

Chapter 2 FUEL AND NITROGEN SYSTEMS

(Completely revised)

LIST OF CONTENTS

DESCRIPTION	Para.	DESCRIPTION	Para.	DESCRIPTION	Para.
<i>Introduction</i>	1	Pressure tests for all types		<i>Checking the vent valve</i>	82
B Mk. 1 Basic system		<i>Checking the vent valves</i>	59	<i>Checking refuelling rate and tank pressure</i>	83
<i>General layout</i>	4	<i>Checking the pressure reducing valve</i>	60	Underwing tank tests	
<i>Main plane system</i>	6	<i>Checking the emergency relief valve</i>	61	<i>Checking jettison valve operation</i>	85
<i>Fuselage system</i>	8	<i>Checking the recuperator air supply</i>	62	<i>Checking refuelling rate and cut-off valve action</i>	86
<i>Recuperators</i>	11	<i>Checking the engine component air bleed piping</i>	63	<i>Checking pipe couplings for leaks</i>	87
<i>Refuelling</i>	13	Capacity checks and gauge calibration	64	<i>Checking tank pump fuel transfer rate</i>	88
<i>Defuelling</i>	16	Refuelling and defuelling tests	65	<i>Checking emergency transfer rate</i>	89
<i>Venting and pressurizing</i>	18	<i>B Mk. 1 and B/PR Mk. 1</i>		<i>Checking defuelling rate</i>	90
<i>Nitrogen and air systems</i>	24	<i>Checking tank pressure and refuelling rate</i>	67	REMOVAL AND ASSEMBLY	
B PR Mk. 1 system		<i>Checking tank pressure and defuelling rate</i>	68	<i>Precautions when fitting or removing tank cells</i>	91
<i>General layout</i>	29	<i>Checking underwing tank piping</i>	69	<i>Cell and tank bay preparation</i>	96
<i>Refuelling and defuelling</i>	31	<i>B/K Mk. 1 and B/K/PR Mk. 1</i>		<i>Fitting tank bay protective strips</i>	99
<i>Venting and pressurizing</i>	32	<i>Checking tank pressure and refuelling rate</i>	70	<i>Fitting a fuselage tank cell</i>	100
B/K Mk. 1 and B/K/PR Mk. 1 systems		<i>Checking tank pressure and defuelling rate</i>	71	<i>Fitting transfer tank cells</i>	102
<i>Introduction</i>	33	<i>Checking flow through probe</i>	72	<i>Fitting a wing tank cell</i>	103
<i>Receiver role</i>	34	Leak tests		<i>Fitting fuel cell manhole covers</i>	104
<i>Refuelling the tanker/receiver</i>	37	<i>Wing tank vent system leak test</i>	73	<i>Fitting wing tank access panels</i>	106
<i>Defuelling the receiver aircraft</i>	40	<i>Wing tank leak test</i>	74	<i>Tank fittings and fuel pump removal</i>	108
<i>Tanker aircraft</i>	41	<i>Refuelling system leak test</i>	75	<i>Engine master and crossfeed cocks removal</i>	110
<i>Defuelling the tanker aircraft</i>	50	<i>Fuselage vent system leak test (less glass-cloth ducts)</i>	76	<i>Fuel distributor box removal</i>	111
SERVICING		<i>Fuselage vent system glass-cloth duct leak test</i>	77	<i>Wing tank transfer cock removal</i>	112
Flow tests for all types		<i>Pump vapour, recuperator, air feed and bleed lines leak tests</i>	78	<i>Fuselage pump housing removal</i>	113
<i>Checking free flow from each pump to engines</i>	54	<i>Nitrogen system pipelines leak test</i>	79	<i>Recuperator removal</i>	114
<i>Checking transfer tank free flow</i>	55	Bomb bay tank tests		<i>Fuselage booster pump removal</i>	115
<i>Checking transfer tank flow to fuselage tanks</i>	56	<i>Checking the pressure reducing valve</i>	81	<i>Flowmeter transmitter removal</i>	116
<i>Checking transfer tank positive lock non-return valve</i>	57			<i>Wing stalks fitting and removal</i>	117
<i>Checking recuperator operation</i>	58			<i>Underwing tanks fitting and removal</i>	118
				<i>Bomb bay tanks fitting and removal</i>	119

RESTRICTED

LIST OF ILLUSTRATIONS

	<i>Fig.</i>		<i>Fig.</i>		<i>Fig.</i>
<i>Fuselage fuel system diagram — B Mk. 1 and B/PR Mk. 1</i>	1	<i>Fuselage reducing and relief valve assembly</i>	9	<i>B/K Mk. 1 and B/K/PR Mk. 1 fuel system — Tanker role</i>	15
<i>Main plane fuel system diagram — B Mk. 1 and B/PR Mk. 1</i>	2	<i>Fuselage fuel system diagram — B/K Mk. 1 and B/K/PR Mk. 1 (Receiver)</i>	10	<i>Bomb bay arrangement — Tanker role</i>	16
<i>Main plane fuel system</i>	3	<i>Main plane fuel system diagram — B/K Mk. 1 and B/K/PR Mk. 1</i>	11	<i>Fuel system test diagram</i>	17
<i>B Mk. 1 fuselage fuel system, port side</i>	4	<i>B/K Mk. 1 and B/K/PR Mk. 1 fuselage fuel system, port side</i>	12	<i>Fitting a fuselage tank cell</i>	18
<i>B Mk. 1 fuselage fuel system, starboard side</i>	5	<i>B/K Mk. 1 and B/K/PR Mk. 1 fuselage fuel system, starboard side</i>	13	<i>Fitting a wing tank cell</i>	19
<i>Fuselage tank pressurizing and venting diagram</i>	6	<i>B/K Mk. 1 and B/K/PR Mk. 1 probe system</i>	14	<i>Location diagram — tank components</i>	20
<i>Main plane fuel system pressurizing and venting diagram</i>	7			<i>Tank components — 1</i>	21
<i>Pressurizing and venting system</i>	8			<i>Tank components — 2</i>	22
				<i>Tank components — 3</i>	23
				<i>Transfer tank starboard cell fuel pump assembly — post-Mod. 2443</i>	24

LIST OF TABLES

	<i>Table</i>
<i>System alternatives</i>	1
<i>Fuel load distribution</i>	2
<i>Special tools and equipment</i>	3

LIST OF APPENDICES

1. Wing stalks *(to be issued later)*
2. Underwing tanks *(to be issued later)*
3. Bomb bay fuel tank *(to be issued later)*
4. Fuel system components
(to be issued later)

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DESCRIPTION**Introduction**

1. The basic fuel system for use with AVTUR, AVTAG or AVGAS is employed in bomber aircraft, the only variation being availability of additional fuel load when two streamlined tanks are slung, one under each main plane. These tanks, common to all aircraft types, are completely self-contained and are interchangeable both on and between aircraft (*App.* 2). A tank can also be fitted in the bomb bay to provide additional fuel for aircraft used in PR or tanker roles. The fuel contents gauges are operated electrically by tank units in the various fuel cells which are partly interconnected to form tanks, both in the main planes and fuselage.

2. All aircraft types have provision for pressure refuelling and defuelling, restricters in the fuel lines ensuring even flow at a pressure unlikely to cause cell damage, and a supply of nitrogen or air in conjunction with an elaborate venting system ensuring against collapsing or straining the flexible

fuel cells when refuelling or defuelling is in progress. For flexible fuel cell information see A.P.4117A, Vol. 1 and 6, Sect. 3.

3. The possible type variations brought about by introduction of varying fuel capacity and fuel system alterations for the allotted flying tasks, are given in Table 1 which will be further referred to in the particular paras. describing the system in that type. It will be seen that all types are capable of being used in the bomber role and of carrying underwing tanks, the addition of a bomb bay tank and fuel system alterations limiting the type application to the specific roles. It should be noted that the table refers only to possible applications, i.e., B/K Mk. 1 aircraft are capable of fitment as tanker/receivers with a bomb bay tank or as bomber/receiver without the additional tank; further, a tanker aircraft although having the necessary fuel system alterations to be tanker/receiver, may have the probe removed and the fuel line blanked so that it may operate as a tanker only.

B Mk. 1 — Basic system**General layout (fig. 1 and 2)**

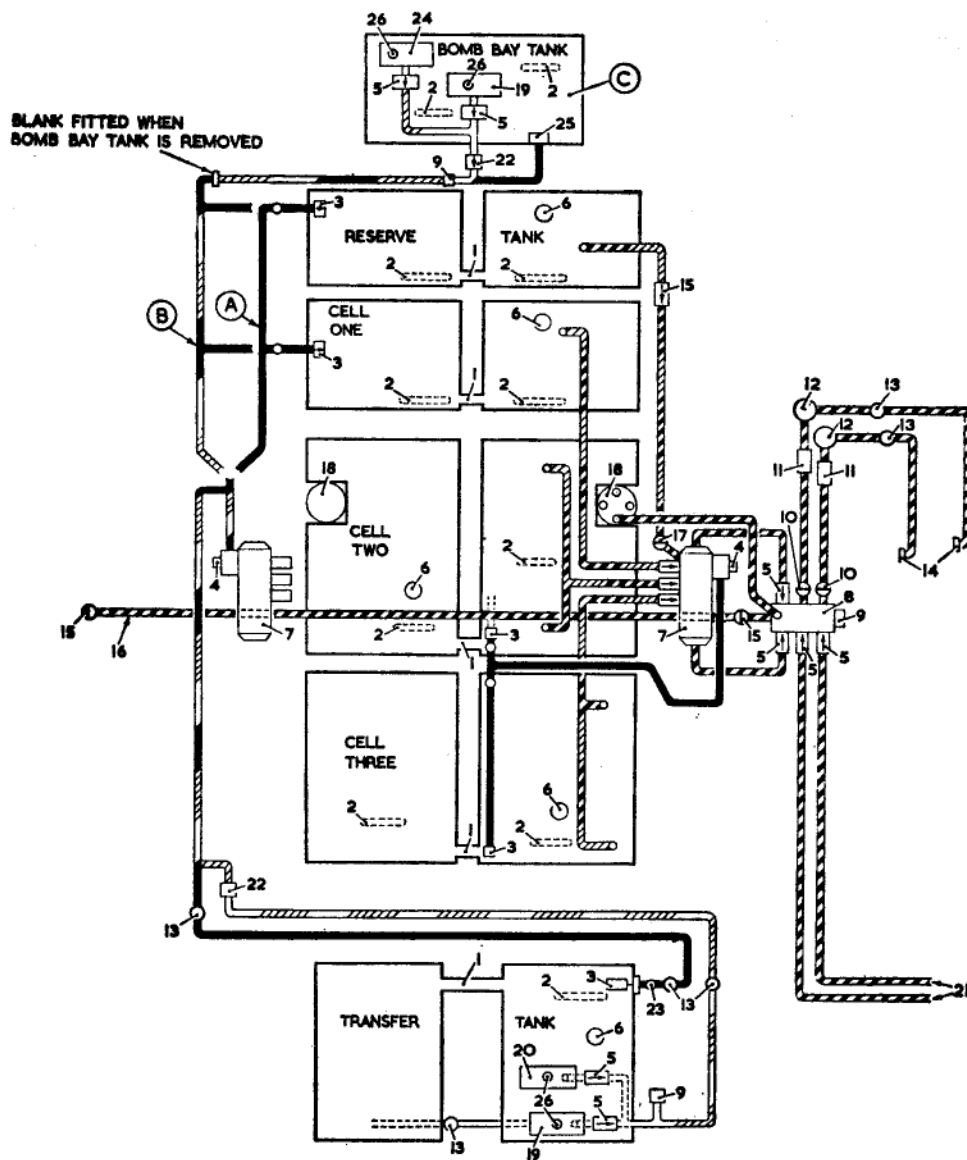
4. This is the basic system for all types, subject to the variations given in Table 1 when required for other roles, but as a bomber aircraft would be subject only by alteration to enable it to be refuelled in flight. The installation operates under booster pump pressure and comprises two separate systems. The port wing system and fuselage port cells feed No. 1 and No. 2 engines as the port system, the starboard wing system and fuselage starboard cells feeding No. 3 and 4 engines as the starboard system, and the transfer tank not being included directly into either. The two systems are interconnected by a cross-feed pipe, fuel transfer (permitting fuel from any tank to be fed to any engine) being controlled by two electrically-operated cocks which are normally CLOSED. ◀Reversion of flow is prevented where necessary by non-return valves, the connecting pipes to many of these being labelled (Mod. 2736) to indicate direction of flow. ▶

5. Low pressure warning switches are fitted in both the port and starboard fuel collector

TABLE 1
System alternatives

Type	Bomber	Bomber/ Receiver	Tanker	PR	Bomb bay tank	Underwing tank
B Mk. 1	Yes	—	—	—	—	Yes
B/PR Mk. 1	Yes	—	—	Yes	Yes	Yes
B/K Mk. 1	Yes	Yes	Yes	—	Yes	Yes
B/K/PR Mk. 1	Yes	Yes	Yes	Yes	Yes	Yes

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- 1 TANK INTERCONNECTORS
- 2 FUEL CONTENTS GAUGE TANK UNIT
- 3 PRESSURE REFUELLING CUT-OFF VALVE
- 4 PRESSURE REFUELLING CONNECTION
- 5 FUEL NON-RETURN VALVE
- 6 PRESSURE REFUELLING FLOAT SWITCH
- 7 FUSELAGE PUMP HOUSING AND PUMPS
- 8 FUEL DISTRIBUTOR BOX
- 9 LOW PRESSURE WARNING SWITCH
- 10 ENGINE MASTER COCK
- 11 FUEL HEATER
- 12 FLOWMETER TRANSMITTER
- 13 FUEL DRAIN
- 14 SUPPLY TO ENGINES
- 15 CROSSFEED COCK
- 16 CROSSFEED
- 17 RESERVE TANK COCK
- 18 RECUPERATOR
- 19 FUEL PUMP
- 20 STANDBY FUEL PUMP (MOD. 2443)
- 21 FROM WING SUPPLY
- 22 POSITIVE LOCK NON-RETURN VALVE
- 23 RESTRICTOR VALVE
- 24 STANDBY FUEL PUMP (MOD. 2473 AND 2444)
- 25 PUMP HOUSING VENT
- 26 WATER DRAIN

NOTE:-
 PIPE LINE (A) B. MK. I ONLY
 PIPE LINE (B) B/PR. MK. I ONLY
 TANK (C) B/PR. MK. I ONLY

REFUEL
 DEFUEL
 TRANSFER
 FEED

Fig. 1. Fuselage fuel system diagram — B Mk. 1 and B/PR Mk. 1

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boxes, and in the underwing tanks. Those in the collector boxes are operated by fuel pressure dropping below 4 lb/in² and in underwing tanks below 8 lb/in², causing the switch contacts to be made and a red warning lamp on the pilots' fuel control panel to be brought into circuit. The fuel collector boxes feed directly to the engines on that side, consequently a lamp showing red from either of these indicates starvation on that side and the immediate remedy is to bring into operation the fuel cross-feed cock.

Main plane system (fig. 3)

6. Each outer plane houses five flexible fuel cells, the two inboard being interconnected to form No. 1 wing tank and the three outboard No. 2 tank, both being vented to a common ducting terminating at the wing tip trailing edge. Fuel drains are provided at each tank inner cell, and water drains are fitted to the inter-cell feed pipes and on the wing tank fuel pumps located in No. 1 tank outer and No. 2 tank inner cells. All cells carry a fuel contents gauge tank unit, and each tank inboard cell carries a pressure refuelling float switch and a pressure refuelling cut-off valve incorporating a fuel non-return valve. The cut-off valves are connected by pipelines to the defuelling selector valve which is also connected to a pressure refuelling point on the wing undersurface and to the underwing tank when fitted.

7. Fuel from the underwing tank is either pumped or forced under pressure to the selector valve and passed to the two wing tanks. Fuel from each wing tank is pumped to the distributor box in the system and, in the event of a wing pump failure, an electrically-actuated cock (in the transfer pipe joining the two tanks) may be opened to permit fuel to flow under gravity from one tank to the other. Should wing tank pump failure be experienced in both pumps

on the same side, however, fuel cannot be drawn from that wing unless the appropriate fuselage pump is switched off. If this is done the pressure in the collector box on that side will fall, fuel from the wing will flow under gravity through the non-return valves and be drawn away by the engine fuel pumps.

Fuselage system (fig. 1, 4 and 5)

8. Five pairs of fuel cells on each side of the fuselage centre line form three fuselage tanks, the forward pair the reserve tank, the aft pair the transfer tank, and the remainder from front to rear the main fuselage tank comprising No. 1, 2 and 3 cells. All fuselage tank cells and the reserve tank cells are piped individually to the fuselage pump housing on that side, the transfer tank being piped to the reserve tank and No. 1 cells refuelling line. The reserve tank pipelines embody non-return shut-off valves to prevent fuel surging into the tank should the aircraft suddenly adopt a nose-down attitude, the pump housings having non-return valves at the entry of pipelines from the main tank which will open under the head of fuel when the defuelling selector valves on the housings are selected to FLIGHT.

9. With the exception of the transfer tank, the fuselage tanks feed to the pump housings by gravity, with a cock in the pipeline controlling the flow from each reserve tank cell, and fuel from the pump housings passing to distributor boxes (which are common with the wing supplies) and thence to the engines via engine master cocks, fuel heaters and flowmeter transmitters. Fuel from the transfer tank is not fed directly to the distributor boxes but is pumped to the reserve tank and main tank No. 1 cells via the transfer and refuelling lines (fig. 1, pipeline (A)). Since the amount of fuel in the transfer tank can have a critical bearing on the

aircraft C.G., a standby pump is also fitted in this tank (introduced by Mod. 2443 and labelled AUX. on the control panel) and can be brought into action should pump failure occur.

10. Switching ON the transfer tank fuel pump energizes the reserve tank and main tank No. 1 cell float switch circuits, permitting the valves to open and fuel to transfer as the level in them falls. The reserve and transfer tanks, and each main tank cell, are each fitted with a pressure refuelling cut-off valve, and each individual cell of the reserve and main tanks carries a fuel contents gauge unit; only one gauge unit is fitted in the transfer tank since the cell interconnector is below tank level and allows the complete tank contents to be ascertained. Drain valves on the refuelling panel facilitate pump housing water drainage (overboard through the outer skin), water drains also being provided for the transfer tank booster pumps.

Recuperators

11. A recuperator of 6 gall. capacity is fitted at the side of each No. 2 cell and is connected to the distributor box on that side as a safeguard against engine starvation under negative g conditions which would tend to move the fuel away from the booster pumps and reduce the supply line pressure. Supplied by the engines with constant air pressure at 5.75 to 6.75 lb/in², reducing and non-return valves being included in the supply lines, the recuperator consists of a flexible fuel bag clamped between the halves of a flanged casing and charged with fuel at booster pump pressure of between 12 and 18 lb/in² when the fuel system is operating normally. This distends the bag to its fullest extent and charges the container with fuel sufficient to meet the system requirements during maximum permissible fuel suspension period caused by negative g forces.

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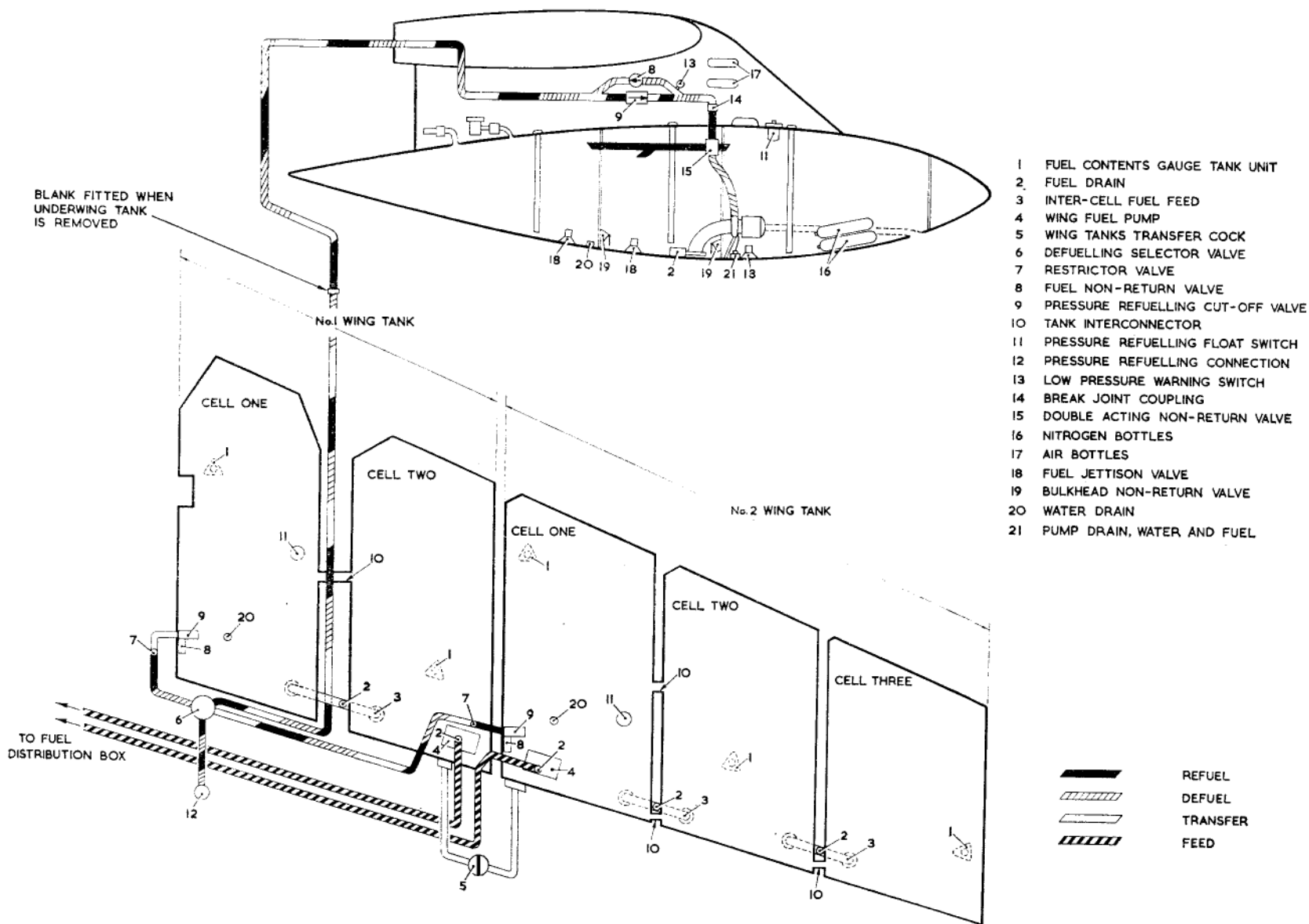


Fig. 2. Main plane fuel system diagram — B Mk. 1 and B/PR Mk. 1

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These would reduce the fuel line pressure and consequently recuperator fuel, being at a higher pressure, would flow into the distributor box to temporarily make good the loss.

12. A fuel connection and a relief valve are fitted at the casing ends, the connection elbow embodying a continuous bleed which allows a small quantity of fuel to pass into the fuel tank under normal conditions, and air (when the recuperator is being charged) as a safeguard against air locks. The relief valve comprises a blanked-off connection, an air inlet, and the air pressure relief valve which is pre-set but adjustable by shim insertion under the valve spring. Recuperator air supply failure would cause a valve in the elbow to cut off fuel supply, leakage from the spring-loaded fuel valve gland being drained overboard. For further recuperator details see A.P.4117A, Vol. 1 and 6.

Refuelling

13. Four pressure refuelling and defuelling connections are provided, one at each side of the fuselage at Stn.524 and one at each main plane undersurface aft of the rear spar at Stn.240, restricters in the lines from the connections limiting the flow to 150 gall. per min. at 50 lb/in². (For refuelling procedure see Sect. 2, Chap. 2). The fuselage port connection serves the reserve tank, main tank No. 1 cells and the transfer tank, the starboard connection serving the main tank No. 2 and 3 cells; each wing connection serves the wing tanks on that side including underwing tanks if fitted. Fuel from the reserve tank and No. 1 cells is fed into the port cell in each case and will weir into the starboard cell through large bore interconnectors as stated in Table 2. The main tank No. 2 and 3 cells are branched from one refuelling line on the starboard side permitting them to be refuelled together, the fuel weiring into the port cells. The transfer tank refuelling inlet

is on the starboard cell, but unlike the reserve and main tanks it has interconnectors between the cells at base level which ensure equal distribution; all refuelling inlets are connected to refuelling cut-off valves actuated through pressure refuelling float switches.

14. To refuel the wing tanks, fuel passes via the refuelling/defuelling selector valve to the inboard cell of each tank, distribution in the tank being maintained by cell interconnectors, and replenishment action controlled by refuelling cut-off valves (embodying non-return valves) at each entry point. When underwing tanks are fitted they are refuelled as part of the wing system via the selector valve and controlled by a cut-off valve fitted in each wing stalk (*App. 2*).

15. Selector switches controlling the solenoids in the refuelling cut-off valves are fitted adjacent to all refuelling connections, float-operated switches wired in series with them being installed in the reserve and transfer tanks, main tank No. 1 and 3 starboard cells, and in the port cell of main tank No. 2 cells, the inboard cells of wing tanks and the underwing tanks (if fitted). The tanks to be filled are selected on the selector switches and the refuelling unit allowed to run until the float switch closes the tank refuelling valve, a condition indicated either by a change of note on the refuelling unit or the refuelling unit gauges ceasing to register flow. When partial refuelling is required in the fuselage main tank No. 1 and 2 cells on the transfer tank, it is important to note that the selector switches must be returned to off BEFORE cutting the flow or stopping the refuelling unit in order to ensure that the tank refuelling valves are hydraulically locked (*Sect. 2, Chap. 2*). On completion of refuelling it will be necessary to place all selector switches at OFF before the access panel can be refitted.

Defuelling (fig. 1 and 2)

16. Selector levers are fitted adjacent to the defuelling points to control the fuselage pump housing non-return valves and wing defuelling selector valves, those controlling the fuselage connections being locked into position by levers after selection is made. The reserve and main tank starboard cells are defuelled through the starboard connection and the port cells via the port connection; in each case the fuel flows into the pump housing to be sucked into the refuelling/defuelling box via a non-return valve and passed to the defuelling vehicle. By lever selection, individual cells may be defuelled if required. The transfer tank is also defuelled from the port connection, although in this case the fuel is sucked into the defuelling box via the booster pump line and common refuelling/defuelling lines. It can be isolated if the positive-lock non-return valve in the pipeline is placed in the LOCKED SHUT position. Should it be necessary to defuel all fuselage tanks simultaneously, the wing tank must be empty to ensure a forward C.G. position (*Sect. 2, Chap. 2*).

17. Wing and underwing tanks are defuelled from the wing refuelling/defuelling connections, wing fuel being sucked through non-return valves in the refuelling cut-off valves and passing to the defuelling selector valve. Before defuelling either wing, operate the 'P' type cock in the relief valve by-pass to ensure that the vent piping is clear of fuel. Fuel from the underwing tanks is sucked through the pumps and double-acting valves in the tank, via non-return valves by-passing the refuelling valves in the stalks, and to the defuelling selector valve, and thence to the defuelling connection.

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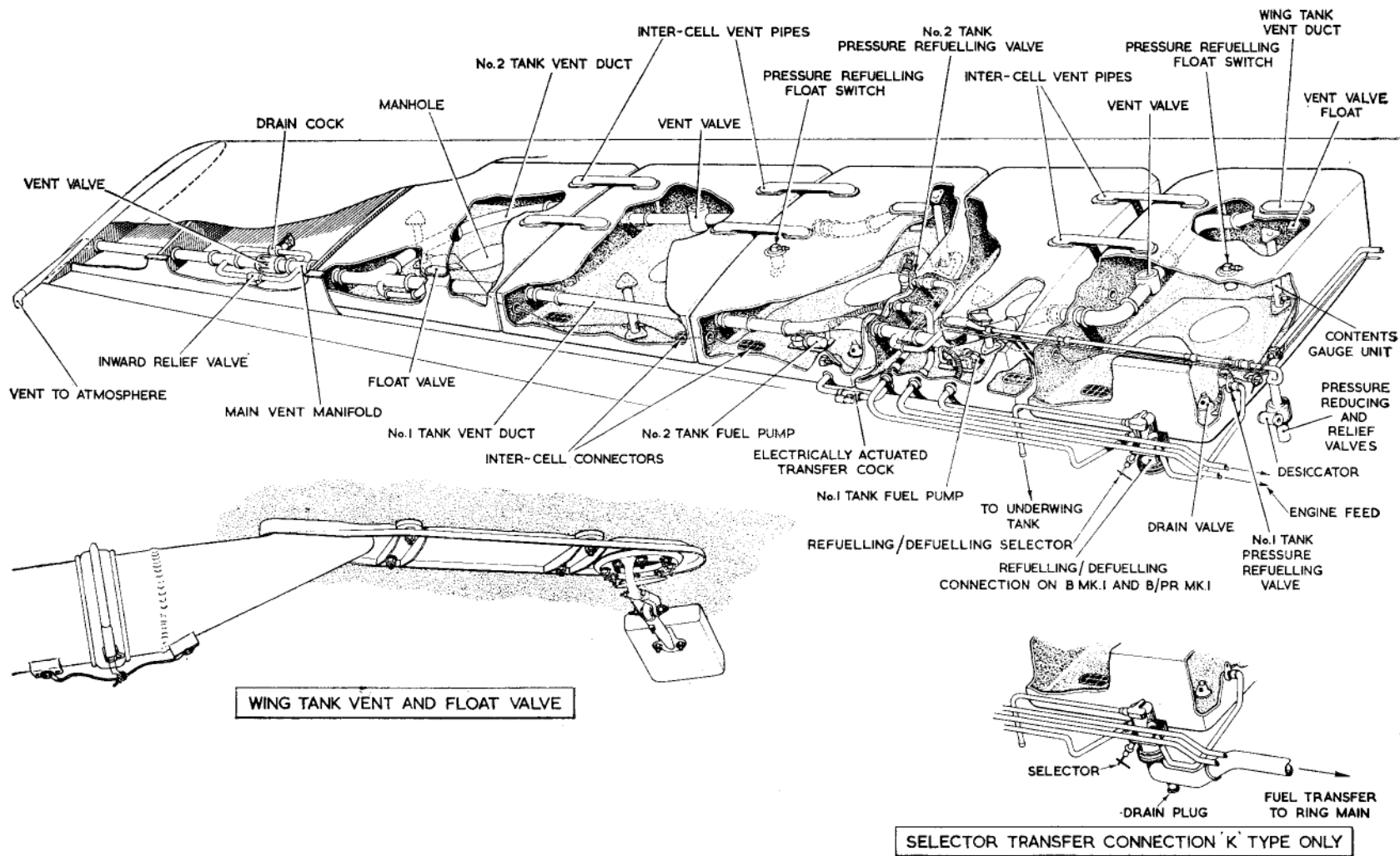


Fig. 3. Main plane fuel system

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TABLE 2
Fuel load distribution

	<i>Tank capacity</i>		<i>Usable fuel</i>		<i>Remarks</i>
	<i>Imp. gall.</i>	<i>lb. @ 0.76 s.g.</i>	<i>Imp. gall.</i>	<i>lb. @ 0.76 s.g.</i>	
Fuselage:—					When refuelling:—
No. 1 cell	734 ± 10	5,578	734 ± 10	5,578	Weirs from port at 335 gall.
No. 2 cell	1,370 ± 10	10,412	1,370 ± 10	10,412	Weirs from starb. at 650 gall.
No. 3 cell	1,286 ± 10	9,774	1,286 ± 10	9,774	Weirs from starb. at 650 gall.
Reserve	590 ± 10	4,484	590 ± 10	4,484	Weirs from port at 270 gall.
Transfer	710 ± 10	5,396	710 ± 10	5,396	
Wing:—					
No. 1 tanks	1,106 ± 10	8,406	1,090 ± 10	8,284	8 gall. per tank unusable
No. 2 tanks	946 ± 10	7,190	930 ± 10	7,068	8 gall. per tank unusable
Underwing (2 × 1,615)	3,230 ± 15	24,548	3,200 ± 10	24,320	15 gall. per tank unusable
Total B Mk. 1	9,972 ± 85	75,788	9,910 ± 80	75,316	
Bomb bay	575 ± 10	4,370	570 ± 10	4,332	5 gall. unusable
Total other types	10,547	80,158	10,480	79,648	

- Note:— (1) Bomb bay tanks are not fitted to B Mk. 1.
(2) A fuselage *tank cell* includes port plus starboard individual cells.

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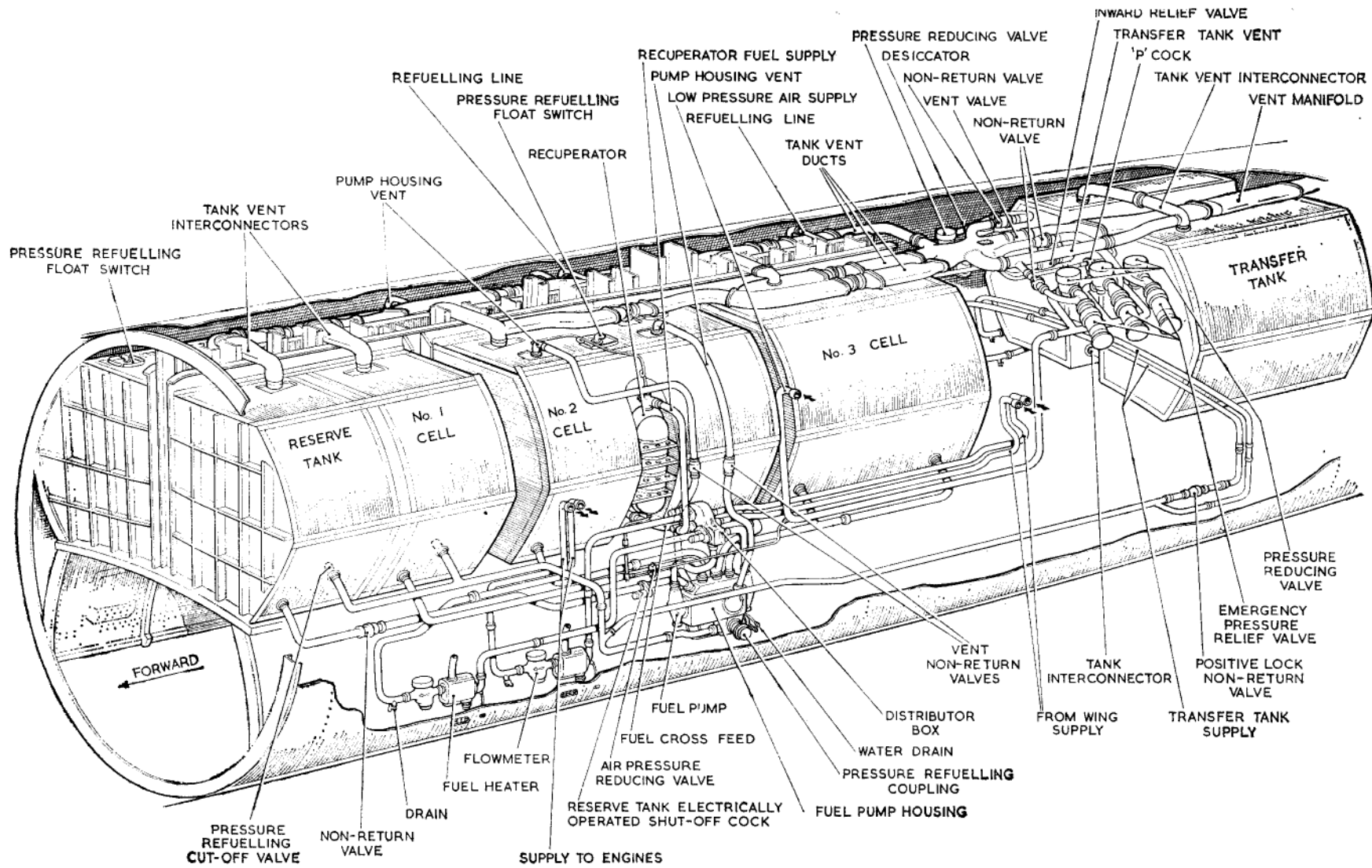


Fig. 4. B Mk. 1 fuselage fuel system, port side

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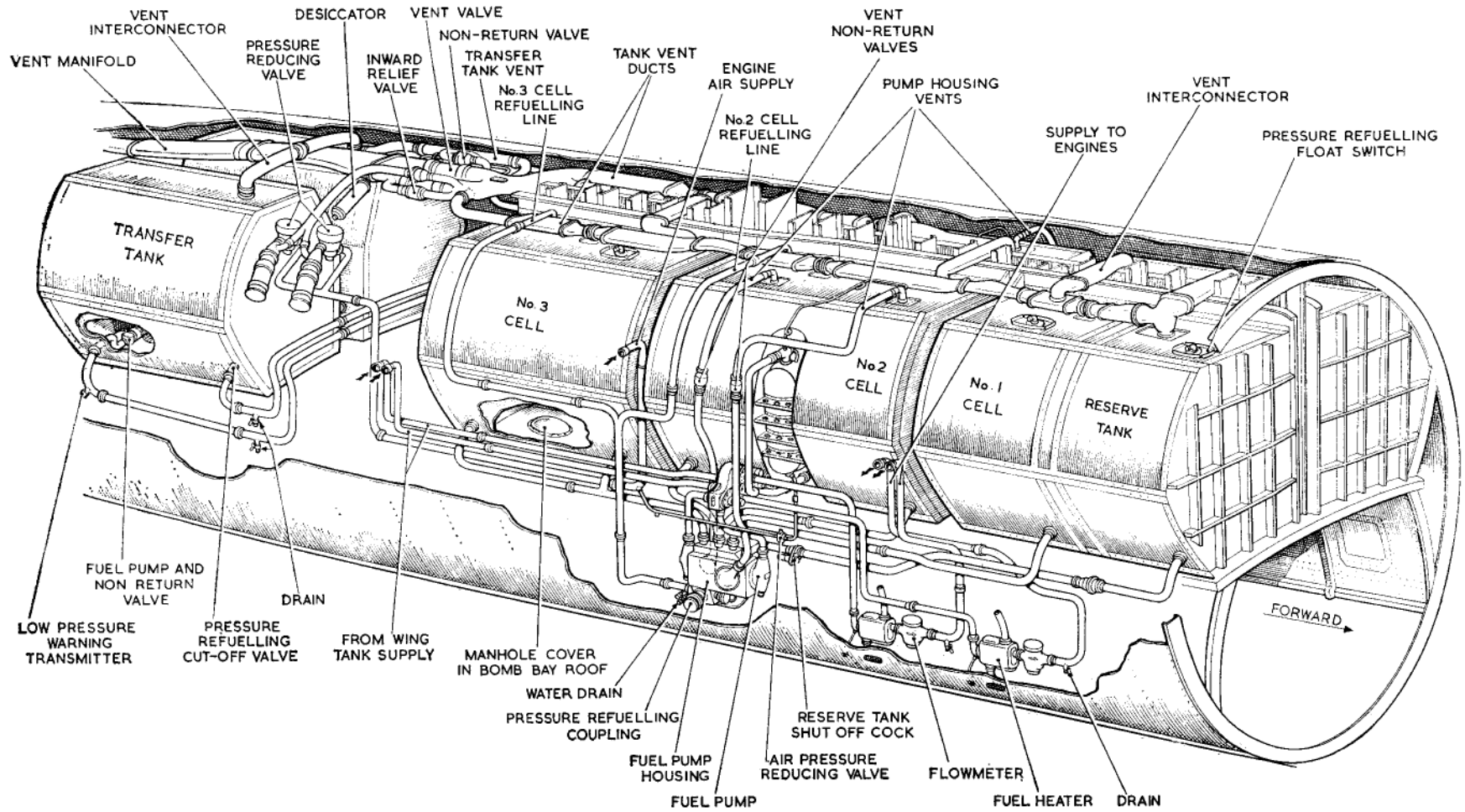
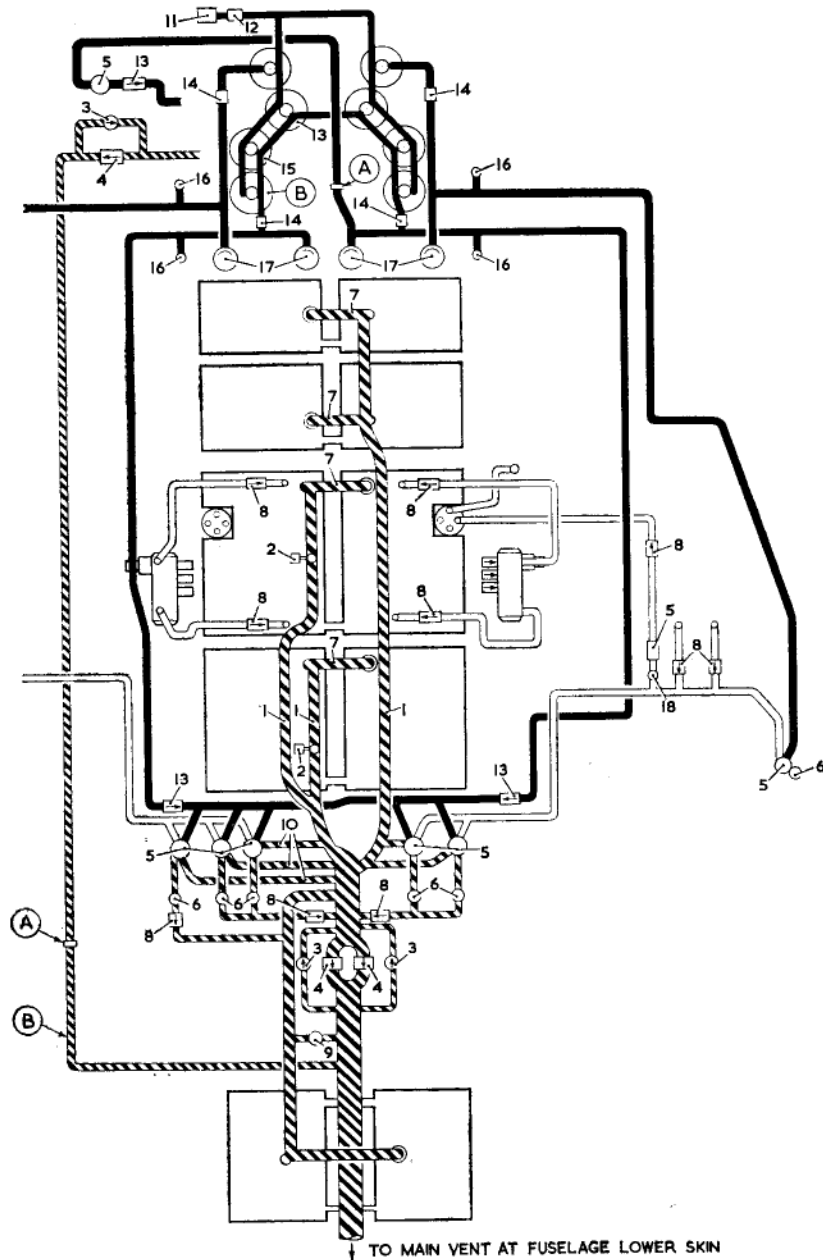


Fig. 5. B Mk. 1 fuselage fuel system, starboard side

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- 1 FUSELAGE VENT DUCT
- 2 VENT FLOAT VALVE
- 3 INWARD RELIEF VALVE
- 4 PRESSURE RELIEF VENT VALVE
- 5 PRESSURE REDUCING VALVE
- 6 EMERGENCY PRESSURE RELIEF VALVE
- 7 INTER-CELL VENT
- 8 NON-RETURN VALVE
- 9 DRAIN COCK
- 10 SENSING LINES
- 11 NITROGEN CHARGING VALVE
- 12 NITROGEN FILTER
- 13 NITROGEN NON-RETURN VALVE
- 14 NITROGEN MASTER COCK
- 15 NITROGEN BOTTLE (2250 LITRE)
- 16 NITROGEN TEST POINT
- 17 NITROGEN PRESSURE GAUGE
- 18 WATER DRAIN

NOTE:- (A) BLANK FITTED WHEN BOMB BAY TANK IS REMOVED
 (B) ALL TYPES EXCEPT B.MK.I

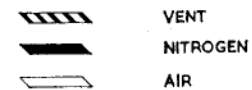


Fig. 6. Fuselage tank pressurizing and venting diagram

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Venting and pressurizing (fig. 5, 6, 7 and 8)

18. Each wing and the fuselage fuel systems are separately vented and will permit dispersal of large quantities of fuel in emergency should a cut-off valve fail to operate during refuelling. The underwing tanks (if fitted) are also independently vented (*App. 2*). In order to prevent the flexible fuel cells collapsing, a differential pressure between 0.9 and 1.2 lb/in² above ambient is maintained in the fuel system and is obtained either automatically from the engine air supply when the engines are running, or by the use of nitrogen which must be turned on before take-off since there are no controls or indicators for the system. Underwing tanks can only be nitrogen pressurized (*App. 2*).

19. Each pair of fuel cells in the fuselage system (*fig. 5*) are joined by vent pipes at their upper surfaces, those joining the reserve tank and main tank No. 1 cells being connected to a common vent pipe passing rearwards over the starboard cells to join the main vent manifold in the rear servicing loft. Vent pipes from main tank No. 2 and 3 cells include float-type vent valves and are routed independently to the rear to join the main duct. The vent pipe connecting the two transfer tank cells is connected to the main vent manifold by ducting running forward along the roof on the port side, the joint being aft of the port and starboard vent junctions and forward of the manifold bifurcation embodying vent valves. The manifold bifurcation embodies two pressure relief vent valves, each by-passed by a pipe embodying an inward relief valve, all rejoining to form the main vent trunk running aft to exhaust to atmosphere via a flame trap in the fuselage underskin at Stn.1020.

20. An additional pipe, joining the transfer tank vent pipe and main vent trunk, by-

passes the vent and inward relief valves and has a 'P' type cock fitted to it as a means of releasing vent system pressure and draining fuel or water as necessary. The main vent ducting has four expansion joints (at Stn.425—437, 509—520, 520—528 and 596—607), the glass-cloth laminate vent trunk being supported in clamps lined with felt strip, and attached to the roof. It is important that the clamps are not tightened more than is just sufficient to retain the felt packing strips in contact with the tank.

21. In addition to the fuselage tank venting, two vent pipes extend from each pump housing to the fuselage tank No. 2 cells, each pipe having a non-return valve. The function of these valves is to close the passage to the tank system when defuelling is in progress and thus prevent air being admitted from the vent system to break down the suction by which the fuel is removed.

22. The cells of each wing tank (*fig. 7*) are vented together externally, the main vent ducts for each tank being inside the cells and leading towards the wing to unite in No. 2 tank outboard cell as a common vent terminating in a rearward outlet at the wing tip. The outer vent piping embodies a vent valve, which is by-passed by an inward relief valve and a 'P' type cock, the latter for pressure release and vent system draining. Float vent valves connected to the vent pipes are fitted in both cells of No. 1 tank and cells No. 1 and 3 of No. 2 tank; emergency relief valves, in the main vent pipes in No. 1 cell of No. 1 tank and No. 2 cell of No. 2 tank, operate only if the cut-off valve fails during refuelling.

23. To prevent cell collapse as the fuel is used, all fuselage and wing tanks, excluding the underwing tanks can be pressurized with either air or nitrogen. Nitrogen will not normally be used except in operational con-

ditions, engine air supply being used from all four engines after passing through pressure reducing valves which, in conjunction with the vent valves, maintain the tanks at the desired 0.9 to 1.2 lb/in² pressure. The nitrogen and air systems are complementary to each other and use the same reducing valves; if nitrogen is used it will feed the tanks until the supply is exhausted, after which air supply will automatically take over.

Nitrogen and air systems (fig. 6 and 7)

24. There are three independent nitrogen systems, viz., a fuselage system (*fig. 6*) and one for each main plane (*fig. 7*), all three being charged from a common point in the starboard forward servicing bay where pressure gauges, master cocks and a test panel are housed. Underwing tanks, being independently supplied and operated, are not catered for in these systems (*App. 2*).

25. For the fuselage tanks the supply is held in five 2,250-litre bottles (this number being increased for alternative roles) at a storage pressure of 1,800 lb/in² and is divided into units of two and three bottles, each unit controlled by a master cock and having a test point and non-return valves, and both uniting to form a common supply to five pressure-reducing valves in the rear servicing bay. Each pressure-reducing valve is connected to an emergency pressure-relief valve which will release into the main vent manifold should tank pressure be exceeded, the two port and two starboard reducing valve normal outlets connecting with a non-return valve before joining the main vent manifold forward of the vent. The remaining port pressure-reducing valve outlet is taken to a non-return valve and then to the transfer tank vent line. All reducing valves are connected to the main vent manifold by small-bore sensing lines.

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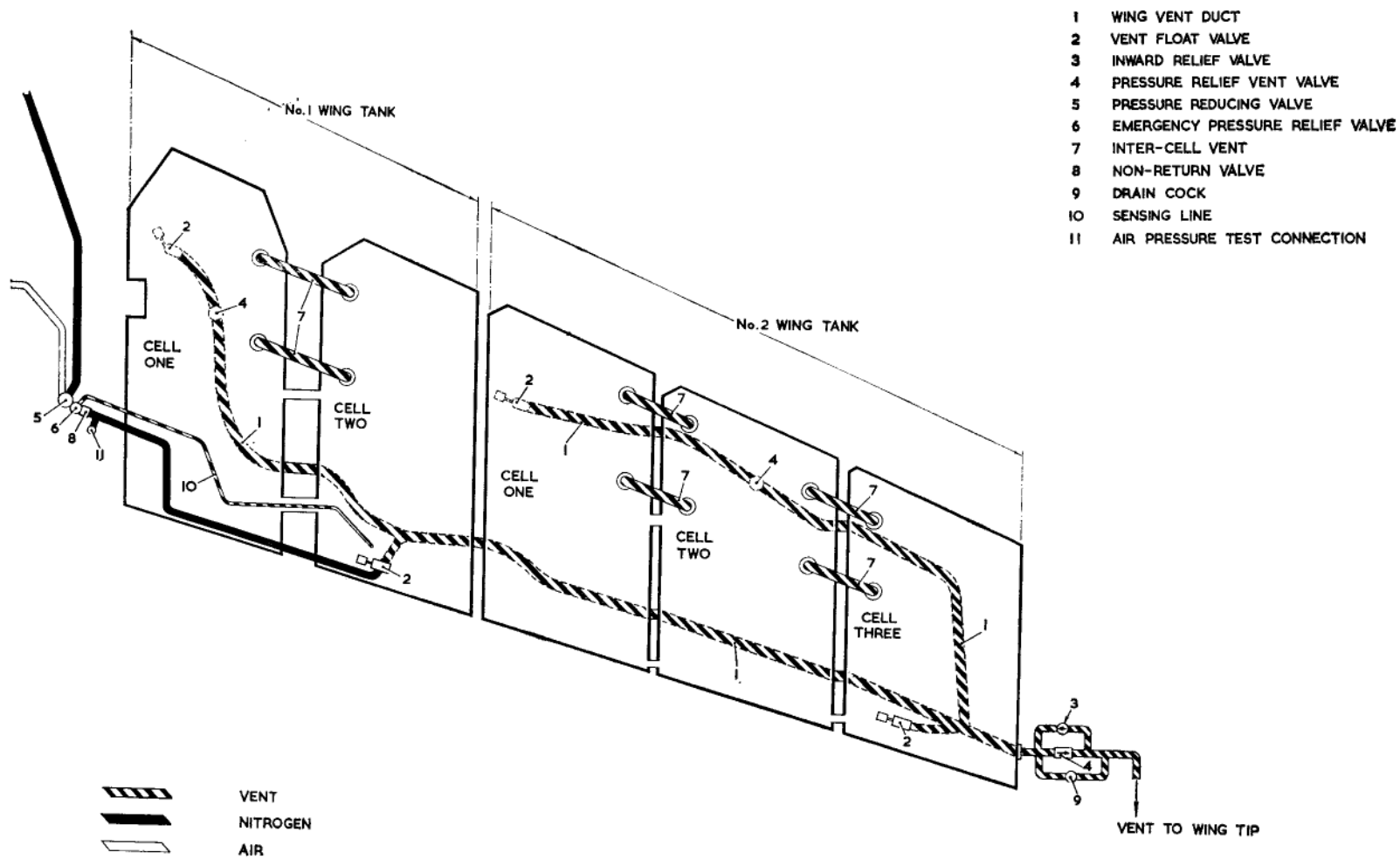


Fig. 7. Main plane fuel system pressurizing and venting diagram

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26. Each independent wing system is served from a single bottle in the starboard forward servicing bay, a pressure gauge, test point and master cock being in the line to a pressure reducing valve outboard of the wheel well. Nitrogen from the reducing valve passes across the head of an emergency pressure-relief valve and via a non-return valve to the vent float housing in No. 1 wing tank outboard cell; a small-bore sensing line connects the reducing valve and main vent duct.

27. Air is normally used to maintain fuel tank pressure and is tapped from each engine low pressure stage. After passing through non-return valves, the two pipes in each installation unite to form a single supply in which a test point is included. The port supply serves the three pressure-reducing valves (*fig. 9*) in the port rear servicing bay and the valve in the port wing, the starboard serving the two pressure-reducing valves in the starboard rear servicing bay and the valve in the starboard wing. A tapping is taken from both port and starboard supplies to pressurize the recuperator on that side, air first passing through a pressure-reducing valve.

28. When the engines are running, air will always be present at the pressure-reducing valves and will take over automatically when the nitrogen system is exhausted or inoperative, an emergency relief valve ensuring that a safe tank pressure is not exceeded. Desiccators are fitted between the pressure reducing valve outlets and the head of each emergency pressure relief valve with the object of removing moisture accumulation by absorption. These consist of glass-cloth bags containing Silica-gel and Cobalt Nitrate, housed in gauze-covered tubes which are threaded at one end and screw into adapters in the pipes. The Silica-gel absorbs the moisture and the Cobalt Nitrate

acts as an indicator, being blue when the mixture is dry and gradually changing colour as the moisture content rises until at saturation point it is pink. The indicator condition can be checked through an inspection window at the desiccator outer end.

B/PR Mk. 1 system

General layout (*fig. 1*)

29. In this type the basic (bomber) fuel system can be supplemented by a metal tank fitted in the bomb bay (*App. 3*), fuel from it being pumped by its self-contained pumps into the reserve tank and main tank No. 1 cells common refuelling line in a manner similar to that used for the transfer tank (*fig. 1, line (B)*). The tank contains two electrically-operated pumps individually controlled from a switch (on the fuel control panel) marked MAIN and AUXILIARY, the later position controlling the stand-by pump introduced by Mod.2444 and 2473 for use in event of normal tank pump failure. Only one low pressure warning lamp is provided, the low pressure switch operating at 4 lb/in² being in the fuel supply line and giving indication of pump failure or tank empty condition.

30. If the condition is tank empty, the red warning lamp will remain on until the control switch is selected OFF. If it should be due to pump failure the pressure will drop to bring the warning lamp on but, when the stand-by pump is selected, the circuit will be switched over and the lamp will go out as the standby pump comes into operation and remain out until the tank is empty. When the bomb bay tank is switched ON, the reserve tank and main tank No. 1 cell float valve circuits are energized and the refuelling valves will open to permit fuel transfer when the level falls. Each pump is fitted with a water drain valve and a gland drain. Although two contents gauge tank units are

provided for the bomb bay tank, they are not connected to fuel gauges when the tank is fitted purely for this role; they will however be connected when the aircraft is converted to PR role.

Refuelling and defuelling

31. Bomb bay tank refuelling is carried out from the fuselage port connection, and is controlled by a float-operated switch, in series with the selector, and a cut-off valve inside the tank. Defuelling from the same connection is similar to the method employed for the transfer tank (*para. 16*), fuel being passed through the booster pump and common line to the refuelling/defuelling box. The pipeline embodies a positive lock non-return valve which permits isolation if required.

Venting and pressurizing

32. There is no engine air supply to the bomb bay tank and, as in the case of underwing tanks, nitrogen is used for pressurizing and must be turned ON before take-off. An extra nitrogen bottle is added to the fuselage bank and a tapping taken off the nitrogen line on the fuselage starboard side to supply the bomb bay tank pressure-reducing valve. This valve outlet to the tank embodies a non-return valve and is connected to the reducing valve by a small-bore sensing line. An independent vent system with inward and outward vent valves is used, connecting the tank directly to and exhausting with the main fuselage system.

B/K Mk. 1 and B/K/PR Mk. 1 systems

Introduction

33. Except for addition of underwing tanks to the basic system and a bomb bay tank as fitted in the B/PR Mk. 1, no additional fuel-carrying capacity is added to these aircraft

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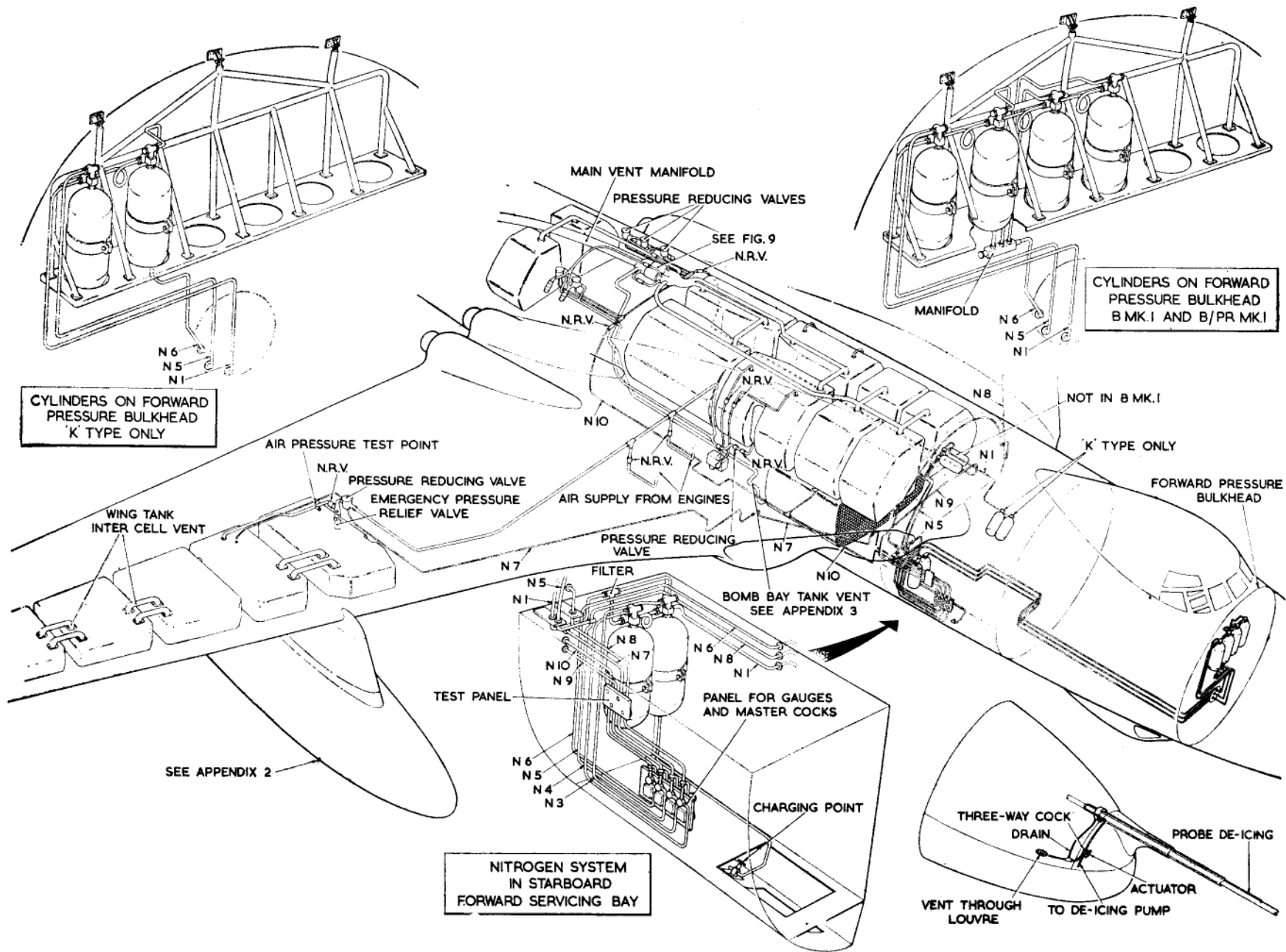


Fig. 8. Pressurizing and venting system

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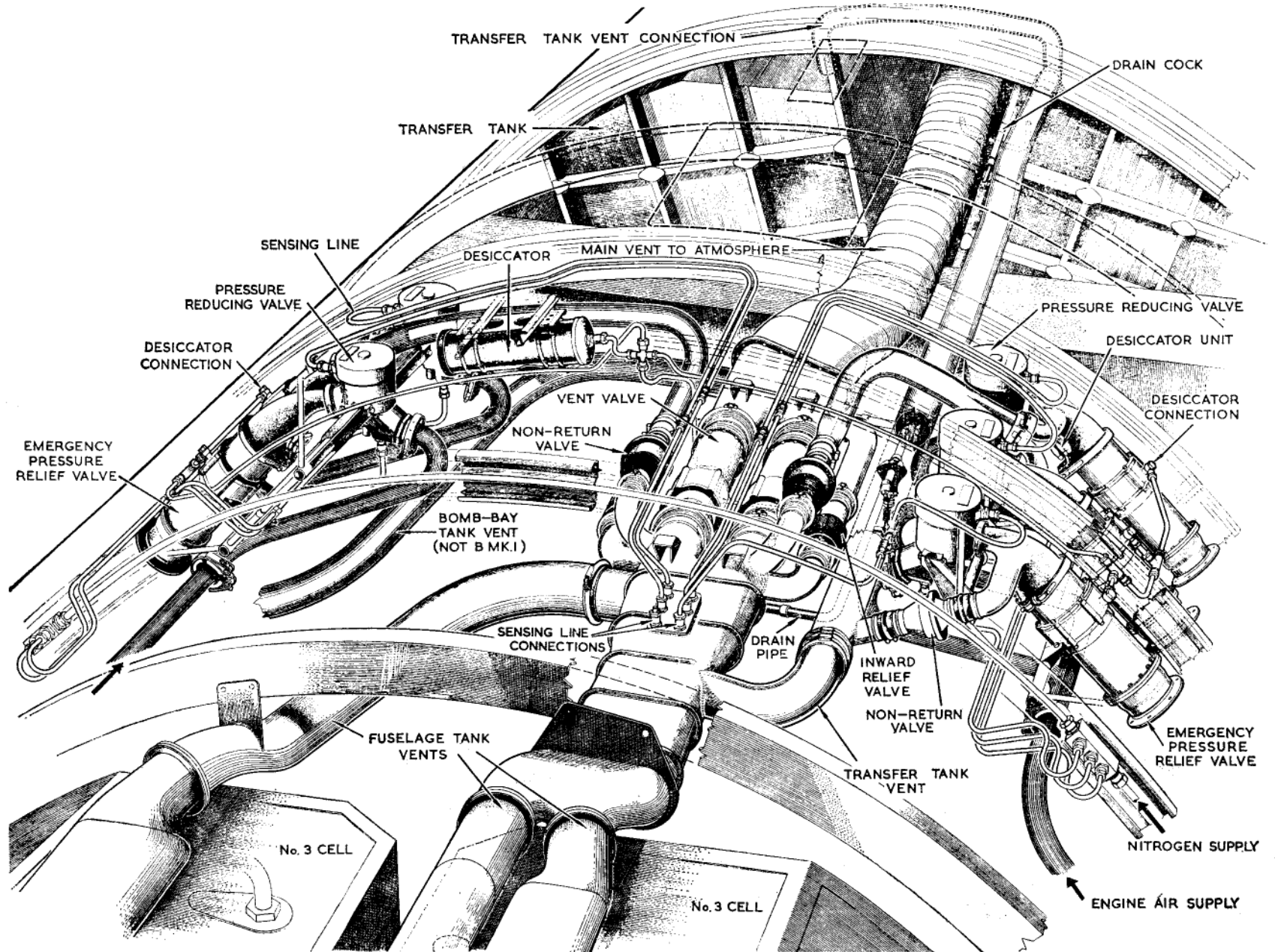


Fig. 9. Fuselage reducing and relief valve assembly

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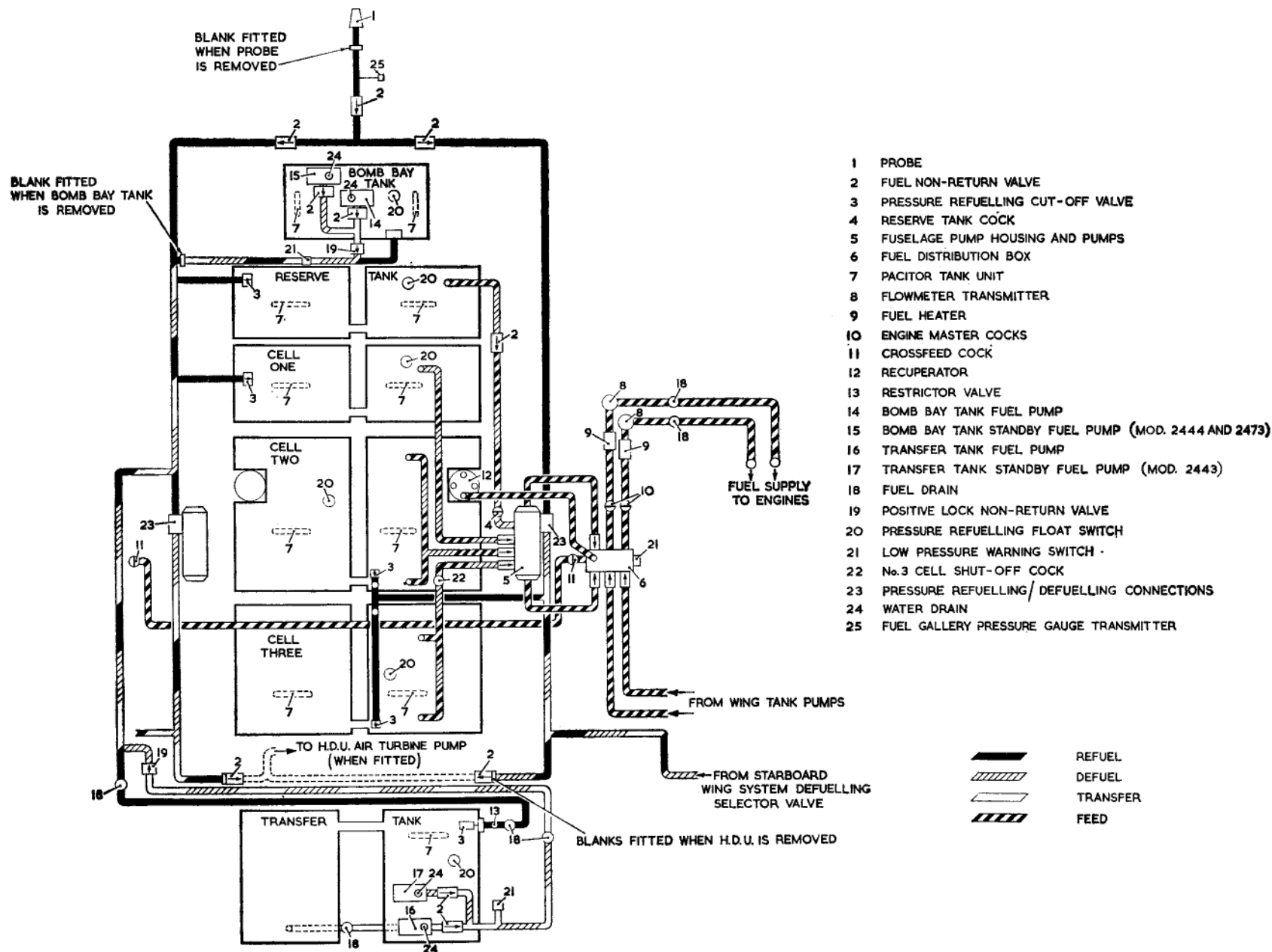


Fig. 10. Fuselage fuel system diagram — B/K Mk. 1 and B/K/PR Mk. 1 (Receiver)

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types. The aircraft fuel systems are modified to enable aircraft to be refuelled in flight, whilst in the tanker role, flight refuelling equipment is fitted in the bomb bay and the system modified to enable part of the fuel load to be transferred whilst the aircraft is in flight (Sect. 2, Chap. 6).

Receiver role (fig. 10 and 11)

34. The alteration is applicable to all 'K' type aircraft and consists of fitting a fuel-receiving probe projecting forward through the nose scanner bonnet, together with the necessary non-return valves and piping to conduct the incoming fuel to the fuselage and wing tank systems. It is not essential for the probe (introduced by Mod. 2012) to remain fitted to aircraft not in use as refuelling-in-flight receivers.

35. The probe (fig. 14) is a length of shrouded fuel pipe fitted with a reception nozzle having an independent de-icing and vent system, and also a fuel pressure gauge (Mod.2684) tapped into the probe fuel pipe to give independent indication of fuel reception to the receiver pilot. The de-icing and vent system is self-contained, consisting of a 1-gall. fluid tank, electrically-operated de-icing pump, electrically-actuated three-way cock, and pipelines terminating in a jet at the probe nozzle assembly; the whole is controlled by a switch on the starboard coaming panel. When switched ON it operates both the pump and cock, causing fluid to be passed to the nozzle where it emerges from a ball valve and is spread over the probe contact face by the airflow. When switched OFF, the pump is switched off and the three-way cock is moved to vent the probe system to atmosphere through a port in the radome starboard side. In the scanner housing, water and fuel draining from the pipe connections passes to atmosphere at the fuselage outer skin. The probe and reception

coupling for in-flight refuelling contact are described in A.P.4611, Vol. 1 and 6.

36. From the probe a fuel line, in which there is a non-return valve and a fuel pressure transmitter, passes outside the pressure cabin port side and enters the fuselage immediately aft of the rear bulkhead where it bifurcates to pass through the port and starboard servicing bays; a non-return valve is included in each pipeline. The pipes are blanked off in the rear servicing bay to form a 3 in. ring main (fig. 12 and 13) connecting all fuselage tanks, branch pipes from it passing to each inner plane to be ducted under the engine jet pipes and carried outboard aft of the outer plane rear spar to connect with each wing system selector valve. The ducts under the jet pipes are fire-proof and drained to atmosphere.

Refuelling the tanker/receiver (fig. 10 and 11)

37. In the receiver and tanker roles, wing connections have been deleted and all ground refuelling and defuelling is carried out from the fuselage connections, the bomb bay tank being refuelled from the port connection. Ground refuelling procedure is given in Sect. 2, Chap. 2. Restricters in all refuelling lines, except those serving the bomb bay and underwing tank, prevent damage during ground refuelling and ensure that all tanks are replenished evenly when refuelled in flight. When ground refuelling, delivery is at 51 lb/in², the starboard refuelling connection accepting fuel at approx. 280 gall. per min. and the port at approx. 330. In the receiver role, the bomb bay tank fuel contents gauge units are connected and operative but, although on the refuelling-in-flight panel the state of both bomb bay and transfer tanks could be read if switched on, they will be switched to PILOT at this position in this role, and are served by only one selector switch

on the pilots' fuel panel, giving an indication only for the tank selected.

38. When refuelling in flight, the tanker aircraft equipment is capable of feeding the probe at the rate of 500 gall. per min. at 50 lb/in² pressure; a pressure drop of approx. 15 lb/in² will occur across the refuelling coupling and probe nozzle due to restriction, thereafter the fuel being fed into all tanks via the piping described in para. 36. The probe pressure gauge mounted on the pilots' starboard quarter panel and giving indication of receiving, will register a pressure of approx. 25 lb/in² when all tanks are receiving, rising to a surge pressure of 50 to 55 lb/in² as the tanks reach their maximum fuel level. The refuelling valve selector switches for each tank and an eleven-lamp TANKS FULL indicator are positioned on the starboard coaming panel. When ON is selected, the refuelling valve circuit in the selected tank is energized and the relevant lamp in the TANKS FULL indicator will come on and remain on until the tank is full and the float switch breaks the circuit to the refuelling valve solenoid, the valve automatically closing and the lamp going out.

39. When the tanks are full or the required quantity has been taken in, the selector switches must be set to OFF. If this is not done, a tank becoming partially empty will allow the float switch to complete the circuit to its refuelling valve and cause a fuel feedback during transfer operations. The bomb bay and transfer tank float switches are wired in parallel, one indicator lamp representing both tanks; the TANKS FULL indicators for the fuselage tank No. 1 cells and the reserve tank will also operate whenever fuel is transferred from the bomb bay and transfer tanks.

Defuelling the receiver aircraft (fig. 10 and 11)

40. Ground defuelling for aircraft fitted in

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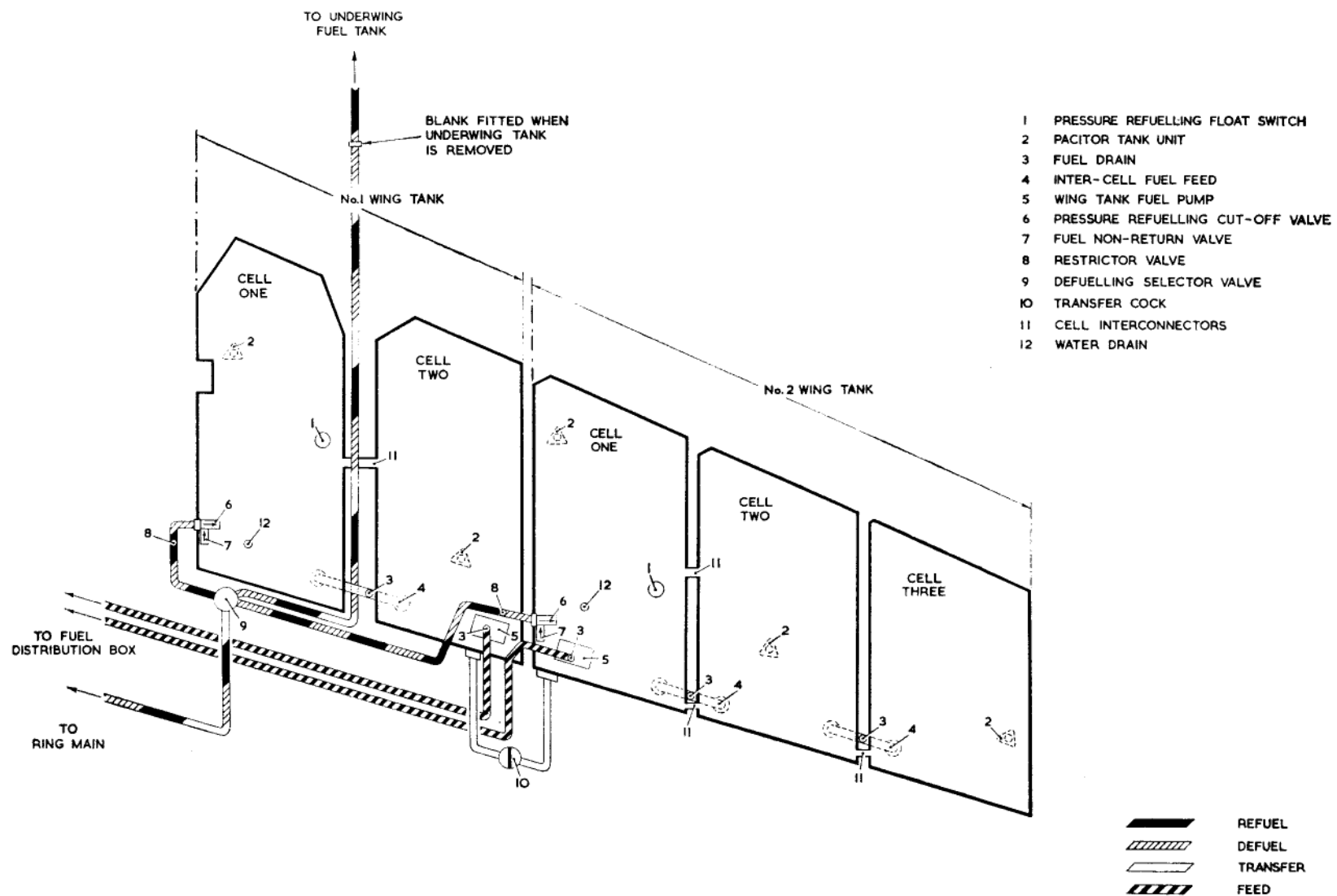


Fig. 11. Main plane fuel system diagram — B/K Mk. 1 and B/K/PR Mk. 1

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the receiver (and tanker) role is carried out from the fuselage refuelling/defuelling points only, fuel from the wing and underwing tanks being fed to the wing selector valves and thence to the fuselage connections via the 3 in. ring main. To defuel the wing and underwing tanks it will be necessary to remove the access panels at the wing tank fuel selector valve positions, pull the selector levers down to their fullest extent and make selection as required, finally returning the selectors to FLIGHT before pushing home the levers and replacing the panels. When defuelling is to be carried out and wing fuel is not to be removed, the panel must be opened and the selector moved to SHUT before defuelling commences, returning the selector to FLIGHT and replacing the panel on completion. All other selection is made at the fuselage defuelling points, but it should be noted that whatever selection may be made at the port point, the bomb bay and transfer tanks will be emptied if the positive-lock non-return valves in the pipelines to these tanks have not been moved to the LOCKED SHUT position. For defuelling procedure and tank sequence refer to Sect. 2, Chap. 2.

Tanker aircraft (fig. 15 and 16)

41. Aircraft used in the tanker role are fitted with special equipment to facilitate fuel transfer to another aircraft whilst in flight (Sect. 2, Chap. 6) and the fuel system is modified to enable the transferable load to be isolated from the fuel required by the tanker aircraft. In this role, fuel in the wing tanks, fuselage No. 1 and 2 cells and the reserve tanks, is reserved for tanker consumption, the transferable load being carried in both underwing tanks, fuselage No. 3 cells, bomb bay and transfer tanks.

42. If necessary, the pilot may transfer underwing tank fuel to the wing tanks by

selecting the underwing tank switches on the pilots' control panel either to MOTOR ON, which switches on the tank pump and transfers fuel in the low pressure condition, or in the event of pump failure to MOTOR TRIP—EMERGENCY ON which utilizes the high pressure nitrogen system to transfer the fuel. These switches override those on the operator's panel and energize the wing tank float switches, but the pilots' underwing tank contents gauges will not operate unless the pilot/operator switches on the operator's panel are selected to PILOT. Whichever is used, the motors must always be tripped and the switches returned to OFF on completion of fuel transfer. Similarly, the pilot also has access to the fuel in the bomb bay and transfer tanks by selecting the relevant switches, but unless the pilot/operator switches on the operator's panel are selected to PILOT, the contents cannot be read on the pilots' fuel panel gauges.

43. An isolating cock, fitted in the fuel lines connecting fuselage No. 3 cells to the pump housings, is closed when the aircraft operates as a tanker and has the pilot/operator switch on the operator's control panel selected to OPERATOR. It is important that the cock is reopened if the aircraft reverts to bomber or PR role, and for this reason the electrical circuit embraces a safety measure which ensures that when the operator's panel is removed, the cock will be opened as soon as the aircraft electrical system is made live.

44. The fuel system major alterations are as follows:—

- (1) The bomb bay tank forward auxiliary electrical booster pump (fitted by Mod.2473) is replaced by an air turbine pump, leaving the remaining electrical pump still in circuit with the pilots' control panel.

- (2) An air turbine pump is fitted in each cell of main tank No. 3 and in each transfer tank cell.
- (3) The transfer tank electrical booster pump (introduced by Mod.2443) is removed; the other pump remains and is in circuit from the pilots' control panel if required.
- (4) Piping is installed and secured to the bomb-bay roof to connect the tanks containing all transferable fuel to the hose drum unit (H.D.U.).

Note . . .

The air turbine pumps, controlled from the operator's panel by START and STOP switches, can be operated only when the switches are set to OPERATOR, the bomb doors are OPEN and the master switch is ON.

45. With the operator's panel master switch selected ON and the six pilot/operator switches selected to OPERATOR, the isolating cocks in the pipelines between the No. 3 cells and the pump housings will be closed, the fuel gauges for the tanks carrying transferable fuel will be isolated (making the pilots' totalizing fuel tank gauges total on No. 1 and 2 cells only) and the control panel gauges operated. All other functional circuits, i.e. those controlling transfer pump switches and H.D.U. operation, will remain inoperative until the bomb bay doors are fully opened under normal method of operation to operate two microswitches and energize all circuits. This will permit turbine pump operation by engine compressor air from the tail plane de-icing ducting, underwing tank pressurization to the high pressure condition when selected, and the refuelling hose to be trailed by using the trail/wind switch selection. With the hose trailed, the bomb door closing circuit is broken and the doors cannot be closed until the hose has been wound fully in and stowed.

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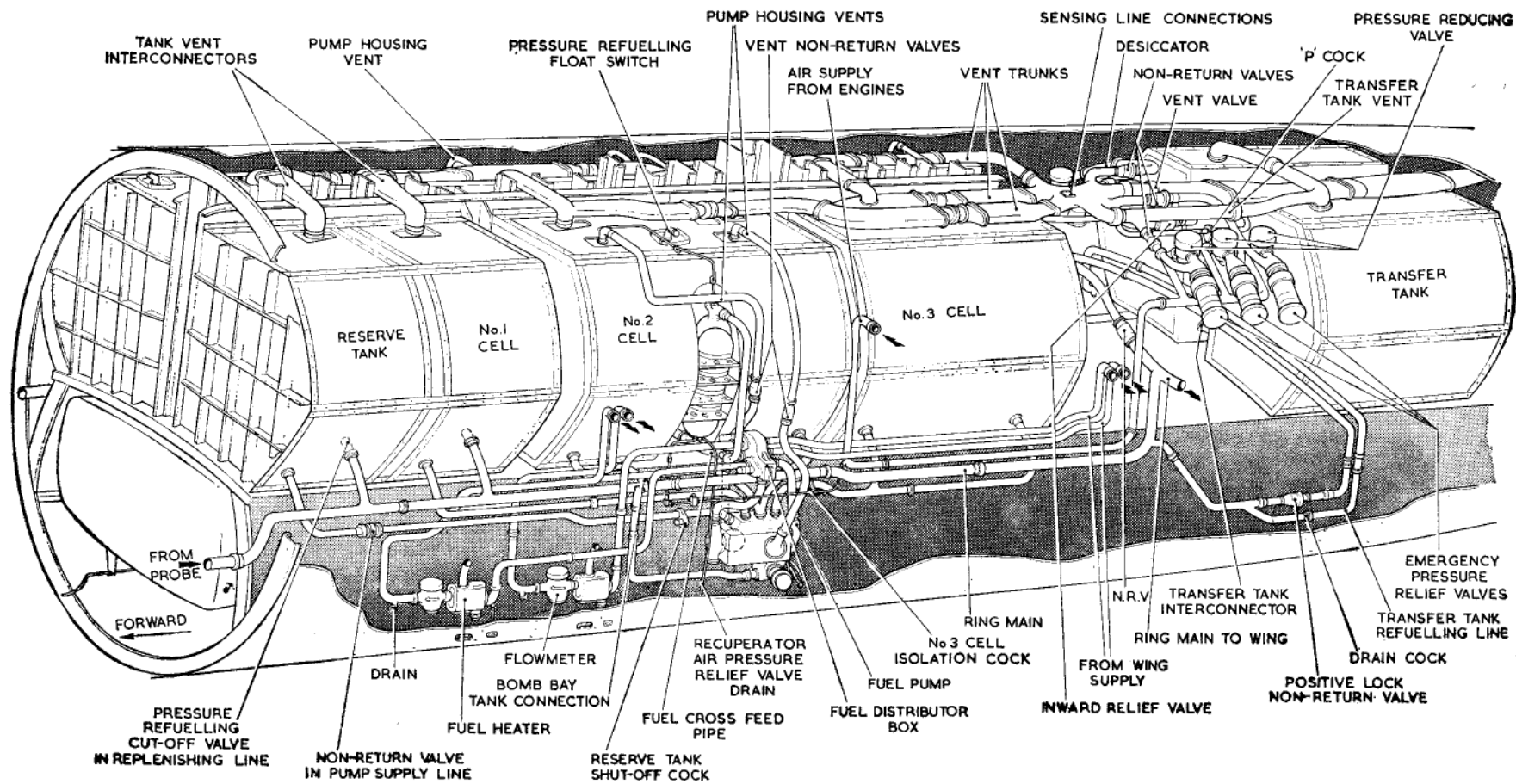


Fig. 12. B/K Mk. 1 and B/K/PR Mk. 1 fuselage fuel system, port side

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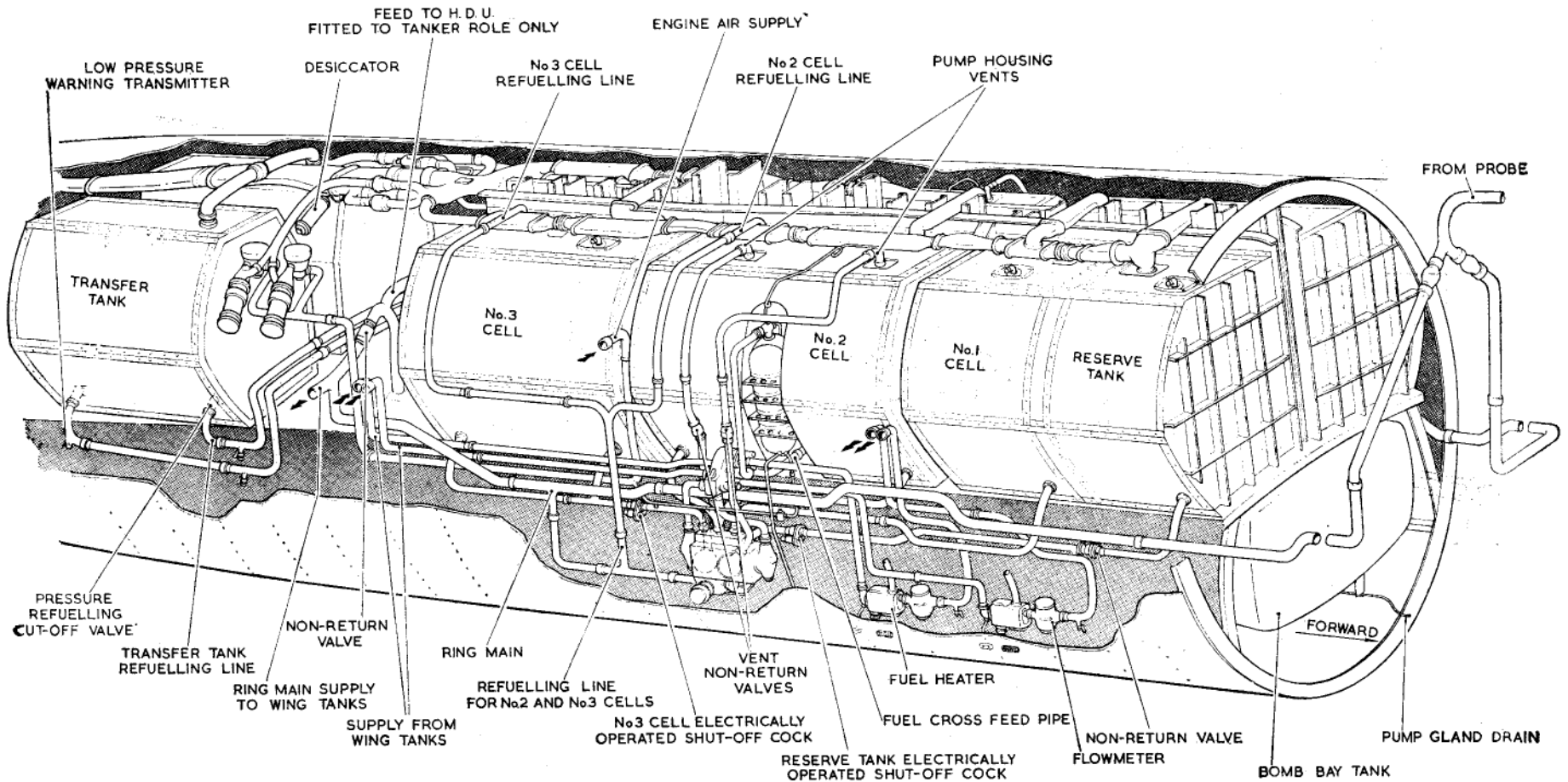


Fig. 13. B/K Mk. 1 and B/K/PR Mk. 1 fuselage fuel system, starboard side

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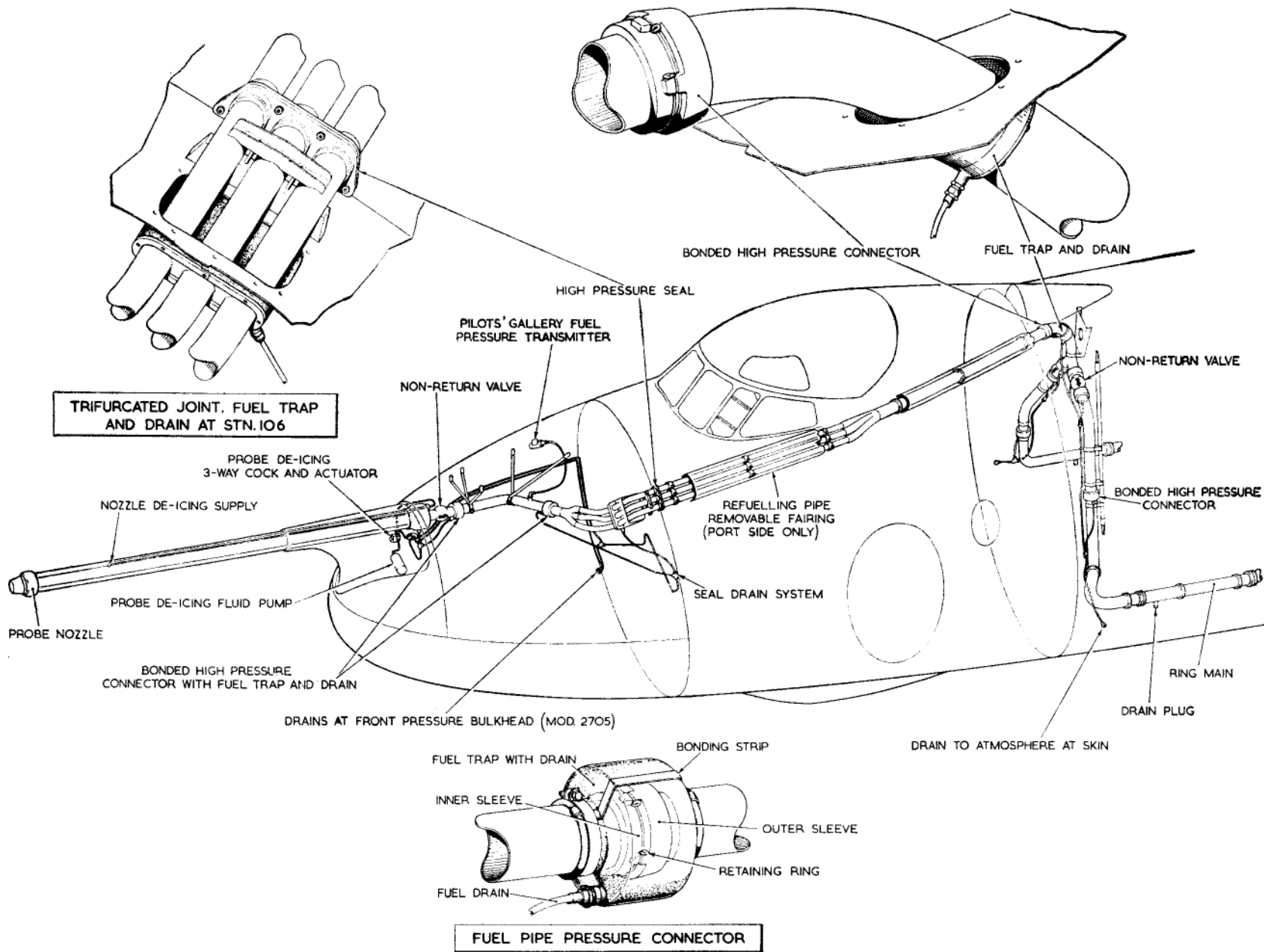


Fig 14. B/K Mk. 1 and B/K/PR Mk. 1 probe system

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46. The H.D.U. and its method of operation and control are described in A.P.4611, Vol. 1. When the signal lamps indicate that contact has been made with the receiver aircraft, by operating the air turbine pumps through the control panel START push switches, fuel can be boosted to the H.D.U. air turbine pump via the bomb bay roof piping. Alternatively, fuel from the underwing tanks can be fed on selection by the tanks electrical pumps, assisted by nitrogen at a pressure of $7\frac{1}{2}$ lb/in², and will pass via the wing selector valve to the 3 in. ring main and thence to the H.D.U.; transfer in this manner does not energize the wing tank float switches as in normal transfer.

47. Whilst the underwing tank fuel is normally transferred to the H.D.U. by a combination of tank pump and nitrogen pressure, should the tanker aircraft need to use the fuel it can be transferred to the wing tanks by using the tank electric pump only, provided that the pilots' control switch is used to override the operator's panel. Similarly, the booster pumps in the bomb bay and transfer tanks are still connected to the pilots' control panel but are operated only in emergency.

48. When using air turbine pumps to transfer fuel it will be found that the amount of unusable fuel will be increased above normal by, or even in excess of:—

Auxiliary tank	40 lb
Fuselage No. 3 cell	240 lb per side
Transfer tank	240 lb per side
Underwing tanks	80 lb each

The increased quantities arise from a combination of higher transfer rate coupled with the use of large bore piping in the transfer system, resulting in considerable reduction

in back pressure and a rapid fall-off in delivery pressure; in consequence, when the pressure switches trip at 8 lb/in² to break the circuits and stop the air turbine pumps, more fuel remains in the tanks concerned than would be the case under normal fuel system operation. An additional reason for rapid pressure drop will be the condition occurring in the underwing tanks towards the end of fuel transfer from them; the nitrogen bottles will be approaching exhaustion, making the delivery weaker and back pressure in the whole system considerably lower.

49. The residual fuel is not entirely lost for use on completion of in-flight refuelling since it is possible to feed this fuel to the tanker engines by setting the pilot/operator switches to PILOT and using the normal electric booster pumps by pilots' control panel selection.

Defuelling the tanker aircraft

50. Defuelling operations on tanker aircraft follow the procedure used on receivers provided that No. 3 cell shut-off cock is opened, the operation being carried out from the fuselage refuelling/defuelling points. This will not affect the fuel trapped in the H.D.U. and the main fuel supply manifold downstream from the non-return valves in the supply lines from the tanks; this fuel must be drained via the drain cock in the H.D.U. air turbine pump casing. Alternatively, hose drum and transfer hose, or complete transfer system draining can be achieved as described in para. 51 and 52.

51. If it is necessary to drain the hose drum and hose, ensure that the fuel valve in the supply manifold is shut in order to isolate the supply lines and tanks. Closing the fuel valve will automatically open the vent valve to vent the hose and drum to atmosphere

via the bomb bay tank vent system. By using the special defuelling adapter (A.P. 4611, Vol. 1, Part 2, Sect. 1, Chap. 1) attached to the defuelling pump hose line and inserted into the reception coupling at the drogue, the fuel in the hose and drum up to the fuel valve can be sucked out, it being unnecessary to unwind the hose from the drum unless subsequent operations will require this action.

52. The complete fuel transfer system can be defuelled by this same method if the fuel valve is opened; alternatively, draining can be effected by attaching a defuelling hose to the adapter in the branch fuel line joining the main fuel supply manifold upstream of the fuel valve at the H.D.U. With the H.D.U. fuel valve open, the complete transfer system can be drained, fuel being sucked to the main supply manifold from the tanks via the pumps, pipelines and non-return valves, to be drawn off together with all fuel in the H.D.U. and transfer hose. All residual fuel in the lines at the time that suction breaks down must be drained via the H.D.U. air turbine casing drain cock.

SERVICING

Flow tests for all types (fig. 17)

53. During flow tests aircraft are to be in rigging position (Sect. 2, Chap. 4) and both 28v and 112v external power supplies are to be available for both indicator and pump operation. Disconnect the engine fuel supply lines at the engine forward bulkhead and from this point connect the fuel system to a receptacle or rig capable of receiving the fuel passed during test, ensuring that the flowmeters are not by-passed. Connect an external air supply at 40 lb/in² pressure into the fuel system pressure lines at the engine supply points (1), together with a suitable gauge to record pressure readings.

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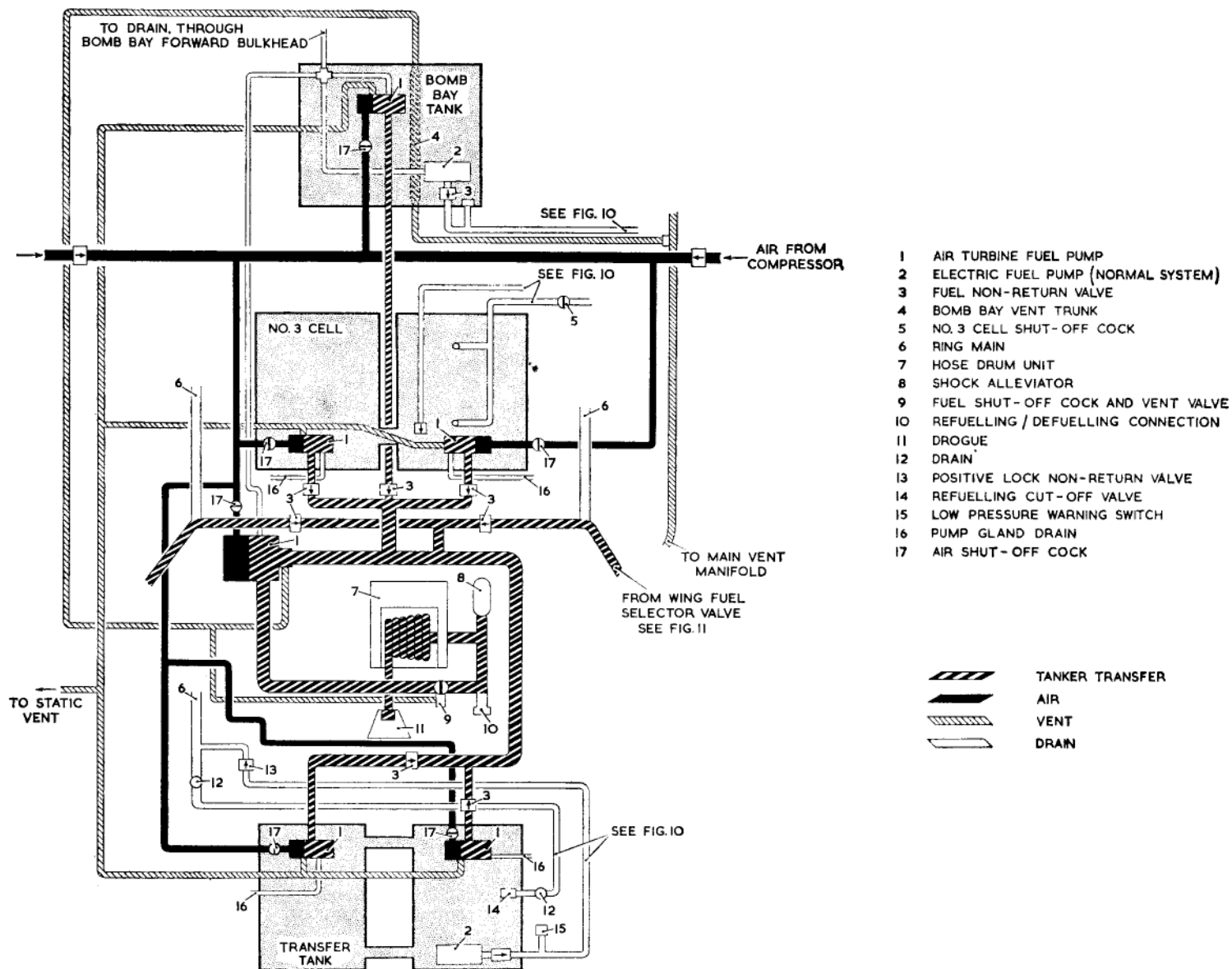


Fig. 15. B/K Mk. 1 and B/K/PR Mk. 1 fuel system — Tanker role

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Test 1 — Checking free flow from each pump to engines.

54. Ensure that the following amounts of fuel are available in the tanks:—

No. 2 fuselage tank cells	200 gall. each cell
No. 1 wing tanks	75 gall. each tank
No. 2 wing tanks	75 gall. each tank

Release the air in the tanks by opening the vent system cocks at the wing tip vents (2) and in the transfer tank system (3). Close the crossfeed cocks and open the master cock on the selected engine system. Switch on each pump in turn and check that the minimum delivery is 8 gall. in 20 seconds. Finally, draw off to a refueller all fuel passed to the receptacle.

Note . . .

There are two crossfeed cocks, each operated by a relay from a common switch. There is only one indicator, OPEN being indicated only when both cocks are open.

Test 2 — Checking transfer tank free flow

55. With 200 gall. of fuel in the transfer tank, ensure that all refuelling valves are switched off. Disconnect the valves in the reserve tank and No. 1 fuselage tank cells after opening the transfer tank vent cock at (3) to release all air from the tanks. To the fuselage port refuelling coupling fit the drain adapter, switch ON the transfer tank pump and check that the flow is not less than 20 gall. in 40 seconds.

Test 3 — Checking transfer tank flow to fuselage tanks

56. With 200 gall. of fuel in the transfer tank and 150 gall. in each reserve tank cell, ensure that all refuelling valves are switched

off. Electrically disconnect No. 1 fuselage tank refuelling valve and check the contents gauge reading for the reserve tank. Switch ON the transfer tank pump and check that the rate of flow is not less than 20 gall. per minute.

Test 4 — Checking transfer tank positive lock non-return valve

57. When the valve is LOCKED shut, with the handle facing outboard, there must be no flow when the transfer tank fuel pump switch is ON.

Test 5 — Checking recuperator operation

58. If No. 2 tank has been removed, its replacement is not essential for this test; the reserve tank should be full and all other tanks either empty or with supply lines isolated. To check the recuperator:—

- (1) To one bulkhead engine supply line connect a flexible hose to receive and transfer to a receptacle all fuel passed during the test.
- (2) Blank off the recuperator bleed line at (4) and select 'R' on the fuel pump housing non-return valve selector.
- (3) To the recuperator air supply line at (5) upstream of the pressure reducing valve, apply external air pressure at 40 lb/in².
- (4) With the engine master cocks CLOSED and the reserve tank cock OPEN, switch on one fuselage fuel pump and allow it to run for 3 minutes.
- (5) Switch the fuel pump OFF, OPEN the engine master cock in the line selected for transfer to the container and check that discharge from the recuperator is at least 6 gall. in 30 seconds.

Pressure tests for all types (fig. 17)**Note . . .**

During all pressure system tests it is essential that the air supply is turned on slowly and that pressure is applied gradually and smoothly.

Test 1 — Checking the vent valves

59. Disconnect the pipeline connecting the fuselage starboard pressure-reducing valves to the main vent at (6) and connect in an external air pressure of 40 lb/in². At (7) on the fuselage main vent manifold, fit a 0 to 5 lb/in² pressure gauge to the sensing line connection. Turn on the air supply and check that the tank vent valves operate at a pressure between 1.8 and 2.2 lb/in². Re-make the joint at (6), disconnect the starboard wing supply line at (8) outboard of the emergency pressure relief valve and non-return valve, and connect in the external air supply to check the wing vent valves. Repeat the test for the port wing.

Test 2 — Checking the pressure reducing valve

60. Disconnect the engine air supply from one port and one starboard engine at (1) upstream of the non-return valve and connect in an external supply at 40 lb/in² pressure. Fit pressure gauges (0 to 5 lb/in²) at the main vent sensing connections at (7) and the wing air pressure test connections (9). Blank off the undercarriage lock mechanism heater pipes at (10). To each test point in the starboard servicing bay, connect a dry air bottle charged to 1800 lb/in². Using the following supplies, check the tank pressure to ensure that they are between 0.9 and 1.2 lb/in²:—

- (1) With external 40 lb/in² air supply ON and nitrogen master cocks OFF.

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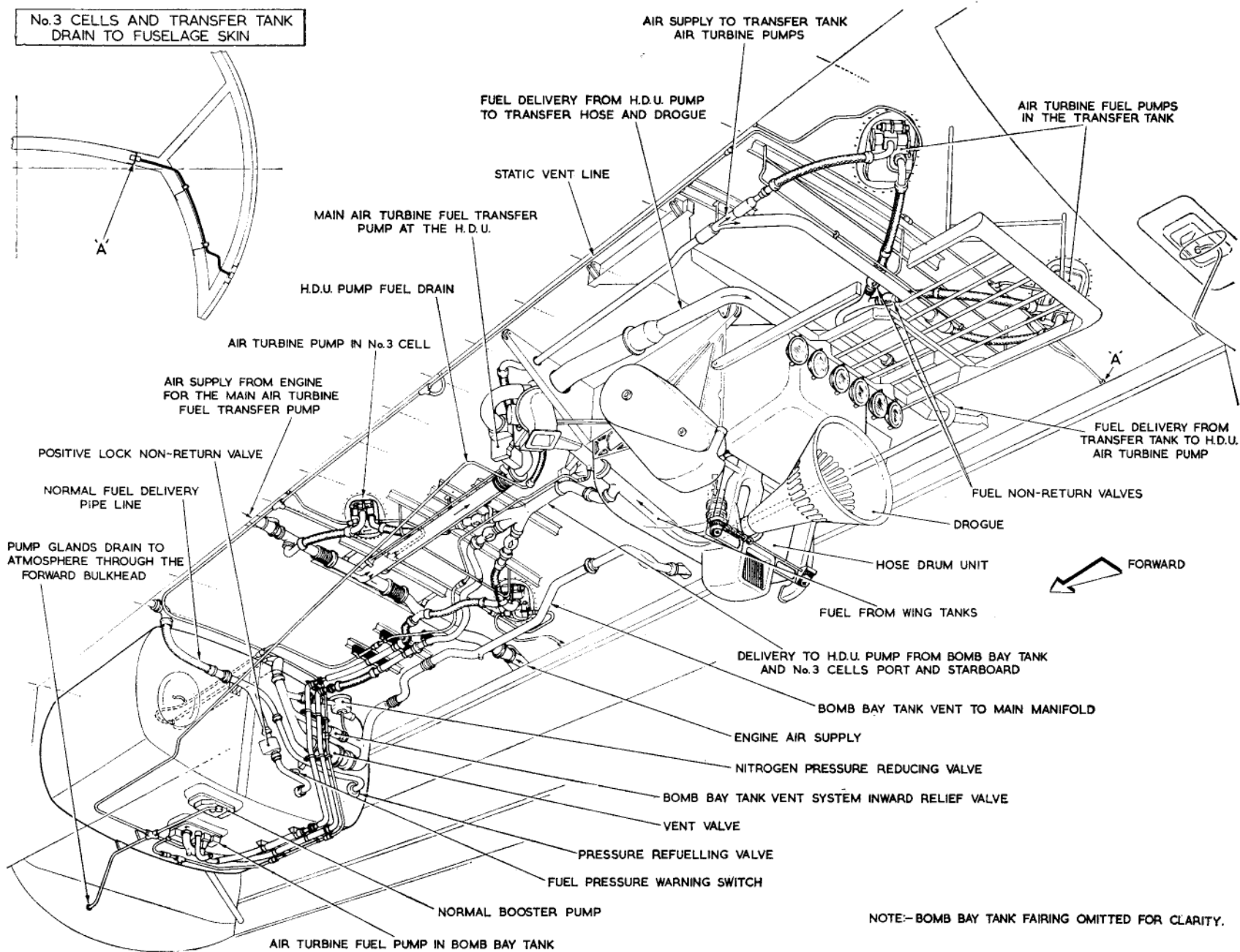


Fig. 16. Bomb bay arrangement—Tanker role

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- (2) With external 40 lb/in² air supply ON and nitrogen master cocks ON.
- (3) With external air supply OFF and nitrogen master cocks ON.

Alternatively, if the nitrogen system has already been tested, test by using dry air bottles charged to 1800 lb/in² and operating the nitrogen master cocks (11) to isolate the feed lines in turn.

Test 3 — Checking the emergency relief valve

61. Equipment requirements are for Test 2. Disconnect the fuselage starboard pressure-reducing valves sensing lines at points (12). Check that tank pressure does not exceed 1.5 to 2.5 lb/in² and that excess air or nitrogen exhausts through the emergency relief valve when:—

- (1) The external air supply is ON and the nitrogen master cocks are OFF.
- (2) The external air supply is OFF and the nitrogen master cocks are ON.

Repeat the tests for the fuselage port system and both wing systems by disconnecting at points (13) and (14) at the fuselage and wing pressure-reducing valves respectively, as required.

Test 4 — Checking the recuperator air supply

62. Equipment requirements as for Test 2. With the external air supply ON, record the starboard recuperator air feed pressure at (15) between the reducing and non-return valves. This should be from 7 to 9 lb/in². Repeat the test on the port recuperator.

Test 5 — Checking the engine component air bleed piping

63. Disconnect and blank off the air lines to the pressure-reducing valves in the fuselage and wing starboard systems at points (16) immediately before each input position. Blank off the undercarriage lock mechanism heater pipe at (10). With 80 lb/in² air pressure applied at the engine connections (1), there must be no leakage. Repeat the test for the port system.

CAPACITY CHECKS AND GAUGE CALIBRATION

64. If through change of fuel tank, gauge etc., tank capacity calibration checks are required, it will be necessary to refer to the procedure for setting up fuel gauges given in Book 3, Sect. 5, Chap. 6 for B Mk. 1 and B/PR Mk. 1, and in Chap. 9 for K type aircraft. In each case the aircraft must be laterally level during the operation, the fuselage datum being 2 deg. nose down in B Mk. 1 and B/PR Mk. 1, and 1½ deg. nose down in K type aircraft.

REFUELLING AND DEFUELLING TESTS (fig. 17)

65. For these tests, connect pressure/suction gauges reading from -1 to +5 lb/in² at (18) in both the port and starboard wing pressure systems, and at (7) on the fuselage main vent manifold.

66. Refuelling and defuelling is to be carried out, using the selective refuelling switches and defuelling valves. For each selection a fuel contents gauge check should be made to ensure that only the selected tank is being refuelled or defuelled. When defuelling fuselage tanks on K type aircraft, the wing defuelling selector valves must be SHUT if fuel is not to be removed from them.

B Mk. 1 and B/PR Mk. 1

Test 1 — Checking tank pressure and refuelling rate

67. Set the refueller to maximum governed r.p.m., select the required tank and record the refuelling rate and tank pressure.

Refuelling rate

150 gall. per min. maximum
120 gall. per min. minimum

Tank pressure

1.8 to 2.2 lb/in²

Note...

If the transfer tank is to be kept empty, ensure that the positive-lock non-return valve is LOCKED SHUT (Sect. 2, Chap. 2).

Test 2 — Checking tank pressure and defuelling rate

68. Apply external air supply at 40 lb/in² at any engine air connection and set the defueller to maximum governed r.p.m. Select the required tank or tanks and record the defuelling rate and tank pressure. If the transfer tank is empty, ensure that the positive lock non-return valve is LOCKED SHUT.

Defuelling rate

75 gall. per min. maximum

Minimum tank pressure

Atmospheric

Test 3 — Checking underwing tank piping

69. Select UNDERWING tank at the wing refuelling/defuelling selector valve and whilst refuelling is in progress check the piping and joints for leaks.

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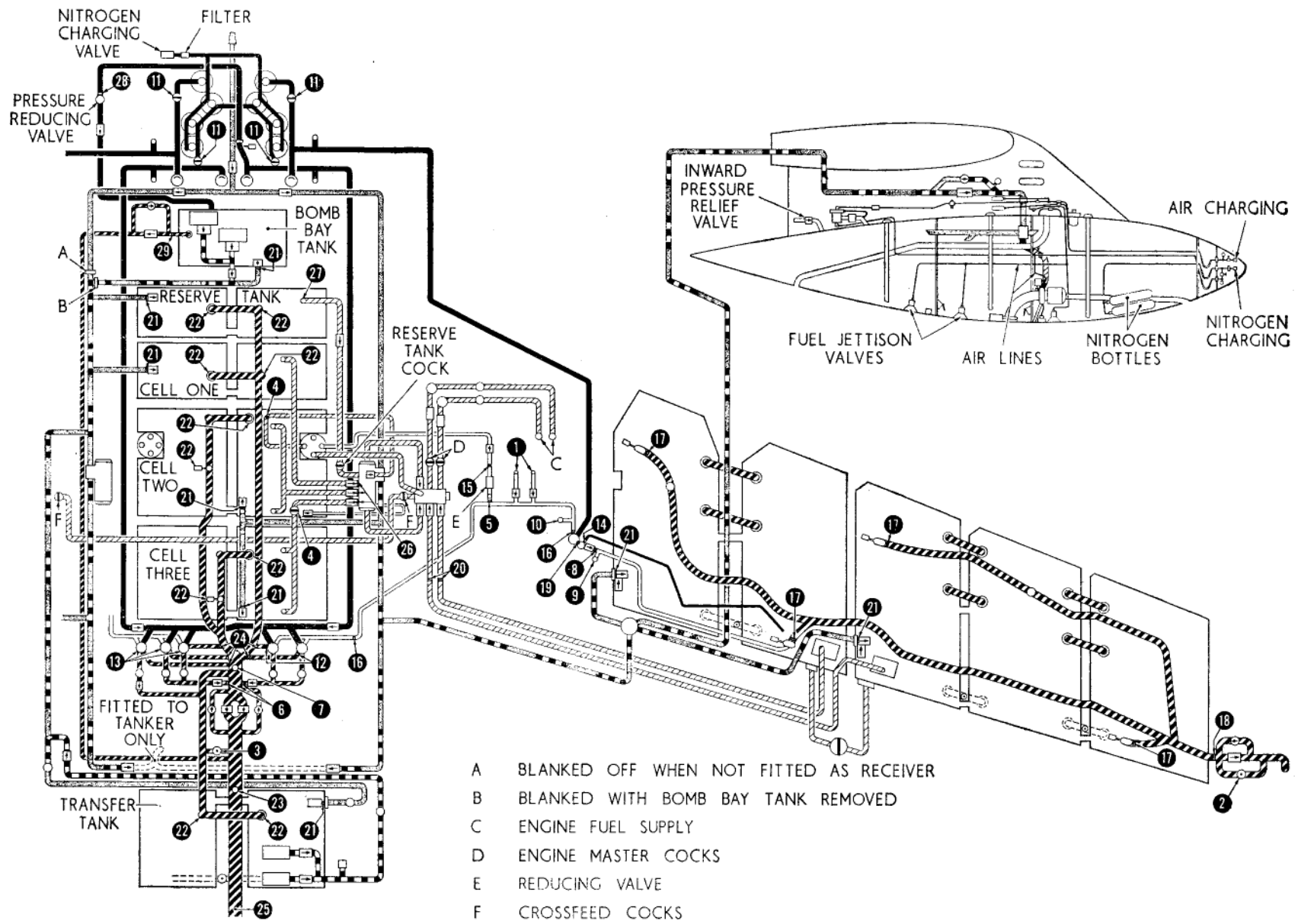


Fig. 17. Fuel system test diagram

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B/K Mk. 1 and B/K/PR Mk. 1

Test 1 — Checking tank pressure and refuelling rate

70. Set the refueller to maximum governed r.p.m., select the tanks in turn and record the refuelling rate and tank pressure as follows:—

Tank pressure
1.8 to 2.2 lb/in²

Refuelling from the starboard ground connection, all quantities ± 5 gall. per minute:—

Fuselage cell No. 2
140 gall. per min.
Fuselage cell No. 3
140 gall. per min.
Starboard wing No. 1 tank
85 gall. per min.
Starboard wing No. 2 tank
72 gall. per min.

Refuelling from the port ground connection, all quantities ± 5 gall. per minute:—

Fuselage reserve tank
88 gall. per min.
Fuselage cell No. 1
98 gall. per min.
Fuselage transfer
145 gall. per min.
Port wing No. 1 tank
85 gall. per min.
Port wing No. 2 tank
72 gall. per min.
Fuselage bomb bay tank
127 gall. per min.

Test 2 — Checking tank pressure and defuelling rate

71. Proceed as described in para. 68 except that, before selecting the required tank or tanks, ensure that the electrically-operated cock in No. 3 cell supply line is open.

Test 3 — Checking flow through probe

72. Connect external air pressure supply at 40 lb/in² to the engine air inlet connection (1). Set the refueller at maximum governed r.p.m. and connect the refueller hose to the aircraft probe by means of the special coupling, Ref. No. 27F/3077. In turn, select fuselage tank No. 1 and No. 3 cells; the flow rate and recorded pressures should be:—

Fuselage tank No. 1 cell
95 \pm 5 gall. per min.
Fuselage tank No. 3 cell
135 \pm 5 gall. per min.
Probe pressure
50 lb/in²

Pressure at gallery gauge
25 lb/in² approx. with tank practically empty, rising to a surge pressure up to approx. 50 lb/in² as the tank becomes full and the shut-off valve operates.

LEAK TESTS (fig. 17)

Test 1 — Wing tank vent system leak test

73. Remove the tank doors and blank off the vent pipes at the last joint before entry to the tanks at point (17), at the wing tip vent (18) and downstream of the wing pressure reducing valve at (19). With the wing test connection blanked at (9), apply 3 lb/in²

air pressure at (8) and check for leaks. There must be no pressure drop over a period of 15 minutes. Repeat for the opposite wing.

Test 2 — Wing tank leak test

74. Remove the blanks at (17) in No. 1 tank and remake the joint at (19). Blank off the fuel supply lines from the pumps at (20) in the upper servicing bay. Disconnect the engine air supply line at (16) and connect in an external supply at 2.5 lb/in² pressure to feed the wing tank. Pressure must be maintained for 15 minutes without dropping. Repeat the test for No. 2 wing tank and also for the opposite wing.

Test 3 — Refuelling system leak test

75. Blank off the wing and fuselage tank refuelling pipes at the refuelling cut-off valves at (21), and the underwing tank refuel/defuel pipelines at the non-return valve joint (fig. 2). Test for leaks by applying fuel pressure at 50 to 75 lb/in² as follows:—

B Mk. 1 and B/PR Mk. 1.—To the wing refuelling connection to test wing tank pipelines and to the fuselage refuelling connections for fuselage tank piping.

B/K Mk. 1 and B/K/PR Mk. 1.—With the wing defuelling valve set to FLIGHT, apply the pressure via the probe and/or fuselage refuelling connections.

Leakage in either case is not permitted.

Test 4 — Fuselage vent system leak test (less glass-cloth ducts)

76. Blank off as follows:—

- (1) The fuselage vent system at all vent entries to tanks and at the vent valves (22).

RESTRICTED

- (2) At the joint downstream from the main vent valves between the main vent manifold and glass-cloth duct (23).
- (3) The five sensing lines from the fuselage pressure-reducing valves at the main vent manifold sensing line connections (24).
- (4) The pressure reducing valve feed lines at the main vent (6).

At the main vent manifold sensing connection normally blanked off (7), connect an external air supply and pressurize the system at 3.5 lb/in². No leakage is permitted.

Test 5 — Fuselage vent system glass-cloth duct leak test

77. Blank off the main vent outlet (25) and pressurize the glass-cloth duct from (23) at 0.5 lb/in². The pressure drop must not exceed 0.15 lb/in² over a test period of 15 minutes.

Test 6 — Pump vapour, recuperator, air feed and fuel bleed lines leak tests

78. Proceed as follows:—

- (1) Lock the fuselage pump housing non-return valves (26) CLOSED, and OPEN the reserve tank cock.
- (2) Blank off the refuelling pipelines at the tank entries (21).
- (3) Blank off the pump housing vapour pipes and recuperator bleed line at (4).
- (4) Close the engine master cocks.
- (5) Apply 15 lb/in² air pressure at the reserve tank connection giving gravity feed to the pump housing (27) and check for leaks.
- (6) At point (15) downstream from the reducing valve in the recuperator air supply line, apply additional air supply at 6 lb/in² and check for leaks.

No leaks are permitted on these tests.

Test 7 — Nitrogen system pipelines leak test

79. Initial installation tests of nitrogen systems are made using dry clean air, complete exhaustion being necessary upon completion. All subsequent tests are carried out, using nitrogen.

- (1) With the nitrogen master cocks in the OFF position, charge the bottles to 1800 lb/in² pressure through the normal charging points. Check over a period of 12 hours for pressure drop, indicating leakage.
- (2) Blank off the nitrogen feed lines at the reducing valves, open the master cocks and repeat the leak test.

No leaks are permitted in this system.

BOMB BAY TANK TESTS (fig. 17)

80. The following tests, in addition to those given for the fuel system, are made with the bomb bay tank fitted to the aircraft. For tests before assembly or with the tank removed, see App. 3.

Test 1 — Checking the pressure reducing valve

81. With the nitrogen master cocks OFF, connect a dry air supply at 1800 lb/in² to the pressure reducing valve inlet side at (28). At the tank vent outlet (29) connect a pressure gauge to read 0 to 5 lb/in². Slowly turn on the air supply and check that the tank pressure remains between 0.9 and 1.2 lb/in² and that the valve vents excess air to atmosphere.

Test 2 — Checking the vent valve

82. With the tank outlets blanked and the pressure reducing valve sensing line disconnected and sealed off, pressurize the tank and check the pressure at which the vent valve operates.

Tank pressure

1.8 to 2.2 lb/in²

Test 3 — Checking refuelling rate and tank pressure

83. Close and electrically disconnect the transfer tank and No. 1 cell refuelling valves. Connect the refueller to the fuselage port ground connection and set the refueller at maximum governed r.p.m. Select the bomb bay tank ON and record the refuelling rate.

Refuelling rate

127 to 150 gall, per minute

Tank pressure

1.8 to 2.2 lb/in²

UNDERWING TANK TESTS

84. The following system checks are carried out with the underwing tanks installed and are additional to all fuel system checks described in this chapter. Where it is necessary to operate the fuel pump during testing, it may not be operated for periods longer than two minutes unless blast cooling is provided. After each two-minute period, a cooling time of not less than thirty minutes must elapse before further operation. It is also important that the pump is not operated when dry.

Test 1 — Checking jettison valve operation

85. With the fuel tank empty and air bottles charged, position one man to operate the jettison switch and another to check valve movement. With the switch operated, the jettison valves must open and close.

Test 2 — Checking refuelling rate and cut-off valve action

86. With the refueller set at maximum governed r.p.m. and connected to the wing refuelling coupling on B Mk. 1 and B/PR Mk. 1 aircraft, and to the fuselage coupling on K type aircraft, select underwing tank

and check both the refuelling rate and refuelling cut-off valve action.

Refuelling rate
135 to 145 gall. per min.

Test 3 — Checking pipe couplings for leaks

87. Place the wing defuelling selector in the OFF position and switch on the tank pump for a period not longer than one minute. Check that there are no leaks at the Exactor coupling joint between the tank and stalk, and at the high pressure joint between the stalk and wing. Switch off and allow the pump to cool before further operation.

Test 4 — Checking tank pump fuel transfer rate

Note . . .

The test period must be limited if blast cooling is not provided.

88. Ensure that the wing tank fuel level will permit transfer to be made. On the selector valve, select the required wing tank. On the pilots' underwing tank switch select MOTOR ON and run the pump for two minutes max. before selecting the pilots' control switch first to MOTOR TRIP — EMERGENCY ON and then to OFF. Check by the tank gauges the amount of fuel transferred, and cross check if necessary by refuelling the underwing tank.

Transfer rate
95 to 105 gall. per min.

Tank pressure
0.9 to 1.2 lb/in²

Test 5 — Checking emergency transfer rate

89. Check the condition of air and nitrogen

bottles and recharge if necessary. Select the desired tank on the wing refuelling selector valve and on the pilots' control switch select MOTOR TRIP — EMERGENCY ON. Maintain the transfer condition for four minutes before moving the switch to OFF. By means of the tank gauges, check the amount of fuel transferred and cross check by refuelling the underwing tank if necessary.

Transfer rate
20 to 30 gall. per min.

Tank pressure
6.9 to 7.9 lb/in²

Test 6 — Checking defuelling rate

90. Couple the defueller to the appropriate wing or fuselage defuelling coupling and select UNDERWING TANK on the refuelling/defuelling selector valve. With the refueller set at maximum governed r.p.m. note the defuelling rate.

Defuelling rate
35 gall. per min.

Minimum tank pressure
Atmospheric

REMOVAL AND ASSEMBLY

Precautions when fitting or removing tank cells

91. In order to gain access to fuel cells or any part of the fuel system, it will always be necessary to remove access panels and doors. Mishandling these items may lead to damage and distortion which would make refitting difficult and could lead to further damage if undue force is applied. Panels and doors should not be left piled on the ground after removal; a component rack,

Ref. No. 4G/534, is provided and should be used.

92. Only sparkproof tools and explosion proof torches and lighting may be used when working inside fuel cells. Ensure that lamps are adequately protected in order to prevent damage to the cells, and that the operator is supplied with protective clothing and remote breathing equipment before entering a tank. For further fuel cell detail refer to A.P.4117A, Vol. 1 and 6, Sect. 3, Chap. 5, App. 6, and for handling precautions see Sect. 1, Chap. 4.

93. All fuel cell components having wire-locked nuts or fittings must wherever possible have the locking wire intact prior to insertion into or on removal from the cell. The action of locking them after securing the component into position or of breaking the locking before the component is removed. (in order to facilitate more easy assembly or removal) presents a hazard that must be avoided.

94. When removal operations involve items of equipment that are electrically operated or have electrical connections attached to them, the following action must be taken before any removal action is commenced:—

- (1) Disconnect and remove BOTH external supplies.
- (2) Ensure that BOTH battery switches are OFF.
- (3) Remove the fuses from the circuits of all components to be removed, or having connections to be disconnected.

95. Except where specifically given, assembly and removal operations are complete reversals. It is important that the type and method of bonding is carefully noted and that the correct method is employed when components are reassembled.

RESTRICTED

Cell and tank bay preparation

96. Particular attention must be paid to tank bay cleanliness before fitting fuel cells; this includes studs, fittings and cell plating, and in addition, careful removal of swarf, filings and foreign matter.

97. All projections liable to contact fuel cells are covered with protective rubber strips. Ensure that these are intact or correctly repaired before attempting to fit a cell. Before fitting cells, assemble the fittings to them and ensure that the tank mouldings are not distorted or damaged, and that the nuts securing the fittings are tightened evenly without overtightening. When inserting a cell into the tank bay and fitting it into position, ensure that the tank pad mouldings are not damaged when fitting them over the studs in the tank bay structure.

98. The wing tank bay access doors are part of the wing stressed structure and must be in position whenever a tank bay is carrying a load. For this reason special jury doors (Table 3) should be fitted whenever an access door is removed. When fitting fuel cells or working inside a bay or cell, it is advisable to fit the appropriate jury door; this applies particularly to each inboard tank.

Fitting tank bay protective strips

99. In the tank bay, all projections such as fittings, boundary angles and reinforcing plates that are liable to come into contact with and chafe a fuel cell, are adequately protected by a rubber covering. Where for any reason this covering has been removed, damaged or become detached, a 2 in. wide Hycar repair strip must be applied as follows before the cell is fitted:—

- (1) Carefully remove the damaged strip. It will be found that the tank structure beneath it carries only a primer. Do not disturb the primer or attempt to apply a finishing coat until the

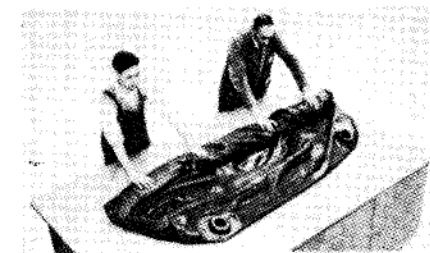
2 in. Hycar strip has been properly secured.

- (2) Clean the primer surface carefully and remove from it any temporary protective such as lanolin or resin.
- (3) Apply a coat of adhesive, Ref. No. 32D/345 (D.T.D.900/4465), evenly over the surfaces to which rubber protective strip is to be secured, and allow it to dry for thirty minutes.
- (4) Wet the Hycar strip prepared surface with thinners, Ref. No. 32D/380, and position the strip. Carefully press out all air bubbles from between the mating surfaces before finally removing the protective tape covering the outer surface. Apply french chalk, Ref. No. 33C/119, to the strip outer surface and area adjacent to the junction of strip and tank to ensure that there will be no adhesion to the fuel cell when it is fitted.
- (5) Touch up the structure surface finish between the Hycar protective strips, using a cockpit green finishing coat to D.T.D.827. Since spray application is difficult in a confined space, the coat may be brush applied. When dry, dust the bay with french chalk, ensuring that application is even without undue accumulation on the various fittings.

Fitting a fuselage tank cell (fig. 18)

100. Before introducing a cell into the tank bay, lay the cell on a clean flat surface and inspect it for damage. Before folding the cell, soap the buttons with castile soap which will serve as a lubricant and assist assembly; alternative lubricants must not be used unless they are officially approved.

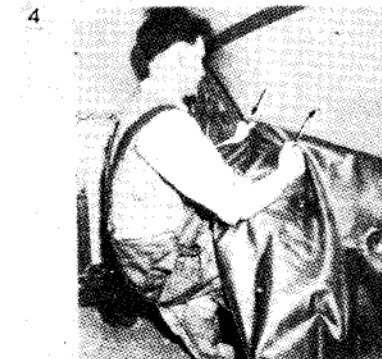
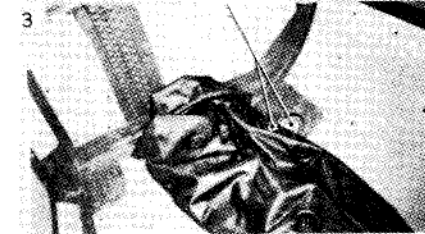
101. It will be necessary for a man to enter the tank bay to receive and fit the cell. Ensure that soft soled shoes are worn and that the clothing has no hard metallic projections or grease patches liable to damage the



KEEP THE MANHOLE UPPERMOST AND SUMP MOULDINGS AT THE FREE EDGE



FEED THE CELL INTO THE TANK BAY AND LINE UP SUMP FITTINGS



SECURE THE BUTTONS STARTING AT LOWER OUTBOARD EDGE

Fig. 18. Fitting a fuselage tank cell

rubber cell. Carry out a final cleanliness check in the tank bay and proceed to fit the cell as follows:—

- (1) With the cell laid flat on the inspection bench and all buttons soaped, roll the cell (fig. 18 (1)), keeping the manhole uppermost and the sump pad mouldings at the free edge.
- (2) With the cell rolled and one man positioned in the tank bay, feed the cell into the bay via the access hatch (fig. 18 (2)), ensuring that the cell does not foul the hatch sides with risk of abrasion.
- (3) Align the sump fittings (fig. 18 (3)).
- (4) Insert the tank buttons into the eyelets along the lower outboard edge (fig. 18 (4)) and work upwards on the outboard wall. With two rows of buttons secured, place the cell across the knees to support it and fit buttons progressively until the tank bay roof inboard edge is reached.
- (5) Leave the tank bay, align the cell manhole and tank bay opening, check that clothing and shoes are clean and enter the cell via the manhole.
- (6) Insert the remaining buttons at the inboard wall, ends and floor, working downwards at the walls and being particularly careful to ensure that the button at the contents gauge tank unit spider is **secured**.
- (7) Remove the blanking plates and fit the sump fittings at the gravity lines (fig. 23, detail 17).

Note ...

Fig. 20 shows the locations of the tank components detailed in fig. 21, 22 and 23.

- (8) Refit the blanking plates.
- (9) Fit the vent connections (fig. 23, detail 18) and weir fittings (fig. 21, detail 1, 2 and 26).
- (10) Fit the refuelling valve (fig. 22, detail 10) to the airframe fitting studs, ensuring that the tank moulding is correctly positioned and lying flush. Fit and tighten the nuts evenly.

Note ...

In No. 2 and 3 port cells the refuelling valve passes through the weir holes; it is therefore necessary to fit the refuelling valve securing clamp AFTER the valve is positioned.

- (11) Fit the contents gauge tank unit cable connection (fig. 23, detail 16) from inside the cell. Care must be taken to avoid damaging the cell on the studs. Fit the co-axial cable fittings to the studs and secure with nuts.

Note ...

The external cable connection in the reserve tank and No. 1 and 2 cells should face aft; in No. 3 cell it faces forward.

- (12) Fit the contents gauge tank unit to the spiders (fig. 22, detail 7).
- (13) Insert the co-axial cable through the floor loops and connect up the contents gauge tank unit and cable fitting.
- (14) Fit the float-operated switch (fig. 22, detail 8) as follows:—

- (a) Before fitting the switch, ensure that the paper packing around the float is completely removed.

To do this it will be necessary to remove the countersunk screws attaching the float casing to the switch main body. A 'Nebar' packing and jointing washer is fitted between the float casing and switch body flange; ensure that this is in position when the float casing is replaced.

- (b) Make the electrical connection to the switch.
 - (c) Fit the 'Nebar' washer over the switch retaining stud ring and locate the switch on the studs, with the red arrow on the switch body base pointing vertically upwards. An oversize stud ensures correct assembly.
 - (d) Fit the clamp ring on the switch flange and secure the assembly with stiffnuts. Do not overtighten.
- (15) Fit the vent float valve (fig. 23, detail 20), securing with washers and stiffnuts.
 - (16) Fit the manhole cover (para. 104).

Fitting transfer tank cells

102. This procedure is the same as that described in para. 100 and 101, with the following additional instructions after the cell is in position and all buttons secured:—

- (1) With a man positioned inside the cell, fit the fuel pump stud ring through the cell pad moulding and guide the studs through the airframe structure stud holes.
- (2) With the stud ring held securely from inside the cell, fit the pump over the

RESTRICTED

stud ring and, whilst the pump weight is taken by the man inside the cell, fit the securing nuts to the studs. Tighten diametrically opposite nuts progressively and evenly to ensure even tightening around the pump flange.

- (3) Fit the flexible pipe between pump and tank sidewall fitting, after ensuring that the special washers are fitted at the pipe ends and that the clip securing the pipe to the pump elbow is positioned to allow pump removal without it fouling the cell.
- (4) Fit the contents gauge tank unit cable connection and ensure that the external fitting points to the eleven o'clock position.
- (5) Fit the crossfeed pipe connections as follows:—
 - (a) Fit the stud ring over the crossfeed pipe connection pad moulding in the starboard cell and through the stud hole in the airframe skin (*fig. 23, detail 25*). Fit the 'Nebar' washer externally to the stud ring, locate the external fitting on the studs and secure the assembly with stiffnuts.
 - (b) Fit the crossfeed pipe connection to the port cell (*fig. 23, detail 24*).
 - (c) Position the crossfeed pipe and coupling and fit to the connections. Tighten the couplings and wire lock to the crossfeed connection fittings.
- (6) Fit the balance pipe stud rings through the cell pad mouldings and the holes in the tank bay side wall (*fig. 23, detail 22*), using care to avoid damage to the mouldings and cell.

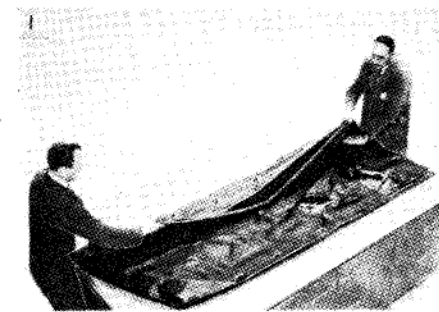
- (7) Position a man between the cells to fit and evenly tighten the balance pipe ring securing nuts.
- (8) Secure the contents gauge tank unit attachment to the stud ring.
- (9) Fit the vent fitting and secure with stiffnuts (*fig. 23, details 21*).

Fitting a wing tank cell (*fig. 19*)

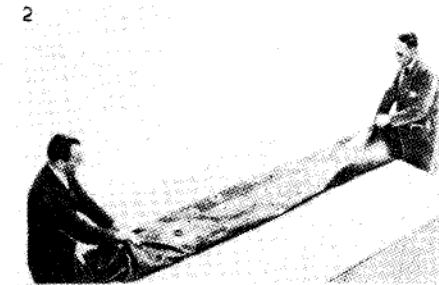
103. Before attempting to fit the cell, inspect carefully for signs of damage, smear all buttons with castile soap and lay the cell out flat on the inspection bench with its top uppermost (*fig. 19 (1)*).

Proceed as follows:—

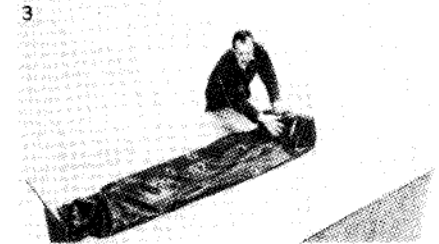
- (1) Fold each side to the centre (*fig. 19 (2)*).
- (2) Carefully roll the cell (*fig. 19 (3)*).
- (3) Place the cell in the tank bay and, starting from the button at the inboard rib, align the cell fittings with the airframe fittings and insert the rib buttons up to the roof.
- (4) Fit the roof buttons until the cell is positioned over the tank bay door, and then spread the remainder of the cell over the tank bay floor.
- (5) Fit the jury door if necessary, enter the cell and fit the remaining buttons whilst at the same time aligning the tank fittings.
- (6) Position the cell moulding around the drain fitting flange and locate the clamp fittings without trapping the moulding. Pass the securing bolt with its spring washer through the assembly and tighten the bolt until the washer is compressed. Do not overtighten the bolt.



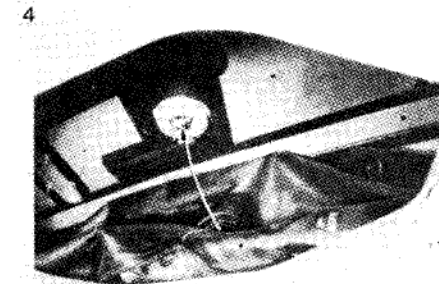
LAY OUT WITH CELL TOP UPPERMOST



FOLD EACH SIDE TO THE CENTRE



ROLL THE CELL



FITTING THE FLOAT VALVE

Fig. 19. Fitting a wing tank cell

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(7) Fit the refuelling valve (fig. 22, detail 10) by fitting the cell pad moulding over the airframe fitting studs and pressing it into the recess around the fitting raised sections. Inspect the electrical connection pins for freedom from damage and check that the pipe union is wire locked. Fit the valve and secure it with stiffnuts.

Note . . .

When refitting the refuelling cuff on the valve, it is important to ensure that the cuff is tight. If loose, it should be tightened by fitting a ½ in. wide strip of 100 mesh brass gauze (Ref. No. 30B/1114) between the valve body and the cuff. ◀To obviate movement of the cuff and thus prevent damage to the wing tank refuelling valve solenoid supply conduit, a retaining strap (post-Mod. 3047) is attached to the cuff and the valve body.▶

(8) Pass the stud ring through the moulding holes from inside the cell and assemble the coaxial cable fitting (fig. 22, detail 9).

(9) Fit the float-operated switch (fig. 22, detail 8) as described in para. 100 (14).

(10) Fit the vent float valve attachment (fig. 21, detail 6) as follows: —

(a) Fit the pad mouldings over the four retaining studs in the roof recess and smooth the cell into the recess.

(b) Thread the flanged washers over the studs, locate them over the cell pad mouldings and secure them with nuts.

(c) Position the vent pipe on the studs and locate it in the recess. It will assist assembly if the vent pipe curved sections are treated with

castile soap. Carefully ease the pipe into position, fit washers over the studs and secure the assembly with nuts.

(d) Fit a 'Nebar' washer to the vent float attachment stud ring, locate the vent float and secure the assembly with plain washers and stiffnuts.

Note . . .

The float should be positioned facing forward, but the valves in the wing tank inboard cells may be turned through 180 deg. so that the float faces aft if it is found that during operation the clearance between the cell and float is less than 0.10 in.

(11) Fit the cell pad mouldings over the sensing line fitting, the vent float valve fitting and the vent pipe elbow.

(12) Fit the sensing line to the union in the roof (fig. 23, detail 14); this joint is secured by a locking plate.

(13) Fit the vent float valve to the studs and secure with washers and stiffnuts (fig. 23, detail 20).

(14) Fit the vent pipe elbow on the studs and secure it with washers and stiffnuts (fig. 23, detail 15).

(15) Soap the intercell connector flange (fig. 21, detail 4) and position it in the cell moulding recess. Rotate the cross member clamps until they engage the fittings metal flange and then tighten the nuts until the spring washer under the nut is fully compressed.

(16) Fit the vent pipe clamp (fig. 21, detail 5) as follows: —

(a) Fit the pad moulding over the roof stud.

(b) Fit the flanged washer on the stud, position it on the moulding and secure with a stiffnut.

(c) Fit a plain washer over the stud, the clamp, followed by another plain washer and then secure the assembly with a stiffnut.

Fitting fuel cell manhole covers.

104. The manhole cover (fig. 22, detail 12) is the standard pattern fitted to wing and fuselage tank cells of all aircraft, with the following exceptions: —

(1) All K type aircraft in the tanker role will employ the pattern shown at fig. 25, detail 28, in fuselage tank No. 3 cells and transfer tank cells, the air turbine pumps used in this role being fitted to the cover.

(2) Aircraft (other than those in tanker role) having Mod. 2443 embodied to introduce an extra electrical fuel pump in the transfer tank, will have the type shown in fig. 22, detail 28, fitted to the transfer tank starboard cell.

105. To fit the manhole covers proceed as follows: —

(1) Fit the cell manhole pad moulding to the manhole cover by carefully easing the moulding over the studs.

(2) For fuselage tank covers, pass the studs through the fixed clamp ring secured in the bomb bay roof panels (fig. 22, detail 12 and 28).

(3) For wing tank covers the studs are passed through holes in a removable clamp ring. The ring is fitted inside the tank bay between the cell and tank plating, is free to move in relation to the cell plating and must be inserted into the bay before operation (1) is carried out on the wing tanks (fig. 22, detail 12).

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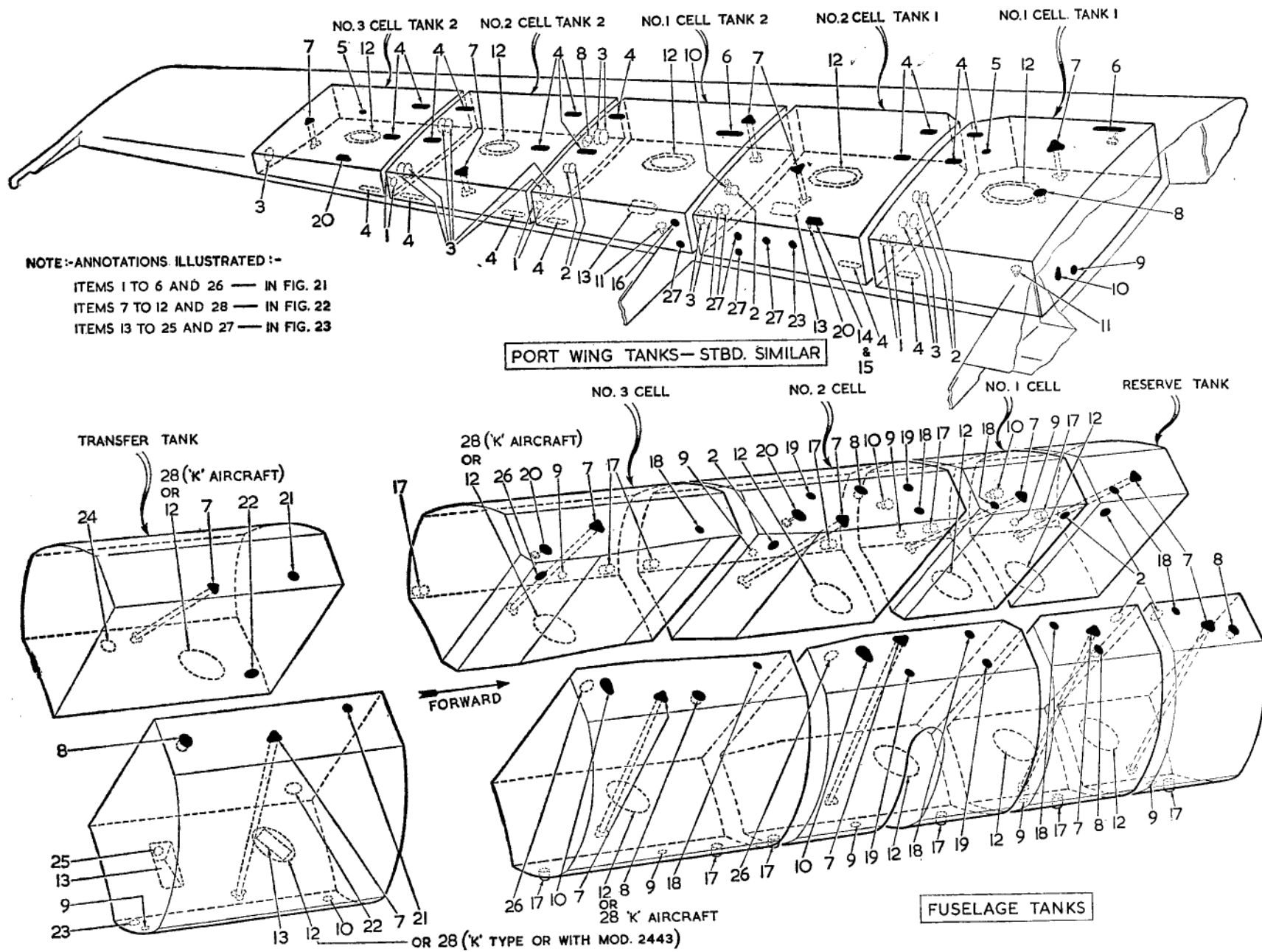


Fig. 20. Location diagram — tank components

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KEY TO FIG. 20**(Location diagram — tank components)****Note ...***All references are made to details numbered
in fig. 21, 22 and 23.*

- | | |
|--|---|
| 1 WING TANK INTERCELL CONNECTOR
FITTED WITH CONTENTS GAUGE CABLE
ASSEMBLY | 16 CONTENTS GAUGE CABLE ASSEMBLY CON-
NECTION AT WING TANK NO. 2 |
| 2 WING TANK INTERCELL CONNECTOR | 17 SUMP FITTINGS |
| 3 WING TANK VENT PIPE FITTING | 18 VENT CONNECTION |
| 4 WING TANK INTERCELL FEED PIPES OR
VENT CONNECTIONS | 19 VENT CONNECTION FROM FUSELAGE PUMP
HOUSING |
| 5 WING VENT PIPE CLAMP | 20 FLOAT VENT VALVE |
| 6 WING TANK VENT FLOAT VALVE AND PIPE
ATTACHMENT | 21 TRANSFER TANK VENT CONNECTION |
| 7 CONTENTS GAUGE TANK UNIT | 22 TRANSFER TANK BALANCE PIPE CONNEC-
TION |
| 8 PRESSURE REFUELLING FLOAT SWITCH | 23 FLEXIBLE PIPE CONNECTION |
| 9 CONTENTS GAUGE CABLE ASSEMBLY CON-
NECTION AT WING TANK NO. 1 | 24 TRANSFER TANK CROSSFEED PIPE CON-
NECTION IN PORT CELL |
| 10 REFUELLING VALVE | 25 TRANSFER TANK CROSSFEED PIPE CON-
NECTION IN STARBOARD CELL |
| 11 WING TANK DRAIN | 26 INTERCELL CONNECTORS IN NO. 3 CELLS |
| 12 MANHOLE COVER | 27 PIPE FITTINGS |
| 13 ELECTRICAL FUEL PUMP | 28 MANHOLE COVERS FOR K TYPE AIRCRAFT
OR IN TRANSFER TANK STARBOARD CELL
FOR AIRCRAFT WITH MOD. 2443 EM-
BODIED |
| 14 SENSING CONNECTION | |
| 15 PIPE FITTING | |

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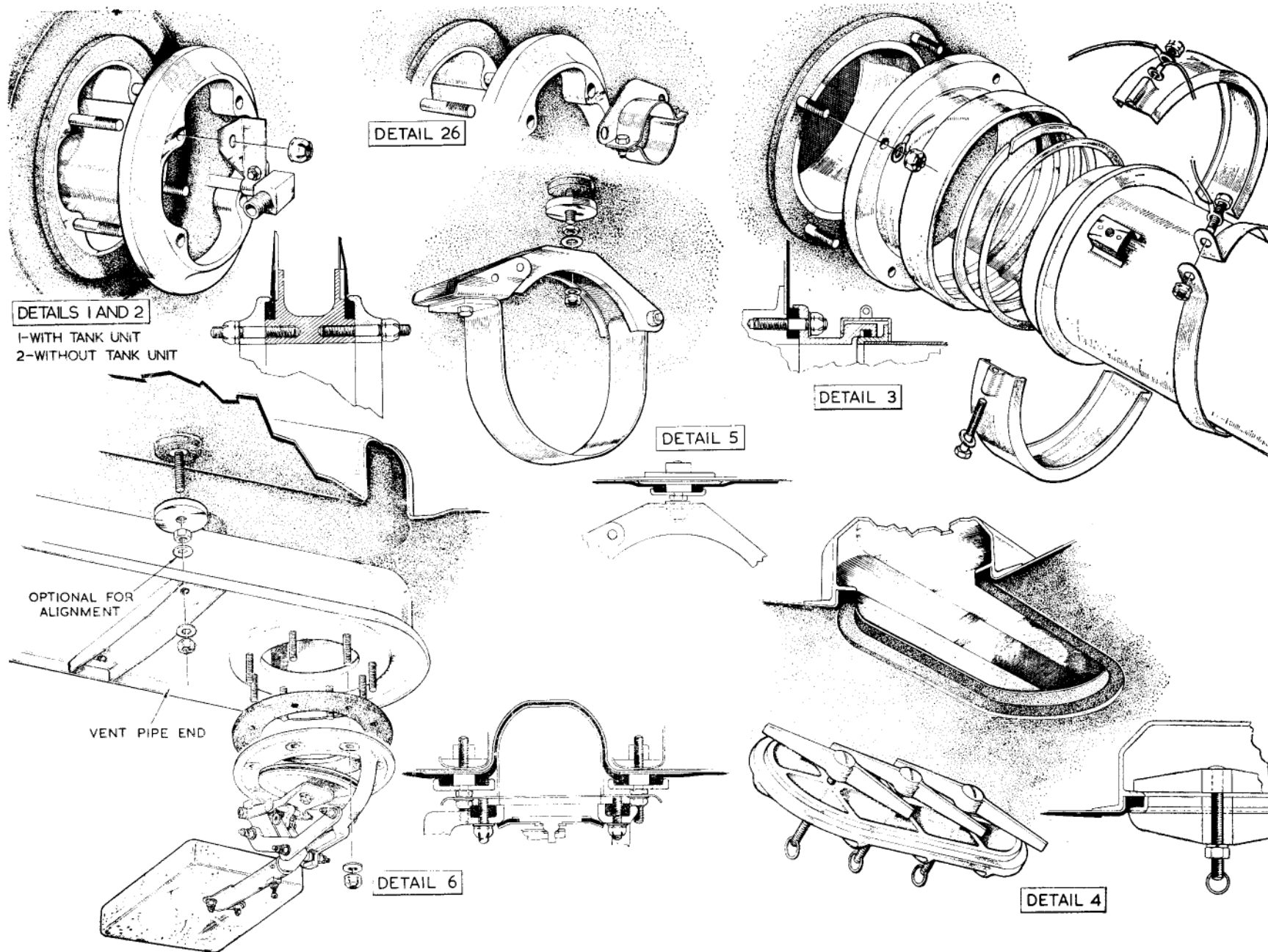


Fig. 21. Tank components — 1

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- (4) Following operation (2) or (3), fit four diametrically opposite manhole cover studs with nuts and close down lightly and evenly.
- (5) Using a feeler gauge, check that the joint between cover and clamp ring is correctly made and evenly tighten the four nuts.
- (6) Fit the remaining studs with nuts and evenly tighten opposite pairs until the joint is made.

Fitting wing tank access panels

106. The manholes of wing tank cells are not finally located until the tank access panels are fitted. Attached to the plating surrounding and forming part of the clamp ring are fittings securing four tie-bolts, the ends of which are threaded and receive spherical-headed ferrules, locked in position by grub screws which in turn screw into the ferrule head and bottom on the tie-bolt to lock the assembly.

107. Offer up the access panel, thread the eyebolts through the channels formed in the panel inner and outer skins and loosely assemble the ferrules to them (*fig. 22, detail 12*). Insert and progressively tighten the screws around the panel periphery. Ensure that the ferrule locking grub screws are loosened right off to the stops formed by pop marks in the screwdriver slot, and screw the ferrules evenly onto the tie-bolts until the clamp ring bottoms onto the access door inner skin. Tighten the grub screws

until they bottom firmly onto the tie-bolts to lock the assembly.

Tank fittings and fuel pump removal (*fig. 24*)

108. It will be necessary to isolate and defuel the tank concerned; for removal of fittings complete defuelling may not be necessary in fuselage tanks, with the exception of the transfer tank, if the tank contents are below weir level. Following pressure defuelling drain all residual fuel in the particular cell by using gravity drain connector, Ref. No. 26SR/95120.

109. Fittings and pump removals are straightforward operations, but attention must be paid to the following details:—

- (1) When removing the electrically-operated fuel pump from No. 2 wing tank inboard cell it will be necessary to lift the stud ring to allow the pump flange to clear the studs. Remove the pump by moving it aft to clear the wing structure.
- (2) To remove the float switch from the same cell, it must first be lifted clear of the studs and then twisted forward for removal and electrical lead disconnection. Avoid fuel cell damage.
- (3) All pump elbows are wire locked. Remove the pumps with elbows attached and locking wire intact, and break the locking only after the item is clear of the cell.

Engine master and crossfeed cocks removal

110. It will be necessary to drain the tanks for cock removal, after which the cocks are accessible through a removable panel in the bomb bay and can be removed by:—

- (1) Ensuring that power supplies are removed.
- (2) Disconnecting the electrical connections.
- (3) Disconnecting the pipe joints.
- (4) Removing the retaining nuts and spring washers on the distributor box studs, or bolts as applicable, and withdrawing the cock.

Fuel distributor box removal

111. The box is bolted to the aircraft structure and is accessible through a panel in the bomb bay. To remove:—

- (1) Drain the fuel tanks.
- (2) Disconnect and remove the elevator control rod adjacent to the box.
- (3) Ensure that power supply is OFF and disconnect all electrical connections.
- (4) Disconnect all pipe joints and connectors.
- (5) Remove the attachment bolts and withdraw the box.

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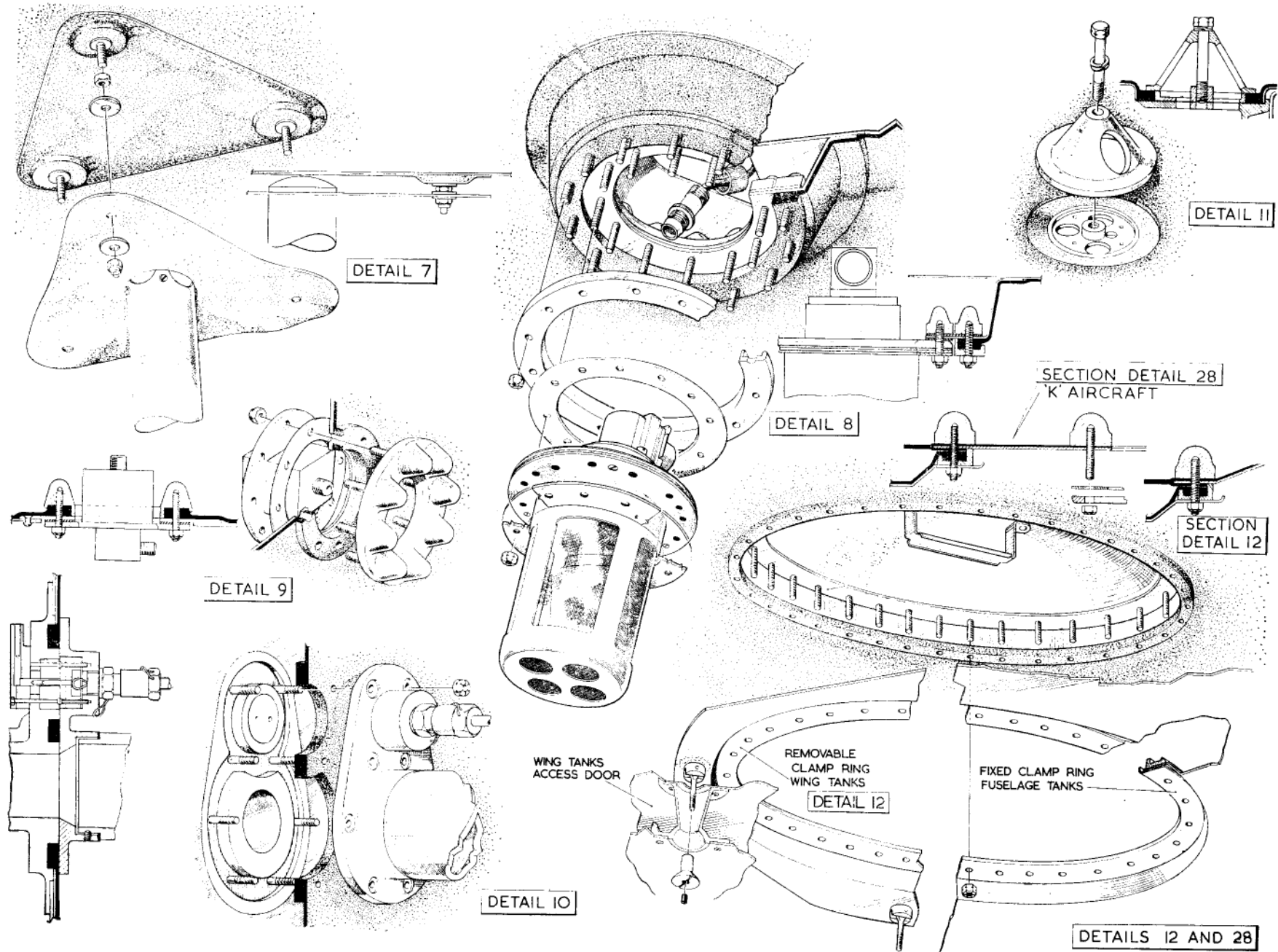


Fig. 22. Tank components — 2

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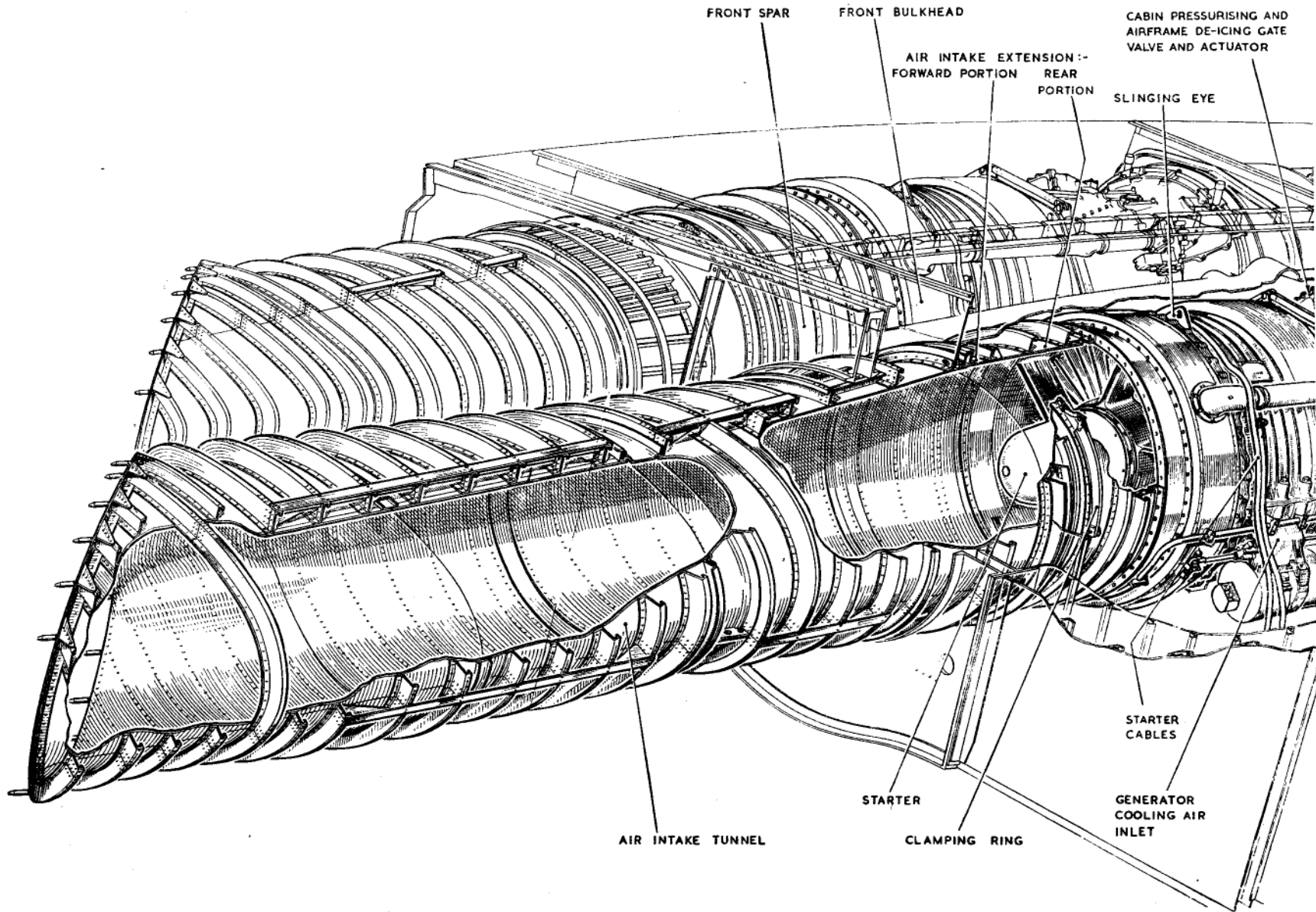


Fig. 1. Engine change unit installation (1)

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Wing tank transfer cock removal

112. The cock is accessible only when the flaps are lowered; after draining the wing tanks, removal is a straightforward operation.

Fuselage pump housing removal

113. The pump housing is bolted to the aircraft structure, and is accessible through a removable panel in the bomb bay. To remove:—

- (1) Ensure that the reserve tank cock is in the OFF position.
- (2) Drain fuselage tank cells No. 1, 2 and 3.
- (3) With power supply removed, disconnect all electrical leads.
- (4) Disconnect all piping joints at the housing.
- (5) Remove the booster pumps.
- (6) Remove the bolts securing the housing to the aircraft structure and withdraw the housing.

Recuperator removal

114. It will be necessary to drain the fuel and remove fuselage tank No. 2 cell for this operation.

- (1) Drain off the fuel and, using gravity drain connector Ref. No. 26SR/95120, drain all residual fuel from No. 2 cell.
- (2) Open up the No. 2 cell manhole, and ensure that power supply has been removed before disconnecting electrical connections to the fuel contents gauge tank unit.
- (3) Disconnect the pipes and tank fittings.
- (4) Remove the mushroom-head screws from the outboard cell plating curved section adjacent to the recuperator, and remove the plating.
- (5) Remove No. 2 cell, reversing the operations described in para. 100.
- (6) Disconnect all pipes at the recuperator.
- (7) Remove the recuperator attachment bolts.
- (8) Remove the recuperator via the bomb bay roof manhole.

Fuselage booster pump removal

115. The pumps are accessible via a bomb bay roof removable panel.

- (1) Drain the fuel tanks as follows:—
 - (a) On aircraft post-Mod. 1427, wing tanks only.

- (b) On aircraft pre-Mod. 1427, all tanks except the reserve tank.
- (2) Select PUMP REMOVAL at the lever under the refuelling panel.
- (3) Check that the reserve tank cock is OFF.
- (4) Check that power supplies have been removed and then disconnect the electrical connections.
- (5) Disconnect the pump pipe connections.
- (6) Remove the nuts and washers from the studs around the pump flange and withdraw the pump.

Flowmeter transmitter removal

116. The transmitter is accessible through a bomb bay roof removable panel.

- (1) Close the engine master cocks and drain the pipeline between cocks and engine via the pipeline drain cocks (fig. 1, item 13).
- (2) Check that power supplies have been removed and disconnect the electrical connections.
- (3) Disconnect the pipeline joints on each side.
- (4) Remove the attachment bolts at the flange and withdraw the flowmeter transmitter.

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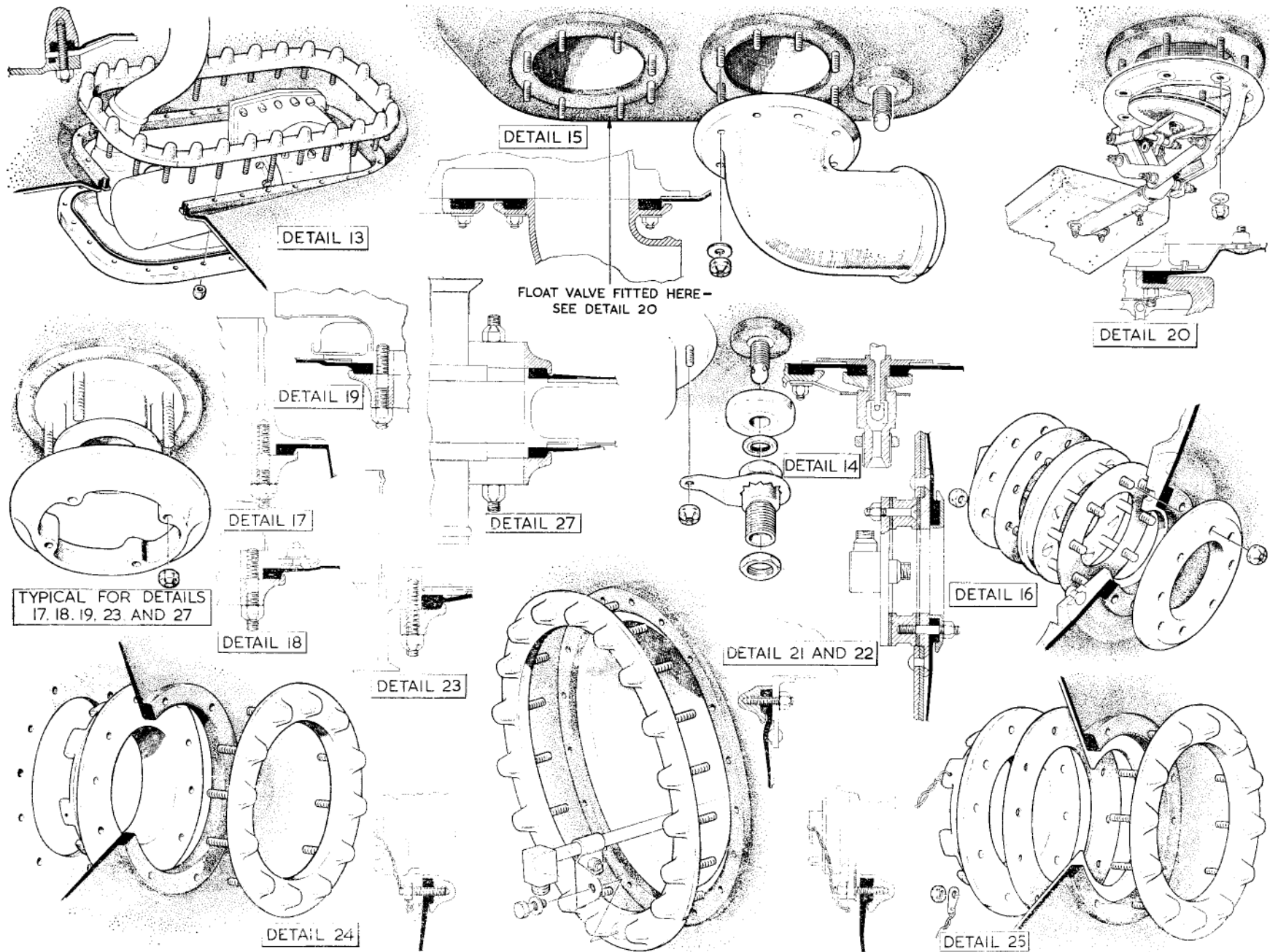


Fig. 23. Tank components — 3

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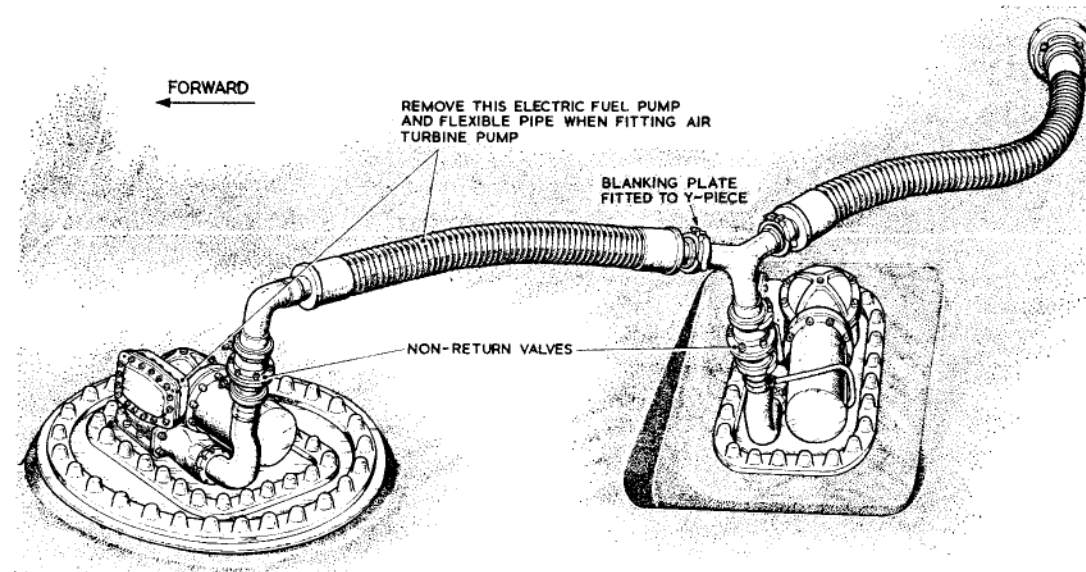


Fig. 24. Transfer tank starboard cell fuel pump assembly — post-Mod.2443

Wing stalks fitting and removal

117. For fitting and removal instructions refer to App. 1 to this chapter.

Underwing tanks fitting and removal

118. For instructions covering fitting and removal refer to App. 2 to this chapter and to A.P.2852B, Vol. 1, Sect. 5, Chap. 3, App. 3.

Bomb bay tanks fitting and removal

119. For fitting and removal instructions refer to App. 3 to this chapter.

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TABLE 3
Special tools and equipment

<i>Ref. No.</i>	<i>Part No.</i>	<i>Nomenclature</i>	<i>Remarks</i>
26SR/95426	70679 Sht.3	Plate, blanking wing tip vents	Post-Mod.868
26SR/95483	70679 — 21	Plate, blanking	} Vent pipe blanks for fuel system checks post-Mod.1954
26SR/95479	70679 — 207	Plate, blanking	
26SR/95481	70679 — 209	Plate, blanking	
26SR/95480	V.G.S. 6301K	Cap, protection	
26SR/95482	V.G.S. 6301V	Cap, protection	
26SR/95343	67479 Sht.714	Jury door, No. 1 cell, port wing	} For use when fuel bay access doors are removed
26SR/95344	67479 Sht.713	Jury door, No. 1 cell, starboard wing	
26SR/95345	67479 Sht.716	Jury door, No. 2 cell, port wing	
26SR/95346	67479 Sht.715	Jury door, No. 2 cell, starboard wing	
26SR/95347	67479 Sht.718	Jury door, No. 3 cell, port wing	
26SR/95348	67479 Sht.717	Jury door, No. 3 cell, starboard wing	
26SR/95114	67479 Sht.88	Jury door, No. 4 cell, port wing	
26SR/95115	67479 Sht.87	Jury door, No. 4 cell, starboard wing	
26SR/95116	67479 Sht.90	Jury door, No. 5 cell, port wing	
26SR/95117	67479 Sht.89	Jury door, No. 5 cell, starboard wing	
26SR/95310	67479 Sht.685	Tool, water drain	For wing fuel tanks
26SR/95256	67479 Sht.645	Tool, water drain	For fuselage fuel tanks
26SR/95180	67479 — 1485	Spanner, special	Water drain valve and pump sump
26SR/95120	F.C.262	Connector, gravity drain	
26SR/95379	67479 — 5513	Spanner, peg	Fuel system desiccator
27F/2445	F.R.S.124	Spanner, union nut, universal	Fuel pipe connectors
IC/6889	—	Spanner, D.E. B.S.W. $\frac{3}{16}$ in. \times $\frac{1}{4}$ in.	} For use inside fuel cells and tanks
IC/6890	—	Spanner, D.E. B.S.W. $\frac{5}{16}$ in. \times $\frac{3}{8}$ in.	
IC/6891	—	Spanner D.E. O.J. 2 B.A. and 3 B.A.	
IC/6892	—	Spanner D.E. O.J. 4 B.A. and 5 B.A.	
IC/6893	—	Spanner D.E. O.J. 6 B.A. and 8 B.A.	
IC/3226	—	Spanner D.E. O.J. B.S.W. $1\frac{1}{8}$ in.	
IB/6897	—	Spanner, special for A.G.S.605 clips	
IB/5266	—	Pliers S/C, sparkproof	

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Chapter 2, Appendix 1

WING STALKS

LIST OF CONTENTS

	<i>Para.</i>		<i>Para.</i>		<i>Para.</i>
<i>Introduction</i>	1	Removal and assembly		<i>Removal of rear crutch assembly</i> ...	10
Description	2	<i>Removal of wing stalk from outer plane</i>	8	<i>Dismantling the rear crutch mechanism</i>	11
<i>Crutch shoes</i>	6	<i>Assembly of wing stalk to outer plane</i>	9	<i>Assembly of the rear crutch mechanism</i>	12
Servicing				<i>Refitting the rear crutch assembly</i> ...	13
<i>Lubrication</i>	7				

LIST OF ILLUSTRATIONS

	<i>Fig.</i>
<i>Wing stalk</i>	1
<i>Rear crutch mechanism</i>	2

Introduction

1. The wing stalk does not form part of the permanent outer plane structure, being fitted only as a special requirement when needed to carry the underwing fuel tank. It is an aerofoil-section structure housing the tank hoisting and suspension equipment and front and rear crutches. The stalk, located on the outer plane front and rear spars by three spigots, is attached at the front end by two captive bolts which pass through the two forward spigots, the rear end being secured by two special $\frac{1}{2}$ in. B.S.F. bolts, Pt. No. 67479-737.

DESCRIPTION

2. The stalk is constructed in three portions, viz., the load-carrying structure and nose

portion, the upper fairing and the rear fairing, the two fairings being secured by counter-sunk-head screws and anchor nuts.

3. The load-carrying structure comprises vertical plate diaphragms riveted to an upper and a lower horizontal rib; passing vertically through the structure is a hoist tunnel fitted with two load-retaining trunnions. Extending fore and aft is a conduit carrying leads to the electrical equipment in the nose portion.

4. From an Exactor coupling on the forward end of the lower rib, a fuel feed pipe extends up and along the centre of the stalk and protrudes into the rear fairing. Incorporated in the pipeline is a pressure refuelling valve, a defuelling non-return valve and a low pressure warning switch. Forward of the Exactor coupling is a series of electrical butt connectors. Two spigot housings are provided on the lower face of the load-carrying structure for use in locating the underwing tank.

5. The nose portion is integral with but of lighter construction than the load-carrying structure, the diaphragms extending chordwise and employing a leading edge member. The detachable upper fairing is a formed skin with two stiffeners riveted to it, and the detachable rear fairing has three chordwise diaphragm ribs with an aluminium alloy trailing edge member.

Crutch shoes

6. Fitted to the lower rib of the load-carrying structure are two pairs of crutch shoes; the rear pair are adjustable and can be raised and lowered by means of two wormshafts driving two wormwheels. Into these wormwheels screw the crutch shoes, a locating pin (riveted to each shoe) being free to slide in and out of the wormwheel retainer and thus prevent rotation of the shoes as they move up and down. The two wormshafts are interconnected by tubes and sleeves, the centre tube running through a ratchet.

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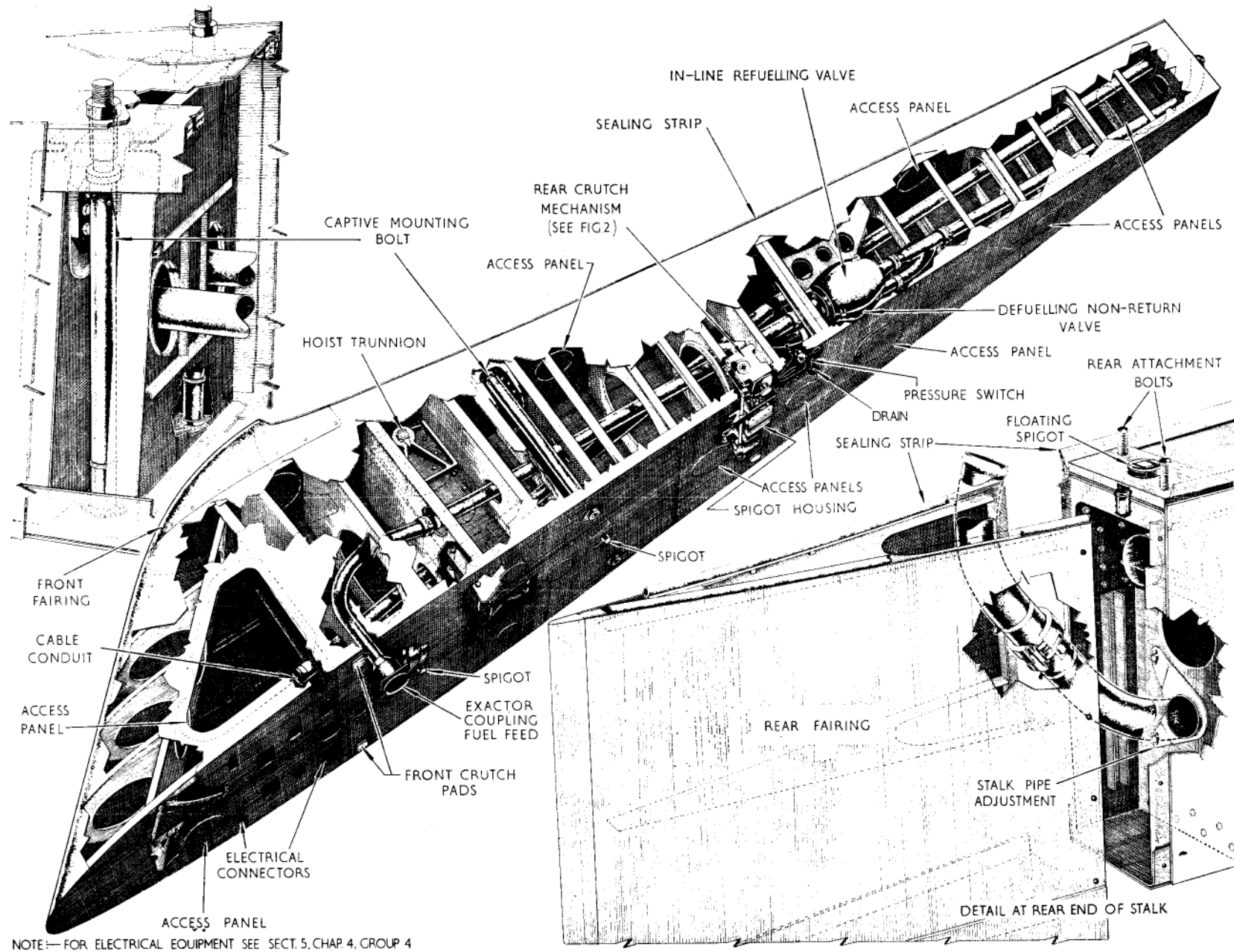


Fig. 1. Wing stalk

SERVICING

Lubrication

7. To lubricate the crutch shoes proceed as follows:—

- (1) Wind the shoes down until the locating pins are clear of the wormwheel retainers.
- (2) Unscrew each shoe and well smear the threads with grease XG-276.
- (3) Screw in the shoes as far as possible by hand, align the locating pins with the holes in the retainer plate, then wind them in.

REMOVAL AND ASSEMBLY

Removal of wing stalk from outer plane

8. Owing to the weight and size of the stalk it must be suitably trestled or slung before attempting removal. To remove a stalk the sequence is the reverse of that for assembly. When the fuel pipe has been disconnected, the blanks and connector cover assemblies must be refitted immediately to prevent ingress of foreign matter.

Assembly of wing stalk to outer plane

9. To assemble a wing stalk to an outer plane, proceed as follows:—

- (1) Remove the hoist tunnel panel from the underside of the outer plane leading edge at Stn.293-5.
- (2) Remove the access panel on the underside of the outer plane, aft of the rear spar at Stn.293-5.
- (3) Remove the two blanking plugs from the attachment points on the front spar.
- (4) At the rear spar remove the two $\frac{1}{2}$ in. B.S.F. csk./hd. blanking screws from the attachment points, and the blanking plug from the spigot location point.
- (5) Remove the upper and rear fairings from the stalk.

(6) Lubricate the spigots on the stalk and the spigot locating holes in the outer plane with grease XG-276.

(7) Offer up the wing stalk and locate the three spigots in the spigot locating holes in the outer plane undersurface.

Note . . .

The rear spigot has fore and aft movement to assist location.

(8) Secure at the front spar attachment points with the two captive tubular bolts; tighten the bolts, using an extension bar, Ref. No. 1L/48, and a wrench, Ref. No. 1L/50, and wire lock.

(9) Secure the rear end of the stalk with the two special $\frac{1}{2}$ in. B.S.F. bolts, Pt. No. 67479-737 and wire lock.

(10) Fit the upper fairing, ensuring that the rubber seal is seating correctly on the outer plane leading edge.

(11) Select UNDERWING TANK on the wing defuelling selector valve to ensure minimum fuel spillage when the fuel pipe connector is removed.

(12) Dismantle the connector on the end of the wing fuel pipe; a few pints of fuel may drain from the pipe.

(13) Dismantle the connector on the end of the stalk fuel pipe and remove the protective caps from the connecting pipe, Pt. No. 67479-889.

(14) Offer the connecting pipe into position and check that there is a 0.1 in. gap at each end; an adjustment is provided for raising and lowering the stalk fuel pipe to achieve this gap (*fig. 1*).

(15) Fit the connecting pipe; when tightening the connections ensure that the bonding screw holes in the connectors are in an accessible position. Connect the bonding leads.

(16) Fit the flame shield to the upper connection.

(17) Connect the electrical wiring; access to the junction box on the rear spar is obtained with the flaps DOWN.

(18) Fit the tail fairing and secure with the csk./hd. screws.

Removal of rear crutch assembly

10. To remove the rear crutch assembly from a stalk proceed as follows:—

- (1) Remove the crutch shoes (*para. 7*).
- (2) From the lower rib remove the two access panels, one forward and one aft of the crutch assembly.
- (3) Remove the six $\frac{1}{4}$ in. B.S.F. bolts securing the spigot housing, this being located between the access panels removed in operation (2). Withdraw the housing.
- (4) Remove the 2 B.A. bolts securing the connecting tubes and sleeves, and disengage these from the splined wormshafts in the crutch mechanism by sliding the sleeves inwards toward the ratchet.
- (5) Remove the four $\frac{1}{4}$ in. B.S.F. bolts securing the ratchet to the diaphragm, and withdraw this assembly.
- (6) Remove the $\frac{3}{8}$ in. B.S.F. bolts securing the crutch mechanisms between the diaphragms and withdraw the mechanisms through the access holes.

Dismantling the rear crutch mechanism (*fig 2*)

11. In the event of damage to the wormshaft or wormwheel, the mechanism may be dismantled as follows:—

- (1) Remove the crutch shoe (*para. 7*).
- (2) Remove the cheese-head lock screw and, using a peg spanner, unscrew the wormshaft retainer, ensuring that the shims are kept for reassembly.
- (3) Withdraw the wormshaft.

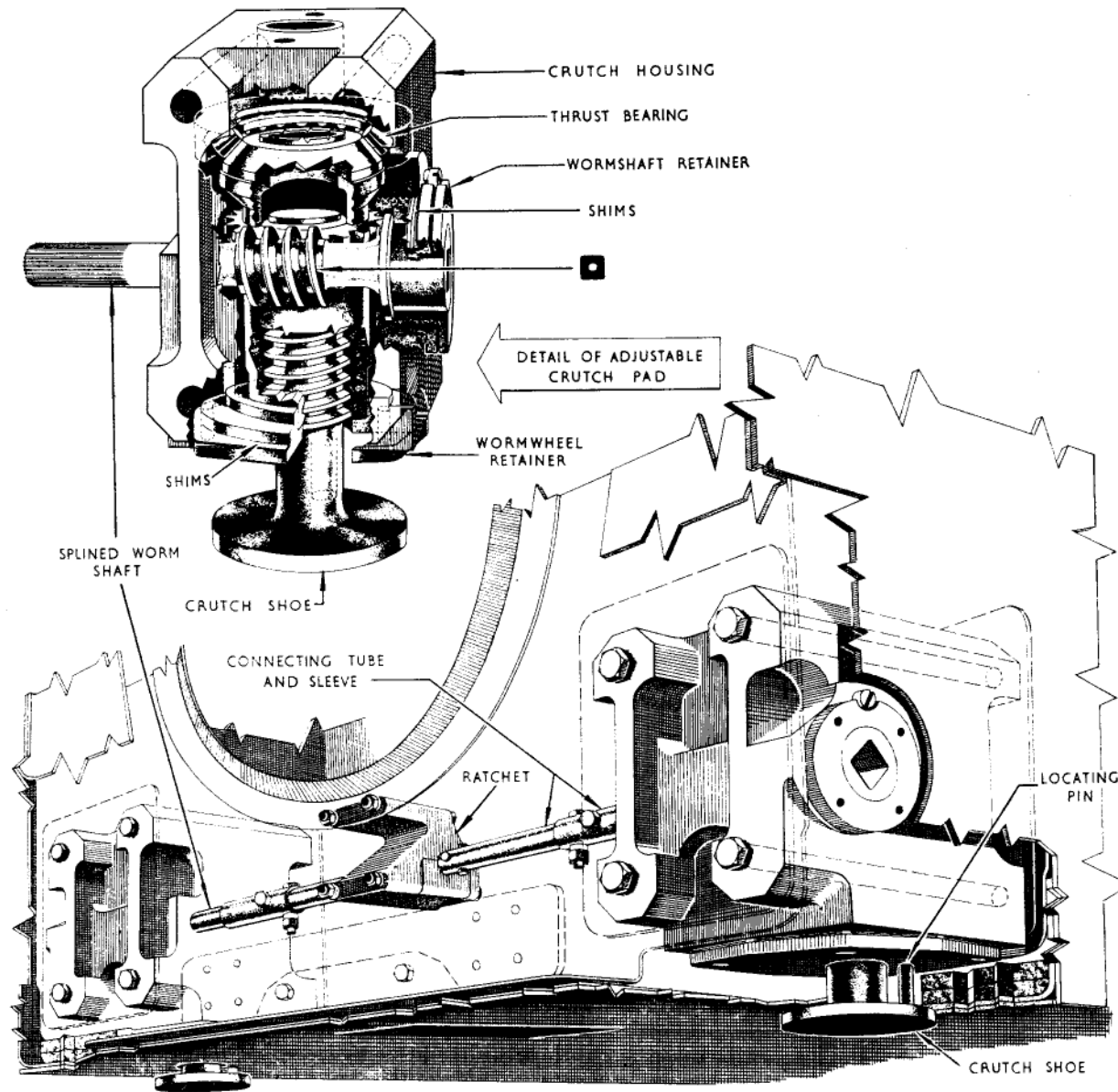


Fig. 2. Rear crutch mechanism

(4) Remove the csk./hd. bolts securing the wormwheel retainer to the bottom of the crutch housing, retaining the shims for reassembly.

(5) Withdraw the wormwheel complete with the bottom half of the thrust bearing.

(6) Extract the top half of the thrust bearing and also the roller race, using an extractor tool through the two holes in the top of the crutch housing in conjunction with a suitable press.

Assembly of rear crutch mechanism

12. This assembly sequence is the reverse of that given in para. 11, except that the following conditions must be observed: —

(1) An end float of 0.0 to 0.01 in. must be obtained by shimming on the wormshaft retainer.

(2) An end float of 0.001 to 0.01 in. must be obtained by shimming on the wormwheel retainer.

(3) Ensure that the wormwheel retainer is fitted with the guide hole for the crutch-shoe locating pin on the aft side of the wormwheel axis.

(4) The mechanism must be packed with grease XG-276 on assembly.

Refitting the rear crutch assembly

13. Refitting the rear crutch assembly to a wing stalk is the reverse of the sequence detailed in para. 10.

RESTRICTED

Chapter 2, Appendix 2

UNDERWING TANK

LIST OF CONTENTS

	<i>Para.</i>		<i>Para.</i>		<i>Para.</i>
<i>Introduction</i>	1	Servicing		<i>During assembly</i>	24
<i>Equipment distribution</i>	5	<i>Protective treatment</i>	18	<i>During removal</i>	25
<i>Refuelling</i>	6	<i>Charging the air system post-Mod. 2634</i>	19	<i>During pre-tensioning and de-tensioning</i>	26
<i>Defuelling</i>	7	<i>Charging the nitrogen system</i>	20	<i>Removal of pump and motor unit from tank</i>	27
<i>Transfer</i>	8	<i>Rectification of minor leaks</i>	21	<i>Assembly of pump and motor unit to tank</i>	28
<i>Pressurizing and venting</i>	13	Assembly and removal		<i>Testing after fitting pump unit</i>	29
<i>Low pressure condition</i>	15	<i>Assembly and removal of tank</i>	22		
<i>High pressure condition</i>	16	<i>Precautions</i>			
<i>Fuel jettison</i>	17	<i>Before assembly</i>	23		

LIST OF ILLUSTRATIONS

	<i>Fig.</i>
<i>Underwing tank</i>	1
<i>Underwing tank pressurizing and venting system</i>	2
<i>Underwing tank pressurizing control</i>	3
<i>Underwing tank suspension</i>	4

TABLE

	<i>Table</i>
<i>Pressure test blanks</i>	1

Introduction

1. When additional fuel load is required an underwing tank of 1615 gall. capacity may be carried under each outer plane at Stn. 293. The tank, which cannot be jettisoned, is a stiffened streamline shell of light alloy, circular in cross-section and strengthened by three bulkheads which divide it internally into four compartments. The small nose compartment does not carry fuel; the two bulkheads separating the other three compartments provide rigid sections against which to pre-tension the tank on assembly to the wing

stalk, and also prevent excessive fuel surge.

2. The tank is supported under the wing stalk (*App. 1*) by a suspension link which engages the release lug on top of the tank, the tank being prestrained against the wing stalk. Two crutching beams are provided at the main bulkheads, each having a shear spigot to cater for any side-loading on the tank, the forward spigot also taking the drag loads.

3. The two main bulkheads, also used for load distribution when the tank is installed, are each connected by a diagonal tubular

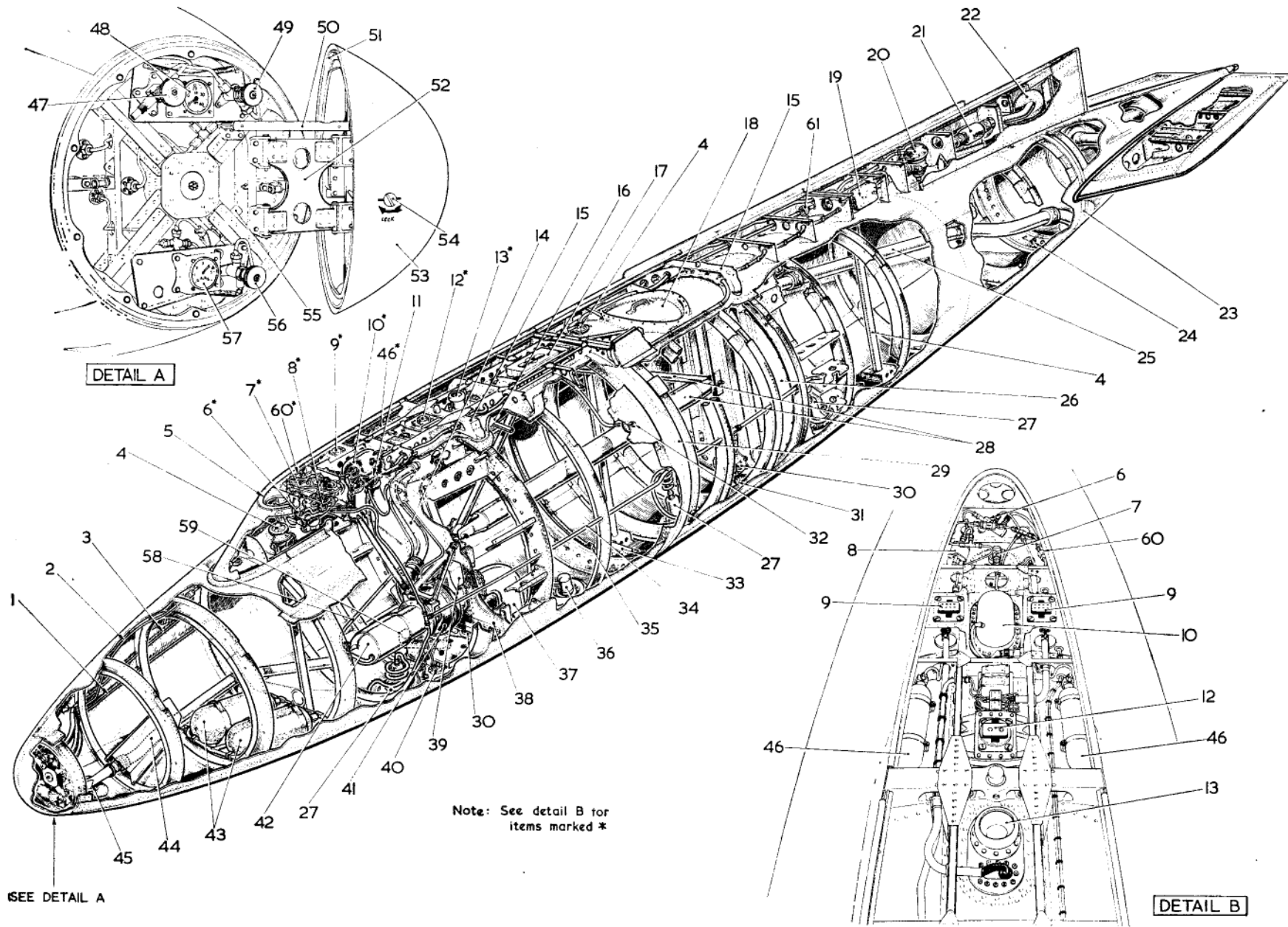


Fig. 1. Underwing tank

Key to Fig. 1. (Underwing tank)

1	NITROGEN LINE FROM BOTTLES	21	INWARD RELIEF VALVE	41	FUEL PUMP
2	AIR LINE FROM BOTTLES	22	INWARD RELIEF PIPE	42	FUEL PUMP MOTOR
3	NITROGEN LINE TO PRESSURE REDUCING VALVE	23	TANK BREAK JOINT	43	NITROGEN BOTTLES
4	PACITOR UNIT	24	DRAIN SLEEVE	44	FUEL PUMP MOTOR AIR COOLING PIPE
5	RUBBER SEALING STRIP	25	VENT PIPE	45	FUEL PUMP MOTOR AIR COOLING INLET
6	SOLENOID-OPERATED AIR REDUCING AND RELIEF VALVE	26	MAIN BULKHEAD, REAR	46	AIR BOTTLE
7	FLOAT-OPERATED SWITCH	27	FUEL JETTISON VALVE	47	NITROGEN CHARGING VALVE
8	UNIMATIC AIR VALVE	28	MAIN SUPPORT STRUCTURE	48	NITROGEN PRESSURE GAUGE
9	ELECTRICAL BUTT CONNECTOR	29	TANK BREAK JOINT	49	NITROGEN MASTER COCK
10	TWO-STAGE PRESSURE RELIEF VALVE	30	NON-RETURN VALVE IN MAIN BULKHEAD	50	STAY TUBE
11	TWO-STAGE PRESSURE RELIEF VALVE SOLENOID	31	TWIN NON-RETURN VALVES IN MAIN BULKHEADS	51	NOSE CAP SEALING RING
12	ELECTRICAL BUTT CONNECTOR	32	RELEASE LUG HOUSING WATER DRAIN	52	NOSE CAP HINGE
13	EXACTOR FUEL COUPLING	33	BALL INHIBITOR ASSEMBLY HOUSING	53	NOSE CAP
14	FUEL SUPPLY LINE FROM PUMP	34	AIR LINE TO FUEL JETTISON VALVES	54	NOSE CAP LOCK
15	CRUTCHING BEAM	35	SACRIFICIAL ANODE	55	AIR RELIEF VALVE
16	REFUELLING DISTRIBUTOR PIPE	36	FUEL DRAIN VALVE	56	AIR BOTTLE CHARGING VALVE
17	RELEASE LUG HOUSING	37	FUEL PUMP INLET PIPE	57	AIR PRESSURE GAUGE
18	MANHOLE COVER	38	MAIN BULKHEAD, FRONT	58	ELECTRICAL CONDUIT TO PUMP MOTOR ◀(fitted with pressure bung, Mod. 2986)▶
19	CONTENTS GAUGE RECTIFIER UNIT	39	AIR RELEASE VALVE	59	FUEL PUMP MOTOR COOLING AIR OUTLET
20	NITROGEN PRESSURE REDUCING VALVE	40	PUMP GLAND DRAIN AND WATER DRAIN VALVE	60	NON-RETURN VALVE
				61	AIR RESTRICTER VALVE

strut (on the tank centre line) to the base of the release lug housing, attachment to the housing being made through a solid tie-bar. When installed the tank is faired into the wing stalk by a stub stalk attached to the tank top; this stub houses the fuel pipe break joint couplings, electrical leads, switches and relief valves (*fig. 1 and 2*).

4. At the top of the two main bulkheads holes provide venting to the two-stage pressure relief valve in the forward fuel compartment and, at the bottom, non-return valves allow fuel to reach the pump inlet in the centre compartment. This inlet passes through the front main bulkhead to the fuel pump housed in the forward fuel compartment.

Equipment distribution (*fig. 1*)

5. The following items of equipment, etc.,

are housed in the tank compartments and stub stalk :—

Nose compartment.—

Nitrogen charging valve and filter
Nitrogen pressure gauge
Nitrogen master cock
Air charging valve
Air pressure gauge
Air pressure relief valve
Access door to forward fuel compartment

Front fuel compartment.—

Pressure refuelling float switch
Two-stage pressure relief valve
Water drain valve
Contents gauge tank unit
Fuel jettison valve
Nitrogen bottles
Fuel pump and motor
Pump inlet venting air release valve
Pump motor cooling duct

Centre fuel compartment.—

Double acting non-return valve
Contents gauge tank unit
Fuel jettison valve
Fuel drain valve
Tank access door
Sacrificial anode
Ball inhibitor assembly
Bulkhead non-return valves
Fuel pump inlet

Rear fuel compartment.—

Contents gauge tank unit
Fuel jettison valve
Water drain valve
Main vent outlet

Stub stalk.—

Air bottles
Air line non-return valves
Unimatic solenoid-operated valves
Exactor fuel coupling break joint
Pressure refuelling cut-off valve

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Fuel non-return valve
 Low pressure warning switch
 Air restrictor valve
 Tank contents gauge rectifier unit
 Nitrogen pressure reducing and non-return valves
 Inward pressure relief valve

Refuelling (Chap. 2, fig. 2)

6. The underwing tanks are refuelled as part of the wing system, wing refuelling points being used on B Mk. 1 and B/PR Mk. 1 aircraft and the fuselage points on B/K Mk. 1 and B/K/PR Mk. 1 aircraft. By either method fuel is pumped to the wing tank refuelling/defuelling selector valve and passed to the underwing tank, via the refuelling/defuelling/transfer pipeline and a double acting non-return valve in the centre fuel compartment, whence it is fed to all three compartments. The double acting non-return valve closes the defuelling/transfer line between the valve and pump when refuelling is in progress and, on defuelling or transfer, the valve closes the refuelling pipeline from the pump. Unlike the remainder of the aircraft refuelling system, there are no restricters in the lines, refuelling being controlled in the forward fuel compartment by a pressure refuelling float switch operating a cut-off valve in the stub stalk.

Defuelling (Chap. 2, fig. 2)

7. When the wing tank selector is moved to UNDERWING TANK, fuel will be sucked from the tank via the pump inlet, pump and double-acting non-return valves in the centre fuel compartment, through a non-return valve by-passing the refuelling cut-off valve in the stub stalk, to the selector valve. In B Mk. 1 and B/PR Mk. 1 aircraft it will then pass to the wing defuelling point to be drawn away by the defuelling vehicle; in K type aircraft it will pass from the selector to the 3 in. ring main and be drawn off at the fuselage refuelling/defuelling points.

Transfer

8. Fuel can be transferred from the tank, using one of three alternative mediums, viz:—

(1) The electrically-driven pump housed in the front fuel compartment.

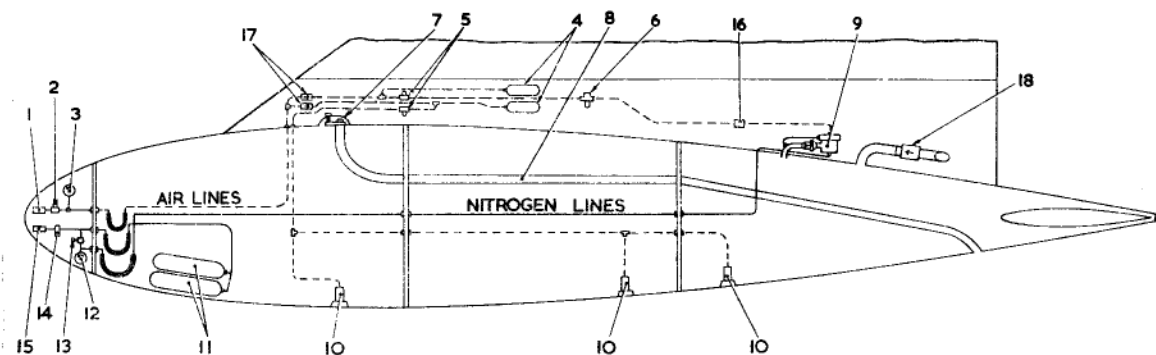


Fig. 2. Underwing tank pressurizing and venting system

- | | |
|------------------------------------|---------------------------------|
| 1 AIR CHARGING CONNECTION | 10 FUEL JETTISON VALVE |
| 2 AIR PRESSURE RELIEF VALVE | 11 NITROGEN BOTTLES |
| 3 AIR PRESSURE GAUGE | 12 NITROGEN PRESSURE GAUGE |
| 4 AIR BOTTLE | 13 NITROGEN MASTER COCK |
| 5 UNIMATIC SOLENOID-OPERATED VALVE | 14 NITROGEN CHARGING FILTER |
| 6 AIR PRESSURE REDUCING VALVE | 15 NITROGEN CHARGING CONNECTION |
| 7 TWO-STAGE PRESSURE RELIEF VALVE | 16 AIR RESTRICTOR VALVE |
| 8 VENT PIPE | 17 NON-RETURN VALVE |
| 9 NITROGEN PRESSURE REDUCING VALVE | 18 INWARD RELIEF VALVE |

(2) High pressure nitrogen to force the fuel through the supply system.

(3) A combination of both pump and nitrogen pressure.

It must be carefully noted that underwing tank pumps are dependent upon ram air for cooling, and for this reason they are not switched on until the aircraft is airborne. For ground testing they must not be operated for periods in excess of two minutes unless blast cooling is applied, and a cooling period of not less than 30 min. must elapse between any two 2-min. test runs. It is also important that the pump is not allowed to run in the dry condition; switching off at TANK EMPTY indication is essential. A fusible link is included in the pump motor circuit as a precautionary measure, the link being affected by temperature and fusing to break the circuit when undue temperature rise occurs.

9. When the load is *consumable fuel*,

selecting the double-poled switch on the pilots' fuel panel to MOTOR ON will isolate the operator's panel START and STOP push switches and the low pressure indicator lamp, and will start the tank pump motor to transfer fuel to the wing tanks via the wing selector valve and wing tank refuelling cut-off valves at approx. 90 gall. per min., and at the same time the circuit to the pilots' low pressure warning lamp will be made. The solenoid in the air pressure reducing valve is not energized when this switch is selected, air at atmospheric pressure being present at the nitrogen pressure reducing valve piston head; this condition will permit nitrogen to pressurize the tank in the low pressure condition. To stop the pump it is not sufficient only to move the switch to OFF; it must first be moved to MOTOR TRIP—EMERGENCY ON and then placed at OFF in order to trip the circuits to the motor and pressure switch. In aircraft post-Mod. 2784 an indicator, fitted to the pilots' fuel panel, will show WHITE when the pump circuit is made and there is electrical supply to the pump motor, but in no way indicates fuel pressure.

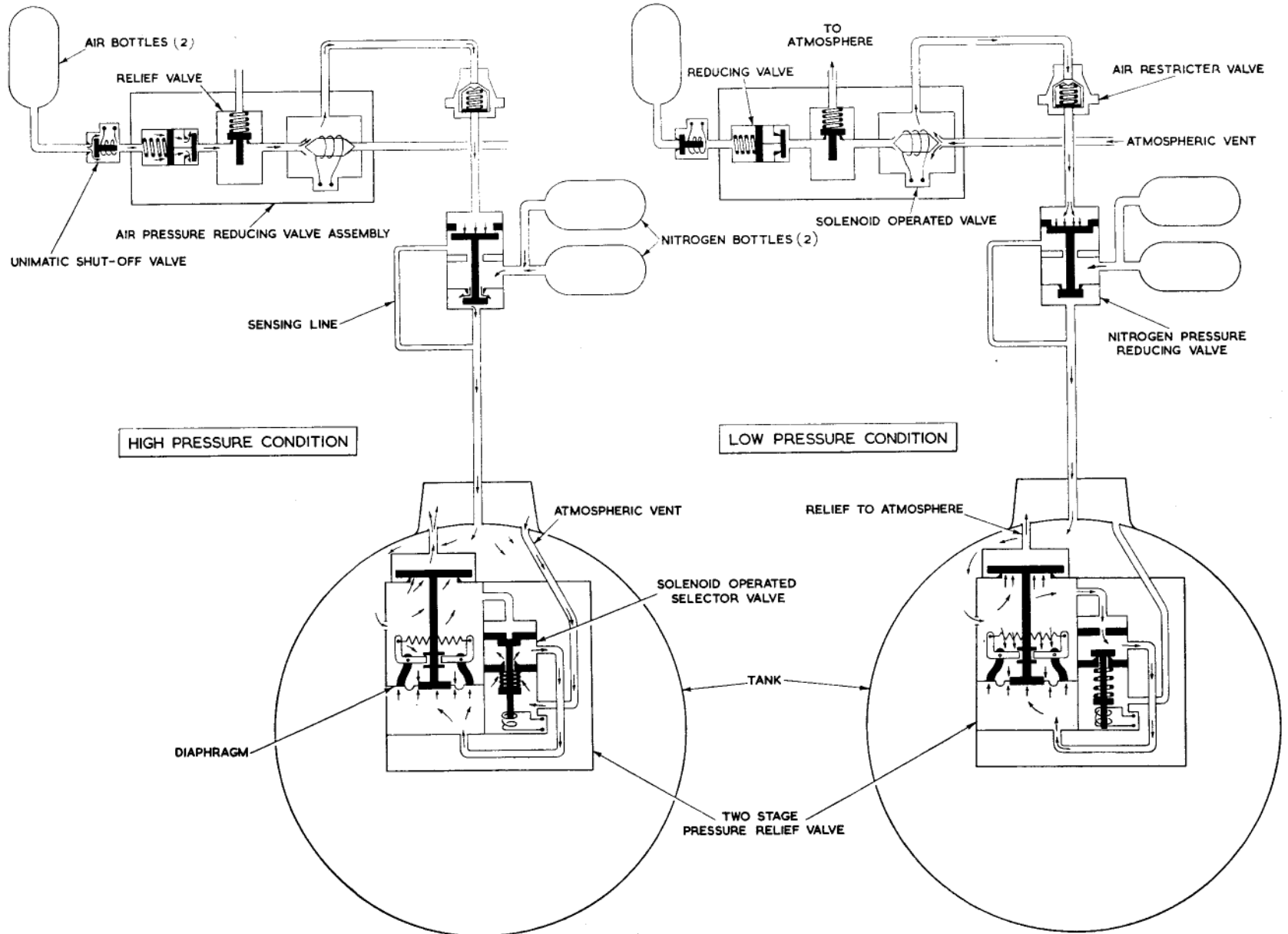


Fig. 3. Underwing tank pressurizing control

10. In the case of pump failure the pilots' control switch is moved to MOTOR TRIP—EMERGENCY ON and in this position the pump motor supply is cut off, the pressure warning indicator will remain in circuit, and the Unimatic air shut-off valve, air pressure reducing valve and two-stage pressure relief valve solenoids will be energized (fig. 3). This closes the line to atmosphere and permits air at approx. $6\frac{1}{2}$ lb/in² to act upon the nitrogen pressure reducing valve piston, resulting in a nitrogen build-up in the tank to force the fuel along the supply lines to the wing tanks. In these conditions transfer rate will be reduced to approx. 20 gall. per min., the supply line pressure will be approx. $7\frac{1}{2}$ lb/in² and will be insufficient to operate the warning indicator pressure switch, consequently the lamp will remain *on* and the contents gauges must be used to ascertain the tank condition. When nearly all the fuel has been transferred the system must be switched off to prevent nitrogen discharging into the wing tanks, otherwise the higher pressure would vent itself into the wing vent system and in so doing would be liable to vent a large quantity of fuel to atmosphere.

11. When the underwing tank fuel is part of a tanker *transferable* load, transfer is controlled from the operator's control panel and will be made by simultaneous use of high pressure nitrogen and the tank pump. When the bomb-bay doors are opened, the relative control switches being at OPERATOR and the master switch ON, the circuit to the Unimatic air shut-off valve, air pressure reducing valve and two-stage pressure relief valve solenoids will be energized; this will close the line to atmosphere and allow air under pressure to pass to the nitrogen pressure reducing valve piston head, causing it to move and permit nitrogen to enter the tank to produce the high pressure condition. Although fuel will commence to flow to the wing selector valve and ring main, the supply line pressure will be only approx. $7\frac{1}{2}$ lb/in² and insufficient to operate the warning indicator pressure switch which is set to make at 10 lb/in² and break at 8 lb/in² (18 and 16 lb/in² respectively, pre-Mod. 2447), the operator's panel warning lamp will be *on* and remain so until the pump

is started by the operator's START push switch.

12. This switch must be depressed and held until the pressure builds up and the warning lamp goes out, an indication that the electrical circuit has been reset and transfer at approx. 140 gall. per min. can continue until the tank is empty or transfer cessation is required. When the tank is empty the pump will be stopped automatically by pressure switch action but the nitrogen will remain *on* either until the bomb-bay doors are closed, or the operator's panel switch is set to PILOT.

Pressurizing and venting (fig. 3)

13. The underwing tanks are pressurized by nitrogen, each tank having a self-contained system operated from two 2250-litre bottles charged to 1800 lb/in². The bottles are fitted in the forward fuel compartment and pass nitrogen to a pressure reducing valve in the stub stalk before it is fed into the tank upper surface via a non-return valve. A small-bore sensing line connects the nitrogen pressure reducing valve and tank supply line. The system can be operated under two different conditions; in a high pressure condition when fuel is being transferred to another aircraft during refuelling in flight operations, and in a low pressure condition when fuel is transferred to the wing tanks as consumable load. In each of these conditions nitrogen is used in conjunction with the tank pump and should not be confused with the special condition arising from tank pump failure when nitrogen only is used to secure fuel transfer.

14. The system is governed by a solenoid-operated air pressure reducing valve and a nitrogen pressure reducing valve which together provide the high or low pressurized condition, and a two-stage pressure relief valve to maintain the desired tank pressure and relieve excessive pressure in either condition by venting to atmosphere through the tank underskin. The air pressure reducing valve, two-stage pressure relief valve and Unimatic air shut-off valve solenoids are electrically interconnected. To operate the valves controlling tank pressurization and fuel jettison, air is supplied from a self-contained system comprising two air storage bottles in the stub stalk connected to a charge-

ing point in the nose compartment which also houses a pressure gauge and a relief valve set to relieve at 450 lb/in².

Low pressure condition

15. In the low pressure condition, the Unimatic air shut-off valve, air pressure reducing valve and two-stage pressure relief valve solenoids will not be energized, air at atmospheric pressure being permitted to enter the lines and operate upon the nitrogen pressure reducing valve piston head. In this condition and with the nitrogen turned *on* before take-off, it will pass to the tank and pressurize it at 0.9 to 1.2 lb/in², a sensing line between the tank supply and the nitrogen pressure relief valve piston underside regulating the condition and supply. The two-stage pressure relief valve solenoid has not been energized, tank pressure being able to pass to each side of the diaphragm. The diaphragm area being less than the pressure relief valve area, a toggle spring is used to counteract the differential and will restrain the valve on its seating provided that the tank pressure does not rise above the valve operating pressure of approx. 2.2 to 2.75 lb/in². Pressure rise above this setting will cause the valve to lift and all excess pressure will be vented to atmosphere via the main vent duct and tank underskin.

High pressure condition

16. In the high pressure condition, the air pressure reducing valve solenoid will be energized and move the valve to close the line to atmosphere and open the line from the air storage supply; the Unimatic air shut-off valve solenoid will also be energized and air permitted to pass via the air pressure reducing valve to the nitrogen pressure reducing valve piston head where it will exert a pressure of 6.0 to 6.7 lb/in². In this condition, nitrogen having been turned *on* before take-off will pass to the tank and pressurize it at approx. 6.9 to 7.9 lb/in². The two-stage pressure relief valve solenoid will also have been energized, the valve moving to close the inter-connection between the upper and lower chambers and open the lower chamber to atmospheric pressure. In this condition

there is tank pressure in the upper chamber and atmospheric pressure in the lower, so that differential pressure is of higher value than in the low pressure case and the valve will not open unless tank pressure rises above the valve setting of approx. 8.5 to 8.75 lb/in², in which case excess pressure will be vented to atmosphere via the main vent duct and the tank underskin.

Fuel jettison

17. Fuel may be jettisoned in an emergency by means of three jettison valves (*App. 4*) in the base of the tank, the valves being operated by a self-contained air system in each tank. Two air bottles charged through the charging valve on the front bulkhead to 450 lb/in² supply air pressure via a Unimatic jettison air valve to open the valves when the appropriate fuel jettison switch on the cockpit port coaming panel is selected to JETTISON.

SERVICING

Protective treatment

18. The tank is treated internally for protection against corrosion but this will still occur if the protective film is damaged. Mod. 2949 introduced an improved method of anti-corrosive protection and on tanks post-Mod. 3009 the nose ring and front bulkhead are of aluminium alloy in lieu of magnesium alloy. Care must be taken to avoid damaging the protective film, but where this is damaged by tools or during removal or assembly of the front bulkhead, or if corrosion is evident when the nose cap door is opened, it must be treated with a temporary film. This should be made up to Spec. D.E.F.2331 (lanolin in white spirit), using lanolin, 33C/511, and white spirit, 34D/264, in a mixture of 30 to 70 by weight.

Charging the air system post-Mod. 2634

19. In this system the air pressure gauge and pressure relief valve (set to 450 lb/in²) are positioned upstream of the non-return valves

and air bottles, thus the gauge will register the lower pressure of the systems. This is because the air pressure in the system between the gauge and the non-return valves, if higher than the pressure downstream of one non-return valve, will flow through that non-return valve into the system with the lower pressure and be registered on the gauge. The higher pressure in the other system is withheld from the gauge by the non-return valve.

Note . . .

It is essential when charging the air system to open the charging cock not more than ¼ of a turn. This will prevent the pressure in the bottles exceeding the pressure shown on the gauge due to surging.

Charging the nitrogen system

20. The nitrogen system should be charged as detailed in Sect 2, Chap. 2, Para. 15.

Rectification of minor leaks

WARNING . . .

Breathing apparatus must be used when working in a confined space, the technique being anaesthetic but not toxic. Where possible a gentle circulating dry air system should be applied.

21. A minor leak in an area where there is a covering of Bostik may be rectified as follows, using an equal mixture of Bostik 1752 and Bostik 1790.

- (1) Clean the surface around the leak by applying a clean cloth dampened with Bostik thinners 6822.
- (2) Brush on an even coverage of the Bostik solution.
- (3) Allow 24 hours drying time before allowing contact with fuel.

ASSEMBLY AND REMOVAL

Assembly and removal of tank

22. Full details of the tank assembly and removal are contained in A.P.2852B, Vol. 1, Sect. 5, Chap. 3, App. 3, to which reference should be made. Use is made of a bomb hoisting gantry and ground hoisting equipment in conjunction with the following tank suspension equipment (*fig. 4*):—

Item	Ref. No.
Load retaining pawl mechanism	11A/4100
Lifting eye	11A/4111
Suspension link	26SR/10765

To prevent damage to the hoist tunnels and mechanism, phenolic resin rubbing strips are bonded, post-Mod. 3021, to the suspension links.

Note . . .

There are two types of bomb-hoisting gantry in current use with ram pistons of different areas. When calculating the hydraulic gauge pressure required during the pre-tensioning and de-tensioning operations care must be taken to adopt the correct figure for the type of gantry being used. The two types are:—

- (1) Crane gantry, bomb hoisting, Ref. No. 16A/1931 (Piston area 11.08 sq. in.)
- (2) Truck, bomb hoisting, Ref. No. 16A/2303 (Piston area 14.65 sq. in.)

Precautions

Before assembly

- 23.** (1) Apply grease XG-275 to the dowels and ensure that electrical connections are clean and free from moisture.
- (2) Check the position of the tank suspension lug as follows:—
- (a) Screw the lug into its housing on top of the tank until the top of the lug is flush with the top of the housing.
 - (b) Screw back the lug until it is in correct athwartships alignment.

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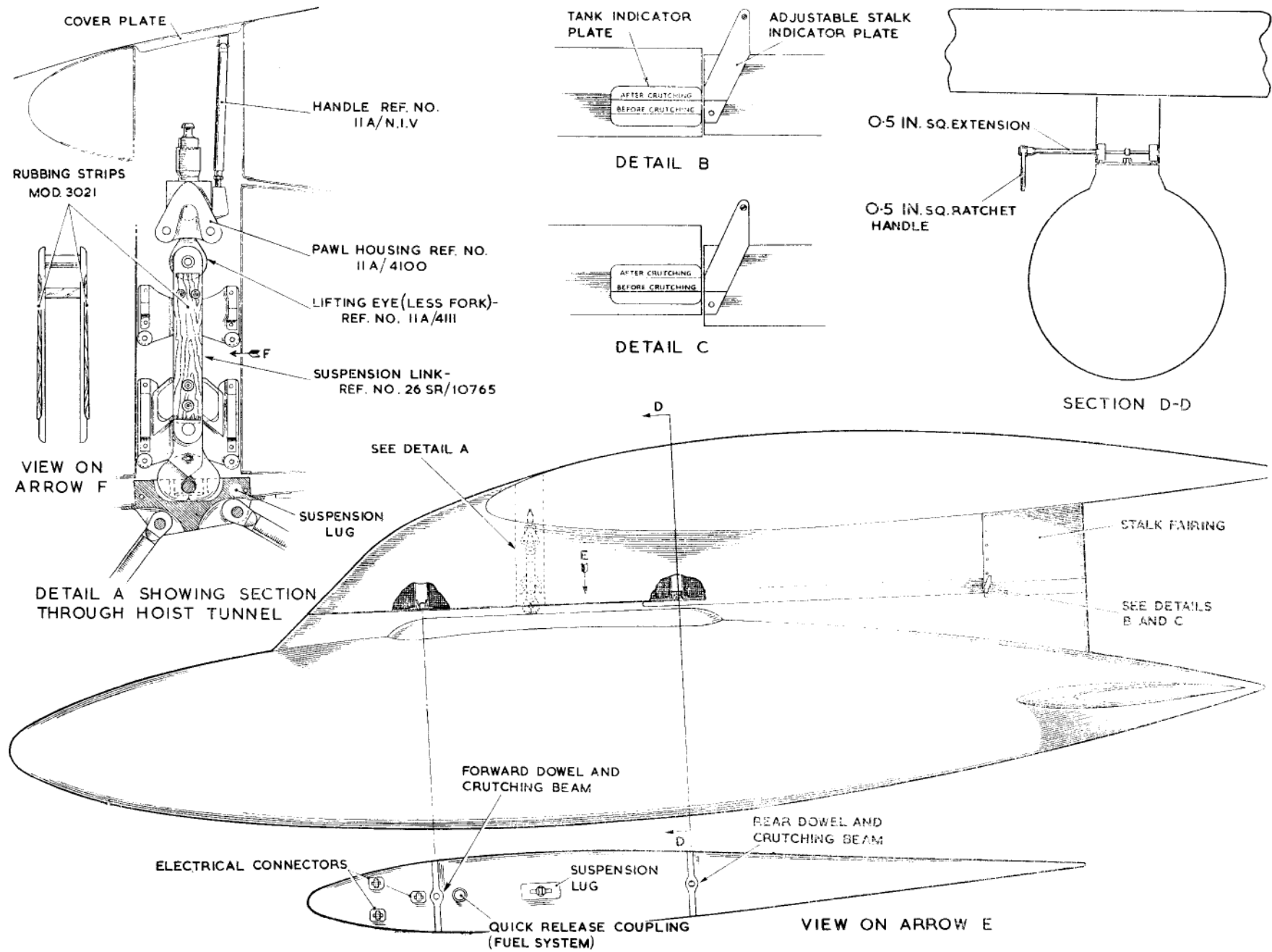


Fig. 4. Underwing tank suspension

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During assembly

24. When the tank is nearing the stalk, keep the tank in a tail-high position so that the rear dowel engages before the front one to prevent the electrical and fuel connections near the nose being damaged.

During removal

25. First lower the tank nose to avoid damaging the electrical and fuel connections. Should the tail of the tank stick due to its binding on the lap plates it should be pulled clear by hand.

During pre-tensioning and de-tensioning

26. For both pre-tensioning and de-tensioning operations during assembly and removal of a tank, a steady pressure of 40,000 lb must be maintained at the hoist jack. It is dangerous to exceed this pressure.

Removal of pump and motor unit from tank**WARNING...**

(1) **The tank must be defuelled before attempting to remove the pump and motor unit.**

(2) **It is essential that breathing apparatus is used when working in a tank that has been drained and still contains fuel vapour.**

27. To remove the pump and motor unit proceed as follows :—

(1) Unlock the nose cap fasteners (*fig. 1*) and swing the nose cap clear of the nose cap bulkhead.

(2) Remove the three split pins and hinge pins securing the nose cap hinge plate and the stay tube ; the nose cap is then free and can be removed.

(3) Remove the ten 2 B.A. bolts from the nose ring casting and carefully push the

nose cap bulkhead into the tank, care being taken to avoid damaging the rubber flex pipes in the process. Lift this bulkhead and, by means of the locating spigots on its rear face, position it on the two brackets on the tank starboard wall ; access may then be gained to the tank forward compartment.

(4) Uncouple the ram air cooling pipe at the union forward of the motor housing.

(5) Loosen the two jubilee clips securing the cooling pipe to the starboard side frames.

(6) Disconnect the electrical leads at the terminals on the motor housing.

(7) Uncouple the centre union on the electrical conduit and remove the clamp securing the conduit to the bracket on the ram air cooling pipe.

(8) Disconnect the couplings on the cooling air outlet pipe and remove the centre portion to prevent possible damage to the pipe when removing the pump.

(9) Disconnect the gland drain pipe adapter on the floor of the tank and disconnect the clip attaching the pump by-pass pipe to the reinforcing falsework below the pump.

(10) Uncouple the first union from the pump on the pump delivery line.

(11) Remove the four stiffnuts securing the pump mounting strut to the pump casting. Loosen the strut attachment at the bulkhead and raise the mounting strut clear of the pump.

(12) Disconnect the side stay from the pump mounting strut fork-end by removing the attachment bolt ; by loosening the strut attachment to the tank structure, the side stay may be moved clear of the pump.

(13) Remove the securing bolt from the pump casting lower port side.

(14) By careful manipulation the pump may then be withdrawn from the pump inlet pipe. Ensure that the O ring seal is withdrawn with the pump.

Assembly of pump and motor unit to tank

28. Assembly of the pump and motor unit is a reversal of the removal sequence. When installing the unit ensure that the O ring seal is fitted and that it is not damaged.

Testing after fitting pump unit**WARNING...**

It is essential that neither fuel nor fuel vapour leaks into the pump motor canister. To eliminate the risk of an explosion, ensure that no leaks occur when carrying out the following tests.

29. After installing a pump and motor unit the following tests must be made before closing the tank:—

(1) Blank off the tank outlets and the fuel pump inlet (*Table 1*) and fit a 15 lb/in² pressure gauge to the connection on the pressure reducing valve elbow. Blank off the sensing line to the reducing valve FLQ/A/3. Energize the solenoid of the pressure relief valve type F.R.1607200.

(2) Apply and maintain an air pressure of 10 lb/in² at the vent pipe blank. Check for leaks the vent pipe, the pump inlet fuel pipes and the air pressure release valve and pipes ; no leakage is permissible.

(3) Apply and maintain an air pressure of 10 lb/in² at the blank on the cooling air outlet pipe. Check for leaks the pump cooling air inlet, the outer pipes, the pump conduit and the canister ; no leakage is permissible.

Note...

Ensure that the pump delivery line coupling has been connected correctly as it is not subject to a pressure test.

TABLE 1**Pressure test blanks**

Description	Part No.	Application
Pressure plate, front	73379-285	Ram air cooling inlet
Pressure plate, rear	73379-287	
Plug	73379-289	
Seal	73379-293	Pump cooling air outlet
Blanking plate	73379-291	
Blanking plate	73379-295	Relief valve vent duct
Seal	73379-297	
Blanking plate	73379-299	Pump inlet duct
Clamping block	73379-3699	Exactor fuel coupling
Clamping block	73379-3700	
Seal	73379-3703	
Seal support plate	73379-283A	

Chapter 2, Appendix 3

BOMB-BAY FUEL TANK

LIST OF CONTENTS

	<i>Para.</i>		<i>Para.</i>		<i>Para.</i>
<i>Introduction</i>	1	<i>Testing the vent valve</i>	10	<i>Vent system ducting leak test</i>	15
<i>Description</i>	2	<i>Testing the tank pressure and refuelling rate</i>	11	Assembly and removal	
<i>Venting</i>	4	<i>Testing the flow from the electrical pumps</i>	12	<i>Fitting the tank in the bomb bay</i> ...	16
<i>Pressurizing</i>	5	<i>Testing the positive lock non-return valve</i>	13	<i>Removing the tank</i>	17
Servicing		<i>Checking the tank pressure during defuelling</i>	14	<i>Fitting the vent system, pre-Mod.2614</i>	18
<i>Testing (tank removed from aircraft)</i> ...	7			<i>Fitting the vent system, post-Mod.2614 and 2847</i>	19
<i>Tank leak test</i>	8				
<i>Testing the pressure reducing valve</i> ...	9				

LIST OF ILLUSTRATIONS

	<i>Fig.</i>
<i>Bomb-bay tank</i>	1
<i>Bomb-bay tank testing</i>	2
<i>Bomb-bay tank venting system</i>	3
<i>Cradle for lifting bomb-bay tank</i>	4

TABLE

	<i>Table</i>
<i>Tank and vent system components</i>	1

Introduction

1. On B/K Mk. 1, B/PR Mk. 1 and B/K/PR Mk. 1 aircraft a tank of 575 gall. capacity may be carried in the bomb bay, attached to the forward end of the bomb-bay roof at Stn.425-35 and 490-01. The tank is refuelled/defuelled from the fuselage port connection as detailed in Sect. 2, Chap. 2, and the fuel is transferred via the refuelling line to the

reserve tank and the No. 1 cell of the fuselage main tank when required for use. The two tank pumps are individually controlled from a MAIN and AUX switch on the fuel control panel; the AUX setting controls the operation of the standby pump introduced by Mod.2444 and 2473 for use in the event of normal pump failure.

Description (fig. 1)

2. The tank, rectangular in section, embodies four tubular longerons with diagonal stabilizers stiffened with diaphragms; the skin plating is of light alloy and all joints are riveted. At each top corner of the tank is a lug for attachment to the bomb-bay roof.

3. Mounted on the tank rear end is the nitrogen pressure reducing valve, the vent valve, inward relief valve, fuel pressure warning light transmitter and associated piping. The vent trunk extends along the top of the

tank with two tank connections, the foremost of which is open and the other incorporates a float-type vent valve. The refuelling / defuelling / transfer pipeline bifurcates before entering the tank; the lower pipe (incorporating a positive lock non-return valve) is connected to the fuel pump, while the upper pipe is connected to the refuelling cut-off valve. Fitted to the inside of the tank is a float switch. Five water drain valves are disposed along the bottom of the tank and a fuel-level window is fitted in the end face of the tank.

Venting (fig. 3)

4. The vent system is separate from but exhausts into the main fuselage vent system. The vent trunk on top of the tank is connected to a large-bore duct incorporating a vent valve on the rear of the tank; by-passing this valve is a pipe with an inward relief valve. From the rear of the tank the vent duct extends

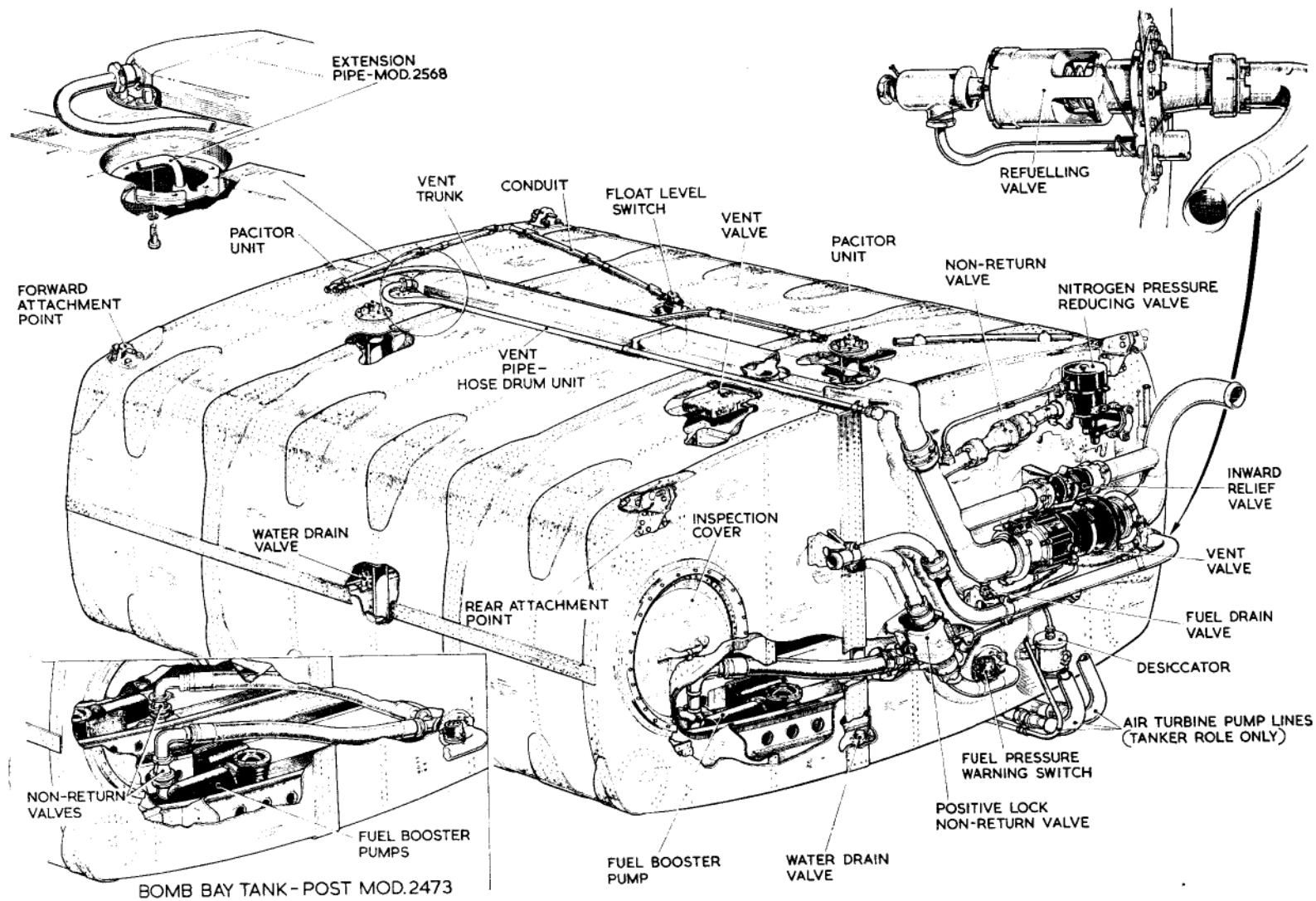


Fig. 1. Bomb-bay tank

along the bomb-bay roof starboard side to Stn. 645 (Stn. 649 post-Mod. 2614) where it rises to join the main fuselage vent system. Three drains are provided, viz., a drain cock in the vent piping at Stn. 577 and a drain plug at each side of the vent on the rear of the tank, for releasing vent pressure or draining fuel or water from the vent ducting. A desiccator is fitted to this ducting on the rear of the tank.

Pressurizing

5. There is no engine air supply for pressurizing. A nitrogen supply is tapped from the nitrogen supply line on the bomb-bay starboard side to the pressure reducing valve on the rear of the tank to pressurize the tank at 0.9 to 1.2 lb/in². The outlet from the reducing valve to the tank incorporates a non-return valve and is connected to the top of the reducing valve by a sensing line.

6. The operation of the pressurizing and venting systems is described in Sect. 4, Chap. 2.

SERVICING

Testing (tank removed from aircraft) (fig. 2)

7. The tank must be in a level attitude and supported by the tank attachment lugs during the following tests.

Tank leak test

8. Blank off all tank outlets and apply a pressure of 4 lb/in² to the tank; no leaks are permissible.

Testing the pressure reducing valve

9. Connect an 1800 lb/in² dry air supply to the pressure reducing valve at A and fit a 0 to 5 lb/in² pressure gauge at E. Turn on the air supply and check the tank pressure which should be 0.9 to 1.2 lb/in²; the valve will operate and vent the tank to atmosphere.

Testing the vent valve

10. (1) Blank off the tank outlets.
- (2) Disconnect the sensing line from the pressure reducing valve to the vent pipe at B.
- (3) Turn on the air supply and check the pressure on the gauge at E at which the valve operates. The relief pressure must be 1.8 to 2.2 lb/in².

Testing the tank pressure and refuelling rate

11. (1) With the refuelling valve and the float switch energized, connect the refueller at C.
- (2) Commence refuelling at maximum governed r.p.m. The pressure at E must be between 1.8 and 2.2 lb/in² and the refuelling rate 80 ± 5 gal. in five minutes.

Testing the flow from the electrical pumps

12. (1) With the tank pressurized and the main and auxiliary pump connected to a 112 v. electrical supply, disconnect the refueller and connect C to a suitable receptacle.
- (2) Switch on the main pump and, timed over five minutes, the flow should be 80 ± 5 gal.
- (3) Repeat operation (2), using the auxiliary fuel pump.

Testing the positive lock non-return valve

13. With the handle normal to the valve centre line, switch on the main fuel pump; there must be no fuel leakage at C.

Checking the tank pressure during defuelling

14. (1) Connect the refueller at C, and set to defuel at maximum r.p.m.
- (2) Check the rate of defuelling and the tank pressure; the latter should be minimum atmospheric.

Vent system ducting leak test

15. (1) Disconnect and blank-off the ducting at the connection to the nitrogen pressure reducing valve on the tank and at the connection to the fuselage main ducting.
- (2) Apply an air pressure of 7.5 lb/in² and check all joints, using a soap and water solution; no leaks are permissible.

ASSEMBLY AND REMOVAL

Fitting the tank in the bomb bay (fig. 4)

16. Ensure that the aircraft is standing on its wheels, that it is defuelled in accordance with the procedure detailed in Sect. 2, Chap. 2, and that the forward lamps have been removed from the bomb bay. Then proceed as follows:—

(1) Position the tank on the special handling trolley Ref. No. 26SR/95547 ◀ (PR role) or Pt. No. 73379, Sht. 569 (FR role) ▶ under the bomb-bay forward end attachment points, and remove the quick-release pins from the four attachment fittings on the tank.

(2) Using the trolley and minilift hoists, raise the tank so that its rear attachment fittings engage the hook fittings at the rear attachment points.

(3) Lift up the tank front end in order to engage its front attachment fitting quick-release pins with the bomb-bay roof front attachment points.

(4) Insert the pins in the rear attachment points and remove the trolley and the hoists.

(5) Select "R" on the fuselage port refuelling/defuelling selector cock, set the port reserve fuel tank cock to OFF, and ensure that the transfer tank positive lock non-return valve is LOCKED SHUT.

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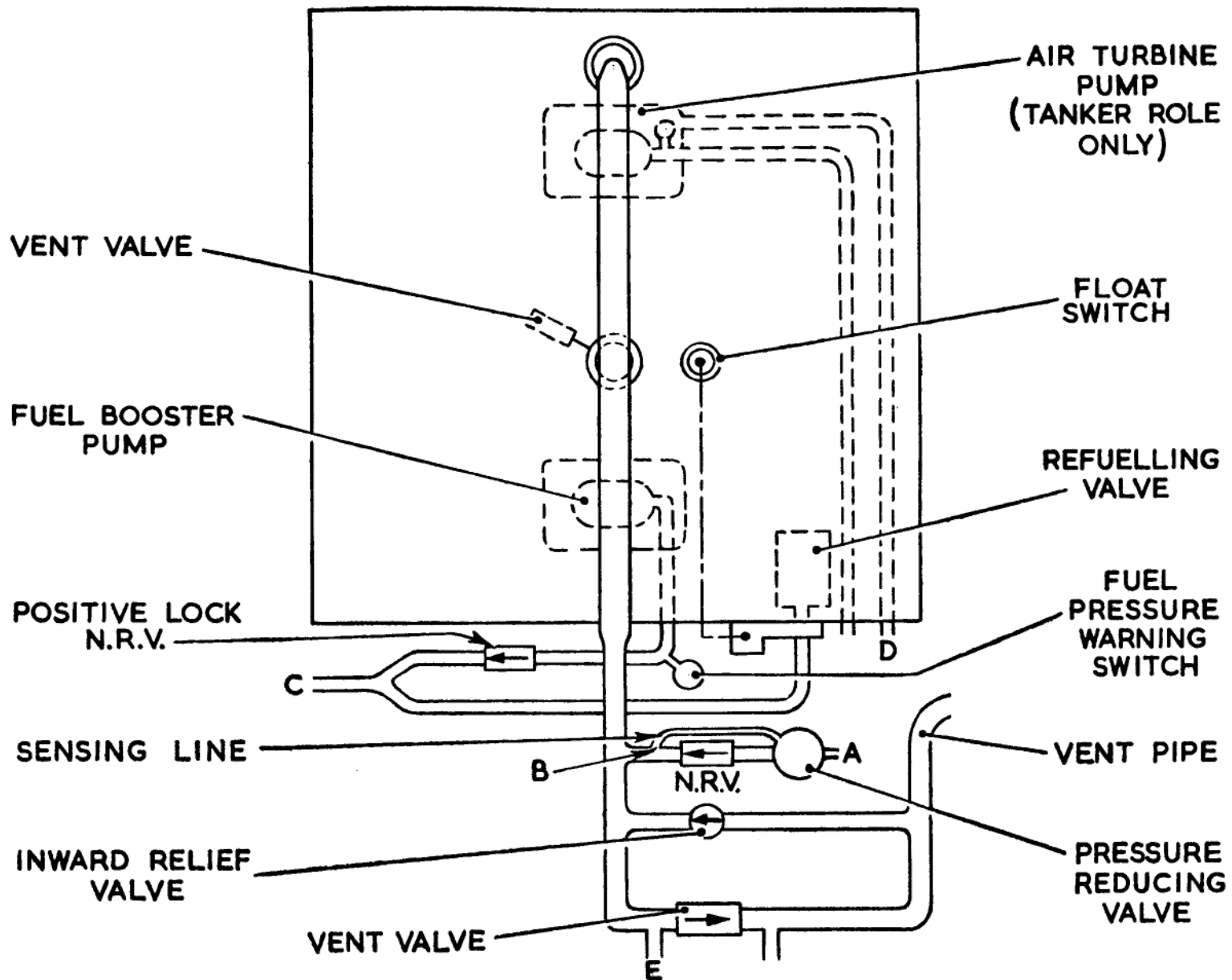


Fig. 2. Bomb-bay tank testing

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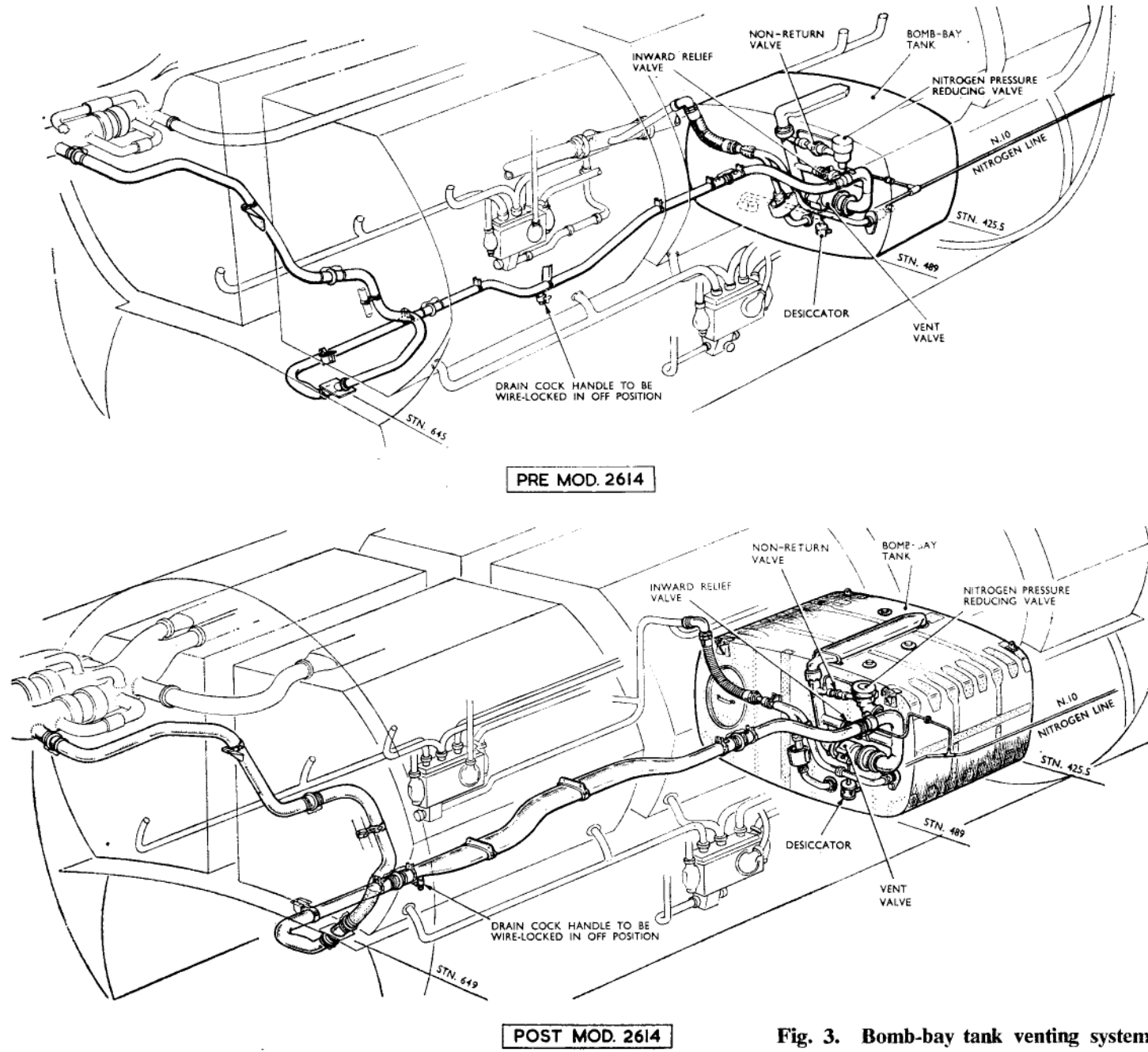


Fig. 3. Bomb-bay tank venting system

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Note . . .

Access to this valve is gained through a panel just aft of the port refuelling point. In the LOCKED SHUT position the valve control handle prevents closure of the access panel.

(6) Remove the blanking cap from the fuel connection in the port side wall of the bomb bay; also remove the blanking cap from the fuel pipe on the rear of the tank and position a suitable receptacle to collect the fuel remaining in the pipelines (approx. 6 gall.).

(7) Referring to Table 1, connect the tank to the bomb-bay connection, using the flexible hose (2) and the pipe coupling (4). The coupling is fully described in A.P.4511, Vol. 1 and 6, Sect. 5, Chap. 2.

(8) Ensure that the nitrogen shut-off valve in the starboard servicing bay is closed and, from the nitrogen connection in the bomb-bay starboard wall, remove the blanking cap and secure it on the adjacent stowage. Remove the blanking cap from the pressure reducing valve lower connection on the rear of the tank.

(9) Using the flexible hose (3), connect the pressure reducing valve to the bomb-bay nitrogen connection.

(10) Lock all pipe and hose connections and connect the two electrical plugs to the appropriate sockets on the starboard forward side.

(11) Select FLIGHT on the refuelling/defuelling selector cock, reset the transfer tank positive lock non-return valve to OPEN, and replace the access panel.

Removing the tank

17. The removal sequence is essentially the reverse of that detailed in para. 16. Ensure that the aircraft is defuelled and that "R" is selected on the refuelling/defuelling selector, that the port reserve fuel tank cock is OFF and the transfer tank positive lock non-return valve is LOCKED SHUT. A suitable receptacle must be provided to collect the fuel remaining in the pipelines (approx. 6 gall.) when the pipe coupling is removed.

Note . . .

Before putting a removal tank into store, (Mod. 2822 provides for a spreader bar and sling Pt. No. 71079 Sht. 657 for hoisting the tank and cradle when away from the aircraft) ► drain all fuel, blank off all tank outlets, and connect a nitrogen supply at 1800 lb/in² to the pressure reducing valve. Turn on the supply and hold the forward water drain valve open for one minute which is sufficient to fill the tank with nitrogen. Turn off the supply and seal the tank. This purging should be repeated at monthly intervals while the tank is in store.

Fitting the vent system, pre-Mod. 2614

(fig. 3)

18. Mod 2105 provides fixed positions on the bomb-bay roof structure to which the vent ducting for the bomb-bay tank is secured. To assemble the tank venting system, refer to Table 1 for the list of components and proceed as follows:—

(1) Using a coupling (11), connect a pipe (10) to pipe Pt. No. 71079-677 on the vent valve at the rear of the tank. with a pipe bracket (5), secure the pipe to the bomb-bay roof at Stn. 528.

(2) Using a coupling (11), connect a pipe (12) to the pipe (10) and, with a bracket (5), secure the pipe (12) to the bomb-bay roof at Stn. 537-48, 557-38 and 609-4; with a bracket (6), secure also at Stn. 575-88. Ensure that the drain cock in the pipe is wire-locked OFF.

(3) Using a pipe connection (14), connect a pipe (13) to the pipe (12) and secure to the bomb-bay roof with a pipe bracket (5) at Stn. 622. Fit a bracket (20) to the bomb-bay roof at Stn. 634-2, and secure pipe to bracket by means of a pipe bracket (5).

(4) Remove the plate Pt. No. 67427-6351 and, using the existing bolts, secure a pipe stub fitting (15) to the bomb-bay roof at Stn. 645. Using a pipe connection (14), connect the pipe (13) to the stub fitting.

(5) Using a connection (14), connect a pipe (18) to the stub fitting upper end. At the frame between the starboard stringers 7 and 8 at Stn. 673, fit a brac-

ket (7) and secure the pipe to it with a pipe bracket (5).

(6) Using a pipe connection (14), connect a pipe (19) to the pipe (18).

(7) Remove the blanking cap Pt. No. 71027-1449 from the fuselage main vent ducting and connect the pipe (19) to the main vent trunk, using the existing pipe connection.

(8) At the point of intersection of the pipe (18) and the engine air pressurizing pipe to the tanks, secure the pipe (18) by means of brackets (8) and (9).

(9) Fit electrical bonding to all pipe joints. Use bonding wire VGS/1302-A.11 on the first joint from the tank, VGS/1302-A.9 on the joint at the forward end of the pipe fitted in the bomb bay, and VGS/1302-A.6 on the remaining joints in the pipe run to the main vent trunking.

Fitting the vent system, post-Mod. 2614 and 2847 (fig. 3)

19. Mod. 2614 revises the run of the vent system ducting, and Mod. 2847 introduces a pipe of flatter section in the bomb bay, to cater for concurrent fitment of Mod. 2609, 2610, 2612 or 2725.

Note . . .

When the aircraft is operating in either the tanker or the bomber role, pipe (12) or (24) respectively should be fitted in the bomb-bay.

To assemble a vent system using pipe Pt. No. 71079-Sht.611, refer to Table 1 and proceed as follows. (For installing a pipe Pt. No. 71079-767 N.D. refer to para. 18, operation (2)).

(1) As para. 18, operation (1).

(2) Using a pipe coupling (11), connect the pipe (24) to the pipe fitted in operation (1) and secure pipe (24) to the bomb-bay roof at Stn.537-48 and 613-78, using a pipe bracket (5). Fit clips (25) and (26) respectively to the bomb-bay roof at Stn.564-98 and 596, and secure the pipe to these clips.

(3) Using a pipe connection (14), connect a pipe (21) to the pipe (24), and secure to the bomb-bay roof (para. 18, operation (3)).

RESTRICTED

(4) Remove the plate Pt. No. 67427-6351 and, using the existing bolts, secure the pipe stub fitting (15) to the bomb-bay roof at Stn. 649. Using a pipe connection (14), connect the pipe (21) to the stub fitting.

(5) Using a connection (14), connect a pipe (22) to the stub fitting upper end. At the frame between the starboard stringers 7 and 8 at Stn. 673 fit a bracket (7) and secure the pipe to it with a pipe bracket (5).

(6) Using a pipe connection (14), connect a pipe (23) to the pipe (22).

(7) Using another connection (14), connect a pipe (19) to the pipe (23).

(8) Remove the blanking cap Pt. No. 71027-1449 from the fuselage main vent ducting and connect the pipe (19) to the main vent trunk, using the existing pipe connection.

(9) Complete the operations (8) and (9) described in para. 18.

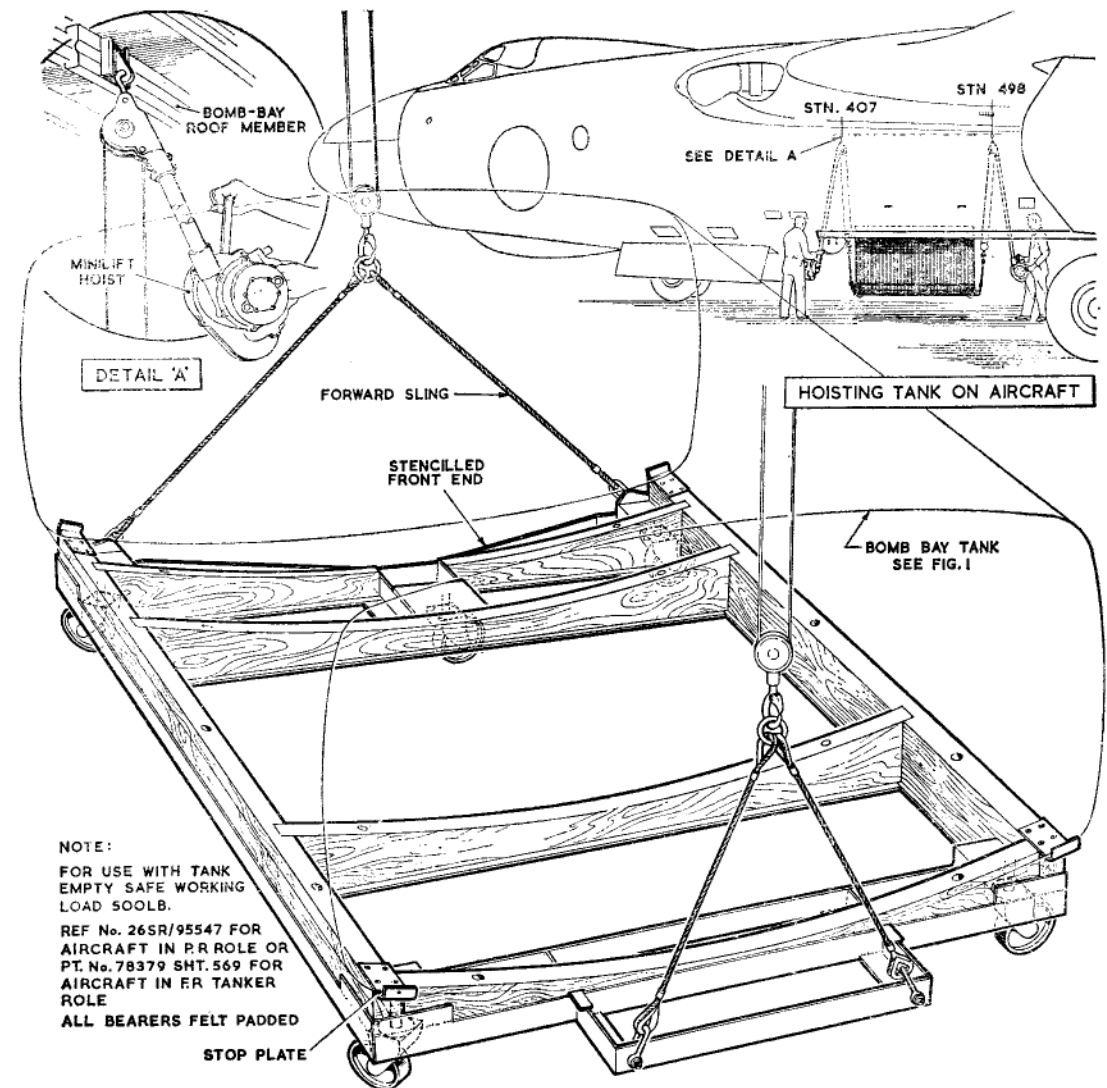


Fig. 4. Cradle for lifting bomb-bay tank

RESTRICTED

TABLE 1
Tank and vent system components

Item	Description	Part No.	Ref. No.	Remarks
1	Fuel tank	71079-Sht. 21	26SR/8441	
2	Flexible hose (fuel)	71079-3483	—	
3	Flexible hose (nitrogen)	67487-65-399	—	
4	Pipe coupling	FRS/110/K	—	
5	Pipe bracket	71079-777	—	
6	Pipe bracket	71079-3413	26SR/11588	
7	Pipe bracket	71079-3635	—	
8	Pipe bracket	71079-3723	—	
9	Pipe bracket	71079-3725	—	
10	Pipe	71079-763	26SR/8472	
11	Rubber coupling	71079-3467	—	
12	Pipe	71079-767N.D.	26SR/8473	
13	Pipe	71079-765	26SR/8474	Pre-Mod. 2614 only
14	Pipe connection	FRS/175/P	27F/3048	
15	Pipe stub fitting	71079-781	26SR/8475	
16	Clip	VGS/383/21	—	} For securing bonding wire
17	Clip	VGS/1000/3	28E/8185	
18	Pipe	71079-1893N.D.	26SR/8476	Pre-Mod. 2614 only
19	Pipe	71079-1891N.D.	26SR/8477	
20	Bracket	71079-3707	—	
21	Pipe	71079-613	26SR/14226	} Post-Mod. 2614 only
22	Pipe	71079-687	—	
23	Pipe	71079-685	—	
24	Pipe	71079-611	—	
25	Clip	71079-645	—	} Post-Mod. 2847 only
26	Clip	71079-617	—	

RESTRICTED

Chapter 2 Appendix 4

FUEL SYSTEM COMPONENTS

LIST OF CONTENTS

	<i>Para.</i>		<i>Para.</i>		<i>Para.</i>
<i>Introduction</i>	1	<i>Testing the refuelling/defuelling box</i>	16	Fuel drain valves	
Wing tanks selector valve	2	Fuel distributor box	17	<i>Dismantling</i>	29
<i>Dismantling</i>	4	<i>Dismantling and assembly</i>	18	<i>Overhaul</i>	30
<i>Overhaul</i>	5	<i>Overhaul</i>	19	<i>Testing</i>	31
<i>Assembly</i>	6	<i>Testing</i>	20	Desiccators	
<i>Testing</i>	7	Water drain valves		<i>Dismantling</i>	32
Fuselage pump housing	8	<i>Dismantling</i>	21	<i>Overhaul</i>	33
<i>Refuelling/defuelling box</i>	9	<i>Overhaul</i>	22	<i>Testing</i>	34
<i>Inlet pipe sub-assembly</i>	10	<i>Assembly</i>	23	Actuated fuel cocks	
<i>Dismantling the pump housing</i>	11	<i>Testing</i>	24	<i>Dismantling</i>	35
<i>Dismantling the inlet pipe sub-assembly</i> <i>(pre Mod. 1427)</i>	12	Underwing tank fuel jettison valve		<i>Overhaul</i>	36
<i>Dismantling the inlet pipe sub-assembly</i> <i>(post Mod. 1427)</i>	13	<i>Dismantling</i>	25	<i>Assembly</i>	37
<i>Overhaul</i>	14	<i>Overhaul</i>	26	<i>Testing</i>	38
<i>Assembly</i>	15	<i>Assembly</i>	27	Heater muff	39
		<i>Testing</i>	28	<i>Assembly</i>	41

LIST OF ILLUSTRATIONS

	<i>Fig.</i>		<i>Fig.</i>
<i>Wing tanks selector valve</i>	1	<i>Water drain valves</i>	6
<i>Fuselage pump housing</i>	2	<i>Fuel jettison valve—underwing tank</i>	7
<i>Inlet pipe sub-assembly—fuselage pump housing (pre-Mod. 1427)</i>	3	<i>Valve test canister</i>	8
<i>Inlet pipe sub-assembly—fuselage pump housing (post-Mod. 1427)</i>	4	<i>Fuel drain valve—wing tanks</i>	9
<i>Fuel distributor box</i>	5	<i>Fuel drain valve—underwing tank</i>	10
		<i>Desiccators</i>	11
		<i>Actuated fuel cock</i>	12

TABLE

	<i>Table</i>
<i>Component location</i>	1

RESTRICTED

(2) *Internal leak test:—*

Apply a fuel pressure of 11 lb/in² for the conditions shown below. For each setting the total leakage from all branches must not exceed 120 cu. in. per min.

- (a) Pressure applied at branch A, locating arm in position B, branch C blanked off.
- (b) Pressure applied at branch A, locating arm in position C, branch B blanked off.
- (c) Valves A. 5749 only, pressure applied at branch A, locating arm in SHUT position, branches B and C blanked off.
- (d) Pressure applied at branch B, locating arm in position A, branch C blanked off.

(3) *Torque tests:—*

- (a) Assemble the gear train on the lower bearing plate and attach it to the body, omitting the free coupling.
- (b) Check that the torque applied at the operating spindle does not exceed 10 lb. in. to disengage the spring-loaded plunger from the countersunk locations, or 5 lb. in. when passing between the locations.
- (c) Remove the gear train and re-assemble complete with the free coupling.
- (d) With no fuel pressure applied, check that the torque required, at the universal joint, to operate the valve does not exceed 35 lb. in.
- (e) Rotate the spindle to branch A and blank off the flanged branch O.
- (f) Apply fuel pressure at 11 lb/in² at branch A and check that the torque required, at the universal joint, to operate the valve, does not exceed 50 lb. in.

FUSELAGE PUMP HOUSING

(fig. 2, 3 and 4)

8. This housing is a light alloy casting forming a box-like manifold the six faces of which are machined for the attachment of components. The housing is handed by these attachments which consist of a pump on each end face, a vapour outlet on each side, but at opposite ends, a refuelling/defuelling box on the underside and the inlet pipe sub-assembly on the top. A water drain is fitted to the base of the housing and each fuel pump has a gland drain.

Refuelling/defuelling box (fig. 2)

9. This box is a light alloy casting with two of its faces machined and fitted with studs, one for attachment to the pump housing and the other to take a refuelling/defuelling coupling. There is an outlet pipe at 90 deg. to the coupling, and a non-return valve in the fuel port from the pump housing. The box is provided with a water drain.

Inlet pipe sub-assembly (fig. 3 and 4)

10. This sub-assembly is bolted to the top of the pump housing to which it provides four

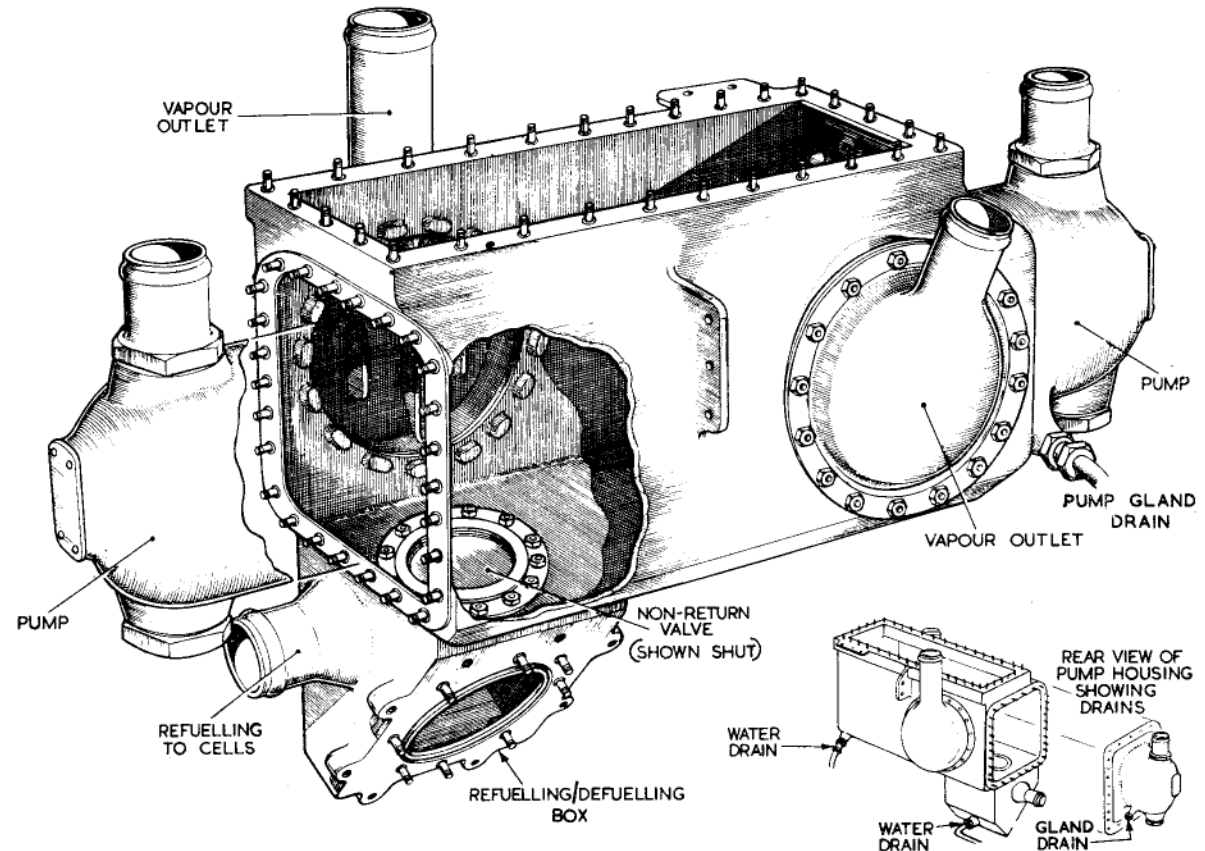


Fig. 2. Fuselage pump housing

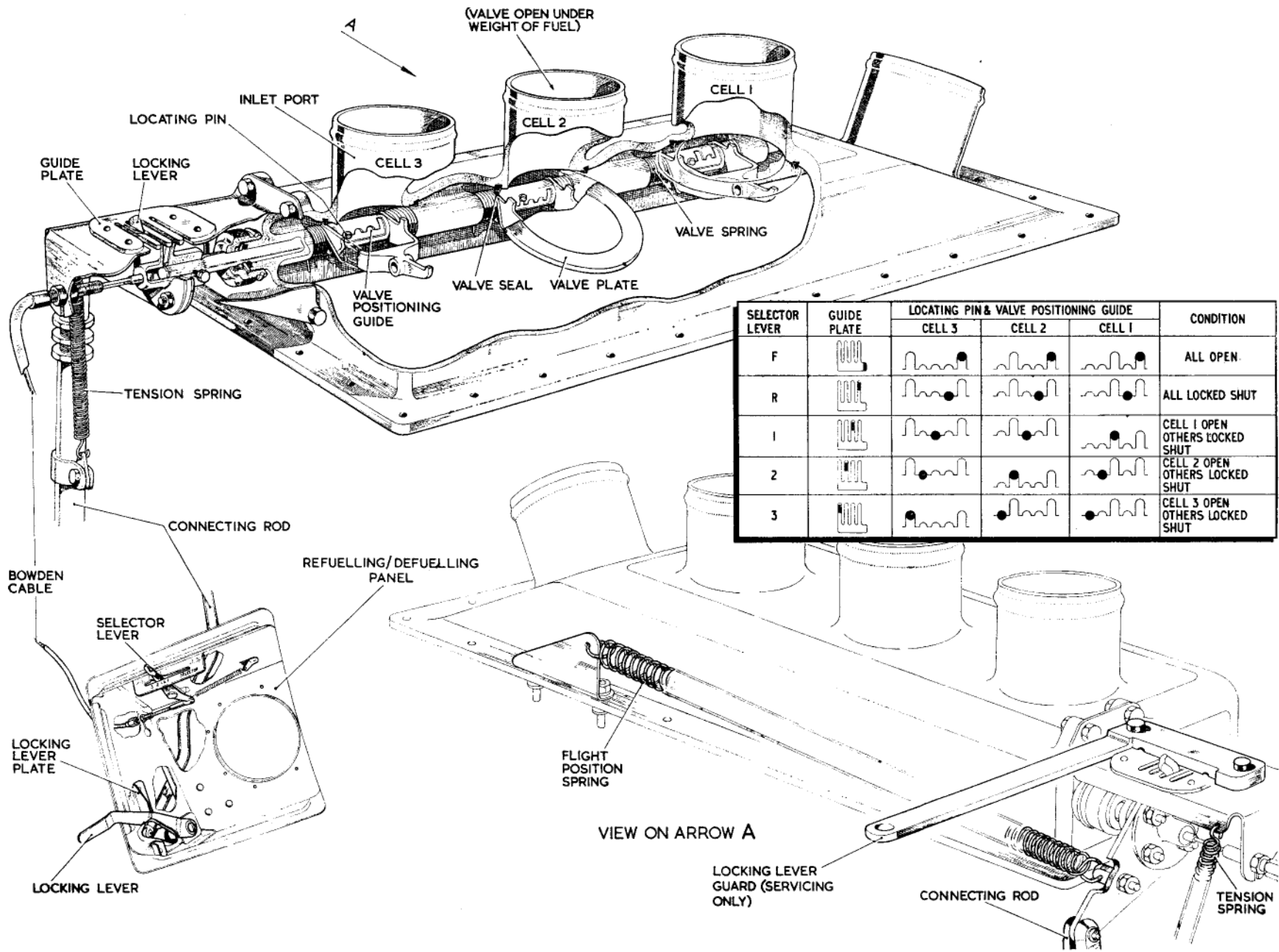


Fig. 3. Inlet pipe sub-assembly—fuselage pump housing (pre-Mod. 1427)

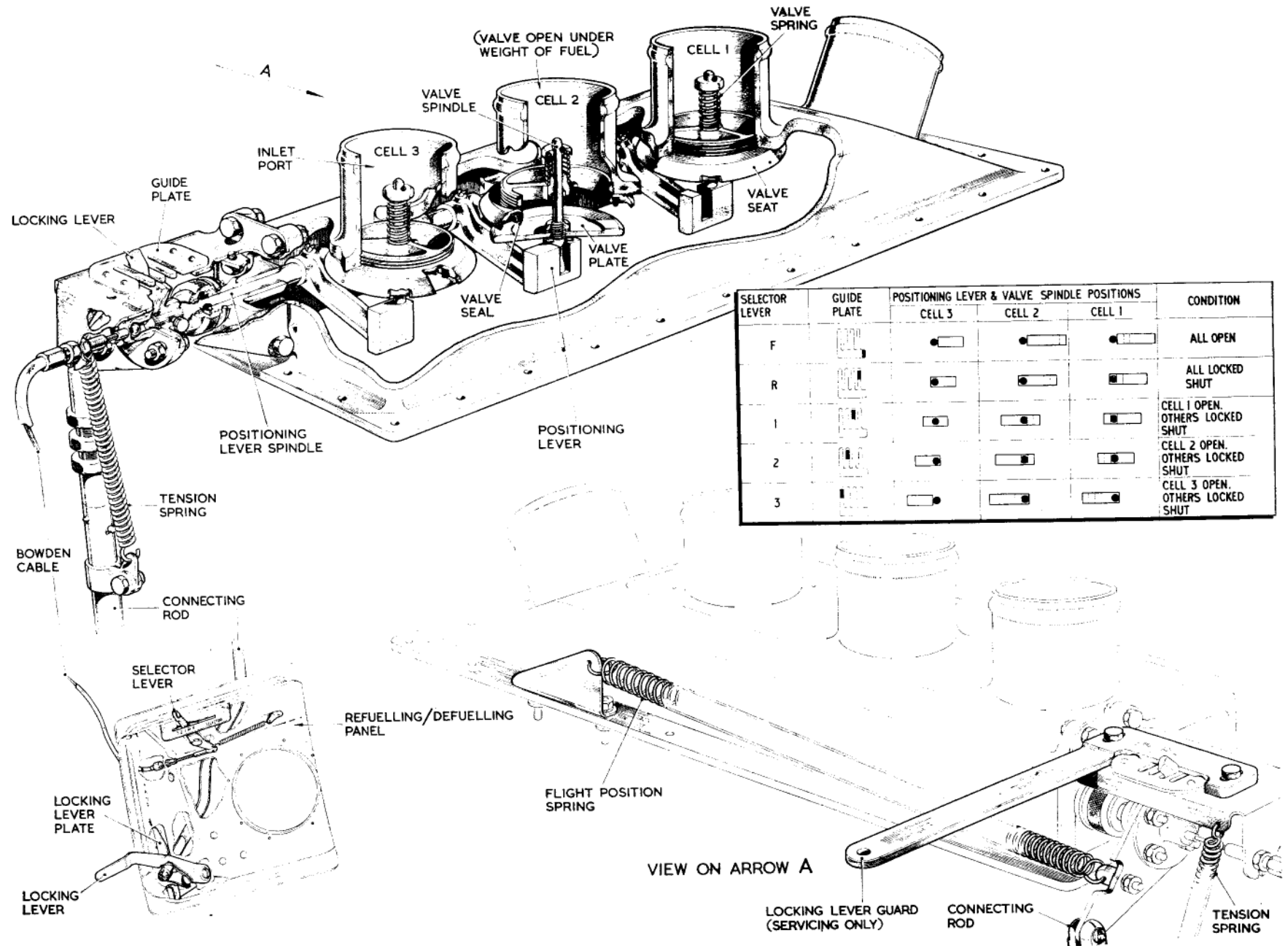


Fig. 4. Inlet pipe sub-assembly—fuselage pump housing (post-Mod. 1427)

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fuel entry ports connecting respectively with No. 1, 2 and 3 cells of the fuselage tank and with the reserve tank. A combined non-return and defuelling valve is fitted at each of the entry ports from No. 1, 2 and 3 cells; all three valves are controlled from a common selector lever and are free to act as non-return valves when the lever is in the FLIGHT position. The lever has four further positions to enable any two or all three valves to be held against their seats so that the reserve tank or any individual cell of the fuselage tank can be defuelled. The control of fuel from the reserve tank is by an electrically-actuated cock in the fuel line from the tank. Two types of combined non-return and defuelling valve are used, pre-Mod. 1427 and post-Mod. 1427, but the selector, locking levers and the lever guide bracket are identical. The operating principle of both types of valve is the same.

Dismantling the pump housing

11. (1) Release the FLIGHT position spring.
- (2) Remove the nuts and spring washers from studs securing the pumps, vapour outlets and inlet pipe sub-assembly, and detach these items.
- (3) Remove the nuts and spring washers from inside the housing, to release the refuelling/defuelling box; this operation will free the non-return valve assembly.

Dismantling the inlet pipe sub-assembly (pre-Mod. 1427)

(fig. 3)

12. (1) Remove the lever guide bracket and locking lever.
- (2) Mark each valve and the adjacent housing to facilitate re-assembly.
- (3) Remove the locating pin from each valve positioning guide.

- (4) Remove the gland nut circlip and unscrew the gland nut.
- (5) Withdraw the spindle. The valves and springs will then drop clear and the valve seating rings can be eased out of their grooves.

Dismantling the inlet pipe sub-assembly (post Mod. 1427) (fig. 4)

13. (1) Remove the lever guide bracket and the locking lever.
- (2) Remove the valves by holding the valve plate against its seat, depressing the spring retaining clip and removing the split pin.
- (3) Before removing the valve bodies, carefully note for subsequent reassembly

the method of wire-locking and the positions of the ends of the wire.

- (4) Break the wire locking and remove the valve bodies.
- (5) Mark each positioning lever and the adjacent housing to facilitate reassembly.
- (6) Remove the gland nut circlip and unscrew the gland nut.
- (7) Remove the split taper-pins from the positioning levers and withdraw the spindle.

Overhaul

14. (1) Thoroughly clean all parts and examine for wear or damage.
- (2) Check the valve seating rings for deterioration.
- (3) Check all studs for security.

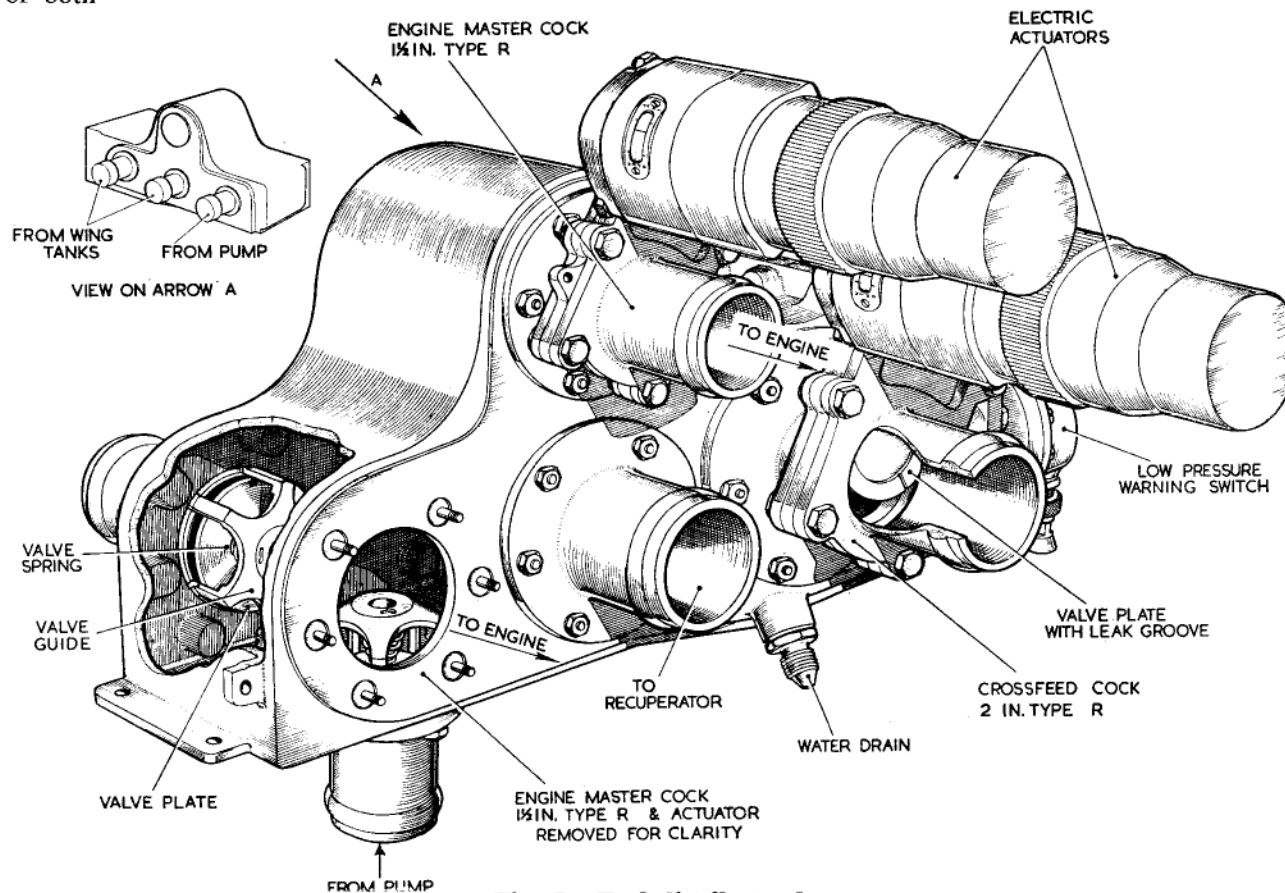


Fig. 5. Fuel distributor box

Assembly

15. Assembly is essentially the reverse of the dismantling operations, but the following points must be carefully noted when assembling the inlet pipe sub-assembly:—

- (1) Ensure that the non-return valves and, post-Mod. 1427, the positioning levers are refitted in the original positions from which they were removed.
- (2) When securing the valve bodies (post-Mod. 1427) they must be wirelocked to each other and care must be taken to ensure that the ends of the wire are tucked into the chamfer on the body and do not obstruct the correct functioning of the valve plates.

Testing the refuelling/defuelling box

16. (1) With the refuelling/defuelling box assembled to the pump housing, test as follows:—

- (a) Blank off the inlet and outlet ports.
- (b) Apply fuel pressure at 75 lb/in² through the drain pipe connection. There must be no leakage from the joint.
- (c) Lower the pressure to 50 lb/in² and allow to settle for 5 minutes. Leakage through the non-return valve to the pump housing must not exceed 25 c.c. per minute.

(2) To test the completed pump housing:—

- (a) Blank all openings with the exception of the three fitted with non-return valves and the drain connection in the pump housing.
- (b) Select R and apply fuel pressure at 15 lb/in² to the drain connection. There must be no leakage from the joints or spindle gland; leakage past each non-return valve must not exceed 10 drops per minute.

(3) To test the leakage rate of non-return valves (pre-Mod. 1427):—

- (a) Select Cell 1 and suspend a 100 lb. weight on the end of the locking lever.
- (b) Apply fuel pressure at 2½ lb/in² at the entry port from Cell 2.
- (c) The leakage through the valve must not exceed 10 c.c. per minute when the locking lever is 0.15 in. from the bottom of the slot in the guide plate.
- (d) Select Cell 2 and repeat the test for Cell 3.
- (e) Select Cell 3 and repeat the test for Cell 1.

(4) To test the leakage rate of non-return valves (post-Mod. 1427), proceed as for pre-Mod. valves but with an 87 lb. weight suspended from the locking lever.

- (a) Apply fuel pressure at 6 lb/in²
- (b) The leakage through the valve must

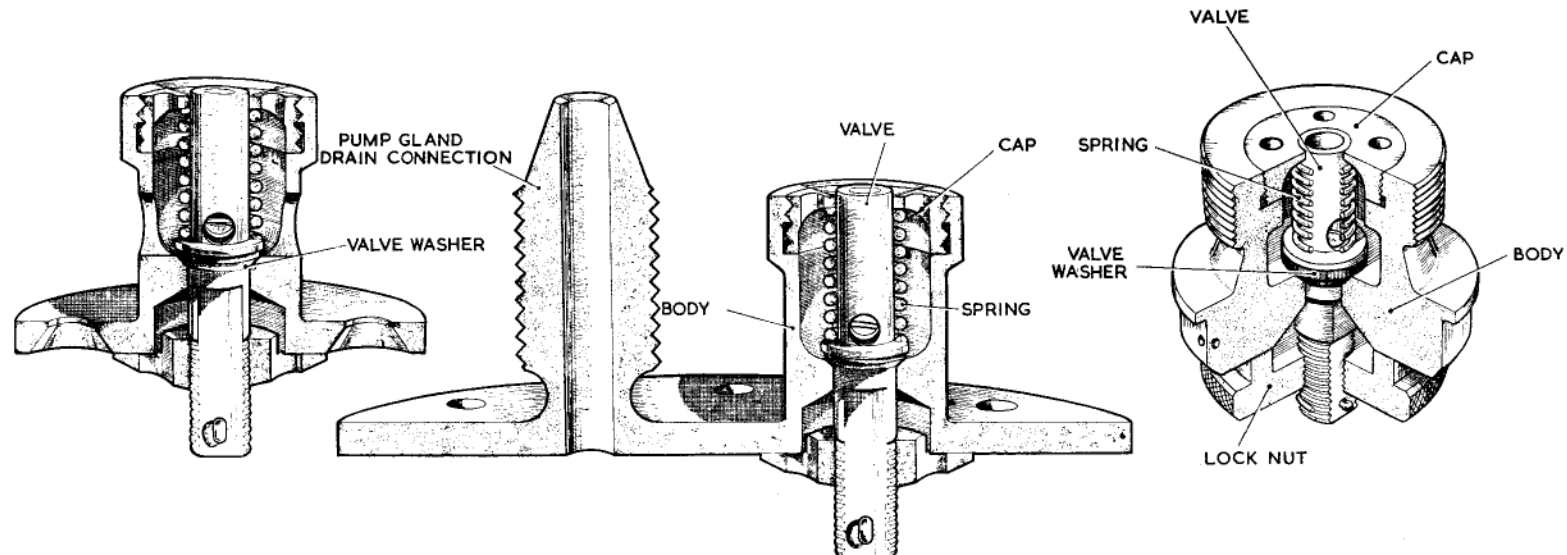


Fig. 6. Water drain valves

not exceed $\frac{1}{2}$ -gallon per minute when the locking lever is 0.15 in. from the bottom of the slot in the guide plate.

FUEL DISTRIBUTOR BOX (fig. 5)

17. Fuel from the wing and fuselage booster pumps is united in the distributor box to give a common supply to the engines. The distributor box is a light alloy manifold, with components bolted to its front, rear and underside faces and to one end. Fuel from the booster pumps in the wing and the rear booster pump on the pump housing enters the manifold through its rear face; fuel from the forward pump in the pump housing enters through the base of the manifold. A spring loaded non-return valve is incorporated in each of these inlet connections to preclude the possibility of fuel being transferred anywhere other than to the engines when the wing and fuselage pumps are not running simultaneously. A small slot, cut in the non-return valve plate in the inlet connection from No. 1 wing tank, relieves any excessive thermal pressures in the distributor box. Machined on the front face of the manifold are four fuel ports to which are attached a crossfeed cock, two engine master cocks and a pipe connection to the recuperator. A fuel low pressure warning transmitter is attached to the manifold end face and a water drain is located in the base.

Dismantling and assembly

18. This is straightforward and no special sequence is required. Care must be taken, however, to ensure that the non-return valve assembly marked POSITIVE LEAK on the flange is replaced in the same position from which it was removed.

Overhaul

19. (1) Clean all parts thoroughly and examine for damage, wear and distortion.
- (2) Check all studs for security.
- (3) The condition of the non-return valve springs is satisfactory if the valves are functioning correctly.

Testing

20. Two tests are required. Assemble a test rig comprising a hand pump, pressure gauge, a fuel reservoir and the necessary piping and fittings. Remove the low pressure warning transmitter and blank off the opening. Blank off the water drain connection and the outlet to the recuperator. Close the 2in. cock and one of the two $1\frac{1}{2}$ in. cocks, blank off the outlets from these cocks and proceed as follows:—

(1) *Testing the non-return valves:—*

(a) Open the remaining cock and apply a fuel pressure of 20 lb/in² through the open outlet to this cock.

(b) After a settling period of not less than five minutes, check that the leakage past the non-return valve marked POSITIVE LEAK is 40 ± 20 c.c. per minute and that leakage past the other three non-return valves is not greater than 10 drops per minute. There must be no leakage past the joint rings.

(2) *Testing the joints:—*

(a) Blank off the POSITIVE LEAK non-return valve and apply air pressure at 40 lb/in² at the open cock.

(b) Immerse in kerosene, ensuring that the level does not rise above the base of the actuators.

(3) There must be no leakage past the joints or seal rings.

WATER DRAIN VALVES (fig. 6)

Dismantling

21. Dependent upon the type of valve to be dismantled, grip the hexagonal valve body in a protected vice or insert two metal pegs in opposite holes in the flange and grip these in a vice, whichever is applicable. Unscrew the cap with a peg spanner and remove the split pin from the plunger stem. Remove the locknut and lift out the spring and plunger assembly.

Overhaul

22. Clean all parts and examine each item for general condition. Should the valve washer show signs of wear or deterioration it must be renewed. When fitting a new washer on the plunger, ensure that the chamfered face is away from the shoulder.

Assembly

23. Reverse the dismantling procedure and secure the cap by centre pop locking.

Testing

24. Assemble a test rig comprising a hand pump, pressure gauge, fuel reservoir, and the

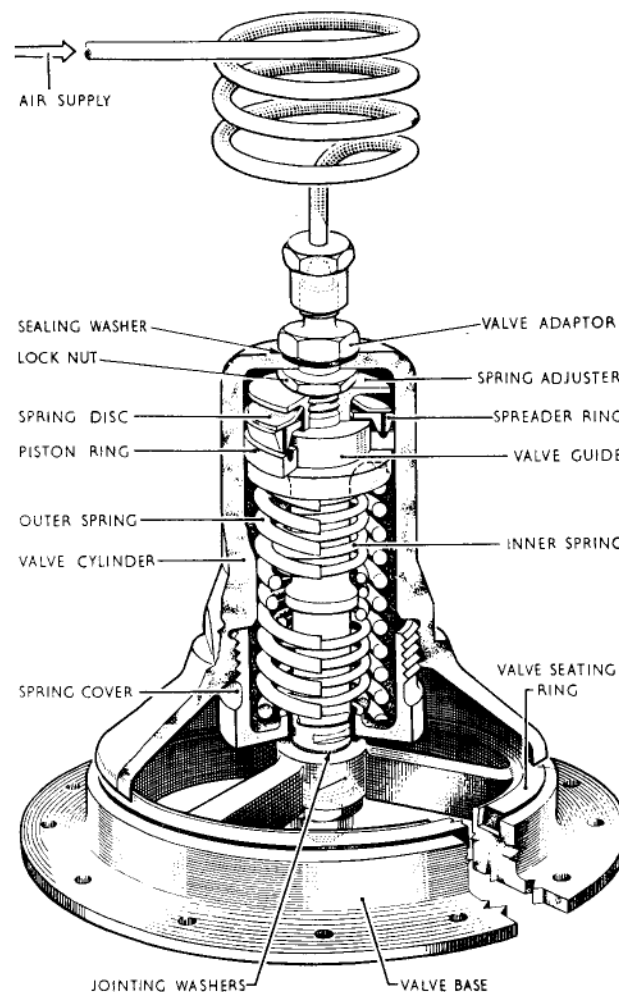


Fig. 7. Fuel jettison valve—underwing tank

necessary piping and fittings. Attach the valve to the rig, apply fuel to the spring side and test for five minutes:—

- (1) Under a 6 in. head.
 - (2) Under a 30 lb./in² pressure.
- There must be no leakage in either case.

UNDERWING TANK FUEL JETTISON VALVE (fig. 7)

Dismantling

25. (1) In a protected vice, grip the valve cylinder, base uppermost.
- (2) Open the valve, by lifting the base away from the cylinder, and insert a spanner to engage the two flats on the piston rod.
- (3) Remove the 7/16 in. B.S.F. Nyloc nut and remove the base.
- (4) Using a large box spanner unscrew the spring cover.
- (5) Withdraw the springs and piston rod assembly.
- (6) Unscrew the spring adjuster from the piston rod and remove the spring disc, spreader ring and piston ring.
- (7) Remove the locknut securing the valve adapter and remove the adapter.
- (8) Remove the valve seating ring from the base.

Overhaul

26. (1) Thoroughly clean all parts and examine for damage, wear and distortion.
- (2) Check the valve seating ring for deterioration.
- (3) Failure on test will indicate the necessary replacements.

Assembly

27. Assembly is the reverse of dismantling. Assemble the valve seating ring to the base,

using P.R.C. 1221 (Ref. No. 33C/1400). The inside bore of the valve cylinder and the piston surface in contact with the cylinder surface should be lightly dusted with molybdenum disulphide powder (Ref. No. 34B/9429867) before assembly. Ensure that the piston ring is assembled the correct way round, i.e., with the groove towards the spreader ring. Lock the valve adapter locknut, the spring adjuster and the spring cover by centre pop locking.

Testing

28. (1) Operational test:—

- (a) Open and shut the valve ◀six▶ times with 450 lb./in² operating pressure applied at the air valve adapter.
- (b) Open and shut the valve ◀six▶ times with 150 lb./in² operating pressure.

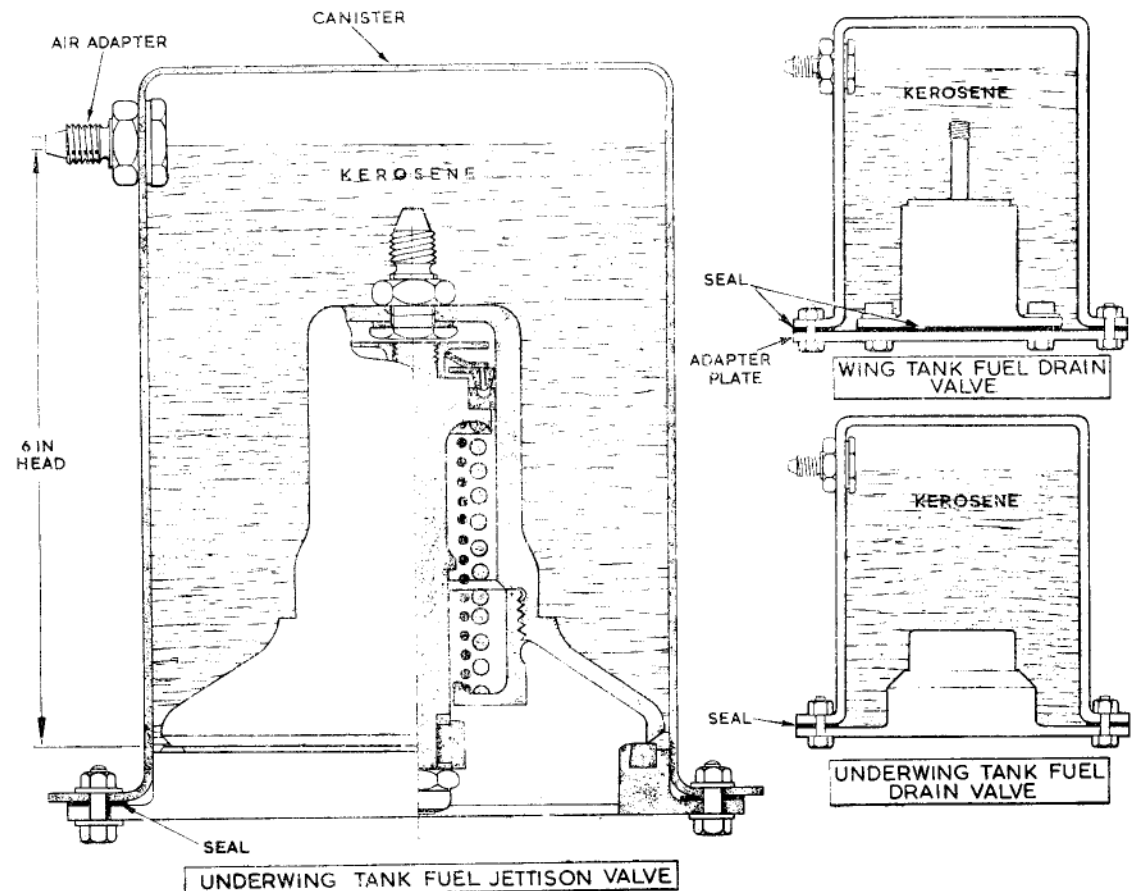


Fig. 8. Valve test canister

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(2) *Proof test for air side:—*

Apply an air pressure of 675 lb./in² at the valve adapter and submerge the valve in kerosine for one minute. There must be no leak.

(3) *Valve seat test (fig. 8)*

This is carried out using a locally manufactured open-ended canister, provided with an air inlet adapter and capable of withstanding an internal pressure of 30 lb/in². Clamp the valve inside the

canister as shown in fig. 8 and test for 5 minutes:—

(a) With a 6 in. head of fuel above the valve seat.

(b) With 15 lb/in² air pressure applied on top of the fuel.

There must be no leakage past the valve seat in either case.

FUEL DRAIN VALVES (fig. 9 and 10)

Dismantling

29. The fuel drain valves in the wing tanks

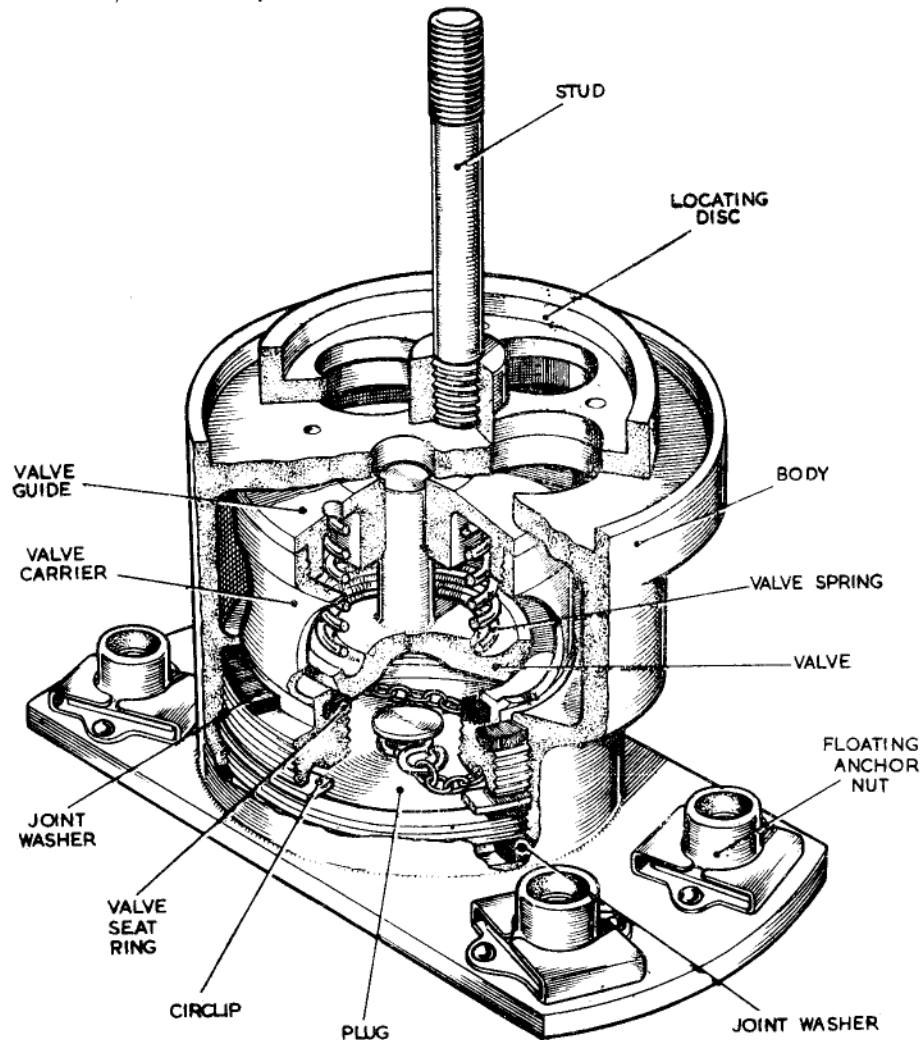


Fig. 9. Fuel drain valve—wing tanks

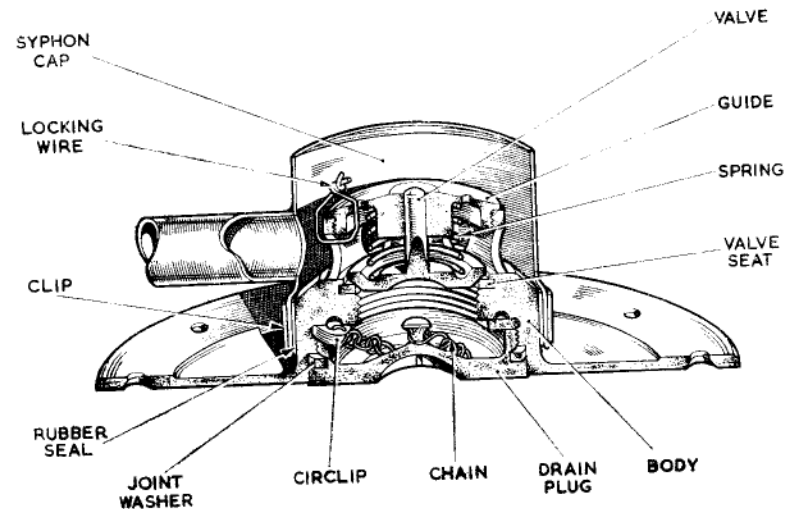


Fig. 10. Fuel drain valve—underwing tank

and the underwing tanks are dismantled as follows:—

(1) *Wing tank valve (fig. 9):—*

(a) Grip the valve body in a protected vice.

(b) Unscrew the captive plug and remove the circlip.

(c) Unscrew the valve carrier and guide assembly, using a peg spanner.

(d) Fit two $\frac{1}{8}$ in. dowels to the holes in the valve guide and grip in the vice.

(e) Unscrew the valve carrier; the valve, valve spring and seating washer can then be removed.

(2) *Underwing tank valve (fig. 10):—*

(a) Remove the syphon cap.

(b) Grip the flange on the valve body in a protected vice.

(c) Unscrew the captive plug and remove the circlip.

(d) Break the wire locking and unscrew the valve guide.

(e) Remove the valve, valve spring and seating washer.

Overhaul

30. Clean all parts and examine for general condition. Should the valve washer or the joint washer show signs of wear or other deterioration it must be renewed.

Testing (fig. 8)

31. Assemble a test rig comprising the canister for testing the underwing tank jettison valve, a hand pump, pressure gauge, and the necessary piping and fittings. Attach the valve to the canister, remove the drain plug and test for five minutes:—

- (1) Under a 6 in. static head of fuel.
- (2) Under 30 lb/in² air pressure applied to the top of the fuel.

There must be no leakage in either case.

Note...

When testing the wing tank fuel drain valve an adapter plate will be necessary as shown in fig. 8.

DESICCATORS (fig. 11)**Dismantling**

32. (1) Grip the barrel in a protected vice and unscrew the end cap.
- (2) Lift out the valve mechanism and filter.
- (3) Remove the cotton wool pad and tip out the silica-gel. The closed end filter will then fall out.
- (4) Remove the gauze-covered plug from the end cap.

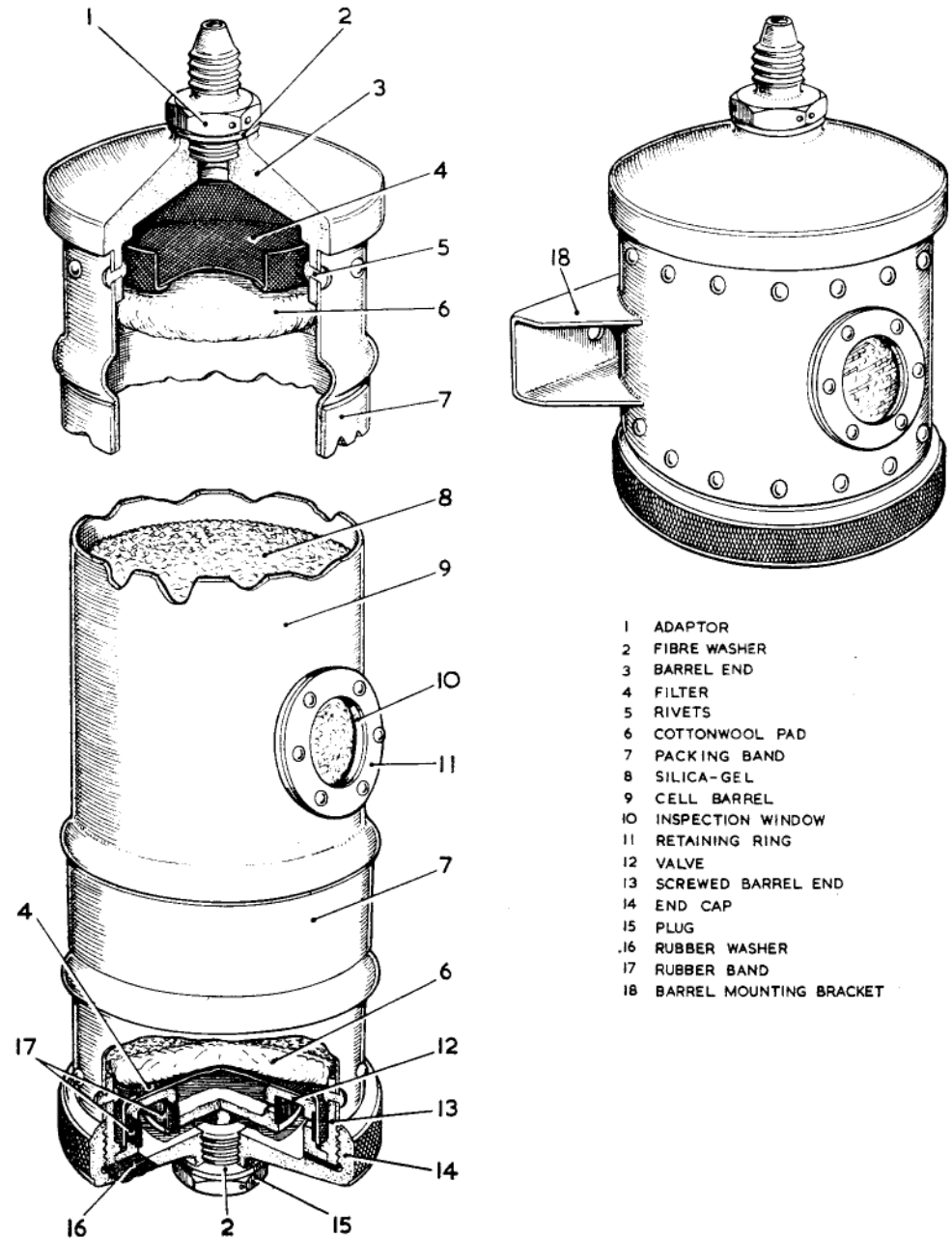
Overhaul

33. Thoroughly clean the filters and the gauze-covered plug. Check the rubber bands on the valve mechanism for deterioration. Renew the silica-gel and the cotton wool pads.

Testing

34. The following tests are necessary:—

- (1) *Test 1:*—
 - (a) Remove the rubber bands from the valve mechanism and blank off the gauze-covered plug connection.



- 1 ADAPTOR
- 2 FIBRE WASHER
- 3 BARREL END
- 4 FILTER
- 5 RIVETS
- 6 COTTONWOOL PAD
- 7 PACKING BAND
- 8 SILICA-GEL
- 9 CELL BARREL
- 10 INSPECTION WINDOW
- 11 RETAINING RING
- 12 VALVE
- 13 SCREWED BARREL END
- 14 END CAP
- 15 PLUG
- 16 RUBBER WASHER
- 17 RUBBER BAND
- 18 BARREL MOUNTING BRACKET

Fig. 11. Dessicators

(b) Apply a suction of 2 lb./in.² to the adapter.

(c) With the suction turned off the internal depression must remain at $2.0 \begin{smallmatrix} +0 \\ -0.1 \end{smallmatrix}$ lb/in² for a minimum of 15 minutes.

(2) *Test 2:*—

(a) Remove the blank from the gauze-covered plug and refit the rubber bands to the valve mechanism.

(b) Apply air at a pressure of $\frac{1}{2}$ to 1 in. of water to the adapter. There should be no air flow through the desiccator.

(c) Increase the pressure; the valve mechanism should operate, allowing air to flow through the gauze covered plug.

(3) *Test 3:*—

(a) Apply air at a pressure of $\frac{1}{2}$ to 1 in. of water to the gauze-covered plug connection. There should be no flow through the desiccator.

(b) Increase the pressure; the valve mechanism should operate, allowing air to flow through the desiccator.

ACTUATED FUEL COCKS (fig. 12)

Dismantling

35. (1) Unscrew the securing nuts and remove the actuator from its mounting. Remove the loose coupling.

(2) Remove the nuts from the periphery of the cock and separate the top and bottom covers from the body. Remove the gland ring.

(3) Remove the valve carrier complete with link, operating spindle, valve plates and spring.

Overhaul

36. (1) Inspect the separated parts for damage and wear.

(2) The mating faces of the valve plates and valve seats may be lapped flat to remove light scores or to stop leaks.

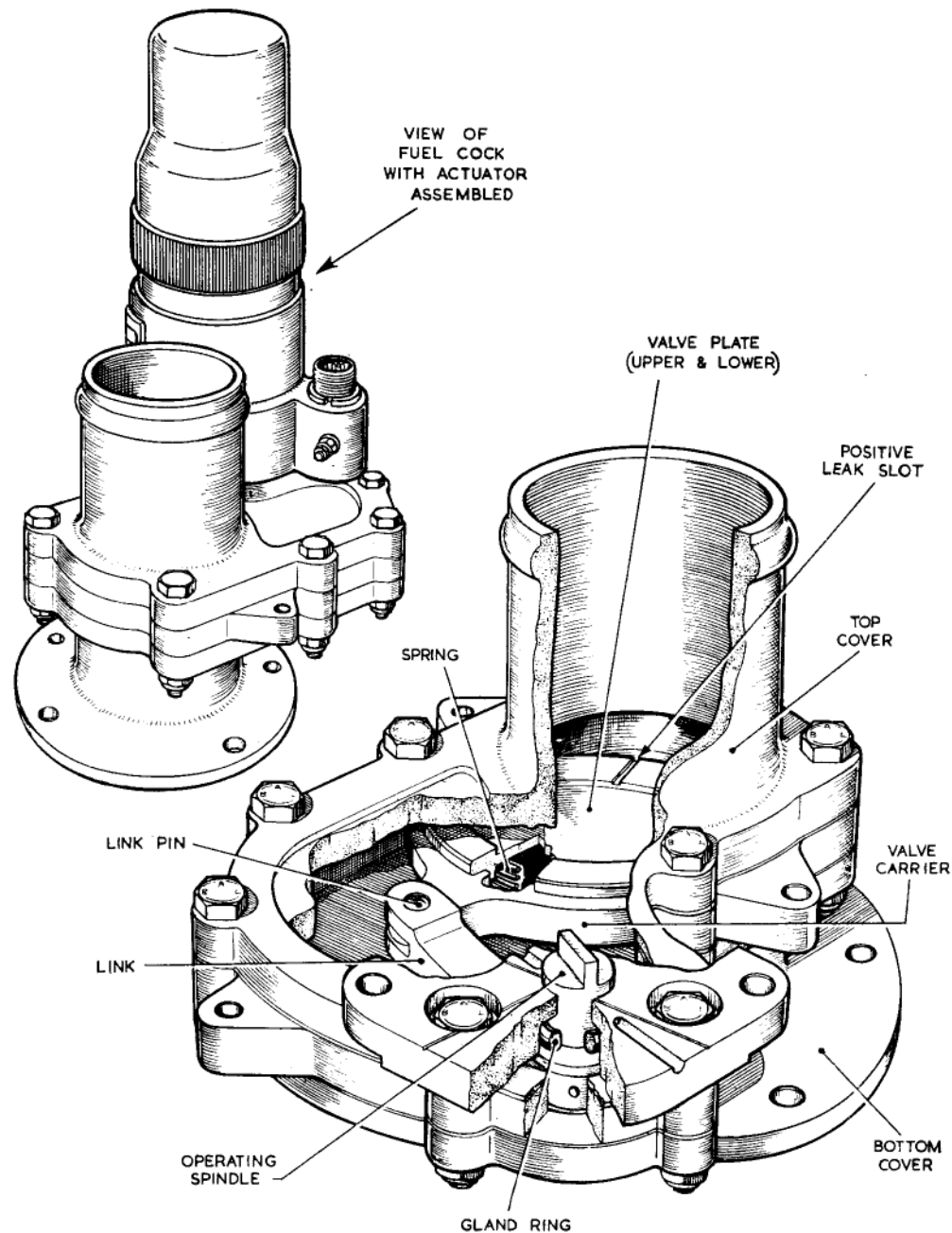


Fig. 12. Actuated fuel cock

- (3) Worn or damaged parts should be renewed as necessary. Renew the joint and sealing washers.

Assembly

37. (1) Fit the gland ring into its recess in the cover.
- (2) Fit the spindle complete with link, valve carrier, valve plates and spring.
- (3) Assemble the end covers to the body, with the joint washers interposed.
- (4) Bolt the assembly together and check for full angular movement of the spindle. This movement should exceed the engraved marks on the cover by at least 2 degrees. Alternatively carry out the angular travel test detailed in para. 38. Before fitting the actuator, carry out the torque and leak tests (*para. 38*).
- (5) Fit the loose coupling and actuator and secure in position.

Testing

38. The following tests are necessary :—

- (1) *Angular travel test*:—

Using the pointer Pt. No. 92449-153 attached to the operating spindle and (dependent on the cock branch connection size) the appropriate gauge plate, ensure that the travel of the operating spindle is such that the pointer fully reaches the engraved lines on the gauge plate.

Valve with 1½ in. dia. branch—Use gauge plate Pt. No. 92449-151 (red disc).

Valve with 2 in. dia. branch—Use gauge plate Pt. No. 92449-149 (blue disc).

- (2) *Torque test*:—

(a) Apply a fuel pressure of 10 lb./in.² to either branch and check that the operating torque required to open or close the cock does not exceed:—

(i) 4 lb. in. for valve with 1½ in. dia. branch.

(ii) 10 lb. in. for valve with 2 in. dia. branch.

(b) Increase the pressure to 50 lb/in² and check that the operating torque does not exceed:—

(i) 16 lb. in. for valve with 1½ in. dia. branch.

(ii) 40 lb. in. for valve with 2 in. dia. branch.

- (3) *External leak test*:—

(a) Blank off one branch, open the cock and apply an air pressure of 110 lb/in² to the other.

(b) Immerse the cock in kerosene for one minute; there must be no leakage from gland ring, joint washers or porous metal.

- (4) *Internal leak test* (must be made after test (3)):—

Remove the blank, close the cock and apply fuel to either branch:—

(a) Under a 6 in. static head.

(b) At a fuel pressure of 50 lb./in.² After allowing 5 minutes to settle down, leakage past the valve plate must not exceed five drops per minute.

(c) Repeat the test, applying pressure to the other branch.

Note . . .

On cocks provided with a thermal relief hole the pressure for the torque test and the internal leak test must be applied only to the branch containing the thermal relief hole.

- (5) *Combined unit test*:—

With the actuator fitted to the cock and at normal room temperature, apply a fuel pressure of 50 lb/in² to either branch. The unit must operate at voltages of 22 to 29 volts. The time for a complete operation in either direction must not exceed 3 seconds at 22 volts. Repeat the test 20 times at 5 second intervals approximately.

HEATER MUFF

39. On aircraft post-Mod. 2107 the air/nitrogen pressure reducing valves in the wing fuel tank pressurization system are each enclosed in a thermostatically-controlled, electrically-heated muff to prevent them freezing and thus becoming inoperative.

40. The muff consists of three separate parts linked together and to prevent it overheating it is essential that it is correctly assembled (*para. 41*).

Assembly

41. To assemble the heater muff, first fit the small clip on the portion over the bottom of the valve, then fit the centre portion and finally the top cover. Assembled in this order, each portion of the muff overlaps the other in correct sequence and the heating elements are in close contact with the metal of the valve.

RESTRICTED

TABLE 1

Component location

Item	Description	No off	Part No.	Ref. No.	A.P. No.	Location
1	Master fuel cock (inner and outer engines) pre-Mod. 2146 post-Mod. 2146 pre-Mod. 2146, post Mod. 2489	4	A.5379-Sht. 1 A.5484-Sht. 1 A.5885-Sht. 1			On fuel distributor box, port and starboard.
2	Cross-feed cock, port pre-Mod. 2146 and 2489 post-Mod. 2146 pre-Mod. 2146, post-Mod. 2489	1	A.5380-Sht. 1 A.5888-Sht. 1 A.5887-Sht. 1			On fuel distributor box, port.
3	Cross-feed cock, starboard pre-Mod. 2146 and 2489 post-Mod. 2146 pre-Mod. 2146, post-Mod. 2489	1	A.5380-Sht. 1 A.5485-Sht. 1 A.5886-Sht. 1		A.P.4377A, Vol. 1, Book 1, Sect. 4, Chap. 2, App. 4	On fuel distributor box, starboard.
4	Transfer cock (wing tanks) pre-Mod. 2146 post-Mod. 2146	2	A.5250-Sht. 1 Mk. M A.5489-Sht. 1 Mk. M			In pipeline between No. 1 and No. 2 tanks.
5	Shut-off cock (reserve tank) pre-Mod. 2146 post-Mod. 2146	2	A.5250-Mk. P A.5489-Mk. P			In pipeline from reserve tank to fuselage pump housing, port and starboard.
6	Shut-off cock, No. 3 cell	2	A.5489-Mk. P			In fuel supply pipeline, No. 3 cell to fuselage pump housing, port and starboard.
7	Defuelling tank selector valve B/K Mk. 1 and B/K/PR Mk. 1 B/Mk. 1 and B/PR Mk. 1	2	A.5749-Sht. 1 A.5415-Sht. 1		A.P.4377A, Vol. 1, Book 1, Sect. 4, Chap. 3, App. 3	Transfer pipeline between underwing and under tanks.
8	Non-return valve (air supply)	4	A.5254-Mk. H			Air supply pipelines from engines.
9	Non-return valve, ½ in., (nitrogen)	2	A.5468D-Sht. 1			Nitrogen supply pipeline from bottles to pressure reducing valves.
10	Non-return valve Reserve and fuselage cells Wing cells	2 2	A.5594-Mk. M A.5594-Mk. K		A.P.1803N, Vol. 1, Book 1, Sect. 7, App. 10	Pipeline pressure reducing valves to fuselage vent duct. Pipeline pressure reducing valves to No. 1 wing tank float valve.
11	Non-return valve (fuel transfer line)	1	A.5491-Sht. 1			Transfer tank pipeline to ring main.
12	Non-return valve (vent line)	1	A.5594-Mk. M		A.P.1803N, Vol. 1, Book 1, Sect. 7, App. 10	Pipeline, pressure reducing valve transfer tank vent pipe.

TABLE 1—(cont.)

Item	Description	No. off	Part No.	Ref. No.	A.P. No.	Location
13	Non-return valve (feed from reserve tank)	2	A.5638-Mk. P A.5666-Mk. P A.5704-Mk. P			Supply pipeline, reserve tank to fuselage pump housing, port and starboard.
14	Non-return valve (air feed to recuperator)	2	A.5287-C			Air supply pipeline, engine to recuperator, port and starboard.
15	Pressure refuelling cut-out valves :—					
	Transfer tank					
	Reserve tank	1	67444-Sht. 9	26SR/3900	A.P.4511, Vol. 1 and 6, Sect. 2, Chap. 3, App.	Mounted in tanks and cell.
	No. 1 fuselage cell	1	67444-Sht. 7	26SR/3901	5	Mounted in cell.
	No. 2 fuselage cell	1	67444-Sht. 5			Mounted in cell.
	No. 3 fuselage cell	4	67465-Sht. 25/26	26SR/3903	A.P.4511, Vol. 1 and 6, Sect. 2, Chap. 3, App. 4	Mounted in No. 1 tank No. 1 cell, and No. 2 tank No. 1 cell.
	No. 1 and 2 wing tanks					
16	Fuel distributor box					
	Port	1	67445-Sht. 40	26SR/7500	A.P.4377A, Vol. 1, Sect. 4, Chap. 2, App. 4	In port and starboard servicing bays.
	Starboard	1	67445-Sht. 39	26SR/7505		
17	Drain cock, P type	3	67427-Sht. 1133			One in transfer tank vent line, and one in each wing vent duct out-board of No. 2 tanks.
18	Non-return valve	1	A.5468-C			Nitrogen supply pipeline to bomb-bay tank.
19	Non-return valve (Mod. 2473)	2	A.5831-Mk. K			Fuel supply pipelines from bomb-bay tank pump and stand-by pump.
20	Fuel pump (fuselage)	4	S.P.E./1204-Mk. 1			On pump housing in servicing bay, port and starboard.
	Fuel pump (wing)	4	S.P.E./1207-Mk. 1			No. 1 tank No. 2 cell, and No. 2 tank No. 1 cell.
	Fuel pump (transfer tank)	1	S.P.E./1207-Mk. 1 }			Transfer tank.
	Fuel pump (transfer tank stand-by)	1	S.P.E./1207-Mk. 1 }			
	Fuel pump (bomb-bay tank)	1	S.P.E./1207-Mk. 1 }			Bomb-bay tank.
	Fuel pump (bomb-bay tank stand-by)	1	S.P.E./1207-Mk. 1 }			
21	Pressure reducing valve (wing)	2	F.L.Q./A/1			Air supply pipeline from engine to wing tank control line.

TABLE 1—(cont.)

Item	Description	No. off	Part No.	Ref. No.	A.P. No.	Location
22	Recuperator	2	SPE/PRC/60A/Mk. 3			Fuselage, adjacent to No. 2 cell, port and starboard.
23	Pressure reducing valves: —					
	Reserve tank	1	FLQ/A/1			Between transfer tank and fuselage No. 3 cell.
	Fuselage cells	3				
	Transfer tank	1				
24	Pressure relief valves, emergency					
	Reserve tank	1	FLP/A/6			Between transfer tank and fuselage No. 3 cell.
	Fuselage cells	3				
	Transfer tank	1				
	Wing tanks	2				
25	Pressure refuelling connection					
	Fuselage	2	F.C.129		A.P.4511, Vol. 1 and 6, Sect. 3, Chap. 1, App. 3	Servicing bay, port and starboard.
	Wing	2	F.C.129 or F.R.0725000/2		A.P.4511, Vol. 1 and 6, Sect. 3, Chap. 2, App. 1	Rear of No. 1 tank No. 1 cell.
26	Non-return valve (air)	4	B.9812000		A.P.4511, Vol. 1 and 6, Sect. 7, Chap. 9	Pump housing vent pipelines to fuselage No. 2 cell.
27	Fuselage vent float valve	2	C.9501235		A.P.4511, Vol. 1 and 6, Sect. 7, Chap. 1	Fuselage No. 2 and 3 cells.
28	Wing vent float valve	8	C.9501235		A.P.4511, Vol. 1 and 6, Sect. 7, Chap. 1	No. 1 tank No. 1 and 2 cells, No. 2 tank No. 1 and 3 cells.
29	Pressure relief valves: —					
	Fuselage	2	FLP/A/5			Fuselage vent duct.
	Wing	2	FLP/A/5			Wing vent duct outboard of No. 2 tank.
30	Fuselage vent, inward relief valve	2	FLS/A/1			Between transfer tank and fuselage No. 3 cell.
31	Wing vent, inward relief valve	2	FLS/A/1			Wing vent duct, outboard of No. 2 tank.
32	Pressure relief valve (No. 1 and 2 wing tank)	4	FPC/A/1			No. 1 tank No. 1 cell, No. 2 tank No. 2 cell.
33	Reducing valve (recuperator air supply)	2	P.S.45			Air supply pipeline, engine to recuperator.
34	Non-return valve (probe line)	3	B.9807000-9			Pipeline probe to ring main (1) and (2).
35	Probe adapter	1	E.3406093			Pipeline probe to ring main.
36	Inward relief valve	1	FLS/A/1	}		Bomb-bay tank.
37	Pressure relief valve	1	FLP/A/5			
38	Pressure refuelling cut-out valve	1	1112639			
39	Fuel heater, inner and outer engines	4	D.257-63A			Fuel supply pipeline distributor box to engine (port and starboard servicing bays).



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