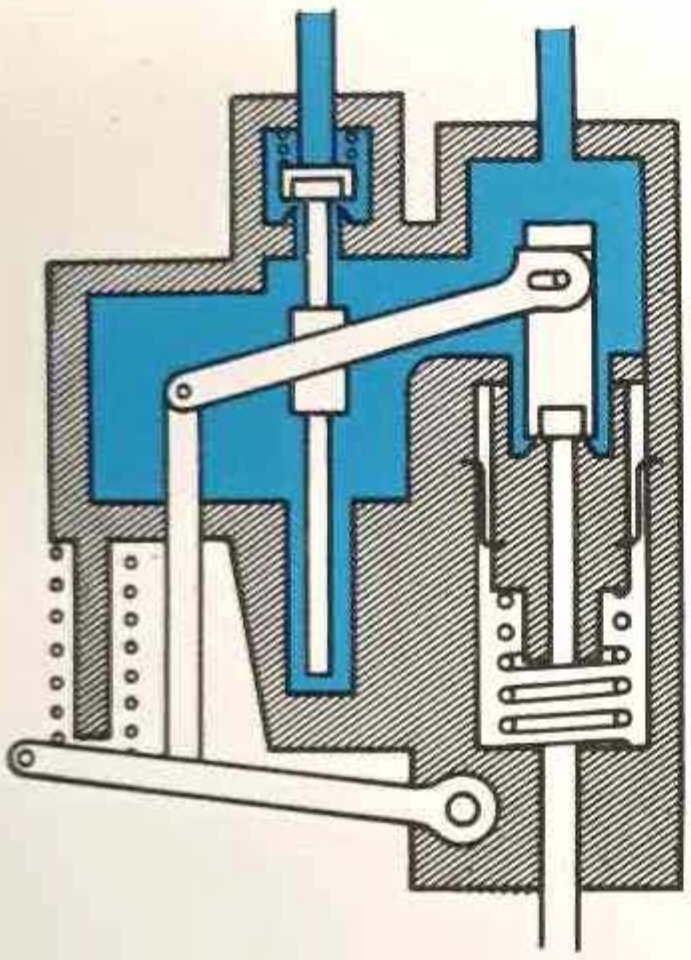


FIG. 5

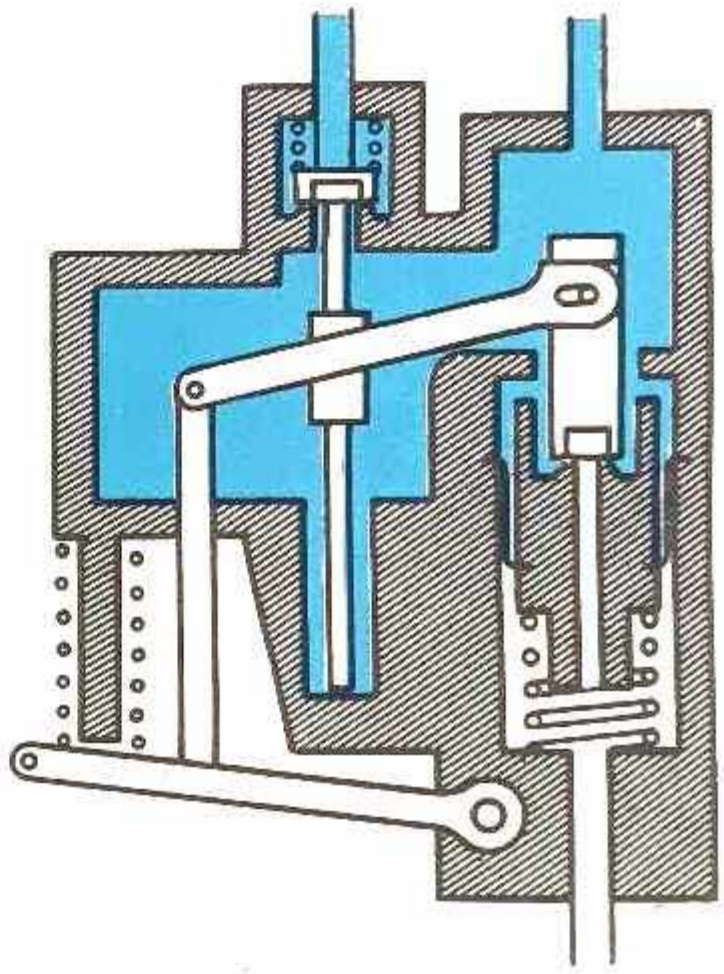


FIG. 6

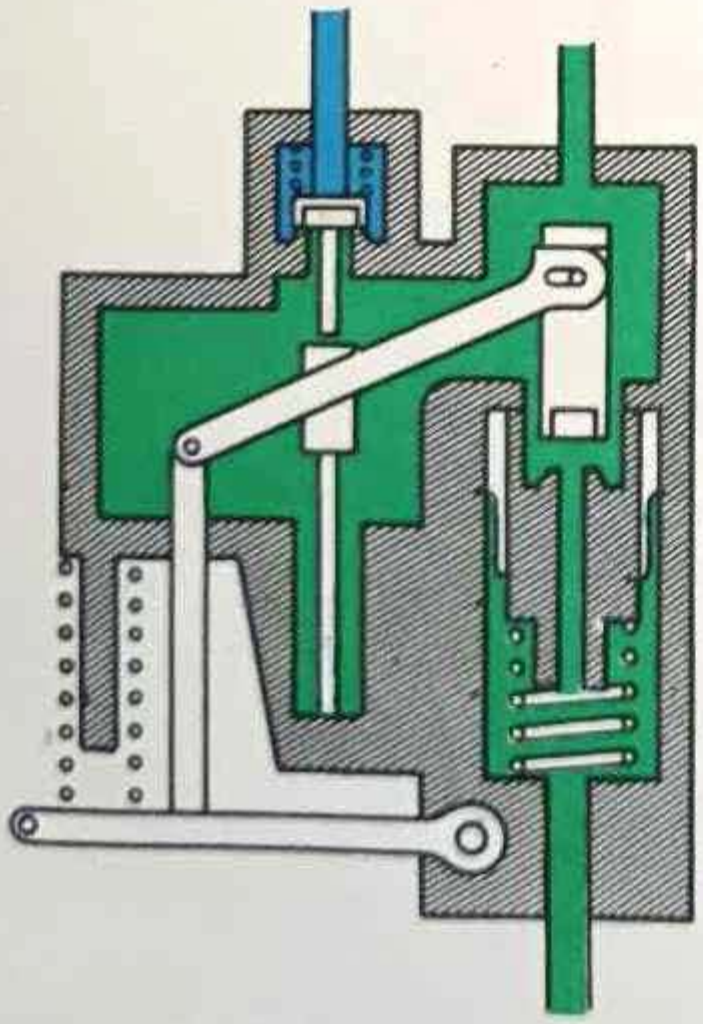


FIG. 7

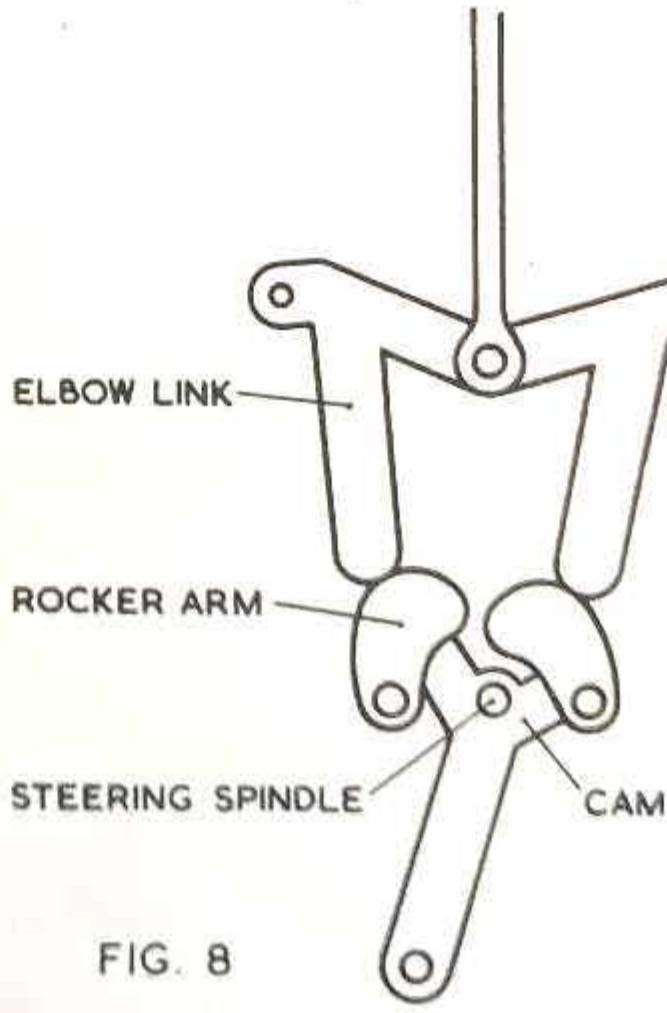


FIG. 8

FUNCTIONAL DIAGRAM OF RELAY CONTROL VALVES, MK. 2

RESTRICTED

indicates incorrect adjustment of the levers operating the valves. The clearance between the inlet valves and the elevator rods, when the brakes are off, should be equal and the adjustable connecting rods should be adjusted so that both exhaust valves close simultaneously.

22. Although a leaking inlet valve is indicated by a pressure drop registered on the supply indicator, when the brakes are applied with the steering lever central, the brake-pressure indicators should be observed. Note that on the side which is leaking the pointer will continuously move up and down the scale. The pressure will slowly build up higher than the normal maximum pressure, then the regulator barrel will move down and open the exhaust. The pressure will drop rapidly to a point less than the normal operating pressure; the regulator spring will then return the barrel to close the exhaust and the cycle will be repeated. If the leakage is rapid it will be audible at the exhaust ports.

23. If the supply pressure drops when the brakes are ON, a check similar to that described in para. 22 should be applied. If it is noticed that after the pressure has built up to the maximum for which the relay valve is set, there is a steady loss shown on one of the brake-pressure indicators followed by a rapid rise to the normal operating pressure. a leaking exhaust valve is indicated.

24. Faulty relay valves must be rectified in the pneumatic servicing bay. Apart from checking for leakage and diagnosing faults, no other servicing will normally be done with the valve installed in the aircraft.

Dismantling

25. (1) Remove all external locking devices.

(2) Remove the steering lever.

(3) Remove the set screws, and withdraw the cover plate complete with the steering spindle.

(4) Remove the four screws from the body top and lift it off the body.

(5) With a scriber, lift the ends of the transverse levers to disengage the elbow links, and remove the rocker arms.

(6) Remove the return springs.

(7) Unscrew the pivot pin to free the end of each transverse lever, unscrew the adjustment screw caps at the base of the valve body and take out the movement face mechanism together with the transverse lever as indicated in fig. 20.

(8) Remove the lever slides from the gland orifices.

(9) Insert the appropriate tool in the push rod orifice, raise the push rod and remove the pin attaching it to the floating beam lever.

(10) Lift out the floating beam levers together with the elevator rods and the exhaust valve plungers.

(11) Using the tool, Stores Ref. 27G/2096, unscrew the nut retaining the gland assembly and remove all the gland parts.

(12) Remove the exhaust caps from the base of the body.

(13) Remove the exhaust plunger springs, distance pieces and locking pins.

(14) Remove the stocking assembly complete with the sealing washers.

(15) Remove the rubber gasket from the body top.

(16) Remove the pressure plugs and washers, and remove the inlet valves and springs from the body top.

Note . . .

Leave the inlet valve seats in position unless it is necessary to repair or renew them.

Assembling

26. Ensure that all parts are clean immediately before assembling, always renew the gasket fitted between the body and the body top and assemble the relay valve as follows:—

(1) Roll back the stockings and dust the inside surface with fine graphite powder. Treat the outer surface similarly and avoid puncturing the stockings.

(2) Insert the stocking assemblies, springs, distance pieces and locking pins in the exhaust valve housings and screw the exhaust caps into position; they should be tight, but must not be tightened sufficiently to damage the stockings.

(3) Insert the gland sealing rings in their housings, fit the heading caps (nuts) to the gland assemblies and push the

assemblies into their housings in the body. The square ends of the rods protruding from the glands must be positioned to engage the floating beam levers.

(4) Pin the elevator rods and the exhaust valve plungers to the beam levers. Position the assembly in the body. raise the push rod assemblies by inserting the tool provided, below the push rod, and pin the beam lever to the square end of the rod.

(5) Screw the lever slides on to the push rods, check the overall length of the push rod assemblies with a gauge (Stores Ref. 27G/2094) and adjust the length to 1·780 in. by turning the lever slides.

(6) Position the transverse levers in their housings, secure them with the pivot pins, and ensure that the levers engage the lever slides on the ends of the push rods.

(7) Fit the return springs to the transverse levers.

(8) Adjust the length of the adjustable connecting rods to 1·375 in. between the pin-centres and fit the remainder of the movement face mechanism. Ensure that the rollers are in position at the ends of the elbow links, raise the ends of the transverse levers and position the rocker arms, then fit the steering spindle.

(9) Position the cover plate and secure it with screws.

(10) Fit the inlet valves, inserting the pins of the valves in the guide holes in the valve seats in the body-top. Fit the springs, washers and pressure caps. If new valves are fitted, place a gauge (Stores Ref. 27G/2095) over the inlet valves positioned in the body-top, and secure it using two knurl headed screws. The pins should be level with, but not project above, the surface of the gauge. If the pins are too long they must be filed to the correct length. To do this, connect the inlet adapter to an air supply of between 200 and 250 lb. per sq. in. and apply air pressure to the valve to prevent it yielding to the pressure of the file.

(11) Connect the body-top to a test rig, apply air pressure to the valves, and check for leakage by applying soapy water at the points marked "P" in fig. 21 (A).

(12) Insert new rubber gaskets in the body-top, position the top on the body and secure it with screws.

(13) Screw the adjustment caps into the base of the body.

(14) Test and adjust the relay valve as described in para. 27.

Testing and adjusting

27. (1) Connect the relay valve to a test rig as indicated in fig. 21 (C), and ensure that the supply pressure corresponds to that quoted in Appendix 1 for the valve under test. Check that the inlet valve is seating correctly; i.e., that no pressure is registered on either of the brake pressure indicators and that no air is escaping from the exhaust cap. Pressure registered, indicates that the exhaust valve is seated and the inlet valve is passing air. This may be due to one or more incorrect adjustments. Screw the cable adjuster in and ensure that the movement mechanism is in the inoperative position. If pressure is still registered adjust the length of the connecting rod until the air exhausts, indicating that the exhaust valve is unseated. If the air continues to exhaust, adjust the elevator rod to allow the inlet valve to seat. At the same time, check that the exhaust valve is not closed by the lowering of the floating beam lever.

(2) With the steering lever central, operate the valve to apply the brakes, note the maximum pressure and if necessary, adjust the pressure adjuster to obtain the correct pressure; screwing the adjuster out increases the pressure. Release the pressure and check that the exhaust is rapid and equal for both valves.

(3) Apply air pressure to the valve and check the freedom of the mechanism by moving the steering lever over its full range of travel several times, checking that the pressures are equal each time the lever is central, and that one side is completely exhausted before the lever reaches the 45 deg. mark. Failure to exhaust completely may be due to incorrect tension of the cable or to slight inaccuracy in the adjustment of the connecting rods; adjust as necessary.

(4) With the steering lever central, check the valves for synchronization. The maximum variation permissible is 5 lb. per sq. in. difference in the pressures, indicated on the port and starboard

indicators, at any position on the scale. Move the steering lever 45 deg. to port and apply air pressure at 100 lb. per sq. in. Without moving the operating lever, move the steering lever to 45 deg. starboard position, when a pressure of 100 lb. per sq. in. should be registered on the starboard indicator; an error of plus or minus 5 lb. per sq. in. is permissible but must not be exceeded. If adjustment is necessary proceed as described in para. 28 or 29.

(5) Test for leakage, using a soap solution, at the following points:—glands, stockings, inserts and adapters. Afterwards, wipe the component dry, removing all traces of soap and moisture.

(6) Release all pressure and disconnect the valve from the test rig.

(7) Connect the valve to the duration test rig as indicated in fig. 21 (B). Blank off the adapters for the brake lines, apply the normal maximum pressure for 15 minutes, leaving the control lever in the parked position, to check the exhaust valve sealing; no loss of pressure should be indicated on the gauge. Release the parking catch and check for loss of pressure from the supply after the valves have been in the inoperative position, for 15 minutes. If a loss is indicated examine the inlet valve, clean or adjust as necessary to correct the fault.

(8) When all the tests are satisfactorily completed fit all the external locking.

Connecting-rod adjustment

28. For small adjustment to the connecting rod, slide the spring clip clear of the adjusting screw and rotate the screw in the required direction. Refit the spring clip to lock the screw when the adjustment is complete.

29. For larger adjustments, proceed as follows:—

(1) Lift the transverse lever, fig. 13, to the extent of its travel.

(2) Push the rocker arm clear of the rollers and lift it out (*fig.* 14).

(3) Repeat (1) and (2) for the opposite side, lift the elbow links and extract the fulcrum pin (*fig.* 15).

(4) Remove the cable block, lift the elbow links clear of the movement face and adjust the length of the rod by rotating the elbow links (*fig.* 16). It is not normally necessary to adjust by more than 2 complete turns.

(5) Reassemble the movement mechanism and apply the tests (*para.* 27).

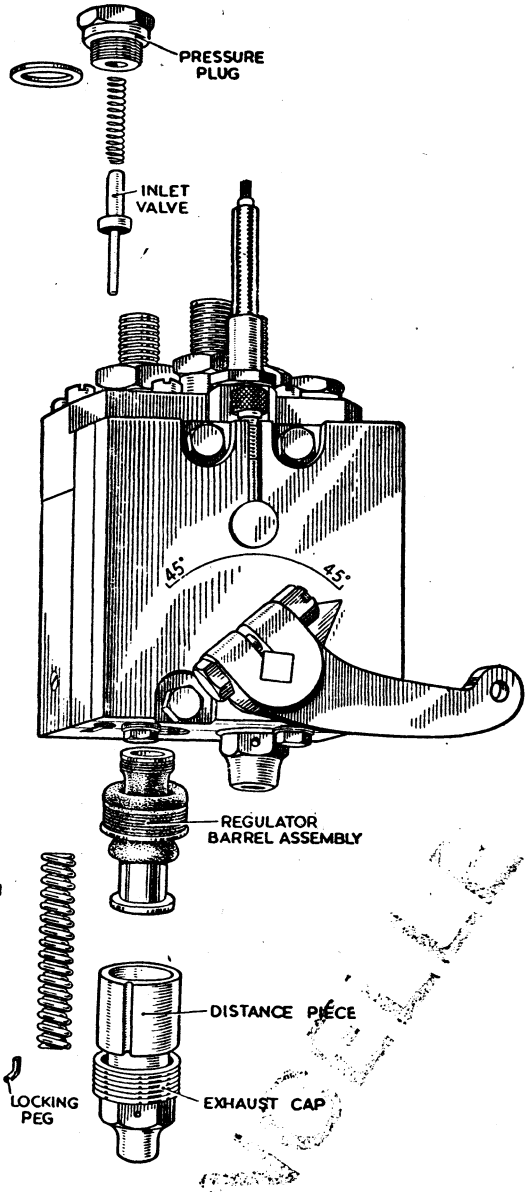


Fig. 9. Details of Mk. 2 relay valve

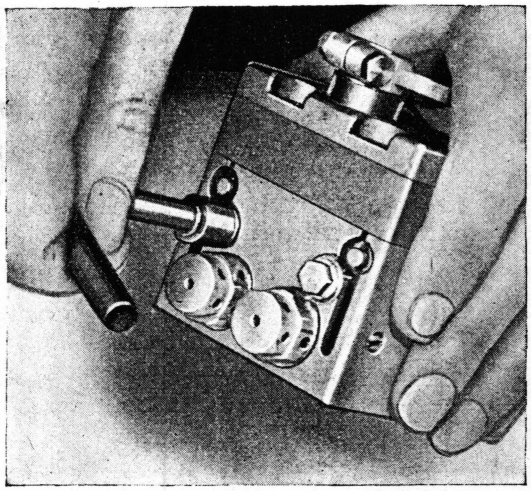


Fig. 10. Removing the inlet valve adjusting screw cap

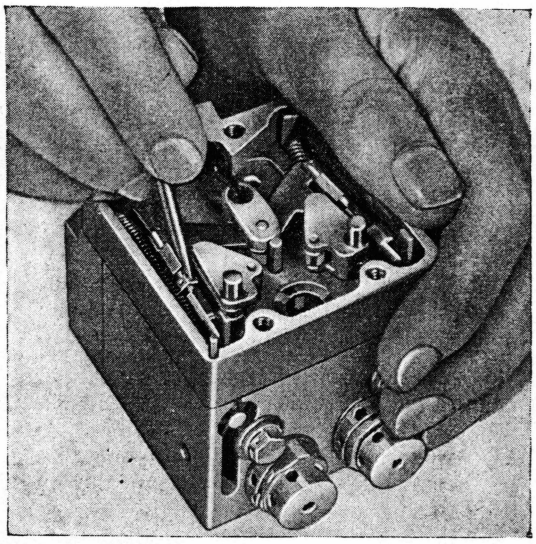


Fig. 12. Adjusting a connecting-rod length—small adjustment

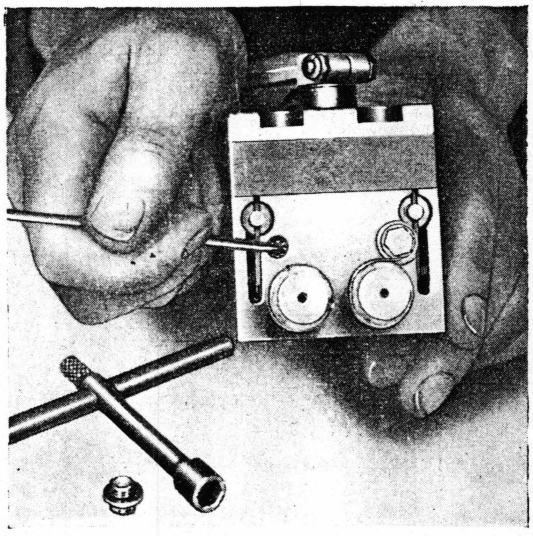


Fig. 11. Turning the inlet valve adjusting screw

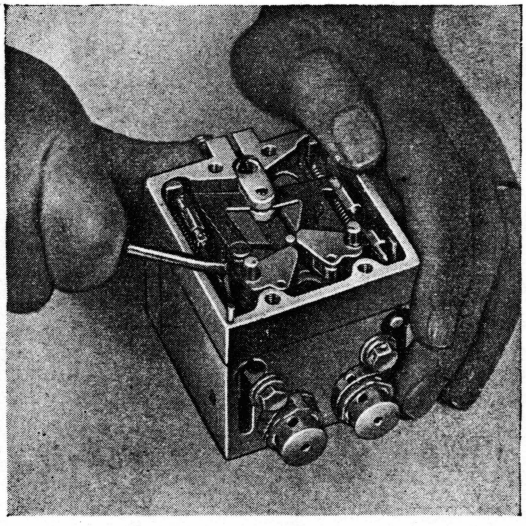


Fig. 13. Lifting a transverse lever

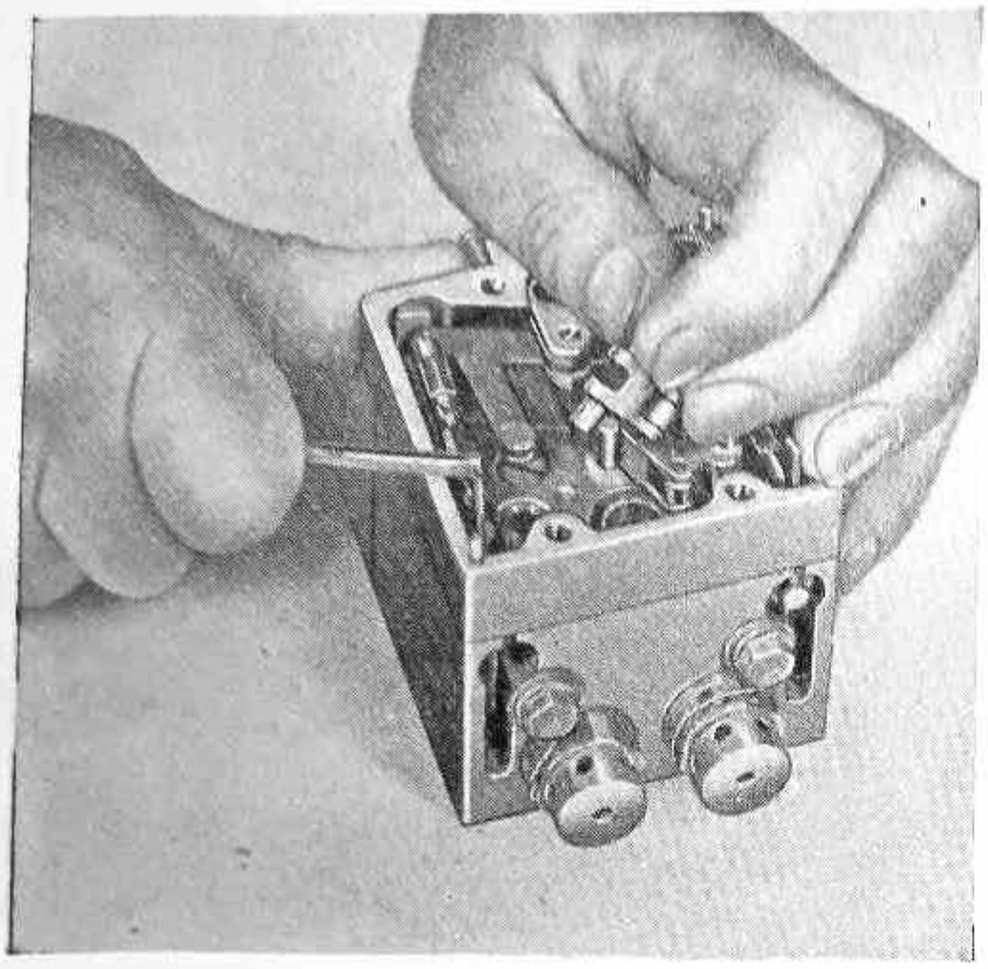


Fig. 14. Removing a rocker arm

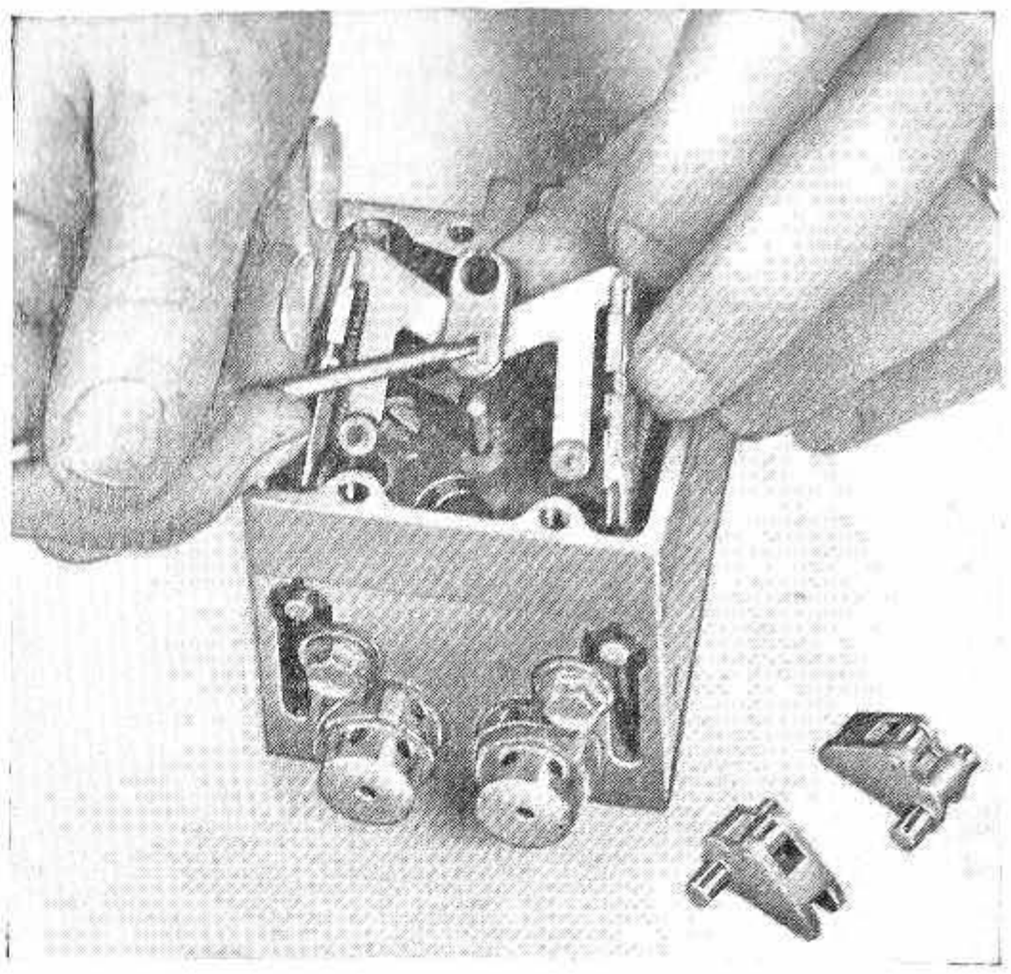


Fig. 15. Removing the cable block pin

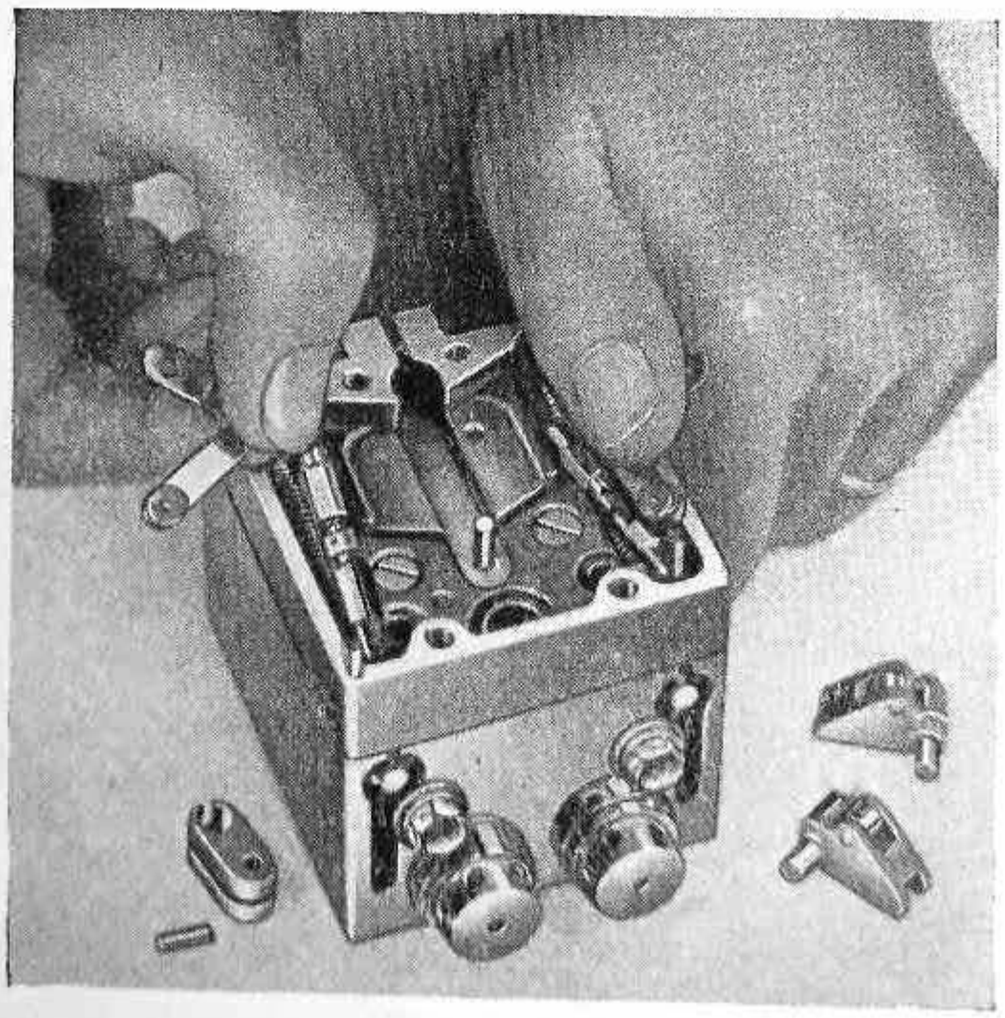


Fig. 16. Adjusting a connecting-rod length—large adjustment

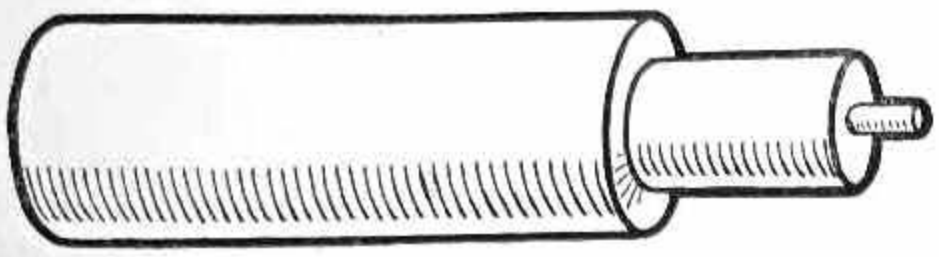


Fig. 17. Tool for raising the push rod

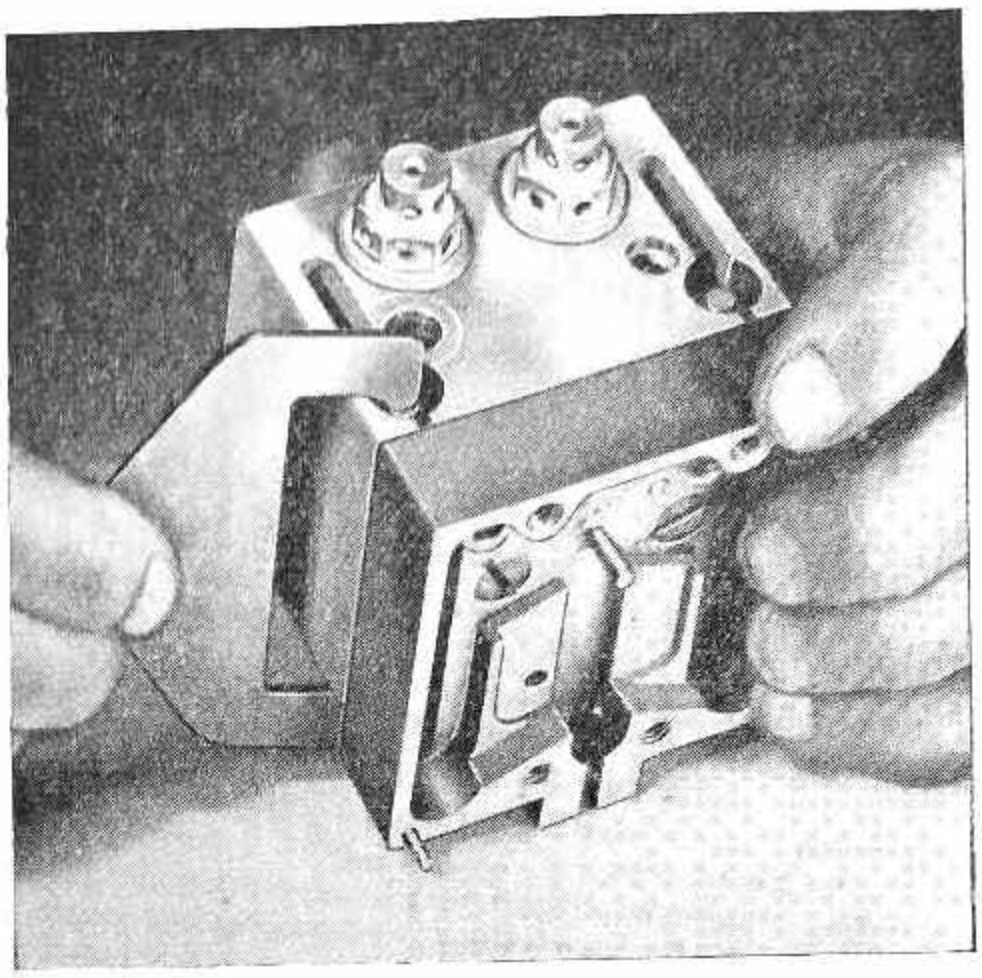


Fig. 19. Gauging a push rod

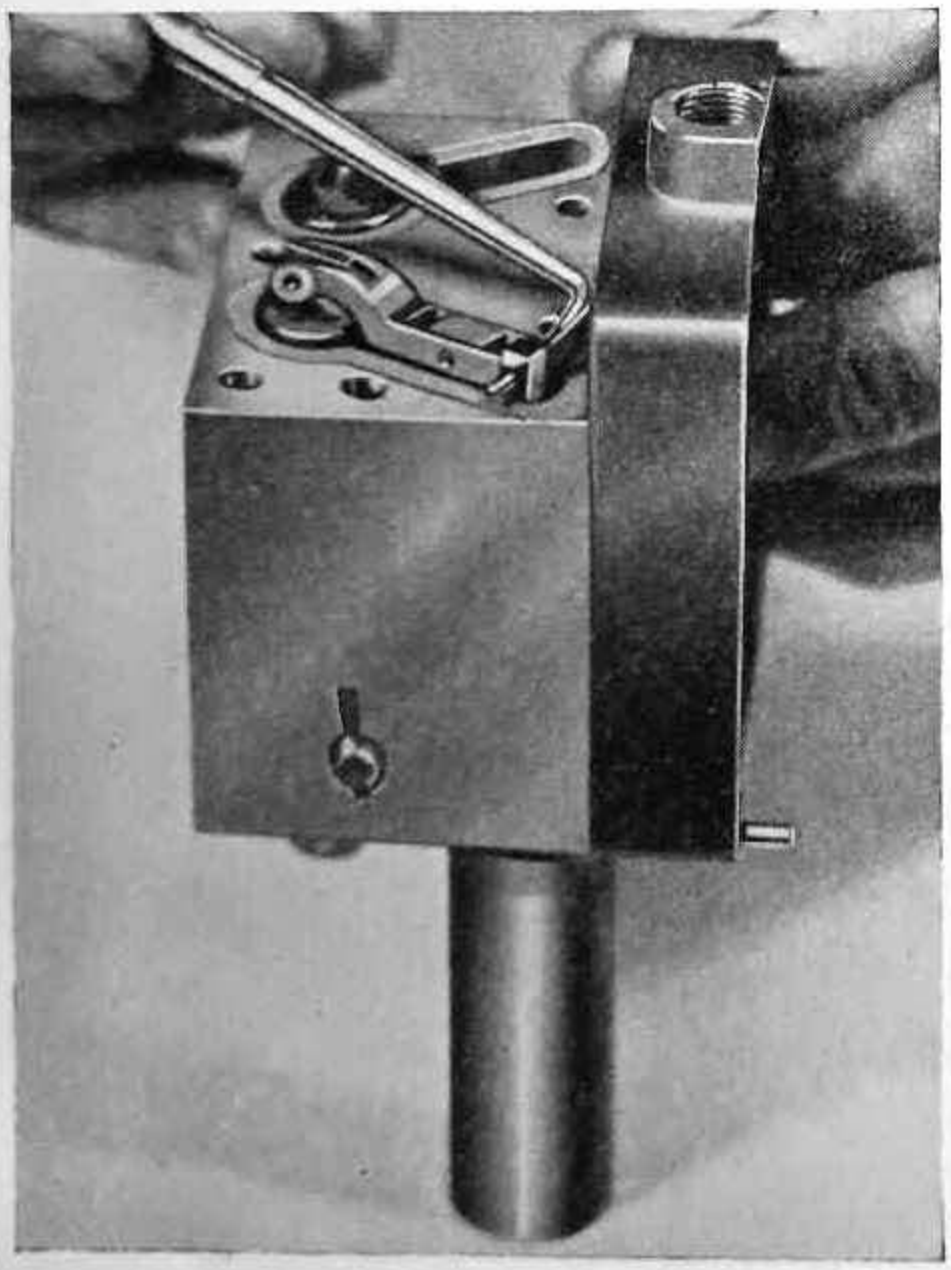


Fig. 18. Removing pin from push rod

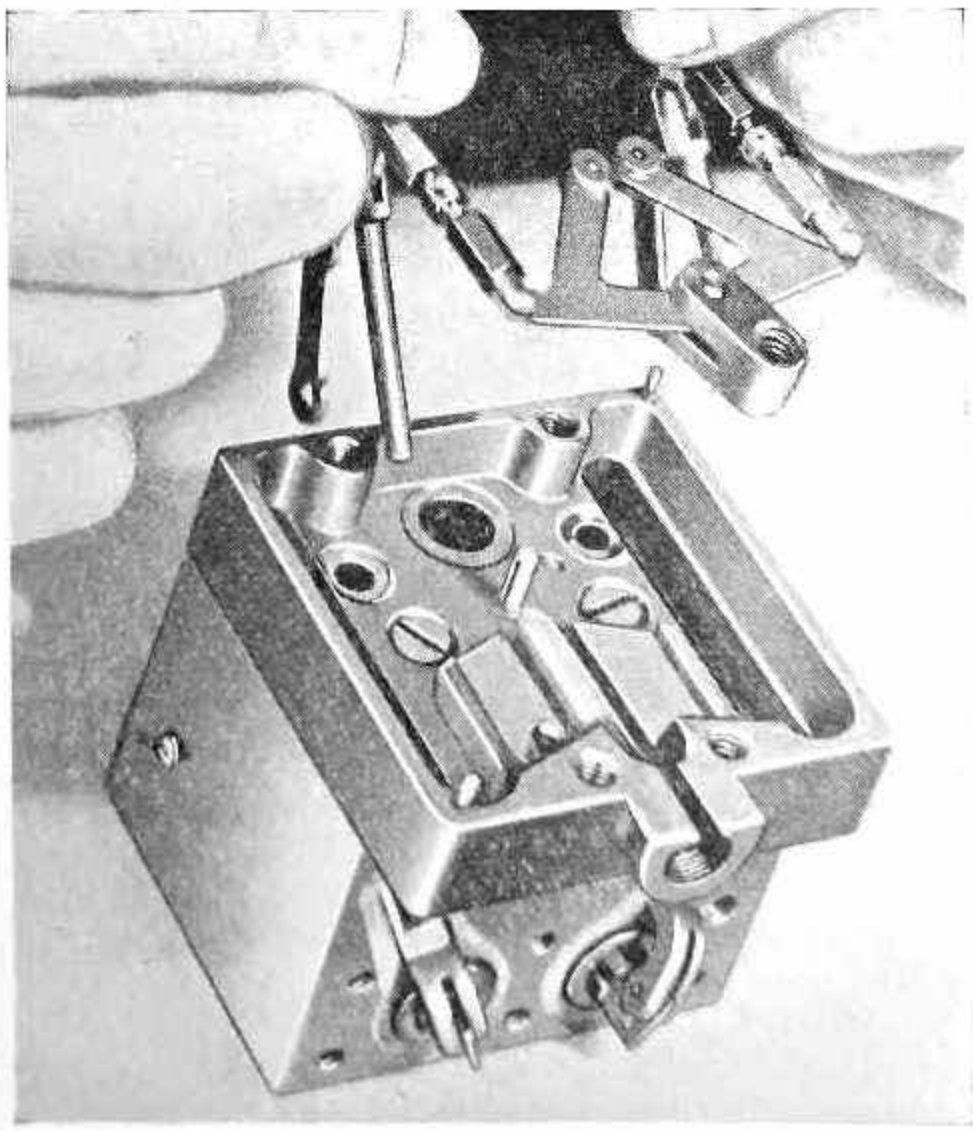
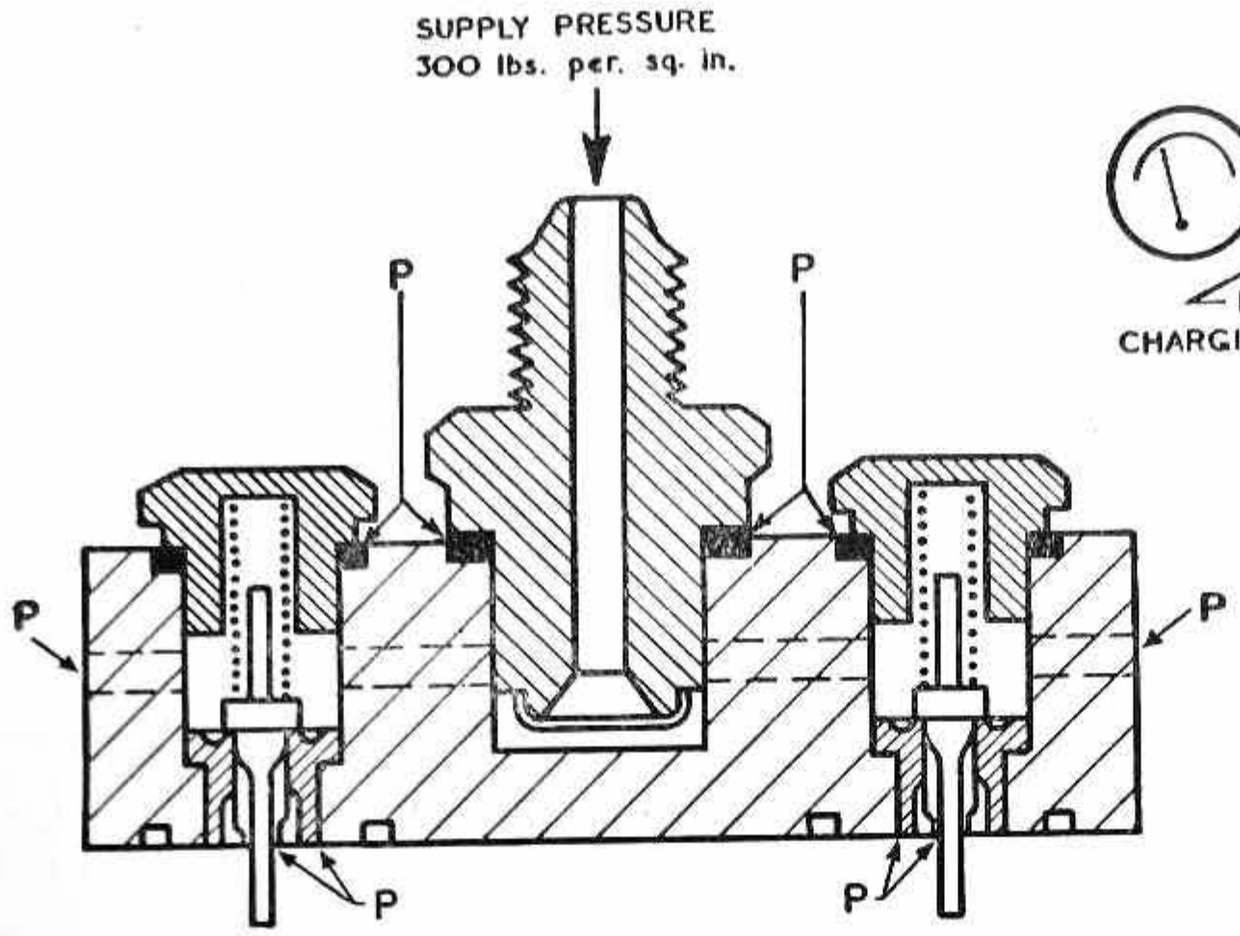
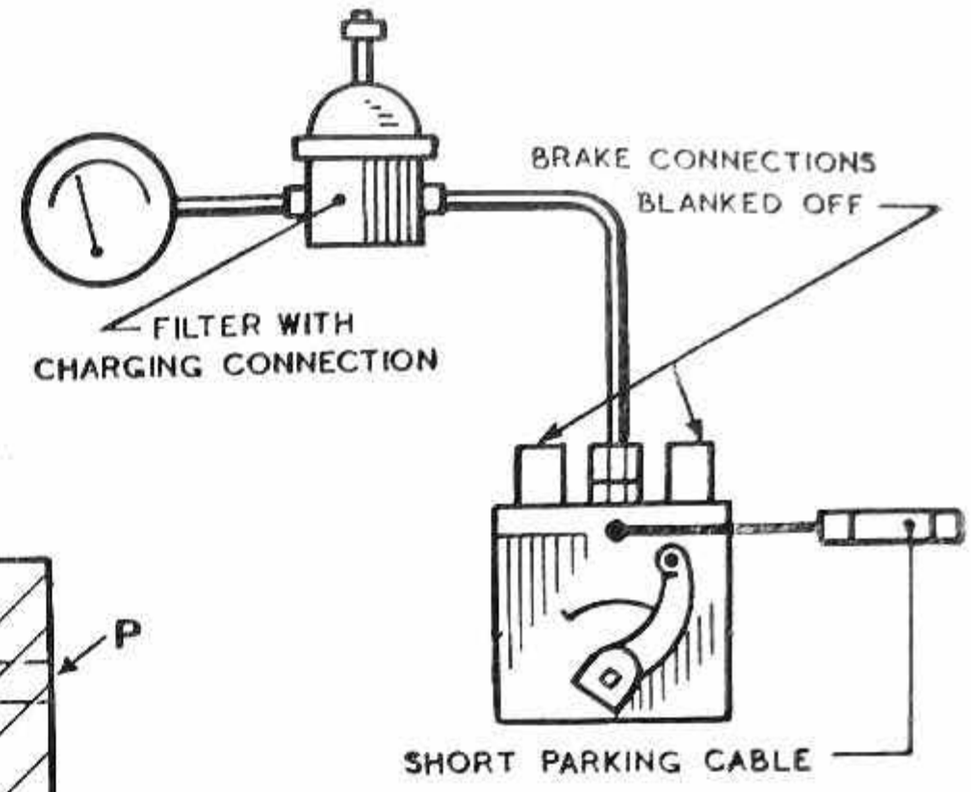


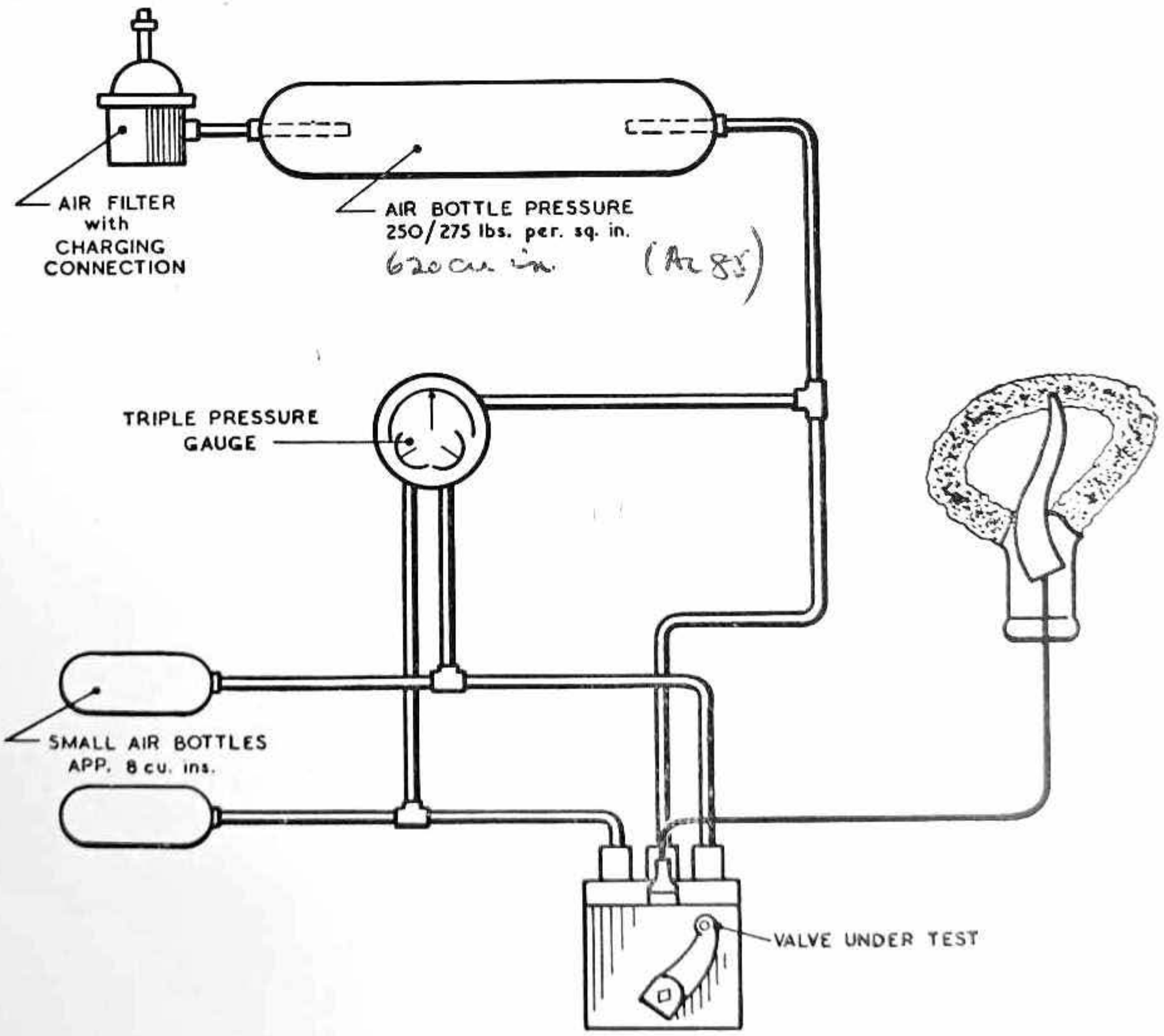
Fig. 20. Removing the link mechanism and transverse levers complete



'A' LEAKAGE POINTS IN HEAD



'B' DURATION TEST RIG



'C' MAIN TEST RIG

Fig. 21. Mk. 2 relay valve test rigs

RESTRICTED

APPENDIX I

DETAILS OF RELAY CONTROL VALVES, Mk. 2

Part No.	Connections		Maximum pressure lb. per sq. in.		Remarks
	Supply	Delivery	Supply	Delivery	
AH.8288	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	110	A.M. standard unit without steering lever
AH.8289	$\frac{3}{8}$ in. B.S.P.	0·600 in. × 19 t.p.i.	310	110	As for AH.8288. 0·600 in. × 19 t.p.i. is for $\frac{5}{16}$ in. o/d tube
AH.8014	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	110	Without steering lever
AH.8354	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	As for AH.8288
AH.8361	$\frac{3}{8}$ in. B.S.P.	0·600 in. × 19 t.p.i.	310	200	A.M. standard unit without steering lever. 0·600 in. × 19 t.p.i. is for $\frac{5}{16}$ in. o/d tube
AH.8353	$\frac{3}{8}$ in. B.S.P.	0·600 in. × 19 t.p.i.	310	200	As AH.8361 but with steering lever AHO.3642 fitted
AH.8350	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	As AH.8354 but with steering lever AHO.3642 fitted.
AH.8241	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	
AH.8422	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	
AC.1047	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	
AC.1048	$\frac{1}{4}$ in. B.S.P.	0·600 in. × 19 t.p.i.	310	200	0·600 in. × 19 t.p.i. is for $\frac{5}{16}$ in. o/d tube
AC.1156	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	Special exhaust connection without steering lever.
AC.1158	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	Special exhaust connection
AC.1164	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	$\frac{3}{8}$ in. exhaust connection
AC.1167	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	$\frac{3}{8}$ in. exhaust connection
AC.1277	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	Steering lever AHO.3559
AC.1204	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	200	Special exhaust connection
AC.1214	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{4}$ in. B.S.P.	310	110	$\frac{3}{8}$ in. exhaust connection
AH.10182	...	...	...	...	AH.8288 with lever AHO.3642
AH.10226	...	...	...	...	AH.8288 with lever AHO.15361
AH.10233	...	...	...	...	AH.8288 with lever AHO.15402
AC.10668	...	...	...	...	AC.1164 modified for cable extraction
AC.11218	$\frac{1}{4}$ in. B.S.P.	$\frac{1}{8}$ in. B.S.P. (banjo)	310	200	