Chapter 2 FUEL SYSTEM

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

DESCRIPTION

General information *(fig.1 and 2)*

1. The fuel is carried in main-plane, leading-edge and flap tanks *(all of which are integral parts of the associated structures)* and in a jettisonable ventral tank which is attached to the underside of the fuselage. Delivery to the engine and reheat pumps is by electric booster pumps housed in the collector boxes *(fig.3)*, to which the contents of all the tanks are transferred either by electric transfer pumps or air pressure; the supply is controlled through four low-pressure cocks which are electrically operated from the cockpit. Recuperators in the main-plane tanks provide a time-limited supply during negative 'g' or inverted-flying conditions. The contents of the integral tanks are indicated on gauges in the cockpit *(Sect.1, Chap.1)*, and a magnetic-type indicator, similarly located, shows whether or not fuel is being transferred from the ventral tank.

2. Pressure refuelling of the complete system *(Sect.2, Chap.2)* is effected through a single adapter *(access panel 63P)*, fuel entering all tanks *(with the exception of the leading-edge tanks, which are in unrestricted communication with the main tanks)* through a variety of refuelling valves. For information regarding the associated air and electrical systems, refer to Sect.3, Chap. 8D, and Sect.6, Chap.10 respectively.

Tanks

Main-plane and leading-edge tanks (fig.3)

3. The main-plane and leading-edge tanks constitute integral parts of the associated structures, the latter being detachable from brackets secured to spar 1. Although structurally independent of each other, each pair of tanks functions, through unrestricted communicating passages, as one unit.

4. Each main-plane tank is divided into three compartments *(fig.3)* of which the smallest functions as a collector box. During pressure refuelling, the fuel enters the centre compartment through a Mk.12 refuelling valve and from there passes to the other compartments through simple non-return valves in the dividing walls; the leading-edge tank is in free communication with the inboard and centre compartments. The combined leading-edge and main tanks are vented, both inward and outward, by constant differential vent valves. The inward vent valve is mounted in the main-plane leading edge and is connected to the main tank by a pipe passing through the tank end-wall; the outward vent valve is fitted in the inboard compartment roof near the fuselage.

5. When the engines are running, the fuel is transferred from the inboard to the centre compartment by gravity through the non-return valves in the dividing wall *(para.4)*, and from the centre compartment and leading-edge tank to the collector box by transfer pumps through a transfer valve *(para.35)*. The collector box contains two booster pumps which deliver the fuel, through the recuperator and the low-pressure cocks to the engines. The non-return valves in the dividing wall between the collector box and the centre compartment ensure that, in conditions of low fuel content, the collector box remains filled and the booster pumps immersed in both nose-up and nose-down flight attitudes.

6. A gravity-refuelling point is provided in the upper surface of each main tank. This is only a stand-by measure and the filler position is such that the tanks cannot be filled to capacity by gravity. The filler caps must not be removed when the tanks have been fully pressure-refuelled, or fuel will be discharged from the filler orifice.

Flap tanks

7. Each flap constitutes a fuel container and has two compartments. A non-return valve and an unrestricted passage in the dividing wall, allow free flow of fuel between the compartments during refuelling. In fuel transfer conditions, air pressure is applied through the inboard hinge causing fuel to flow from the inboard compartment to the outboard compartment through the unrestricted passage only. From the latter compartment fuel flows, through the outboard hinge, into the fuel system pipelines.

8. Refuelling and defuelling takes place through a Mk.27 refuelling valve in the fuel pipe to the flap. Inward venting is through a non-return valve fitted in a branch pipe from the tank pressurizing pipe, and outward venting is provided by the main tank outward vent valve, flap tank pressure being communicated via a vent pipe embodying a 7-lb pressure-relief valve. An addi-

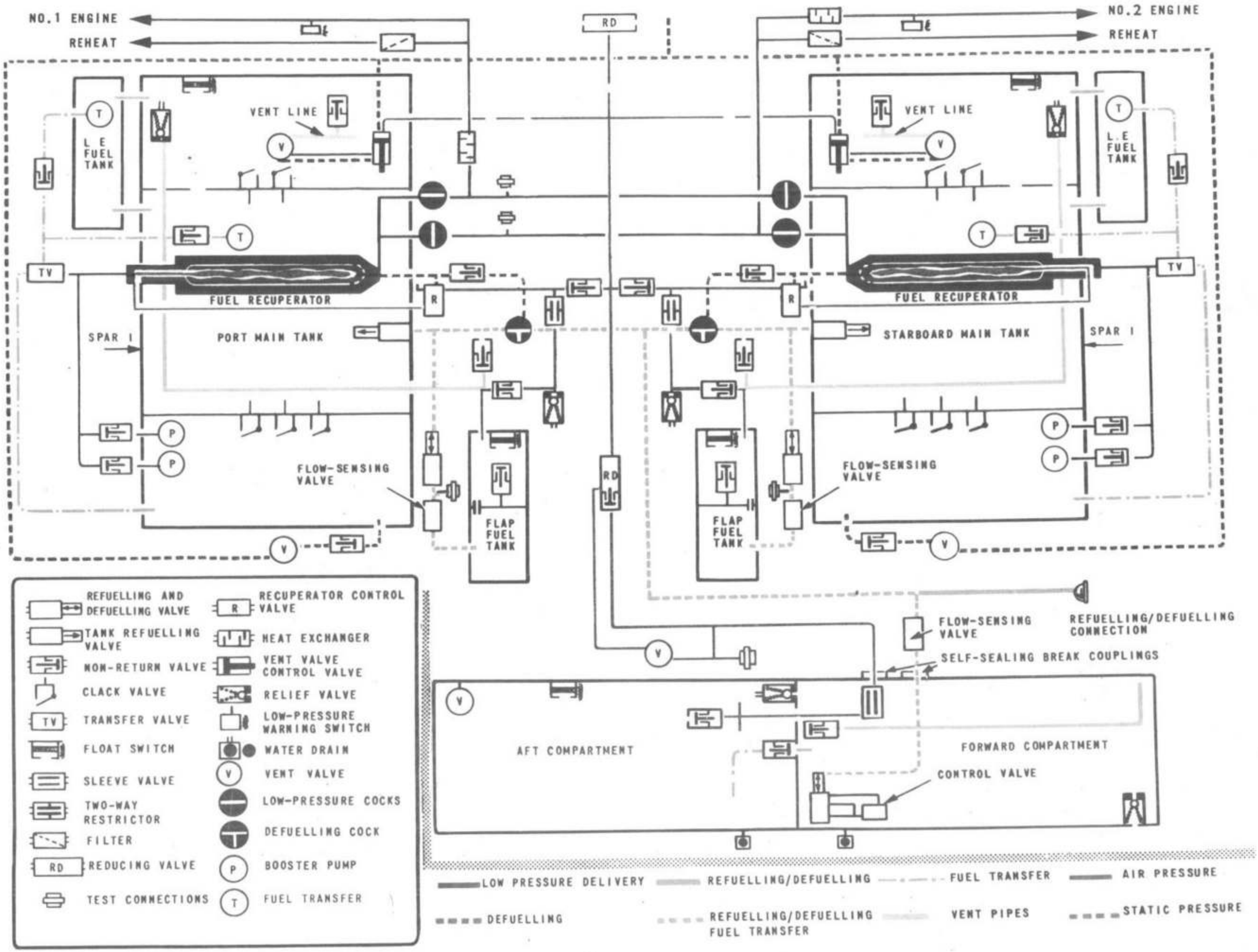

FIG.1. FUEL SYSTEM DIAGRAM

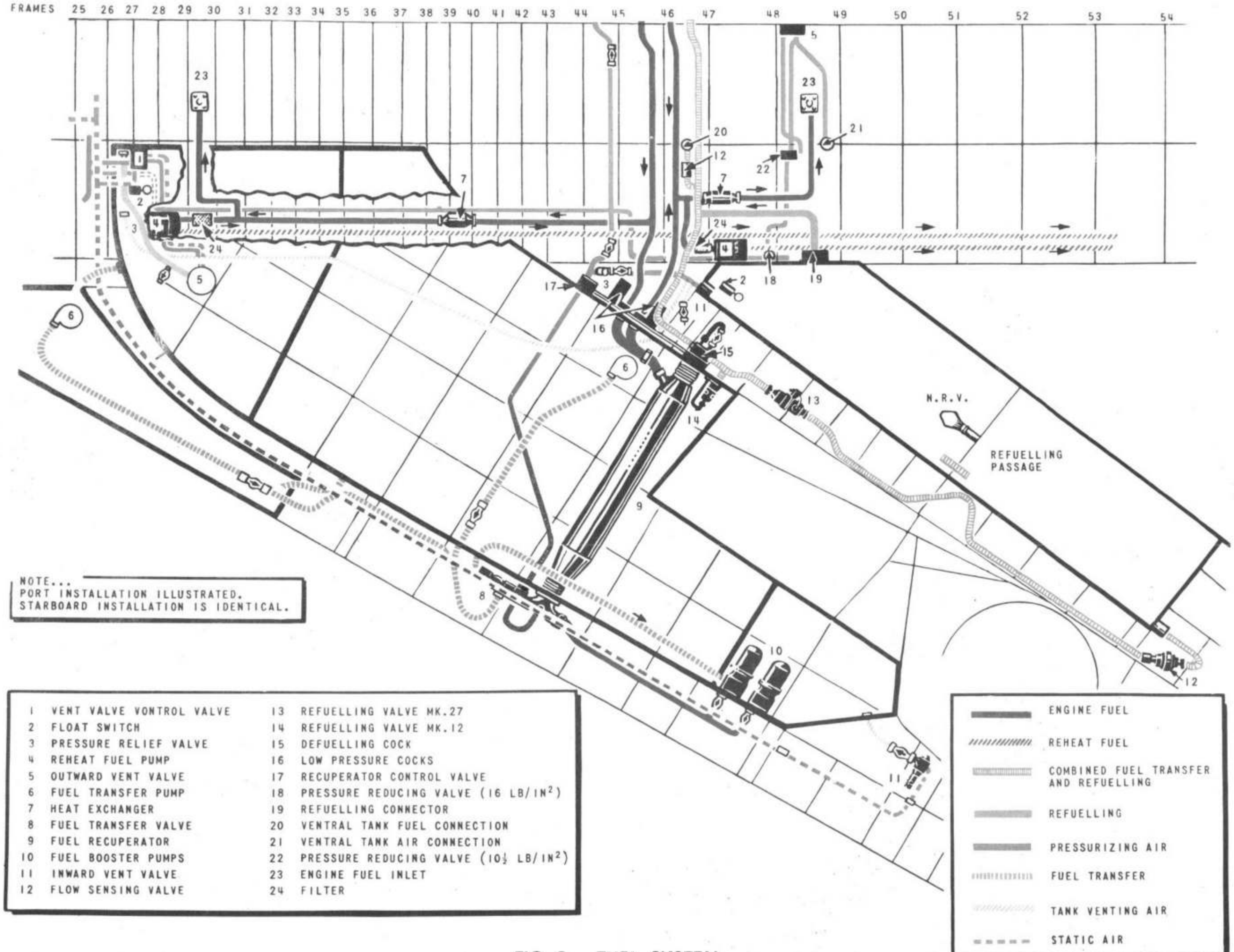

FIG. 2. FUEL SYSTEM

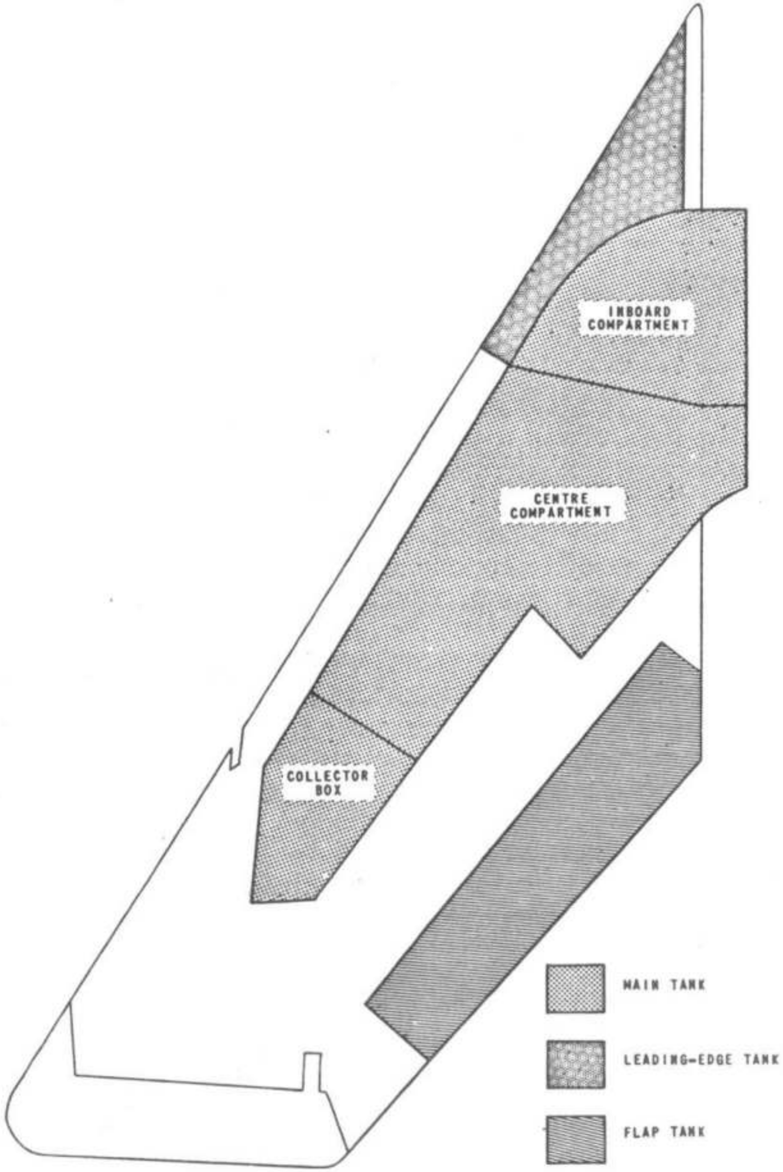

Fig. 3. Arrangement of wing fuel tanks

tional safeguard against over-pressurizing the tank is provided by a 9-lb. pressure-relief valve in the flap tank pressurizing pipe.

Ventral tank (fig.4)

9. The ventral tank is of conventional stressed-skin construction, and its upper surface is so contoured that, when the tank is attached to the aircraft, a rubber seal around the tank periphery is in contact with the fuselage skin. It is attached by a single suspension bolt which engages a manually-operated release unit mounted on the forward face of frame 47; further support is provided by a pair of spring-loaded pivots, forward of frame 55, which engage two lugs formed on the tank aft-end casting. The installation is completed by a small detachable fairing which extends the tank contour aft to the fuselage skin. The fairing is attached by a spring-loaded catch on the tank engaging the shank of a bolt on the fairing, and by a lug on the fairing engaging a spring-loaded pin inside the fuselage. The tank is not normally expendable but it can be jettisoned by pulling a handle in the cockpit *(Sect.1, Chap.1)*. The handle is also used during tank removal.

10. A number of internal baffles reduce fuel surge and one of these divides the tank intq two separate compartments. Pipes passing through the dividing baffle provide interconnections between compartments for the passage of fuel and pressurizing air, and embody non-return valves to ensure that the tank compartments empty in a pre-determined sequence. Simple connectors in the top

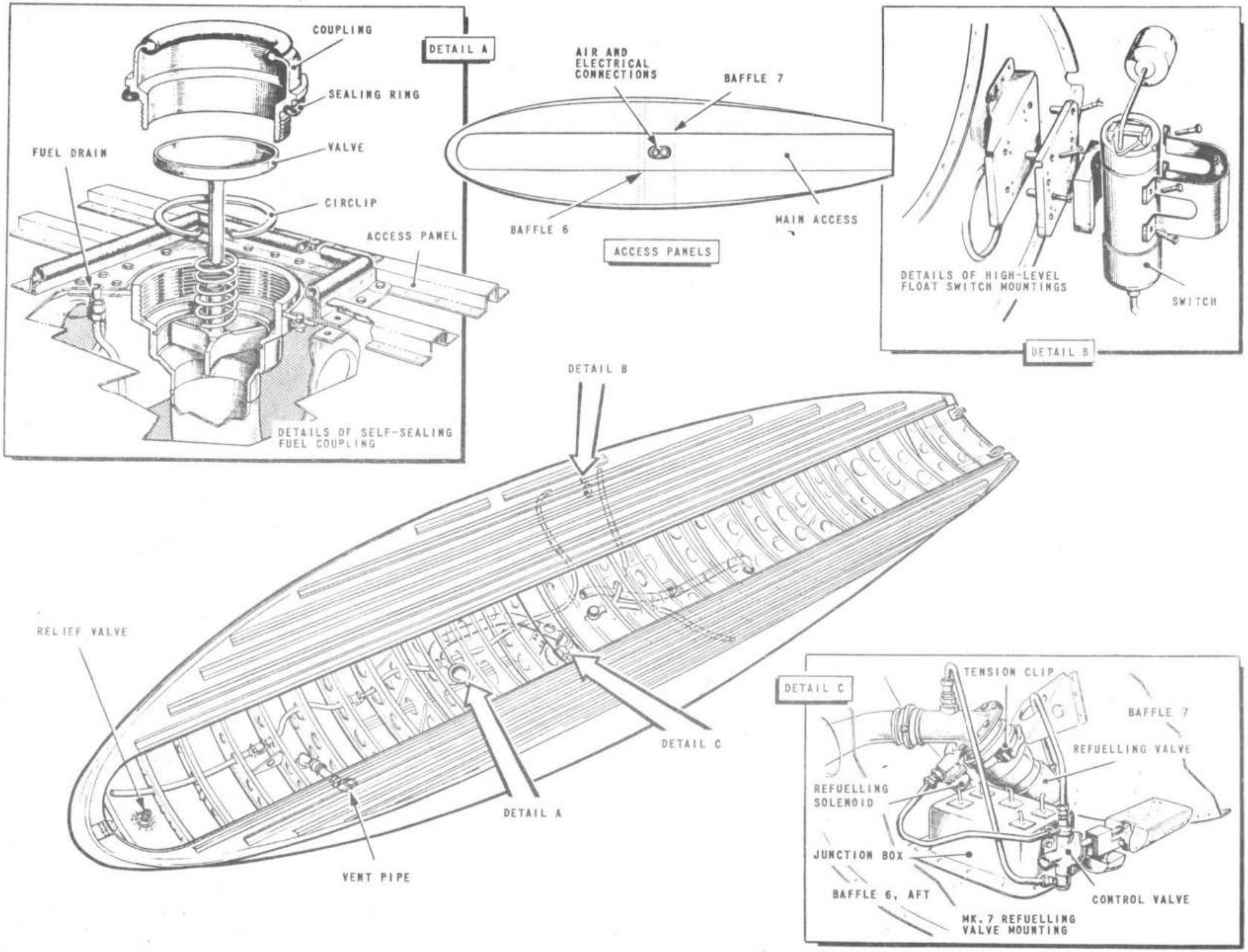

FIG. 4. VENTRAL TANK

of the tank, forward of the dividing baffle, join automatically with corresponding connectors in the fuselage under-surface when the tank is fitted and permit the passage of fuel, air and electrical supplies to or from the tank.

11. Fuel enters and leaves the tank through a Mk.7 fuel/no air valve in the lower end of the fuel pipe. The tank is vented inwards through a valve in the top skin at the aft end; an outward vent valve is located in the fuselage at the starboard side between frames 47 and 48.

12. To guard against over-pressurization of the tank, due to component failure, a relief valve fitted in the tank bottom skin at the forward end permits automatic jettisoning of fuel if the tank pressure exceeds 16.5 lb/in^2 above atmospheric pressure. Any possibility of an air pressure build-up between the tank and the fuselage is prevented by a large-diameter vent pipe passing vertically through the tank at the forward end.

Transfer pumps

13. The transfer pumps are accommodated in housings secured to the lower skins of their respective tanks, and are accessible through removable circular panels in the tank upper skins. The pump is retained in its housing by a circular screwed plug which is locked by a spring circlip. A drain pipe, attached to the housing and communicating with a hole in the bottom skin, carries away any fuel which may by-pass the gland seal into the motor compartment.

Booster pumps

14. These pumps are bolted to a detachable web plate on spar 1, between ribs 10 and 11, in each main plane and are withdrawn with the web plate. A separate drain for each pump opens into the leading-edge fairing, allowing any fuel which penetrates the motor sealing gland to drain through drillings in the fairing.

Fuel valves

General information

15. The fuel valves and their associated control systems permit simultaneous flow of fuel to all tanks during refuelling and a sequenced transfer of fuel between tanks during engine running. The three types of valves fitted include one Mk.7 fuel/no air valve, two Mk.12 refuelling valves and two Mk.27 refuelling valves; control of the valves is effected electrically or mechanically or both.

Mk.7 valve

16. This valve and its associated control valve are fitted in the ventral tank. Its function is to allow fuel to flow into or out of the tank but to prevent air entering the fuel pipelines. The valve operates by differential pressure applied across a piston assembly the differential being controlled by the control valve during fuel transfer, and by an internal solenoid valve during refuelling. Energizing and de-energizing of the solenoid are controlled by the refuelling door microswitch and the ventral tank high-level float switch respectively.

Mk.12 valve

17. A Mk.12 valve is fitted to the forward face of spar 5 in each main tank. When the valve solenoid is energized, fuel is admitted to the main and leading-edge tanks but no reverse flow is permitted; when the solenoid is de-energized there is no flow in either direction. The electrical supply to the solenoid is controlled by a high-level float switch, in the inboard compartment of the main tank.

Mk.27 valve

18. One Mk.27 valve is fitted in the fuel pipeline to each flap tank and controls flow to and from the tank during refuelling, defuelling or fuel transfer. The valve embodies defuelling and refuelling solenoids, the former controlled by a flow-sensing valve in the ventral tank transfer pipe, and the latter by the combined operation of the refuelling adapter access door micro-switch and a high-level float switch in the flap tank. When the defuelling solenoid is energized, no flow through the valve is permitted; completion of the refuelling solenoid circuit permits refuelling flow, and when both solenoids are de-energized defuelling or fuel transfer can take place.

Flap tank flow-sensing valve *(fig.5)*

Description

19. The valve consists of a cylindrical casing enclosing a spring-loaded shuttle, the spindle of which slides in guides in the casing. A cam on the spindle can, in certain conditions, cause movement of a plunger in the casing, and this movement is transferred to the operating lever of an external microswitch. The shuttle incorporates two valve heads separated by a distance tube and the three items are normally held in contact with each other, against the cam shoulder, by the refuelling spring, which is retained by a washer and circlip on the spindle. The defuelling spring, which exerts a greater force than the refuelling spring, holds the main valve head against a seating in the casing when the valve is in its static condition. A gap between the inner valve head and the washer on the spindle permits relative movement between the two components.

◀ Note...

An inherent leakage, from the diaphragm drain, exists when the system is under pressure. This will be apparent during refuelling when the valve is viewed through access panel 130P or S. The maximum allowable rate of leakage is 20 drops per minute and valves which exceed this figure must be renewed. ▶

Operation

20. During engine running, a flow rate of up to 3 gal/min can take place through the gap between the valves and the holes in the main valve, without the valve operating. When the flow exceeds this figure, fuel pressure on the main valve head displaces the shuttle towards the microswitch, causing the cam to lift the plunger and operate the switch. Instantaneous action is achieved by the sudden increase in the effective area of the main valve head as it is lifted from its seating. The valve remains in this position until the flow rate falls to a figure approaching 1 gal/min, when the defuelling spring returns the valve to its static condition.

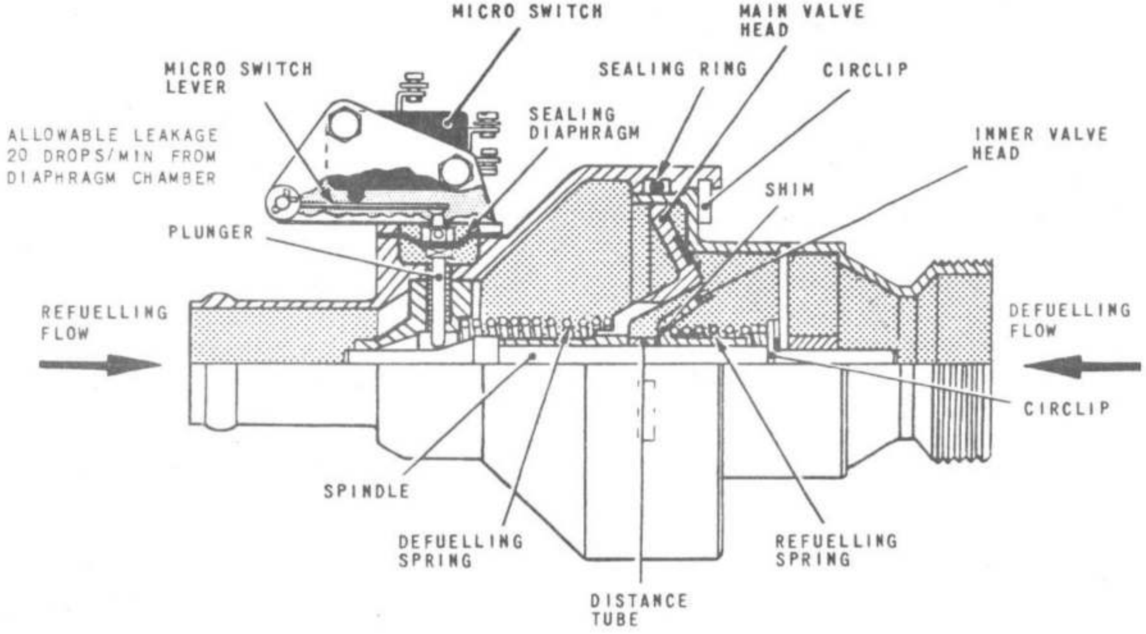

Fig. 5. Flap tank flow-sensing valve

21. When the aircraft is being refuelled, the reverse flow through the valve passes through the holes in the main valve head, and impinges on the inner valve head to displace the latter against the refuelling spring. The increased gap between the valves permits a full refuelling flow rate.

Ventral tank flow-sensing valve *(fig.6)*

Description

22. The valve comprises a cylindrical casing enclosing a spring-loaded shuttle assembly and a spring-loaded refuelling sleeve; a switch unit is bolted to the outside of the casing.

23. The shuttle consists of a slotted spindle on to which are fitted an adjustable valve head, a fixed switch plate housing, an adjustable slotted sleeve and a spindle guide. The latter item is located by a bolt which engages the slots in the spindle and the sleeve. A second spindle guide is fitted in the valve casing and the shuttle can move axially in the guides, within the limits of the slot.

24. The switch unit has an adjustable contact strip between two fixed contacts. During valve operation, the contact

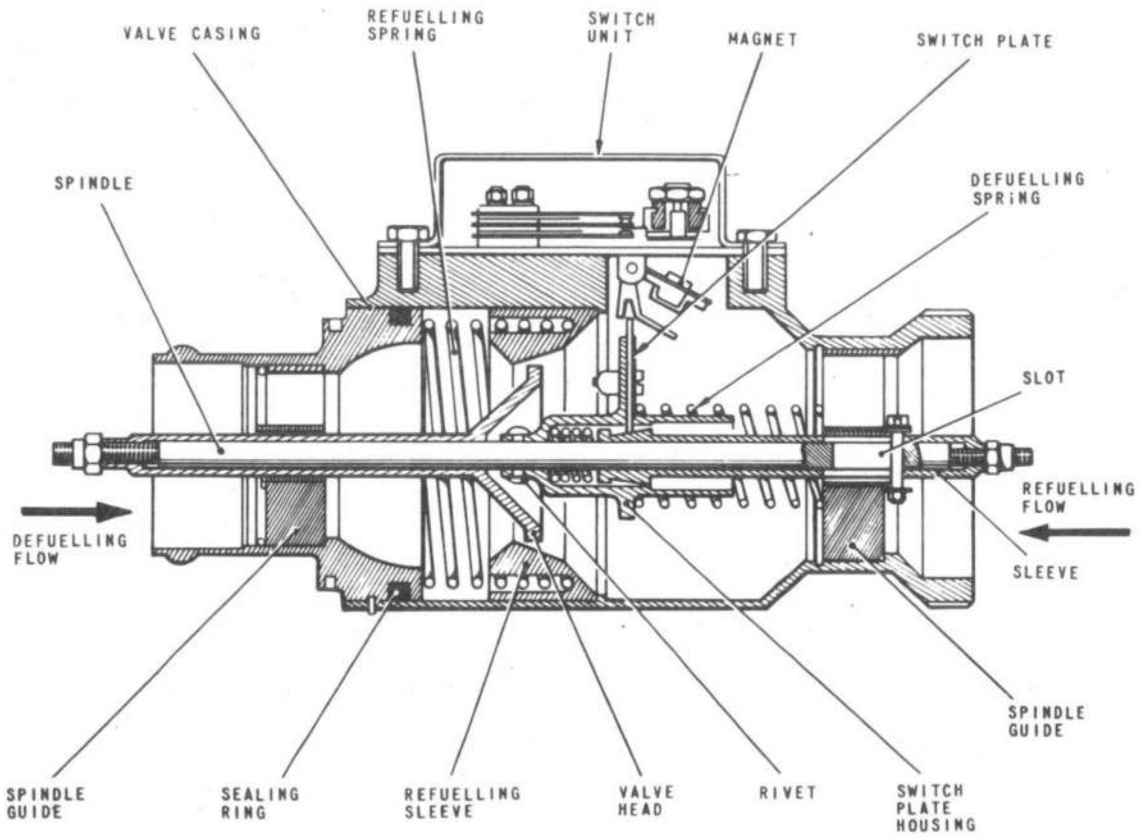

Fig. 6. Ventral tank flow-sensing valve

strip is moved by the attraction of a small permanent magnet, carried by a lever pivoting in a bracket on the bottom plate of the switch.

Operation

25. During engine running, fuel can flow between the valve head and the refuelling sleeve up to a rate of 11 gal/min without operating the valve. When the flow rate exceeds this figure, fuel pressure on the valve head displaces the spindle, against the defuelling spring, causing the switch plate to lift and operate the switch. When the flow rate falls to 7 gal/min, the defuelling spring returns the valve to its static position.

26. During refuelling, the reverse flow through the valve displaces the refuelling sleeve against its spring, allowing fuel to flow around the valve head into the tank at maximum refuelling flow rate.

Fuel recuperator

General information

27. A fuel recuperator is fitted between spars 1 and 5 in each main tank, and is inserted in the low-pressure supply pipe to the engines. Discharge of fuel from each recuperator is effected by compressed air, under the influence of an associated control valve, when delivery pressure falls; the valves are fitted outside the tanks at the inboard end of spar 5 in each main plane.

Recuperator

28. The recuperator comprises a cylindrical outer casing, incorporating a deaeration valve, a perforated inner casing and a rubber bladder and has a capacity of five gallons. The latter component is supported centrally by the recuperator insert through which air is introduced to inflate the bladder. In normal conditions, the bladder is deflated and the annular chamber surrounding it forms a passage for fuel passing from the pumps to the engines. Two outlets, in the aft end plate of the recuperator, are connected to the defuelling pipe and the recuperator control valve respectively.

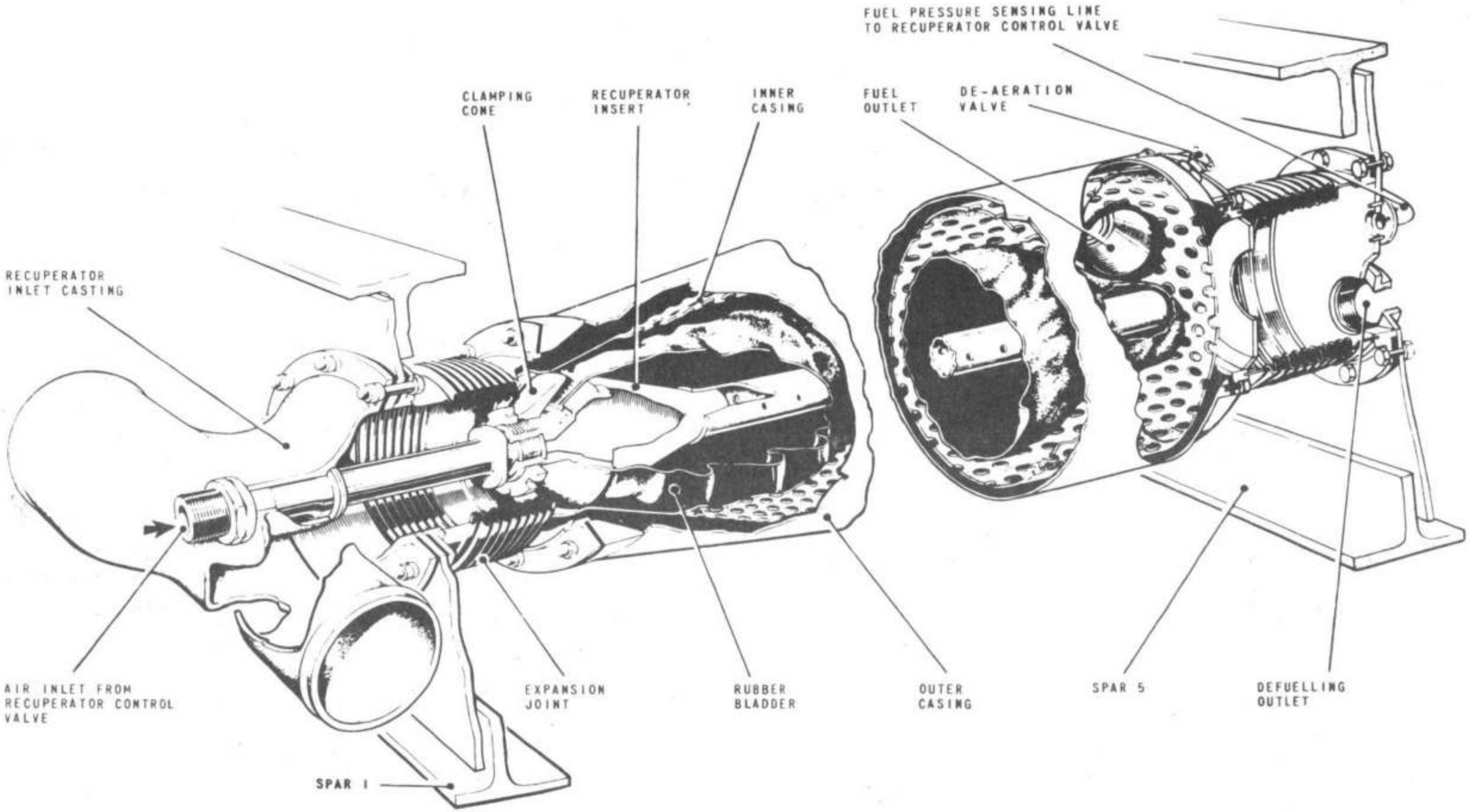

FIG. 7. RECUPERATOR

◄ DE-AERATION VALVE INCORPORATED ►

A2203-2

A/F83/BK.1/8289/2257/500/5-64/BAC/1405

Control valve (fig.8)

29. This valve employs the differential existing between fuel pump delivery pressure and atmospheric pressure to control the operation of the recuperator. ◀ The pressures are applied one to each side of a spring-loaded diaphragm through two inlets, one connected to the recuperator outlet and the other open to atmosphere; the springs assist the atmospheric pressure and are adjusted to apply force to the diaphragm equal to a pressure of 6.4 lb/in^2. A shuttle secured to the diaphragm, slides in a cylinder, the walls of which are pierced by ports communicating with the auxiliary air system and the recuperator bladder respectively. The position of the shuttle, as influenced by the differential pressure across the diaphragm, determines inflation or deflation of the bladder by covering or uncovering the appropriate ports.

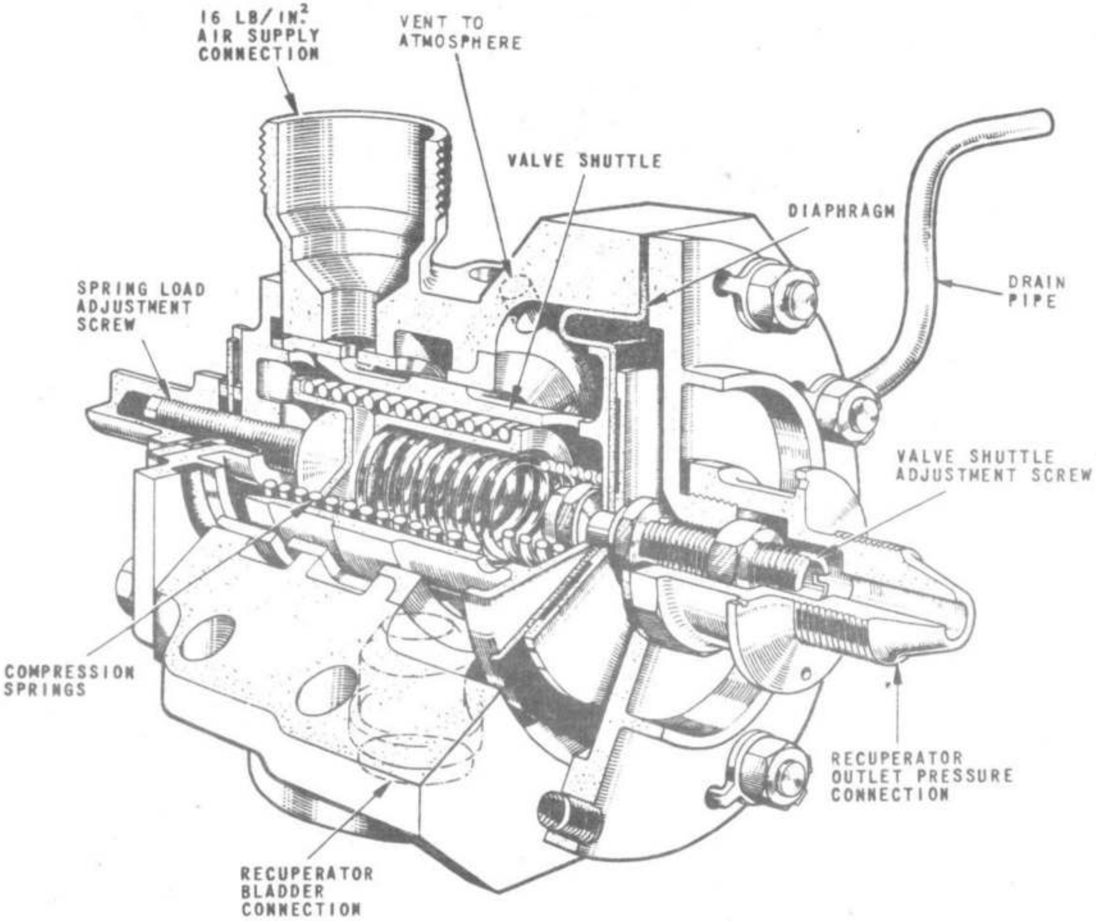

Fig. 8. Recuperator control valve

Operation (fig.9)

30. As long as the differential is greater than 6.4 lb/in^2 the fuel delivery pressure is high enough to compress the springs and vent the bladder to atmosphere. When it falls below that figure, due to fuel pump starvation or failure, the springs move the shuttle to open the bladder to the air supply. Consequent inflation of the bladder discharges the recuperator contents, either partly or completely, into the low-pressure fuel system.

Vent valves

General description (fig.10)

31. With the exception of the simplified types of valve used for inward venting of the ventral and flap tanks, all the vent valves are basically similar in construction and method of operation. Each valve has three chambers separated by two diaphragms. Tank pressure applied to the upper chamber acts upwards against the valve head, and datum pressure in the middle chamber acts downwards against the large diaphragm. Datum pressure may be derived from any of several sources in order to satisfy the venting requirements of the particular tank in which the valve is fitted. The balancing chamber is in direct communication with the atmospheric pressure above the valve head, thus applying equal and opposite forces to the ends of the valve and ensuring that localized pressure variations around the valve head do not affect valve operation. The spring force is applied so that it tends to keep the valve closed, and determines the differential pressure at which venting occurs; it is designed to suit the requirements of the associated tank. Electric heater elements, controlled from a switch on the starboard console, are fitted in all integral tank valves; the ventral tank outward vent valve is not heated.

Inward vent valves

32. Inward vent valves of the above description are fitted one to each main tank and are designed to open when tank pressure falls 0.5 lb/in^2 below datum pressure. The datum pressure is, at all times, that of the aircraft static system, thus providing automatic altitude compensation.

Outward vent valves

33. The outward vent valves in the main integral tanks are designed to open when tank pressure exceeds datum pressure by 1 lb/in^2. The datum pressure, in all circumstances except those of inverted flight and negative 'g' conditions, is that of the aircraft static system. To obviate the possibility of fuel entering the tank-pressure chamber of the vent valves and being discharged from the aircraft *(i.e. during inverted flight or negative 'g' conditions)* a float valve associated with the vent valve connects a 16 lb/in^2 air pressure to the datum chamber; this pressure acting on the diaphragm is sufficient to hold the valve closed. If the small diaphragm

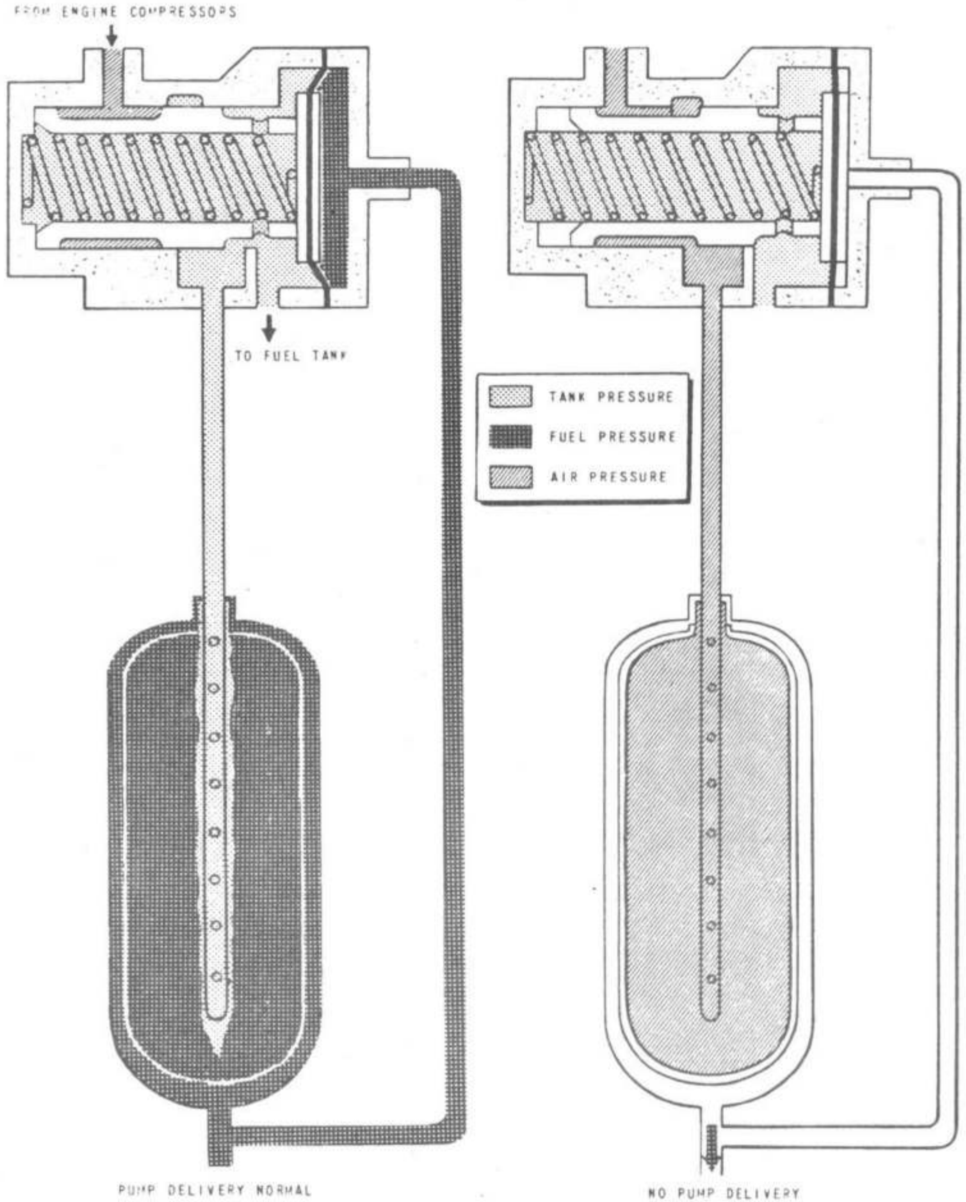

Fig. 9. Recuperator operation

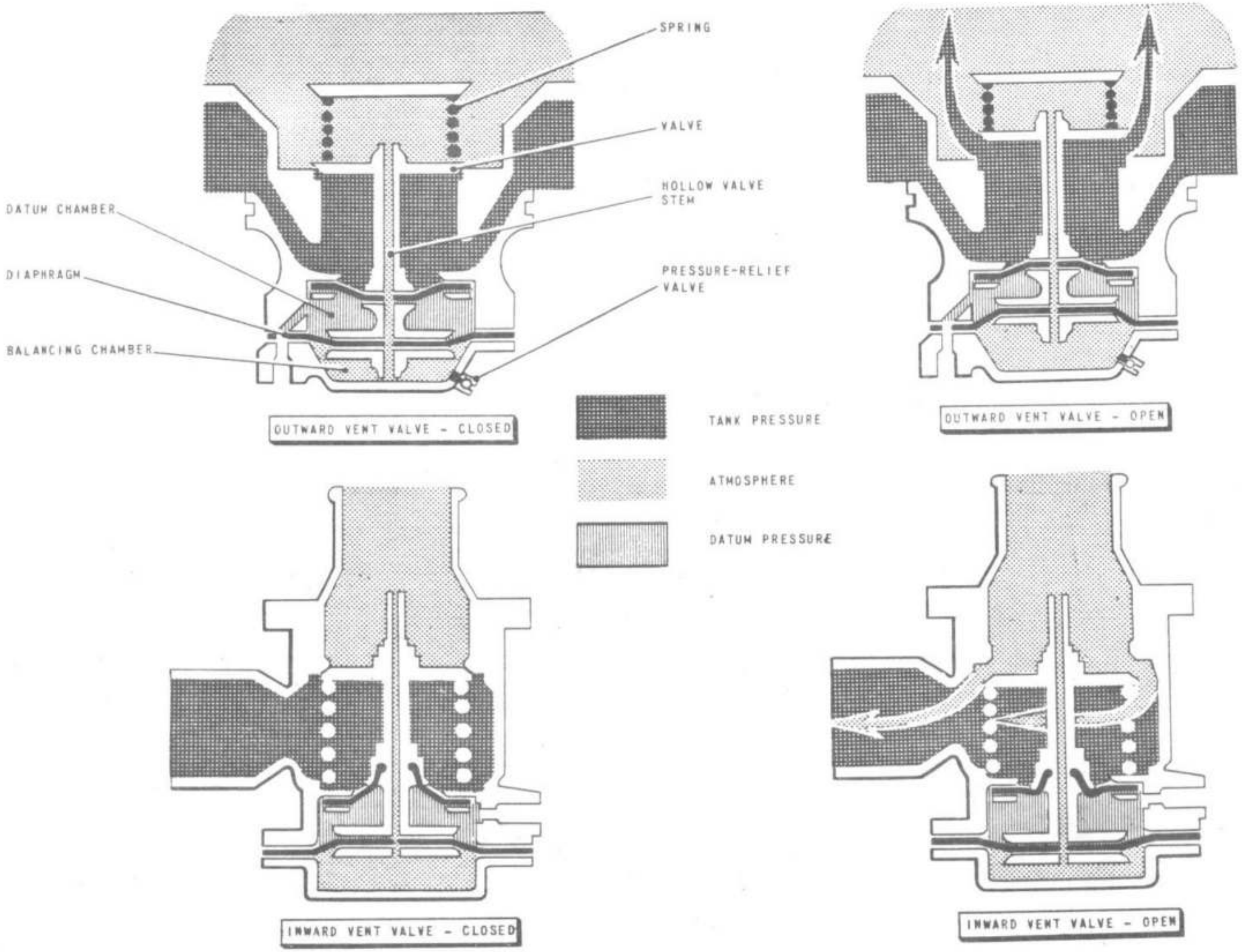

FIG. 10 VENT VALVES

in these vent valves develops a leak, over-pressurization of the tank will result due to tank pressure entering the datum chamber and holding the valve closed. To prevent this a 12 lb/in^2 relief valve is fitted in the wall of the balancing chamber so that when tank pressure reaches this figure the valve will allow it to enter the chamber, and balance the pressures acting on the large diaphragm.

34. To ensure that ventral tank pressurizing air does not open the outward vent valve, during fuel transfer, air at the same pressure is applied to the datum chamber, from one of two tappings on the 10.5 lb/in^2 reducing valve. The vent valve spring is designed to allow the valve to open when tank pressure exceeds datum pressure by 1 lb/in^2, *i.e.*, 11.5 - 12 lb/in^2. During refuelling, when the pressure in the datum chamber is that of the outside atmosphere, venting will occur when the pressure in the aft compartment of the tank is 1 lb/in^2 above atmospheric. In inverted flight or negative 'g' conditions, fuel is prevented from entering the vent valve by a gravity-operated sleeve in the ventral tank air connection.

Transfer and anti-suction valve

35. One of these valves is fitted in each main-plane in the fuel pipe between the transfer pumps and the collector box. While the booster pumps are working satisfactorily the valve permits fuel from the transfer pumps to replenish the collector box. In the event of booster pump failure, however, the valve operates to divert the transfer pump delivery to the recuperator; should all the low-pressure pumps fail, the valve, by isolating the transfer pumps, allows the engine pumps to draw fuel through the booster pumps provided that they are immersed in fuel.

Low-pressure cocks

36. Fuel delivery from the low-pressure pumps to the engine high-pressure and reheat pumps, is controlled by four two-way gate valves. These are operated by electric rotary actuators in circuit with the pilot's fuel pump switches, and are mounted in pairs on the aft face of spar 5 in each main plane, the inboard valve on each spar controlling flow to the No. 1 engine delivery line, and the outboard valve controlling No. 2 engine fuel flow. The electrical circuit allows either engine to use fuel from the tanks in either main plane, but does not allow the tanks in one main plane to feed both engines simultaneously.

Non-return valves

37. A number of standard non-return valves are fitted in the system. When refitting these valves, it is essential that the direction of flow is maintained *(fig. 1)*.

WARNING

Non-return valves must not be dismantled. Suspect valves are to be rejected and serviceable items fitted.

Defuelling cocks

38. A manually-operated three-way cock is fitted in each main plane between trailing-edge ribs 4 and 5, and is accessible behind a circular panel in access panel 99 *(P or S)*. Appropriate selection of the cocks will permit selective defuelling of either the ventral tank, the port or starboard flap tanks, or, in either main plane, the combined contents of the main and leading-edge tanks *(Sect. 2, Chap. 2)*.

Water drain valves

39. One or more water drain valves are fitted in each compartment of each tank, at positions approximating to the lowest points of the compartments. For the location of these valves, refer to Sect. 2, Chap. 4, fig. 4.

Pressure switches

40. A tapping from the No. 1 engine low-pressure delivery pipe is taken to a pressure switch bolted to No. 1 engine-hatch longeron aft of frame 29 at the port side, and a similar tapping from the No. 2 engine delivery pipe is connected to a similar switch attached to the aft face of frame 46. The switch contacts close whenever fuel pressure drops to 3 lb/in^2 and cause warning lamps on the auxiliary warnings indicator panel to be illuminated.

Tank contents gauging

41. Two contents gauges, on the cockpit starboard instrument panel, indicate, when the battery switch is ON, the quantity of fuel contained in the main and leading-edge tanks; they are calibrated in pounds. Indication of flap tank contents is given by the same gauges but only during transfer of fuel from the flaps to the main tanks, thus providing a true indication of available fuel if

transfer failure should occur. There is no gauging of the ventral tank content, but a magnetic indicator, near the contents gauges, shows black when fuel is transferring from the tank and white when there is no flow. Five coloured lamps above the refuelling door are illuminated when the tanks are full and the door is off. Individual lamps are controlled by the high-level float switch in the appropriate tank and all lamps are collectively controlled by the refuelling door microswitch.

Air supply *(fig.2)*

42. The compressed air employed in the functioning of the fuel system is tapped from the engine compressors through a 16 lb/in^2 reducing valve mounted between frames 46 and 47 *(Sect.3, Chap.8D)*. The air is directed from the reducing valve to the vent valve float valves in the main tanks, the recuperator control valves, the flap tanks and a 10.5 lb/in^2 reducing valve between frames 47 and 48. The latter valve directs pressurizing air to the ventral tank and datum pressure to the ventral tank outward vent valve. The 16 lb/in^2 air supply to each flap tank passes through a restriction in the delivery pipe, which reduces the pressure to 4 lb/in^2 in maximum fuel transfer conditions.

Flow during refuelling

43. During refuelling, fuel flows through the open refuelling valves into the centre compartment of each main-plane tank, the outboard compartment of each flap tank, and the forward compartment of the ventral tank. The rising fuel level in the centre compartment of each main-plane tank coincides with a similar rise in the level in the other compartments and in the leading-edge tank, but in the flap tanks and ventral tank, filling of the compartments occurs separately.

44. In each flap tank, fuel from the outboard compartment overflows through connecting pipes into the inboard compartment when the outboard compartment is full. In the ventral tank, however, a build-up of pressure occurs inside the forward compartment as it becomes full, and, when this pressure exceeds that in the rear compartment by 5 lb/in^2 two relief valves open allowing fuel to flow into the rear compartment.

45. The refuelling valves shut off refuelling flow in response to operation of the high-level float switches when their particular tanks are full.

Flow during engine running

46. As the fuel level in the main tanks falls due to engine demand, they are replenished by transfer of the contents of the ventral and flap tanks. The pressurizing air for transferring the fuel is applied to the latter tanks whenever the engines are running, but no fuel transfer can take place until the falling fuel level in the main tanks operates the float switches to open the Mk.12 valves. Initial replenishment of the main tanks is from the ventral tank, air pressure being applied to the aft compartment of the tank to expel fuel into the forward compartment, where it passes through the Mk.7 valve and the flow sensing valve to the main tanks; when the aft compartment is empty, the air pressure enters the forward compartment to continue the transfer. When the ventral tank is empty, the control valve for the Mk.7 valve causes the latter to close and exclude air from the fuel pipes. Simultaneously, the cessation of flow through the ventral tank flow-sensing valve makes an electrical circuit to open the Mk.27 valves in the flap fuel pipes permitting transfer of fuel from the flap tanks. The air pressure is applied to the inboard compartment of each flap tank and expels the fuel through the outboard flap hinge. The flow-sensing valve in the flap fuel line connects the tank capacitor to the fuel gauges. When the flap tanks are empty the pressurizing air enters the main tanks but has only a very small effect.

Flight refuelling

General information

47. *(to be issued later)*

Probe

48. *(to be issued later)*

SERVICING

Refuelling and defuelling

49. For details of these operations refer to Sect.2, Chap.2.

Fuel sampling

50. The fuel sampling tool *(Ref.No. 26DK/95234)* is used for this operation. The tool is applied to each water drain valve in turn and pushed in to displace the valve from its seating, allowing fuel to drain into a suitable container.

Sealing leaking water drain valves

51. A leaking valve should be sealed by screwing a 4 B.A. mushroom head bolt *(Ref. No. 28D/8337)*, fitted with a bonded seal, into the valve and tightening it on to its seating. The valve may still be used in the normal manner after sealing.

Checking the fuel delivery rate

52. Provided there is no obstruction in the low-pressure delivery pipe, between the low-pressure cocks and the engine inlets, satisfactory results to the tests described in Table 5 should be accepted as evidence of satisfactory delivery rate.

Integral tanks pressure test

53. To test the tanks:-

(1) If the tanks have been pressure refuelled set the defuelling cocks in both main planes to DEFUEL MAIN TANKS and draw off not less than 50 gal of fuel.

(2) Remove the cowl and the quick-release cover from the port outward vent valve, replace the screws in the vent valve flange, and weight the valve head to prevent the valve opening *(not less than 60 lb wt)*.

(3) Remove the port gravity filler cap, using key Ref.No.26DK/95233, and substitute the tank pressure testing equipment *(fig.11)*.

(4) Connect an air supply to the testing equipment and slowly open the stop valve. When the pressure gauge registers 10 lb/in^2 close the valve.

(5) Examine the tank area for leakage and rectify as necessary *(Vol.6)*.

(6) Disconnect the air supply and allow the tank pressure to return to normal by opening the stop valve.

(7) Remove the test equipment and refit the refuelling cap.

(8) Remove the weight from the vent valve and refit the quick-release cover and cowl.

(9) Repeat (2) to (8) on the starboard main plane.

Rectification of leaks

54. For information regarding the rectification of leaks in the fuel tanks refer to Volume 6 of this Air Publication.

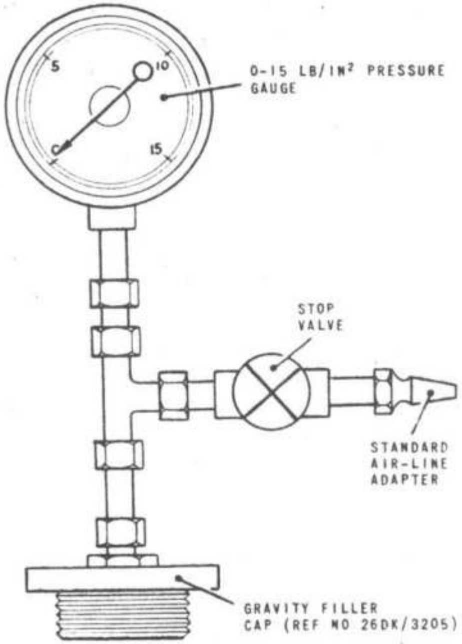

Fig. 11. Integral tank pressure testing equipment

Fault diagnosis

55. The probable causes, methods of tracing and rectification of system faults are given in Tables 2 to 4 inclusive.

REMOVAL AND ASSEMBLY

Note...

(1) Serviceable rubber components removed from the fuel system are to be completely immersed in aircraft fuel, in an opaque container fitted with a lid. They are not to be allowed to dry out or subsequent failure may occur.

(2) When refitting non-return valves it is essential that the direction of flow is maintained (fig.1).

Ventral tank *(fig.12)*

Removal

56. To remove the ventral tank in its fuelled or defuelled condition:-

(1) Remove the tank fairing by first disengaging the catch with a ¼ in. dia. rod and then pushing the fairing aft until it is free to pivot downwards about the lug, allowing the lug to disengage from the spring-loaded pin.

(2) Position a handling trolley *(Ref. No.26DK/95135)* beneath the tank, and adjust it to give adequate support.

(3) Operate the ventral tank jettison handle in the cockpit to disengage the suspension bolt from the release unit.

◀(4) If the tank is to be refitted mark ▶

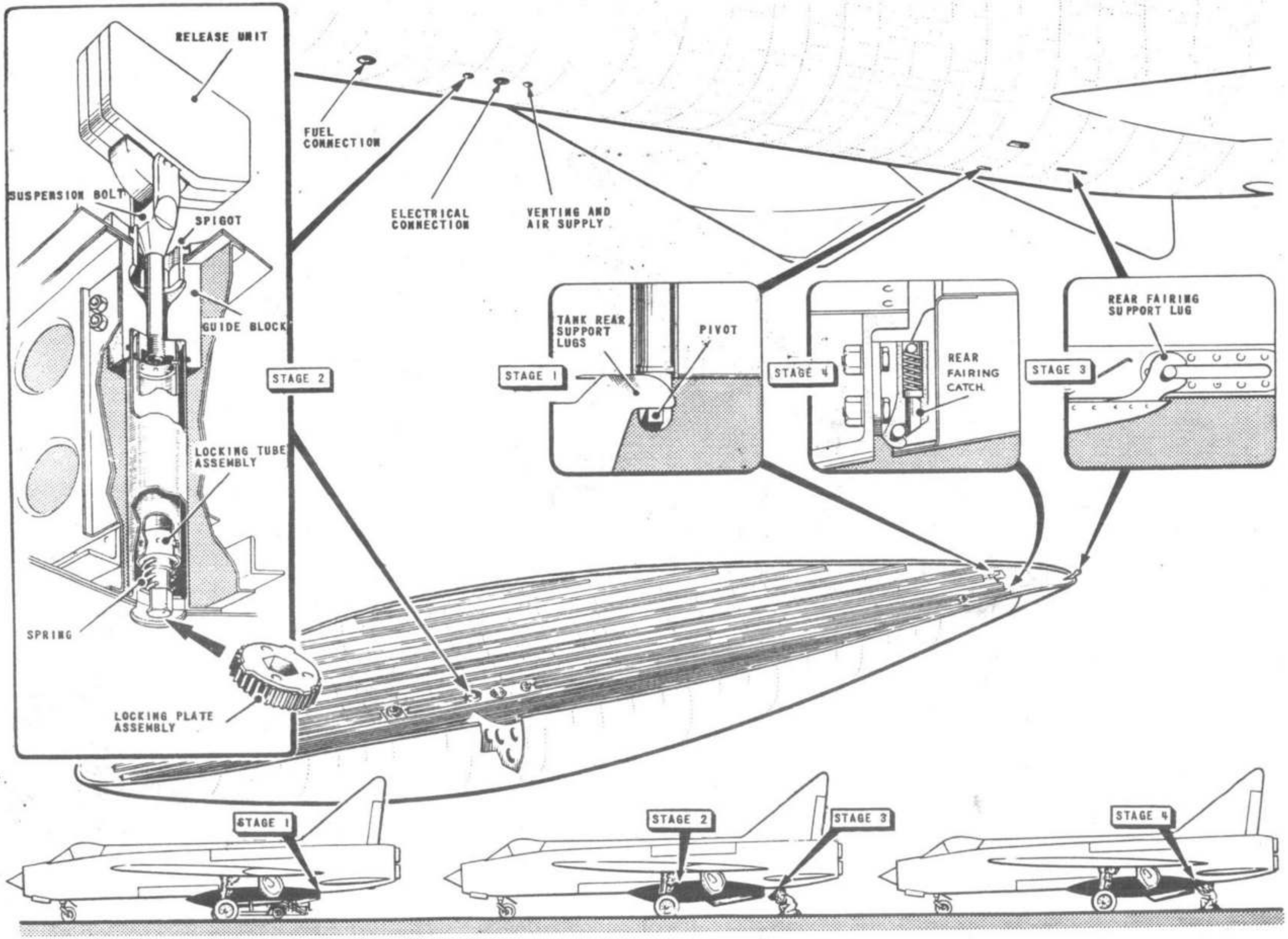

FIG.12. VENTRAL TANK — REMOVAL AND ASSEMBLY

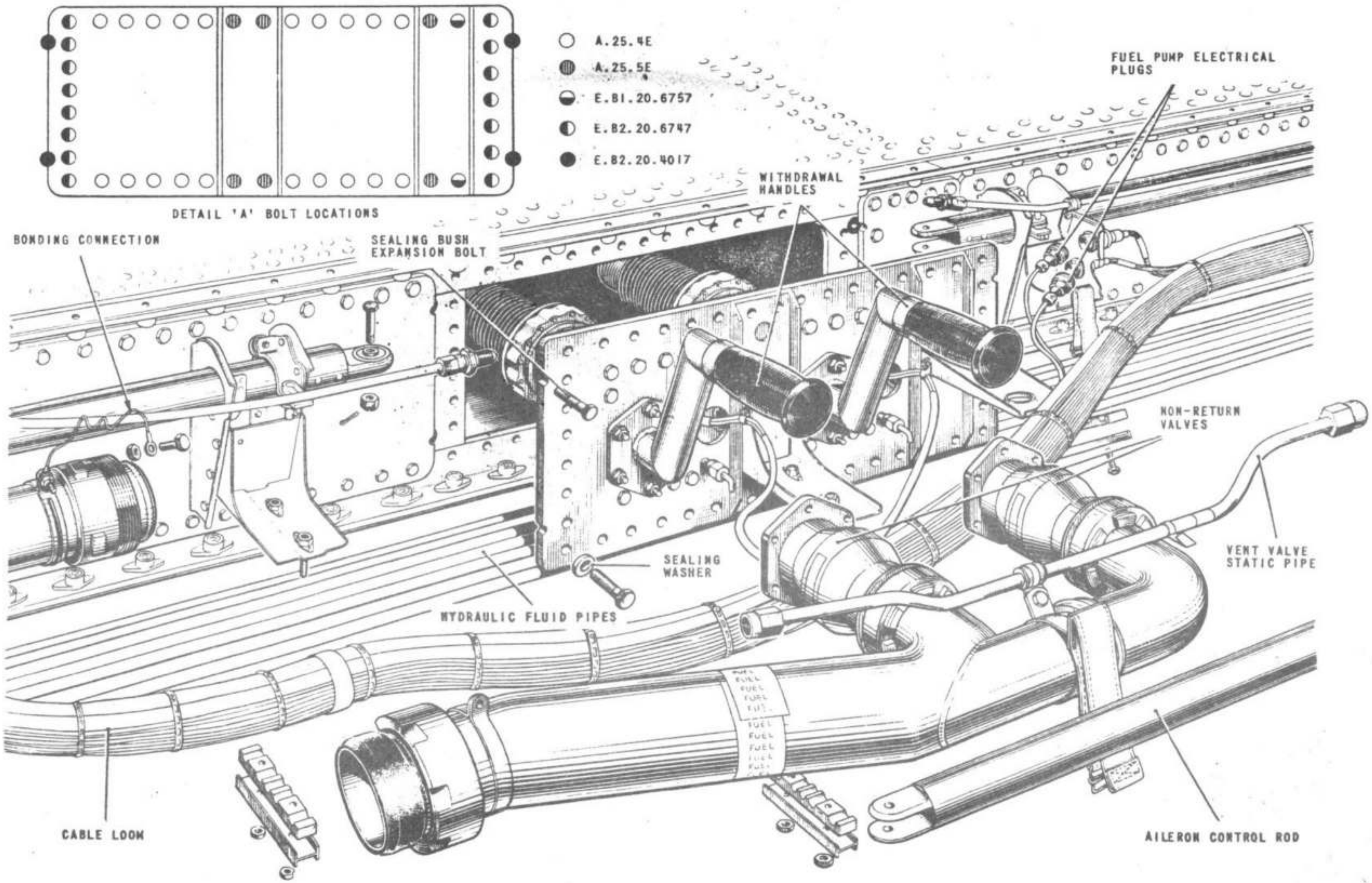

FIG. 13. BOOSTER PUMPS-REMOVAL AND ASSEMBLY

a line on the rear feet of the tank corresponding to the centre line of the squared supporting sleeves *(fig.12, stage 1)*.

(5) Remove the bolts and squared sleeves retaining the tank rear supporting lugs between the spring-loaded forks, and lower the tank.

(6) Blank off all apertures and, if the tank is not to be refitted immediately, place it in a storage stand *(Ref. No. 26DK/95052)*.

Assembly

57. To fit the ventral tank to the aircraft:-

(1) Unscrew the tank suspension bolt from the locking tube and withdraw the tube, spring, and locking plate from the tank.

(2) Insert the yoke-end of the tank suspension bolt through the aperture in the fuselage skin, so that the yoke engages the release unit *(fig.12, stage 2)* and cocks the mechanism. Manually and electrically check the security of the bolt. The electrical check consists of connecting a series-connected lamp and battery, across the two pins of the test plug behind access panel 63P; illumination of the lamp indicates correct cocking of the release unit.

(3) Mount the tank on a handling trolley *(Ref.No.26DK/95135)*. Inspect the tank and aircraft connectors for cleanliness and ensure that all blanks are removed. Position the trolley beneath the aircraft.

(4) Using tool Ref.No.26DK/95071 pull down the two spring-loaded forks in the fuselage at frame 54 and hold them in their extended position. Manoeuvre the tank so that its rear supporting lugs fit between the forks, then insert the squared sleeve between each fork, and retain each sleeve with the special-to-type bolt. Secure each bolt with a washer, slotted nut, and split pin.

(5) Carefully align the marks made in para.56 (4) *(the positions of the rear feet on the squared sleeves are critical)*.

(6) Manoeuvre the tank so that the spigot is central fore and aft and aligned by eye with the socket in the fuselage. Slowly raise the tank on the trolley and, as the spigot approaches the bolt, check with a torch through the bottom housing that the bolt is centring correctly. Very carefully operate the hydraulic lift and feel if there is any resistance to the spigot entering the socket. Any such resistance will indicate malalignment and the tank must be levered fore or aft to reposition the rear feet on the supporting sleeves before completing the lift *(fig.12, stage 2)*.

(7) Insert the locking tube assembly through the serrated aperture in the tank skin, and screw the tube on to the suspension bolt until it is finger-tight.

(8) Push the spring over the hexagon on the lower end of the locking tube assembly, and insert the locking plate assembly *(tongued plate uppermost)* into the serrated aperture in the tank skin, so that it passes over the hexagon. Rotation of the locking tube will probably be necessary before this is possible.

(9) Tighten the locking tube assembly with a torque wrench fitted with a ½ in. B.S.F. socket; press upwards with the socket to disengage the serrations of the locking plate assembly before attempting to tighten. The wrench should be set to slip at 450 $^{+50}_{-0}$ lb in.

(10) Remove the wrench, whereupon the locking plate assembly will be pushed downwards by the spring. If the serrations will not engage when the hexagons are aligned, slacken the locking tube assembly slightly *(the maximum angle through which the locking tube assembly will require to be slackened is less than 10 degrees)*. If the tongues on the locking plate assembly coincide with the gaps in the serrations when the hexagons are aligned, disengage the locking plate assembly and rotate it through 60 degrees.

(11) Fit the tank fairing by inserting the lug, at the aft end of the fairing, through the aperture in the fuselage skin *(fig.12, stage 3)*, so that it engages the spring-loaded pin and moves the pin rearwards. Pivot the fairing forward and upward until the upper surface fits the fuselage skin contour, then move the fairing forward to engage the fairing lock bolt with the catch on the tank.

(12) If the tank is empty, check the correct functioning of the tank pressure-relief valve by screwing a ¼ in. B.S.F. eyebolt into the valve head, and applying a pull force with a spring balance. The valve should open with a pull of 65 ± 5 lb.

Booster pumps *(fig.13)*

Removal

58. To remove the pumps:-

(1) Defuel the associated main-plane tank *(Sect.2, Chap.2)*.

(2) Ensure that no ground electrical supplies are connected, and that the BATTERY and FUEL PUMPS switches are OFF.

(3) Remove the inboard leading-edge fairing and access panel 100.

(4) Unstrap the electrical cable loom traversing spar 1.

(5) Release a sufficient number of hydraulic pipe fairleads to permit removal of the web plate supporting the pumps.

(6) Disconnect the two fuel pump electrical cables at the socket connections, on the leading-edge fairing support rib. Release sufficient strappings to free the cables from the cable loom.

(7) Disconnect and remove the short section of aileron control rod.

(8) Disconnect and remove the vent valve static pipe.

(9) Remove the outboard bonding clip at the fuel pipe joint near rib 10 and disconnect the pipe.

(10) Remove twelve 2 B.A. stiffnuts securing the non-return valves to the web plate and detach the valves, fuel pipe and static pipe as a sub-assembly.

(11) Fit two withdrawal handles Ref.No. 26DK/95183 to the web plate at the position vacated by the non-return valves.

(12) Remove the four sealing washer expansion bolts.

(13) Remove the 43 bolts securing the web plate to the spar.

(14) Remove the spar web plate complete with pumps, by first dropping it downwards behind the nut strip on the lower spar boom and then lifting it forward and upward. Exercise care to avoid damaging the rubber seals bonded to the mating faces of the web plate.

(15) Unclip the cables on the web plate and remove the pump or pumps, taking care to avoid damage to the sealing gaskets. The channel stiffeners on the plate will become detached when the pumps are removed.

Assembly

59. To assemble the pumps, reverse the removal sequence described in para. 58. Refer to fig. 13, detail A for the correct positioning of the web plate fixing bolts. Inspect all gaskets and renew as necessary, and renew all bonded sealing washers.

Transfer pumps *(fig. 14)*

Removal

60. To remove a transfer pump:-

(1) Defuel the appropriate tank *(Sect. 2, Chap. 2)*.

(2) Remove the circular access panel in the upper skin of the main or leading-edge tank from which the pump is to be removed.

(3) Remove the locking circlip from the pump housing.

(4) Unscrew the pump housing cover, using a 7/8 in. B.S.W. box spanner or socket.

(5) Disconnect the two electrical cables from the pump terminals and carefully bend them clear of the pump.

(6) Insert an eyebolt *(Ref.No. 28G/5894)* into the tapping in the pump upper surface and withdraw the pump by exerting a straight pull.

Assembly

61. To refit a transfer pump:-

(1) Lightly lubricate the 'O' rings of the pump with grease XG-410 and insert the pump into its housing, ensuring that the locating dowel enters its slot.

(2) Secure the pump and restore the system to normal by reversing the removal procedure *(para. 60)*.

No. 1 reheat fuel pump *(fig. 15, detail B)*

Note...

Numerals in brackets refer to the illustration.

Removal

62. To remove the pump:-

(1) Remove No. 1 E.C.U. *(Chap. 1)*.

(2) Remove the turbine air inlet pipe (3) by disconnecting at the turbine.

(3) Remove the turbine exhaust pipe (1) by disconnecting at the turbine and at the fuselage skin.

(4) Disconnect the fuel inlet pipe (9) at the pump flange.

A/F49/BK.1/8232/2134/500/9-62/EEA/1405

◄ (5) Disconnect the fuel outlet pipe (8) from the pump. Retain the nipple.

(6) Disconnect the drain pipes from the fuel pump *(detail C - 10)* and oil reservoir *(detail A - 11)*.

(7) Disconnect the servo bleed pipe (7) from the servo bleed valve casing. Retain the nipple.

(8) Disconnect the electrical cable to the servo bleed solenoid (6).

(9) Remove three bolts securing the pump casing to the fuselage mounting bracket (4).

(10) Sever the locking wire on the tension clip bolt (2), remove the bolt and lift the pump out of the fuselage.

(11) Blank off all apertures and pipes on the pump and fuselage.

Assembly

63. To refit the pump reverse the removal operations *(para. 62)*, observing the following precautions:-

(1) All bolts and nuts, with the exception of the tension clamp bolt, are to be locked with serviceable spring washers. The tension clamp bolt must be wire-locked.

(2) Pipe nipples are to be fitted at the fuel outlet (8) and servo bleed (7) connections.

(3) All sealing and insulating gaskets are to be examined for serviceability and renewed as necessary. ►

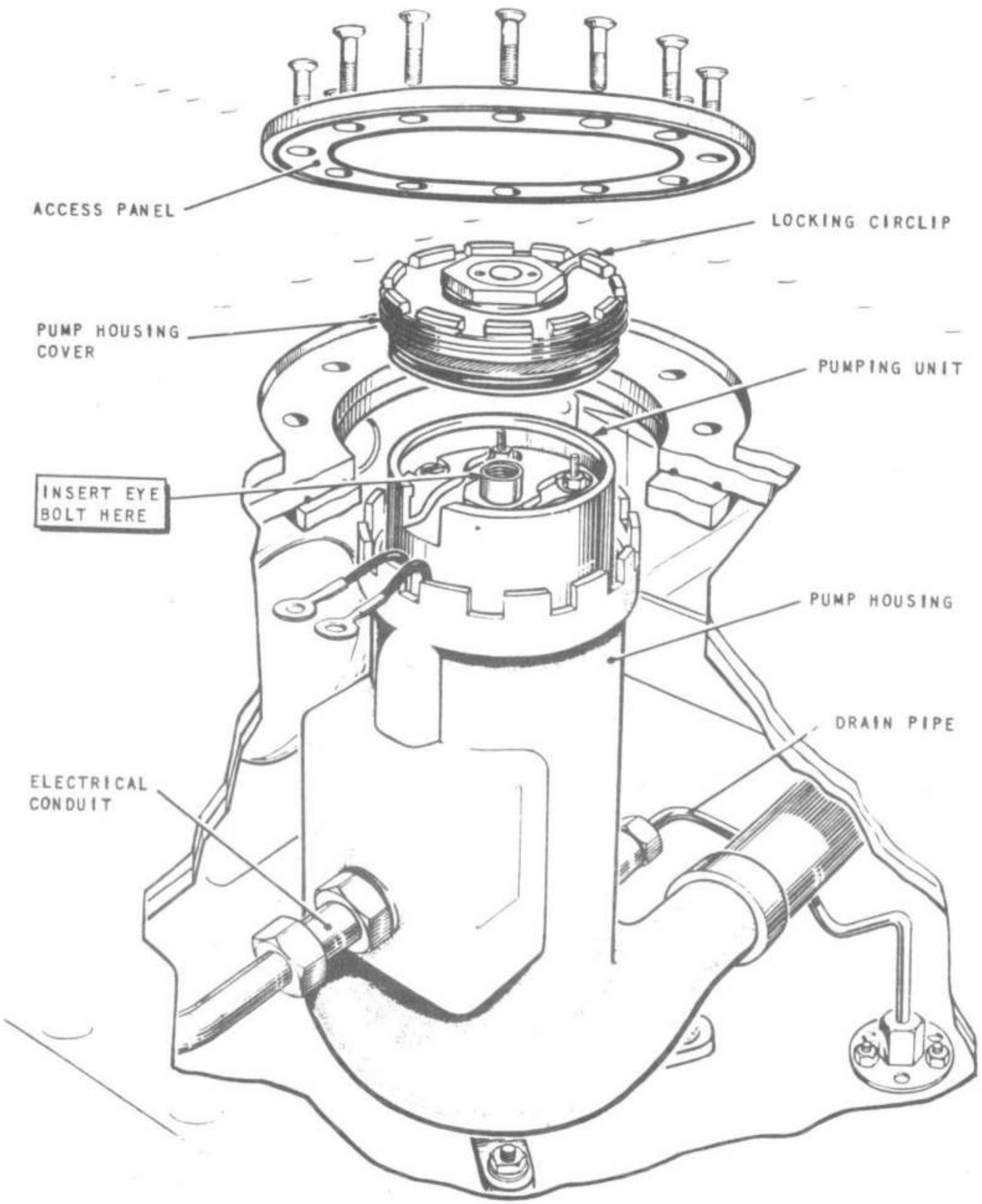

Fig. 14. Transfer pumps - removal and assembly

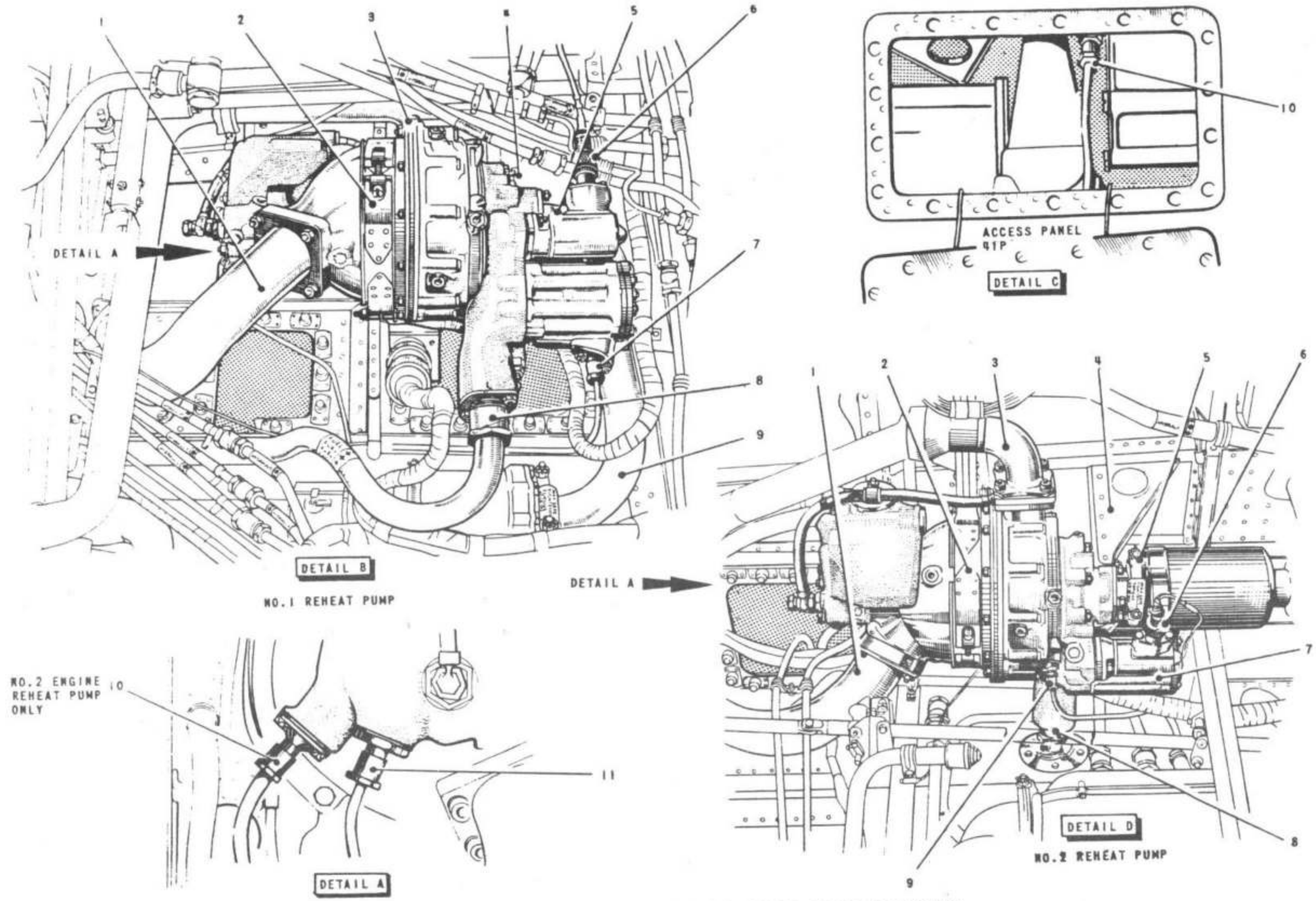

FIG.15. REHEAT PUMPS-REMOVAL AND ASSEMBLY

No.2 reheat fuel pump *(fig.15, detail D)*

Removal

64. To remove the pump:-

(1) Remove the No.2 E.C.U. *(Chap.1)*.

(2) Fit the fuselage walkway *(Ref.No. 26DK/95192)*.

(3) Remove the turbine air inlet pipe (3) by disconnecting at the turbine.

(4) Disconnect the turbine exhaust pipe (1) at the turbine.

(5) Disconnect the fuel inlet pipe by releasing the split clamp (5) between the pump and the filter.

(6) Disconnect the fuel outlet (8) from the pump and retain the nipple. Exercise care to avoid damaging the fire seal in the fire floor.

(7) Disconnect the drain pipes from the fuel pump (9), and oil reservoir *(detail A - 11)*.

(8) Disconnect the oil reservoir replenishing pipe *(detail A - 10)*.

(9) Disconnect the servo bleed pipe at the servo bleed valve casing (7). Retain the nipple.

(10) Disconnect the electrical cable to the servo bleed valve solenoid (6).

(11) Remove three bolts securing the pump casing to the fuselage mounting bracket (4).

(12) Sever the locking wire in the tension clip bolt (2) remove the bolt and lift the pump out of the fuselage.

(13) Blank off all pipes and apertures in the fuselage and on the pump.

Assembly

65. To refit the pump reverse the removal sequence *(para.64)*, observing the necessary precautions *(para.63)*.

Recuperator bladder *(fig.16)*

Removal

66. To remove the recuperator bladder:-

(1) Defuel the associated main-plane tank *(Sect.2, Chap.2)*.

(2) Remove the section of the main plane leading edge fairing between ribs 5 and 10.

(3) Remove the short lengths of aileron control rod extending along spar 1.

(4) Remove the recuperator air supply pipe.

(5) Remove the recuperator inlet casting by disconnecting the two pipe couplings, and removing the two nuts from the recuperator insert and the twelve stiffnuts around the flange.

(6) Withdraw the recuperator insert and bladder.

(7) Blank off all open pipes and apertures.

Dismantling the bladder and insert (fig.7)

67. To dismantle the components:-

(1) Lightly grip the flats of the flange on the recuperator insert in the suitably protected jaws of a vice.

(2) Sever the locking wire and use a standard C-spanner to unscrew the ringnut securing the clamping cone.

(3) Remove the bladder.

Assembling the bladder and insert

68. To assemble the bladder to the insert:-

◀(1) Thoroughly wet the outside of the bladder with fuel *(refer to Leading Particulars)*. ▶

(2) Pass the neck of the bladder over the recuperator insert, ensuring that the bead on the bladder enters the groove on the insert. Do not stretch the neck of the bladder more than is necessary to pull it over the insert.

(3) Fit the clamping cone and secure it with the ringnut; wire-lock the nut to the insert flange.

Assembly

69. To refit the bladder and insert assembly to the recuperator:-

(1) Fold the bladder around the insert.

(2) Carefully introduce the bladder into the recuperator.

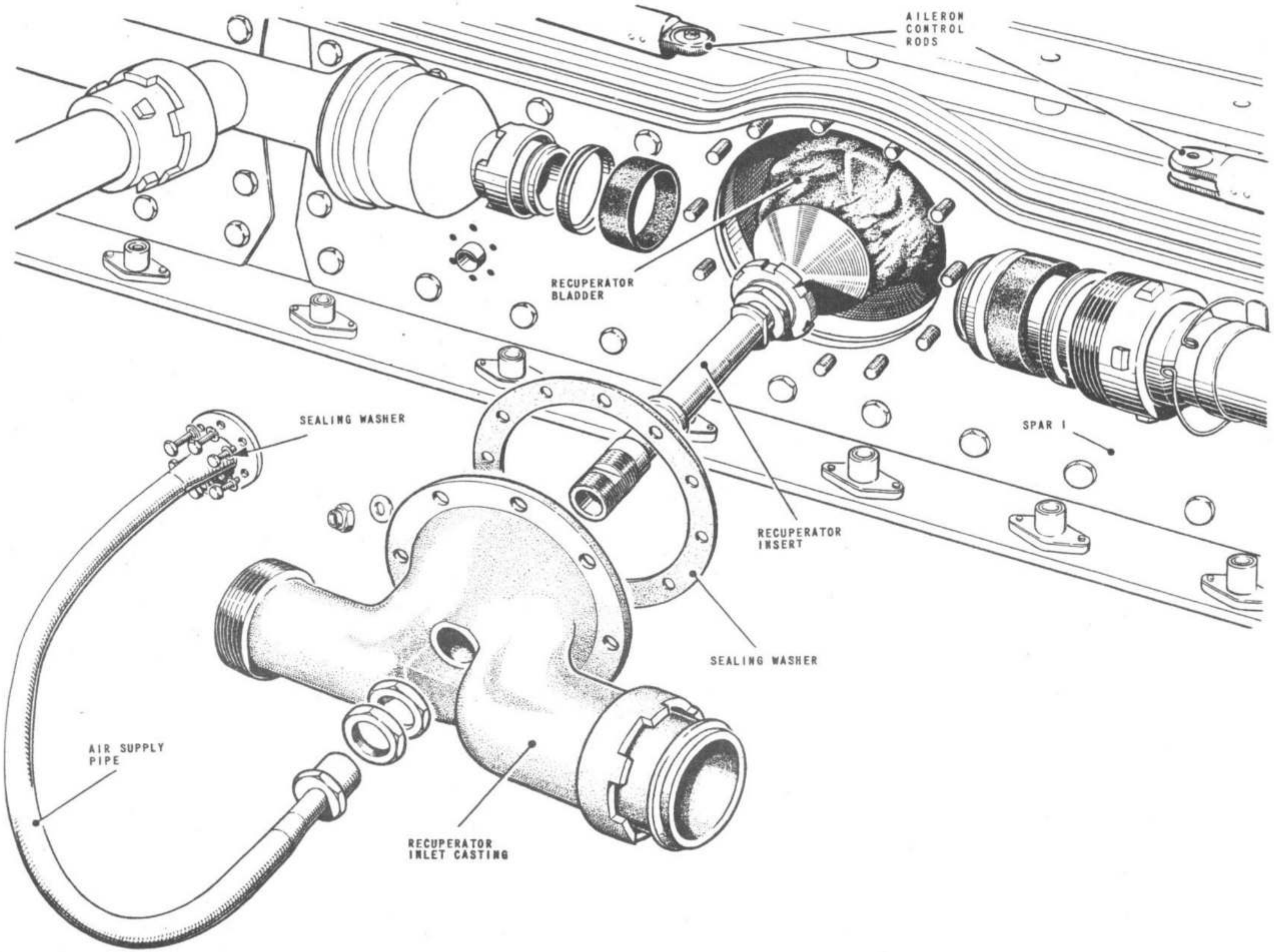

FIG. 16. RECUPERATOR BLADDER - REMOVAL AND ASSEMBLY

B2212-1

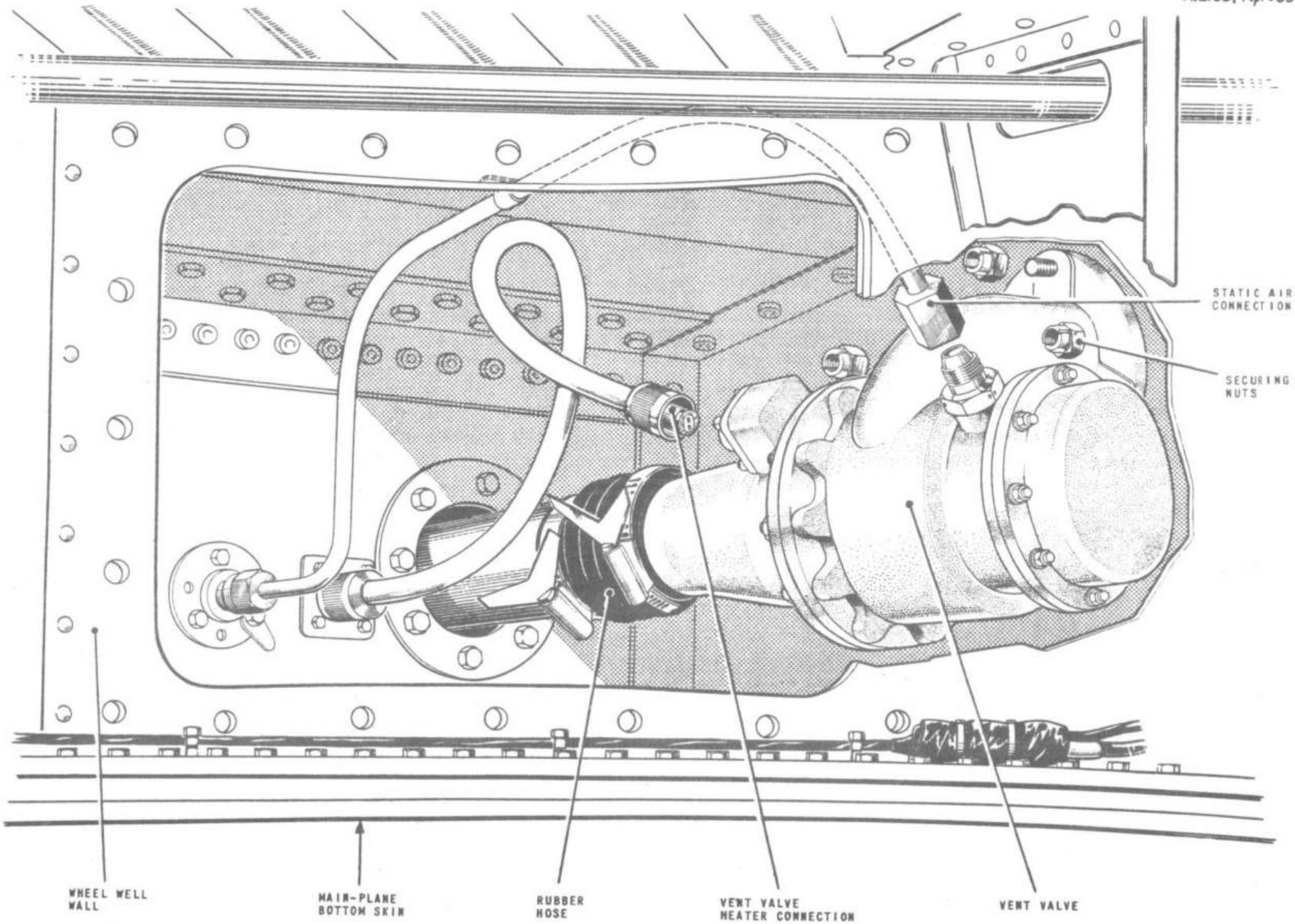

FIG. 17. INTEGRAL TANK INWARD VENT VALVE - REMOVAL AND ASSEMBLY

(3) Reassemble the external components in the reverse order described *(para.66)*.

◀ **Note...**

If the aircraft is likely to remain defuelled for a period in excess of 7 days after the fitting of a replacement bladder, turn OFF the associated low-pressure and defuelling cocks, connect the air and fuel transfer pipes to the recuperator, secure a suitable length of fuel-resistant hose to the recuperator fuel inlet, and, from a position above the recuperator, slowly, to allow for venting, inject approximately four gallons of filtered fuel (refer to Leading Particulars). Blank off the hose and secure it in position above the recuperator. Drain off before reconnecting the fuel inlet pipe. ▶

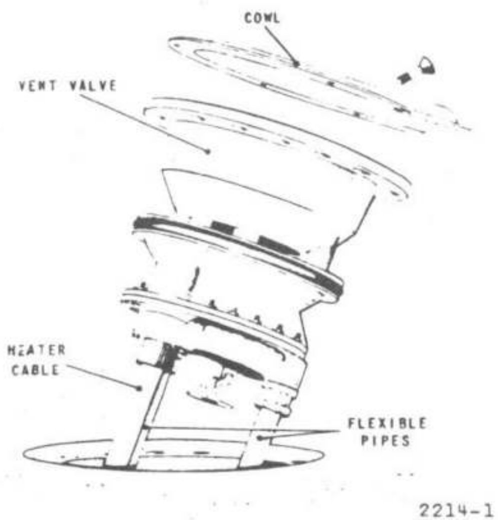

Fig. 18. Integral tank outward vent valve - removal and assembly

Integral tank inward vent valve *(fig.17)*

Removal

70. To remove the valve:-

(1) Ensure that the valve heater switch *(Sect.1, Chap.1)* is OFF.

(2) Remove the access panel in the main wheel well forward wall.

(3) Disconnect the heater element electrical cable at the valve.

(4) Slacken the hose clips on the corrugated rubber hose and slide the hose forward.

(5) Disconnect the static air pipe at the valve.

(6) Remove three nuts securing the valve to rib 13 and withdraw the valve *(the valve mounting flange is sealed with a rubber ring which may become detached when removing the valve)*.

Assembly

71. To assemble the vent valve to the aircraft reverse the removal sequence *(para.70)*.

Integral tank outward vent valve *(fig.18)*

Removal

72. To remove the valve:-

(1) Remove the cowl from the main plane upper surface.

(2) Remove the quick-release cover from the valve.

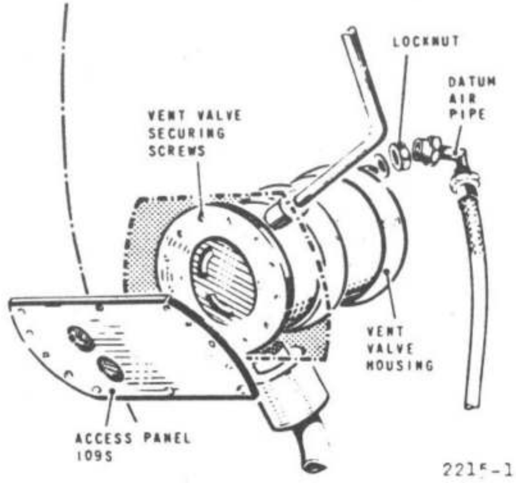

Fig. 19. Ventral tank outward vent valve - removal and assembly

(3) Remove sixteen countersunk bolts around the valve periphery and lift the valve sufficiently to reveal the bottom surface.

(4) Disconnect the datum pressure flexible pipe and the valve heater electrical cable.

Note...

Take care not to immerse the open end of the datum pipe in fuel.

(5) Remove the vent valve from the tank.

Assembly

73. To assemble the valve to the aircraft reverse the removal sequence *(para. 72)*.

Ventral tank outward vent valve *(fig.19)*

Removal

74. To remove the valve:-

(1) Remove No.1 engine jet pipe *(Chap. 1)* and fit the fuselage walkways *(Sect. 2, Chap.4)*.

(2) Disconnect the flexible pipe from the inboard face of the valve shroud.

(3) Remove the locknut from the adapter for the flexible pipe.

(4) Remove access panel 109S *(Sect.2, Chap.4)*.

(5) Remove sixteen countersunk bolts from the valve periphery and withdraw the valve from the fuselage cavity.

Assembly

75. To assemble the valve to the aircraft reverse the removal sequence *(para.74)*.

Leading-edge and flap tanks

76. The method of removal and assembly of both tanks is described in Sect.3, Chap.2.

Main tank high-level float switches *(fig.20)*

Removal

77. The float switches are mounted on the lower surface of two circular panels, one for each tank, which are accessible inside No.2 engine intake duct. The switches are withdrawn with their respective panels after unscrewing the countersunk bolts and the electrical cable. To detach the switch from the panel release the two bolted straps.

Assembly

78. When assembling a replacement switch to the bracket, the switch height is determined by the pitch of the locating straps and shoulders on the switch body. To ensure that the float arm does not foul the delay tank however, it is essential that the long edge of the float arm pivot block is set parallel to a straight edge placed across the mounting bracket flanges.

Vent valve control valve *(fig.20)*

Removal

79. To remove the valve:-

(1) Defuel the associated tank.

(2) Remove the float switch panel *(para.77)*.

(3) Disconnect the three air pipes from the valve.

(4) Unscrew the bolts, securing the valve to the detachable mounting bracket, just sufficiently to allow the valve to be tilted and withdrawn from the bracket *(detail A)*.

(5) Detach the valve from its bracket and withdraw it through the float switch aperture.

Assembly

80. To assemble the valve reverse the removal sequence *(para.79)*.

Flight refuelling probe

Removal

81. *(to be issued later)*

Assembly

82. *(to be issued later)*

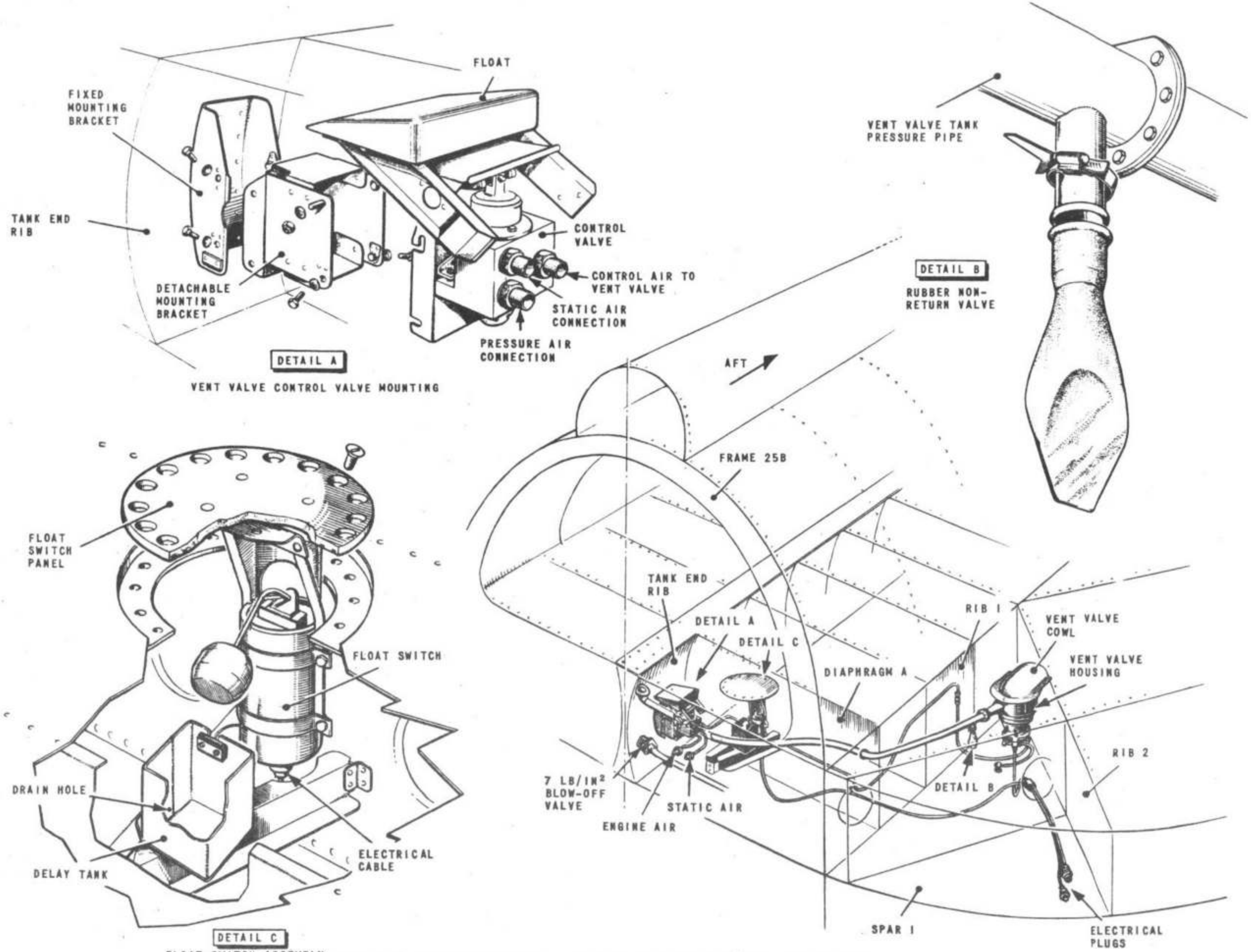

FIG. 20. COMPONENTS – MAIN-PLANE TANK – INBOARD

A/F65/BK.1/8235/2188/500/4-63/EEA/1405

TABLE 1

Principal components

COMPONENT	MAKER AND MAKER'S PART NO.		A.P.	VOL.	SECT.	CHAP.
Fuel pumps						
Booster	Self Priming Pump & Eng.Co.Ltd	SPE 2437	4343D	1	12	2
Transfer	Pulsometer Ltd	PDC 1001 Mk.1	4343D	1 Bk.2		
Reheat	Joseph Lucas	TFP 114	4282A	1	2	
Filters	English Electric Aviation	EB2.57.593				
Heat exchangers	Marston Excelsior Ltd	D 237/1A	2850A	1 & 6		
Refuelling valves						
Main tank (Mk.12, Series 3)	Flight Refuelling Ltd	C 1112000/3 or C 1112655	4511	1 & 6	2	3
Ventral tank — Mk.7 F.N.A. valve	Flight Refuelling Ltd	D 3707000	4511	1 & 6	2	
Ventral tank — Control valve	Flight Refuelling Ltd	D 3707030				
Flap tank (Mk.27)	Flight Refuelling Ltd	C 1127035	4511	1 & 6	2	12
Fuel recuperators						
Port main tank	English Electric Aviation	EB2.57.1053	4700A	1	4	2
Stbd. main tank	English Electric Aviation	EB2.57.1054				
Float valves	Self Priming Pump & Eng.Co.Ltd	SPE 2519 or SPE 2530	4117A	1		
Inward vent valves						
Port main tank	Self Priming Pump & Eng.Co.Ltd	SPE 2340	4737A	1 & 6	4	
Stbd. main tank	Self Priming Pump & Eng.Co.Ltd	SPE 2341	4737A	1 & 6	4	
Flap tanks	Flight Refuelling Ltd	A9809000 or A9809050	4511	1 & 6	7	2
Ventral tanks	English Electric Aviation	EB1.62.563				
Outward vent valves						
Main tanks	Self Priming Pump & Eng.Co.Ltd	SPE 2562	4737A	1 & 6	4	
Ventral tank	Self Priming Pump & Eng.Co.Ltd	SPE 2300	4737A	1 & 6	4	
Transfer valves	Flight Refuelling Ltd	B 9813020	4511	1 & 6	7	12

continu

ABLE 1 Principal components - *continued*

COMPONENT	MAKER AND MAKER'S PART NO.		A.P.	VOL.	SECT.	CHAP.
Non-return valves						
Booster pumps outlet pipes	Flight Refuelling Ltd	9811112	4511	1 & 6	7	2
Transfer pumps outlet pipes	Flight Refuelling Ltd	9807100/2	4511	1 & 6	7	2
Flap tanks pressurizing pipe	Flight Refuelling Ltd	A 9809000 or A 9809050	4511	1 & 6	7	2
Recuperator defuelling outlet	Flight Refuelling Ltd	A 9813014	4511	1 & 6	7	2
Ventral tank vent pipes and main tank vent valve vent pipe	English Electric Aviation Ltd	EB2.62.385				
Relief valves						
Ventral tank baffle 7	English Electric Aviation Ltd	EB2.62.97				
Ventral tank fwd. compartment	English Electric Aviation Ltd	EB2.62.25				
Flap tanks pressurizing pipe	English Electric Aviation Ltd	EB2.57.2151				
Flap tanks outward vent pipes	English Electric Aviation Ltd	EB2.57.1557				
One-way restrictor valve						
Ventral tank	English Electric Aviation Ltd	EB2.62.85				
Defuelling cocks	English Electric Aviation Ltd (modified Vickers Pt. No. D 5828)	EB2.57.1789				
Low-pressure cocks	Vickers-Armstrong Ltd	A.5816-M	4737A	1 & 6	2	
Recuperator control valves	English Electric Aviation Ltd	EB2.57.75	4700A	1	4	2
Flow-sensing valves						
Flap tanks pipe	English Electric Aviation Ltd	EB2.57.1505	4700A	1	4	2
Ventral tank pipe	English Electric Aviation Ltd	EB2.57.2075	4700A	1	4	2
Float switches						
Ventral and main tanks	Flight Refuelling Ltd.	C 3504100/48	1275A	1	24D	4
Flap tanks	Flight Refuelling Ltd.	C 3504100/49	1275A	1	24D	4
Pressure switches	Thermal Control Co. Ltd	T.P. 1278	1275A	1	24A	7
Pressure-refuelling adapter	Avery Hardell Ltd	FC 113	4511	1 & 6	3	5

ed

◄

TABLE 2

Fault diagnosis - fuel asymmetry

POSSIBLE CAUSE	CHECKS	RECTIFICATION
1. ASYMMETRICAL ENGINE SETTING **Failure to cancel REHEAT selection after light-up failure**	Check with pilot on de-briefing	
2. ASYMMETRY THROUGHOUT FLIGHT *(Indicated by increasing asymmetry after emptying of the transfer tanks - check with pilot)*		
(1) **Unserviceable low-pressure cocks**	Suspect the unselected cock on the low contents side Check:-	
	(a) The actuator position indicator. If cock is open suspect electrical circuit	Carry out circuit tests. *(Sect.6, Chap. 10)*. If result is satisfactory change the actuator
	(b) Check the cock for movement by operating FUEL PUMP switch. If actuator moves correctly check for sheared drive as follows:- (i) Drive sheared in "cock closed" position. With pump switch selected to supply fuel through suspect cock, associated low-pressure warning indicator *(auxiliary warning panel)* remains illuminated (ii) Drive sheared in "cock open" position. With pump switch selected to supply fuel through the "non-suspect" cock, associated low-pressure warning indicator for the suspect cock is extinguished **Note...** *Wait for approximately 5 seconds before checking the warning indicator to allow for cock sequencing (Sect.6, Chap.10)*	Renew the unserviceable cock
(2) **Defuelling cock incorrectly selected with access panel fitted** *(only possible after breakdown)*	Check manually	Re-position handle

continued ►

TABLE 2 **Fault diagnosis - fuel asymmetry** - *continued*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
3. **ASYMMETRIC TRANSFER** *(Indicated by asymmetry remaining constant after completion of transfer - check with pilot)*		
(1) **Uneven outward venting pressures** *(Fuel transfer towards lower pressure)*	(a) Check valve types for similarity. Refer to Table 1 for correct valve	Fit correct valves
	(b) If (a) reveals no discrepancy, fit tank pressure test gauges *(fig.11)* to each gravity filler cap. Refuel the aircraft and check the tank pressures. The correct pressure during refuelling should not exceed 1.5 lb/in^2	Renew any valve which does not give the correct tank pressure
(2) **Main tank outward vent valve small-diaphragm failure**	Examine the pressure-head static slots for fuel leakage after refuelling	Renew the vent valve on the low contents sides
(3) **Main tank outward vent valve control valve seized in air pressure to datum chamber position**	(a) Remove the float switch panel *(fig.20)* and check the float of the control valve for freedom (b) If (a) is satisfactory check for internal fault as follows:- (i) Remove the outward vent-valve *(para.74)* (ii) Apply air pressure *(not less than 20* lb/in^2*)* to the auxiliary air system ground air supply connection *(access panel 63P)* and check for air flow from the datum chamber supply pipe	Renew control valve
(4) **Main tank float-switch or Mk.12 refuelling valve** *(These can be separated only by elimination)*	(a) Refuelling valve With all d.c. electrical supplies disconnected, apply refuelling pressure to the refuelling adapter and close the refueller delivery cock. Failure to maintain pressure indicates an unserviceable valve (b) Float switch If (a) is satisfactory connect d.c. electrical supplies and refuel the aircraft. An unserviceable float switch will cause fuel to flow from the outward vent-valve of the associated main tank	
(5) **Float-switch delay-tank drain-hole blocked** *(Float remains suspended and Mk. 12 valve fails to operate)*	Defuel the tank. Remove float switch *(para.77)* and manually fill the delay tank and check the drainage rate. The approx. rate 0.4 in. of depth in 1 min.	Clear hole *(fig.20, detail C)* carefully with a 3/64 in. dia. drill

◄

TABLE 3
Fault diagnosis - fuel venting from integral tank outward vent valve

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART A - VENTING DURING ENGINE GROUND RUNNING	
1. VENTING WITH CHANGE IN AIRCRAFT ATTITUDE		
(1) **Vent valve control valve**		
(a) Float fouling	Check manually after removing the float switch *(para.77)*	Re-position the valve or remove the obstruction
(b) Piston seized in 'static to vent valve' position	Check manually after removing the float switch *(para.77)*	Renew the valve
(c) Incorrect coupling of air and static pipes between spar 1 and control valve, and control valve and vent valve	Check pipe routing *(fig.20)*:- Inboard pipe on spar 1 to bottom forward union on control valve. Outboard pipe on spar 1 to top forward union control valve. Pipe from vent valve to aft union on control valve	Re-position pipes
(d) Control valve to vent valve pipe broken or damaged	Remove the pipe and pressure test it	Renew the pipe
(e) Air supply failure *(In cases where only one engine is running)*	Attach a 0-20 lb/in^2 pressure gauge to the auxiliary air system, and apply air pressure to the ground air supply connection *(access panel 63P)*. When the gauge registers 16.5 lb/in^2 shut off the air supply. A rapid loss of pressure indicates a faulty auxiliary air system n.r.v. in the supply pipe from the engine which was not running	Renew the n.r.v. or re-position it to the correct flow sense *(Sect.3, Chap.8A fig.1)*
2. VENTING DUE TO EXCESSIVE TANK PRESSURE *(Causing vent-valve balance chamber relief valve to open, and allow fuel to vent through the balance duct)*		
(1) **Vent valve control valve**		
(a) Valve not to specification *(External pressure affects valve operation)*	Check part number *(Table 1)*	Fit the correct valve
(b) Piston seized in 'air pressure to vent valve' position or float 'fuel logged'	Check float for freedom of movement and buoyancy	Renew the control valve
(2) **Outward vent valve**		
Small diaphragm failure *(Causes leakage of tank pressure into datum chamber. Tank pressure limited to 12.5 lb/in^2 by balance chamber relief valve)*	Check pressure head static slots for fuel leakage	Renew the vent valve

continued ▶

TABLE 3 Fault diagnosis - fuel venting from integral tank outward vent valve - *continued*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART A - VENTING DURING ENGINE GROUND RUNNING - *continued*	
3. VENTING DUE TO FAILURE OF MAIN TANK FLOAT SWITCH		
(1) **Floating fouling delay tank** *(on reassembly of switch)*	Remove the float switch panel *(para.77)* and check switch position *(para.78)*	Re-position the switch
(2) **Incorrect operating limits**	Refuelling indicator light should be illuminated when the fuel level ***(measured at the float switch access panel)*** is not less than 3.5 in. ± 0.4 below the main plane skin	Re-position or renew the switch
(3) **Float punctured**	Check the float manually for buoyancy	Renew the switch
4. FAULTY VENT SYSTEM		
(1) **Rubber non-return valve on outward vent valve tank-pressure pipe damaged, detached or reversed**	Remove the vent valve *(para.72)* and, through the main-plane aperture:- (a) Check the n.r.v. for security (b) If secure, remove it and check visually for damage	(1) Secure the valve (2) Renew the valve (3) If reversed, fit a new valve
(2) **Rubber sealing ring between outboard vent valve and valve housing damaged or broken**	Remove the vent valve and inspect the sealing ring for damage	Fit a new sealing ring and apply fuel to assist ring to enter housing when refitting the valve
	PART B - VENTING DURING REFUELLING	
1. VENTING WHEN TANK IS FULL (1) **Mk.12 refuelling valve**		
(a) Dirt on valve seat	Disconnect all d.c. electrical supplies. Apply refuelling pressure to the refuelling adapter, using the ground refueller, and close the refueller delivery cock. Check that no loss of pressure occurs	Renew the valve
(2) **Flap tank float switch or Mk.27 refuelling valve failure** *(Causing fuel to overflow through the vent pipe into the main tank)*		
(a) Float switch failure	Check tank full indicator lamp after completely refuelling *(refer to refueller meter)*. If lamp is not illuminated carry out circuit tests to switch *(Book 2, Sect.6, Chap.10)* and if these are satisfactory the switch is suspect	Renew the switch

continued ▶

TABLE 3 Fault diagnosis - fuel venting from integral tank outward vent valve - *continued*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART B - VENTING DURING REFUELLING - *continued*	
(b) Mk.27 refuelling valve failure	(i) Defuel the aircraft *(Sect.2, Chap.2)* (ii) Connect a 0-10 lb/in^2 pressure gauge *(Ref.No.4G/5809)* to the test connection at the valve outlet *(access panel 99P or S)* (iii) Begin to refuel the aircraft and check that the test gauge indicates pressure in the fuel pipe. (iv) Continue refuelling and observe the operation of the associated tank full indicator lamp. When this shows, there should be a simultaneous loss of pressure indicated on the test gauge	Renew the valve
(3) **Main tank float switch**		
(a) Float fouling delay tank	Remove the float switch panel *(para.77)* and check position of float *(para.78)*	Re-position switch
(b) Incorrect float-operating limits	Refuelling indicator light should be illuminated when the fuel level *(measured at the float switch access panel)* is not less than 3.5 in ± 0.4 below the mainplane skin	Renew switch
(c) Float punctured	Manually check the float buoyancy	Renew switch
(d) Defective electrical connections to the float switch or Mk.12 refuelling valve	Make continuity tests in accordance with the electrical circuit diagram *(Book 2, Sect.6, Chap.10, fig.3)*	Rectify as necessary
2. VENTING WHILE LAST 30 GALLONS OF FUEL IS ENTERING THE TANK		
(1) **Vent system**		
(a) Rubber non-return valve on outward vent valve tank-pressure pipe damaged, detached or reversed	Remove the vent valve *(para.72)* and through the main plane aperture:- (i) Check the n.r.v. for security (ii) If secure, remove it and check visually for damage	(1) Secure the valve (2) Renew the valve (3) If reversed, fit a new valve
(b) Rubber sealing ring between outward vent valve and vent-valve housing damaged or broken	Remove the vent valve and inspect the sealing ring for damage	Fit a new sealing ring and apply fuel to assist ring to enter housing when refitting the valve

TABLE 4

...t diagnosis - Internal fuel leakage

...SIBLE CAUSE	CHECKS	RECTIFICATION
...EAKAGE INTO AUXILIARY AIR SYSTEM		
(1) **Recuperator bladder**		
Bladder punctured or clamping cone insecure	(i) Check for leakage from recuperator control valve atmospheric vent (ii) Apply 15 lb/in^2 air pressure to the recuperator air inlet, and shut off the supply. There must be no loss of air pressure over a period of 20 min	Renew the bladder or secure the clamping cone
(2) **Recuperator control valve**		
Diaphragm failure	Check for leakage from atmospheric vent in valve body	Renew the valve
(3) **Recuperator air system**		
Leaking rubber sealing	Check for leakage from recuperator control valve atmospheric vent	
2. LEAKAGE INTO PITOT/STATIC SYSTEM		
(1) **Diaphragm failures in the vent valves**	Carry out pitot/static leakage test *(Sect.7, Chap.5)* isolating each vent valve in rotation	Renew any unserviceable valve
(2) **Air/pressure static pipe between vent valve control valve and outward vent valve damaged**	Remove the pipe and examine it visually, and by pressure testing, for damage	Renew the pipe

►

◀

TABLE 5
Transfer failures

Notes...

1. *Auxiliary air system ground supply and pressure gauge connections are near the refuelling adapter (access panel 63P).*
2. *In all cases where air pressure is required, check that the supply is correct by reference to the pressure gauge (not less than 16.5 lb/in^2).*
3. *For details of the electrical circuits refer to A.P.4700A or F, Book 2, Section 6, Chapter 10.*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART A - VENTRAL TANK TRANSFER	
1. NO TRANSFER		
(1) **Electrical supply failure**	(a) Refuelling fuse burnt out - Mk.12 valve closed (b) Refuelling access panel microswitch:- (i) Check for correct operation by access panel (ii) Check for correct functioning **Note...** *Check (b) can be related to item (6)*	(a) Rectify any circuit fault and renew fuse (b) (i) Ensure correct fitting of access panel (ii) Rectify connections or renew switch
(2) **Defuelling cocks incorrectly selected**	Examine visually	Reset cocks. If cock handles are already correctly set, check assembly of handle to spindle
(3) **Ventral tank outward vent-valve - datum air-pressure failure**		
(a) Small diaphragm failure	(a) Apply air pressure *(Note 1)* and measure datum pressure *(access panel 58S)*. Correct pressure is 9.5 to 12 lb/in^2	(a) Fit a new vent valve and recheck pressure **Note...** *While changing valve carry out check (b)*
(b) 10.5 lb/in^2 reducing valve failure	(b) Apply air pressure *(Note 1)*. Air should flow from the vent valve datum pipe and pressure gauge *(Note 1)* should register 16.5 lb/in^2 **Note...** *This fault can be related to item (6)*	(b) If no air flows and the gauge registers correctly renew the reducing valve. If neither requirement is fulfilled check the auxiliary system *(item 7)*

continued ▶

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART A - VENTRAL TANK TRANSFER - *continued*	
(4) **Mk.7 refuelling valve fails to open due to:-** (a) Valve piston seized closed (b) Control valve seized in empty position	With ventral tank full and refuelling microswitch depressed, apply air pressure *(Note 1)* and check no-flow indicator. If either valve is seized the indicator will show white *(refer to note)* **Note...** *On F Mk.1A this fault will reveal the same signs as failure of the datum pressure relief valve (item 6)*	Remove valves and examine for seizure. Rectify or renew valves *(A.P.4511, Vol. 1 & 6)*
(5) **Mk.12 refuelling valve fails to open** **Caused by:-**	These faults can be separated only by elimination:-	
(a) Main tank high level float switch seized in full position	(a) Remove switch *(para.77)* and check manually for seizure or float arm fouling delay tank	(a) Reposition or renew switch *(para.78)*
(b) Mk.12 valve seized closed **Note...** *There will also be no flap in this instance*	(b) If (a) is serviceable remove Mk.12 refuelling valve and check *(A.P.4511, Vol.1 & 6, Sect.2, Chap.3)*	(b) Rectify *(A.P.4511, Vol.1 & 6)* or renew valve
(6) **Ventral tank datum pressure vent valve** *(F Mk.1A aircraft)* **seized in open position**	Apply air pressure *(Note 1)*, depress refuelling microswitch and ensure that FLIGHT REFUELLING SWITCH is OFF. Remove access panel 54P/S and check aurally for air discharging from valve	Rectify *(A.P.4303E, Vol.1, Sect.2, Chap. 9)* or renew valve
(7) **Air supply failure** *(auxiliary air system)* **Caused by:-**		
(a) 16.5 lb/in^2 reducing valve failure	(a) Check air pressure *(Notes 1 and 2)*	(a) Rectify *(A.P.4303C, Vol.1, Sect.4, Chap.21)* or renew valve
(b) Pressure relief valve seized open	(b) Apply air pressure and check aurally for air discharging from valve **Note...** *On F Mk.1A aircraft depress the refuelling microswitch to avoid confusion with (6)*	(b) Rectify *(A.P.4303C, Vol.1, Sect.4, Chap.27)* or renew valve
(c) Filter blocked	(c) Check air pressure *(Notes 1 and 2)*	(c) Dismantle and clean filter *(A.P. 4303C, Vol.1, Sect.2, Chap.5)*
2. **FAULTY TRANSFER INDICATION** (1) **No flow indicator shows black after completion of transfer. Caused by:-**		
(a) Ventral tank flow sensing valve seized in flow position - flap tank contents will not transfer *(Part B)*	(a) Check by depressing test button on flap tank gauge units cable box *(access panel 124P and S)*. This must be done before refuelling the aircraft and the gauges will indicate flap contents	(a) Renew flow sensing valve

continued ▶

TABLE 5 Transfer faults - *continued*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART A - VENTRAL TANK TRANSFER - *continued*	
(b) Electrical break-away connection failure - flap tank transfer normal	(b) Check continuity through pins 2 and 4 *(Note 3)*	(b) Rectify or renew connector
(c) Magnetic indicator failure - flap tank transfer normal	(c) Check continuity *(Note 3)*	(c) Renew indicator
(2) **No-flow indicator shows white with fuel in tank, air pressure on and all other components serviceable - ventral tank flow sensing valve seized in no-flow position**	Apply air pressure and observe fuel gauge indication This fault will cause gauges to register intermittently an increase of approximately 250 lb	Renew flow sensing valve
	PART B - FLAP TANK TRANSFER	
1. NO TRANSFER		
(1) **Electrical failure**		
(a) Supply failure	(a) (i) Refuelling fuse burnt out - Mk.12 valve closed	(a) (i) Rectify any circuit fault and renew fuse
	(ii) Refuelling access panel microswitch:- (A) Check for correct operation by access panel	(ii) (A) Ensure correct fitting of access panel
	(B) Check for correct functioning	(B) Rectify connections or renew switch
(b) Failure of Mk.27 refuelling valve-operating relay *(Sect. 6, Chap.10)* causing de-fuelling solenoid to remain energized	(b) Check by substitution	(b) Renew the relay and carry out flap tank transfer checks *(Table 6)*
(2) **Ventral tank flow sensing valve seized in flow position**	With d.c. supplies connected and refuelling microswitch depressed check ventral tank no-flow indicator. Correct indication is white	Renew flow sensing valve **Note...** *Refuelling and defuelling may clear the fault, but ensure correct transfer (Table 6) before subsequent flight*
(3) **Air supply failure** *(auxiliary air systems)*		
Refer to Part A, item (7)	Refer to Part A, item (7)	Refer to Part A, item (7)

continued ▶

TABLE 5 Transfer faults - *continued*

POSSIBLE CAUSE	CHECKS	RECTIFICATION
	PART B - FLAP TANK TRANSFER - *continued*	
(4) **Mk.27 refuelling valve piston seized in closed position** **Note...** *The possibility of this occurring should be pursued only when items (1) to (3) have failed*	Carry out fuel transfer check *(Table 6)*. Cockpit indicator will fail to show flap contents. *(This is dependent on the flow sensing valve being serviceable 2 (2))*	Rectify *(A.P.4511, Vol.1 & 6, Sect.2 Chap.12)* or renew the valve
2. FAULTY TRANSFER INDICATION		
(1) **Flap tank flow sensing valve seized in flow position - flap transfer normal**	Completely refuel the aircraft and check the fuel contents indicators. With the flow sensing valve seized the indicator will register 2700 lb with all indicator lamps lit *(normal reading is approximately 2450 lb)* **Note...** *Refuelling may eliminate the fault. Ensure that this is permanent, however, by carrying out transfer checks (Table 6) before subsequent flight*	Renew the valve
(2) **Flap tank flow sensing valve seized in no-flow position - transfer very slow - or faulty electrical connections**	Carry out transfer check *(Table 6)* and, during this, check continuity through the valve switch *(J.B.7 or J.B.8 - Sect.6, Chap.10)*. If no continuity is obtained the valve or wiring is suspect	Rectify wiring or renew valve

TABLE 6 FLOW AND TRANSFER CHECKS

PART A - PUMP TRANSFER

Notes...
(1) The fuel transfer rate is established by referring to the cockpit contents indicators
(2) Measure the fuel pressure at the test connection on the outlet pipe from the inboard low pressure cock in each main plane (access panels 122P and S)

TYPE OF TRANSFER	DIRECTION OF TRANSFER	MAIN TANK FUEL CONTENTS (LB)		DEFUELLING COCK SETTING		PUMPS OPERATING	ELECTRICAL SYSTEM						FUEL TRANSFER RATE (LB/MIN) See note (1)	FUEL PRESSURE (lb/in²) See note (2)	ADDITIONAL INFORMATION
		PORT	STBD.	PORT	STBD.		COCKPIT SWITCHES PORT	COCKPIT SWITCHES STBD.	REFUELLING MICROSWITCH	D.C. SUPPLY	A.C. SUPPLY	FUSES OUT (SECT.6 CHAP.10)			
MAIN PLANE TANK CROSS FEED	PORT TO STBD.	2000 MIN.	750 MAX.	DEFUEL	NORMAL	1 booster 2 booster Transfer	NO.1 ENG.	OFF	RELEASED	ON	ON	1 a.c. nil 2 a.c.	200 + 250 + 45 +	17.0 + 20.0 + 3.5 +	
	STBD. TO PORT	750 MAX.	2000 MIN.	NORMAL	DEFUEL	1 booster 2 booster Transfer	OFF	NO.1 ENG.	RELEASED	ON	ON	1 a.c. nil 2 a.c.	200 + 250 + 45 +	17.0 + 20.0 + 3.5 +	
MAIN TANK TO FLAP TANK CROSS FEED (Ventral tank must be full or not fitted)	PORT MAIN TO STBD. FLAP	500 MIN.	FULL (Refer to end column)	DEFUEL	NORMAL	ALL PORT	NO.1 ENG.	OFF	RELEASED	ON	ON	—	TRANSFER CHECK ONLY		If starboard tank is not full, disconnect electrical supplies to Mk.12 refuelling valve
	STBD. MAIN TO PORT FLAP	FULL (Refer to end column)	500 MIN.	NORMAL	DEFUEL	ALL STBD.	OFF	NO.1 ENG.	RELEASED	ON	ON	—			If port tank is not full, disconnect electrical supplies to Mk.12 refuelling valve
MAIN TANK TO VENTRAL TANK (Flap tanks must be full)	PORT MAIN TO VENTRAL	FULL	—	DEFUEL	ISOLATE	ALL PORT	NO.1 ENG.	OFF	RELEASED	ON	ON	—	TRANSFER CHECK ONLY		
	STBD. MAIN TO VENTRAL	—	FULL	ISOLATE	DEFUEL	ALL STBD.	OFF	NO.1 ENG.	RELEASED	ON	ON	—			

PART B - PRESSURIZED TRANSFER

Notes...
(1) Air pressure is applied to the ground connection (access panel 63P)
(2) Both fuel pumps switches must be selected OFF and d.c. supplies connected
(3) Measure flap tank flow pressure at Mk.27 valve inlet; measure ventral tank flow pressure behind access panel 58S

TYPE OF TRANSFER	DIRECTION OF TRANSFER	MAIN TANK FUEL CONTENTS (lb)		DEFUELLING COCK SETTING		AIR PRESSURE	REFUELLING MICROSWITCH	FUEL TRANSFER RATE	FUEL TRANSFER PRESSURE (lb/in²) See note (3)	TOTAL FUEL TRANSFERRED (lb)	ADDITIONAL INFORMATION
		PORT	STBD.	PORT	STBD.						
FLAP TANK TO MAIN TANK	PORT FLAP TO PORT MAIN	2000 MAX.	—	NORMAL	ISOLATE	ON	DEPRESSED	120 lb + in 5 min.	6 +	250 lb +	Refuelling microswitch must be released for checking flow rate
	STBD. FLAP TO STBD. MAIN	—	2000 MAX.	ISOLATE	NORMAL	ON	DEPRESSED	120 lb + in 5 min.	6 +	250 lb +	Refuelling microswitch must be released for checking flow rate
VENTRAL TANK TO MAIN TANK	—	1000 MAX.	1000 MAX.	NORMAL	NORMAL	ON	DEPRESSED	250 lb + to each main tank in 3 min	9.5 - 12	1950 +	(1) At completion of transfer totals transferred to each wing must not vary by more than 160 lb (2) If transfer to one main tank only is required, set the opposite defuelling cock to ISOLATE