Chapter 2

FUEL SYSTEM

LIST OF CONTENTS

LIST OF CONTENTS (CONT'D.)

LIST OF TABLES

LIST OF ILLUSTRATIONS

DESCRIPTION

Introduction

1. This chapter contains a description of the low-pressure fuel system together with servicing details and the method of removal and assembly of certain components. The high pressure fuel system, contained within the engine, is described in A.P.4712A, Vol.1 for the Olympus 201 and 202 engines and in A.P.102C-0403 for the Olympus 301 engine. A description and details of servicing of the fuel pumps are given in A.P.4343D, Vol.1. The construction of the fuel tanks and details of their servicing is given in A.P.4117A, Vol.1. Since the fuel system is electrically controlled and refuelled, this chapter must be read in conjunction with Sect.6, Chap.1 of this Volume.

General

2. Fuel is normally carried in fourteen flexible tanks accommodated within the structure of the aircraft, five in the port and five in the starboard main plane, with the remaining four tanks in the fuselage above and aft of the nose-wheel bay. Additional fuel can be carried in two rigid removable tanks fitted in the bomb bay when required. Two types of rigid tanks are used, saddle shaped for Blue Steel role aircraft and cylindrical for free-fall role aircraft although a saddle type tank can be fitted in lieu of the forward cylindrical tank.

3. On each side of the aircraft the tanks are divided into two groups. No.1, No.4, No.5 and No.7 tanks provide fuel for the outboard engines and No.2, No.3 and No.6 tanks for the inboard engines. Normally the four engine tank groups function independently, but electrically-operated cross-feed cocks are provided, by the use of which all engines can be supplied from any selected group. They consist of an engine cross-feed cock between each inboard and outboard engine and an aircraft cross-feed cock between the port and starboard sides of the fuel system, and are controlled by switches on the cockpit centre console (fig.2).

4. Due to the configuration of the aircraft the fuel tanks are disposed forward and aft of the aircraft centre of gravity. It is therefore important that the fuel balance is maintained throughout a flight. This is achieved by the incorporation of an electrically-operated sequence timer by the use of which a small quantity of fuel is allowed to be pumped from each tank in turn. The small quantity of fuel pumped from each tank during one cycle of the sequence timer is proportional to the tank capacity and thus the fuel centre of gravity is kept reasonably constant. Similarly when refuelling, each tank is filled with the same percentage of its total capacity to avoid uneven fuel loading.

5. An electrically-operated fuel pump is mounted in the base of each tank to supply low-pressure fuel to the engines. These pumps except those in the fuselage tanks are each contained in a reservoir within the fuel tank, the reservoir fuel level being maintained by an auxiliary pump also mounted in the tank at the opposite end to the main feed pump. In addition, No.1 and No.7 tanks, which are the tanks farthest away from the aircraft C. of G., have transfer pumps to convey the fuel forward or aft should the aircraft become tail or nose heavy.

6. All tanks are pressurised to prevent vapourisation and consequent loss of fuel at altitude. A description of the pressurisation system is given in Chap.6 of this section.

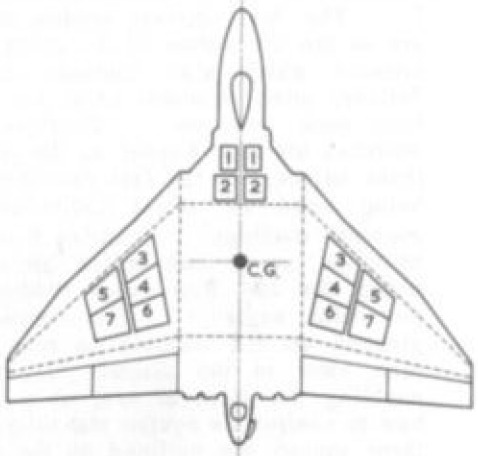
CONTROLS AND INDICATORS

7. The fuel delivery system controls are on the aft portion of the cabin centre console which also contains the fuel delivery pump, transfer pump and cross-feed cock switches. Fourteen push-switches are also housed on the console, those adjacent to the fuel pump switches being used to select individual tank contents readings. A further four push-switches, one to each engine, are used to select the fuel flow gauge reading of a particular engine. The controls are grouped on the console to represent a plan view of the aircraft fuel system, enabling the pilot to see, at a glance, how to control the system manually. The three groups are outlined on the control panel by coloured lines as indicated on fig.2. Four contents gauges, one to each group of tanks, are mounted on the forward portion of the centre console. The contents gauges indicate on the inner scale the amount of fuel, in pounds, in each of the tank groups. The contents of an individual tank in a particular group can be obtained by pressing the associated push switch on the centre console and the tank group gauge outer scale will then indicate the amount of fuel in that tank.

8. A fuel flow meter (Ref.No.6A/4252) and an integrated total fuel consumed indicator (Ref.No.6A/4254) are fitted on the second pilot's instrument panel. The flow indicator shows the rate of flow for any one engine when the associated push-switch on the fuel control panel is pressed. The fuel consumed indicator registers the total rate at which fuel is being consumed by all the engines and the total weight of fuel consumed, it is reset to zero by the switch adjacent to the counter. The remaining controls consist of four low-pressure cock switches and magnetic

NOTE:- THE STARBOARD SIDE OF THE SYSTEM ONLY IS ILLUSTRATED.

ARRANGEMENT OF FUEL TANKS



- REFUELLING
- ENGINE FEED
- TRANSFER
- DEFUELLING
- COMPRESSED AIR
- NON-RETURN VALVE
- FILTER
- AIR/NO FUEL VALVE
- PRESSURE RELIEF VALVE
- RECUPERATOR
- TANK SERVICING COCK
- LOW PRESSURE COCK
- DEFUELLING COCK
- REFUELLING VALVE
- TRANSFER PUMP
- TANK PUMP
- ELECTRICALLY OPERATED
- RECUPERATOR BLEED LINE

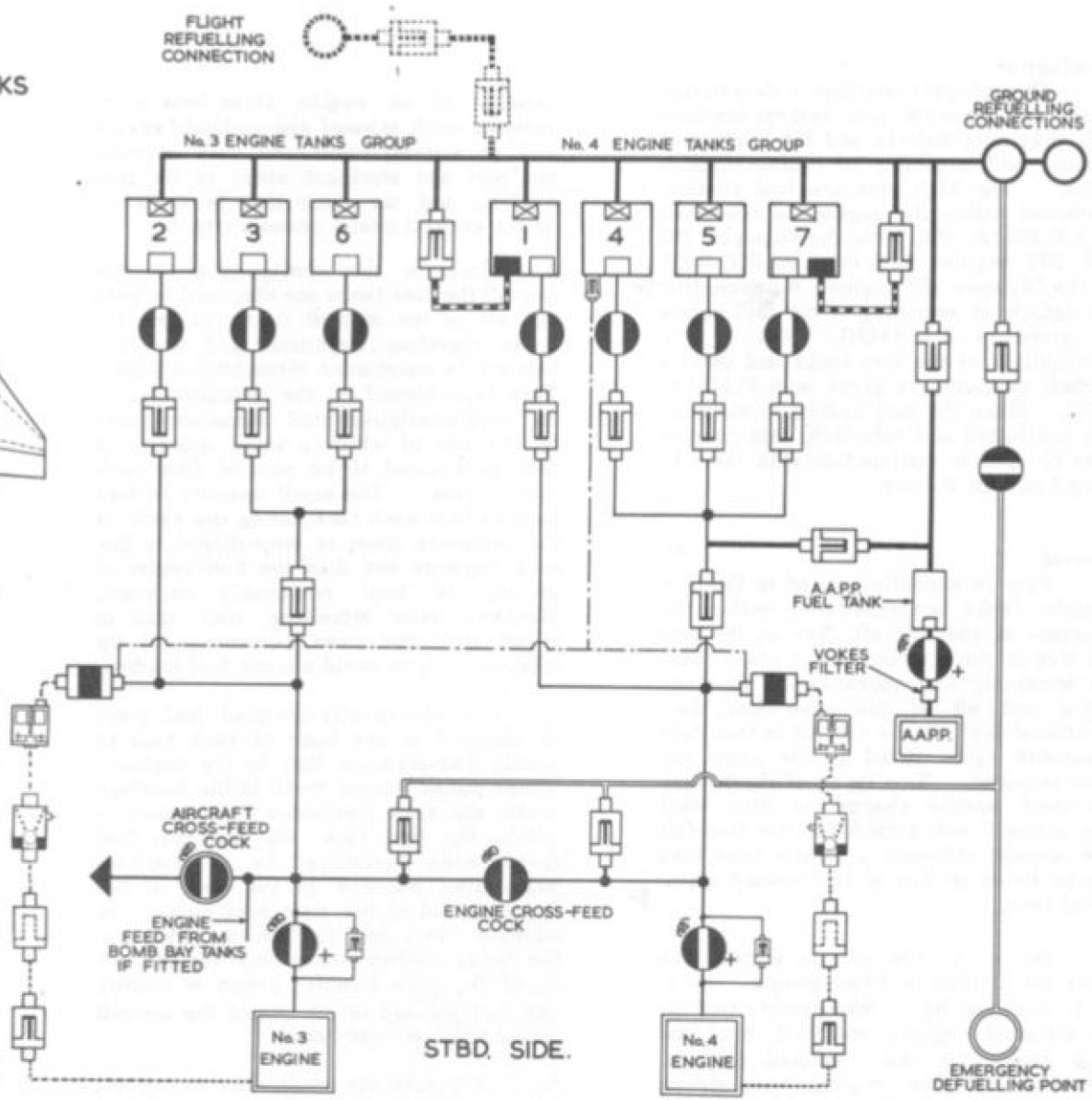


Fig. 1. Fuel system diagram
(◀ Air/no fuel valve added ▶)

RESTRICTED

indicators on the cabin coaming. The engine high-pressure cock controls are incorporated in the throttle levers. Warning indicators which show when the fuel pressure falls below 5 lb/in^2 are mounted on the pilots' centre instrument panel. Fuel contents gauges, one to each group of tanks, are also provided on the navigator's panel.

FUEL TANKS

9. Light-alloy fuel tank compartments are built into the main plane and into the fuselage forward of the front spar as an integral part of the aircraft structure. Bag-like fuel tanks which line the compartments are constructed of flexible rubber and fabric sheeting, the fuselage tanks of 0.040 in Hycatrol H.P.257/40 (D.T.D.1124) and the wing tanks of 0.030 in Hycatrol H.P.257/30 (D.T.D.1132). Metal colletted studs, secured to the tanks by vulcanised rubber rings, are pressed into holes in the skin plating of the compartments to secure the tanks in position. Tie rods, passing through mounted tubes in No.5, No.6 and No.7 tanks, support the skin of these tank compartments. In cross-section, the wing tanks are elliptical and the fuselage tanks rectangular. The bottom surface of each tank is reinforced to carry a magnesium-alloy sump plate upon which a reservoir housing the fuel pump and a refuelling valve is mounted. The upper surface is strengthened to accommodate a vent elbow and an emergency level switch. A Vickers Mk.A ¼ in B.S.P. drain valve (fig.7) mounted on the sump plate, is used to drain water from the tanks.

10. To prevent fuel passing into the vent pipe lines, due to changes in aircraft attitude and consequent fuel swirl, the tanks are fitted with a combined float valve and spring-loaded inward/outward vent valve at the points of entry of each inboard pipe into the tanks.

11. The float valve is cylindrical and houses an inward relief valve, set at a ¼ lb/in^2 and an outward relief valve set at ¾ to 1 lb/in^2. The cylindrical body contains a series of orifices through which air pressure normally enters the tanks and is sleeved with a cork float. When the fuel level rises above the float valve, due to a change in aircraft attitude, the sleeve, being buoyant, floats up the cylindrical body to cover the orifices and thus fuel is prevented from entering the pressure lines. Should the cork float stick and remain covering the orifices, the inward vent valve will be opened by the pressurisation supply and air will continue to flow into the tanks. Conversely, should the pressure in the tanks exceed ¾ to 1 lb/in^2 differential, the outward relief valve will open to release the excess pressure back into the pressurisation lines.

12. A stop in the top of the valve restricts the travel of the inner valve body. If the stops were not fitted and the emergency fuel level switch failed to close the refuelling valve when the refuelling of a tank was completed, continued introduction of fuel into the tank would lift the cork float and valve body until the tank pressurisation line is blanked off and the tank sealed. The pressure built up in the tank would eventually be sufficient to burst the tank and cause damage to the surrounding bay structure. Restricted movement of the inner valve body prevents sealing of the tank and allows excess fuel to escape through the tank pressurisation pipes.

13. The tanks are each equipped with two tank contents gauge transmitter units, an emergency level float switch and a S.P.E. bottom-mounted fuel pump, No.1 and No.7 tanks also having a transfer pump. Manually-operated servicing cocks are interposed in the delivery pipe-lines from the tanks to obviate tank draining when pipe lines are to be disconnected for servicing purposes.

14. To prevent vaporization with consequent loss of fuel, due to either high temperature or high altitudes, the tanks are provided with a pressurisation system. This enables a pre-determined air pressure to be maintained throughout the altitude range of the aircraft.

TANK RESERVOIRS

15. The wing tank main fuel pumps are each housed in a rectangular light-alloy reservoir, situated within each wing tank. For ease of removal and assembly, the reservoirs of No.3, No.4 and No.6 tanks are constructed in three tiers secured together on installation with 2 B.A. bolts and anchor nuts, No.5 and No.7 tanks are constructed similarly but in two tiers. Flap valves, acting as non-return valves, are mounted in each reservoir and are normally in the open position. When the aircraft is nose down, in the diving attitude, the flap valves close and the head of fuel is maintained by the auxiliary pump (para.34).

SYSTEM INSTALLATION

Delivery lines

16. The fuel system installation on each side of the aircraft is basically similar. Pipes and components for the Auxiliary Airborne Power Plant, hereafter referred to as the A.A.P.P., are fitted to the starboard side. With the exception of this difference the following description is applicable to both sides of the aircraft.

17. From No.1, No.4, No.5 and No.7 tanks pump elbows, 1½ in dia, delivery pipe lines lead through Vickers Type R manually-operated servicing cocks and also non-return valves, to prevent re-circulation to the tanks, into a common 2 in dia. pipe line. This line, in which

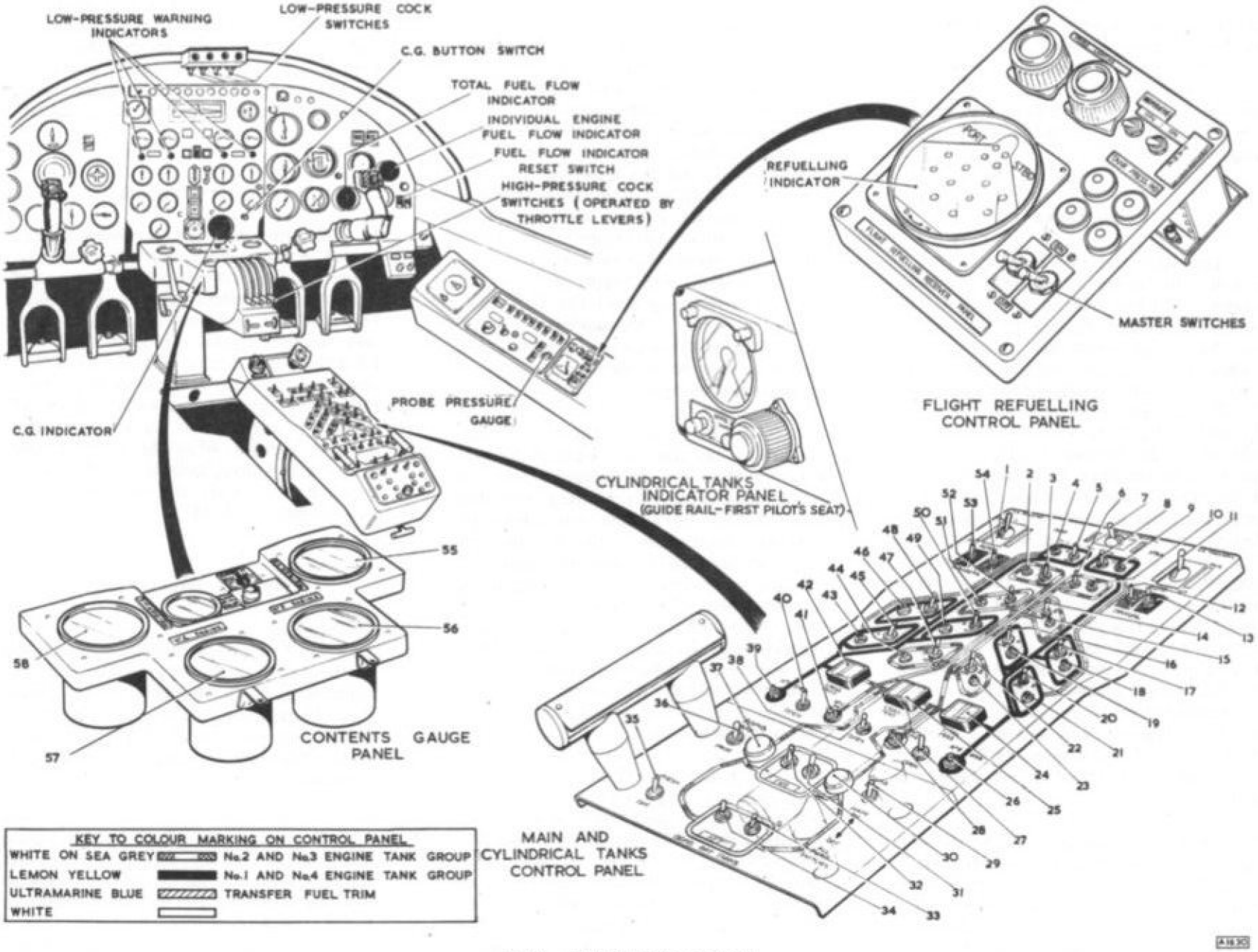


Fig. 2 Fuel system controls

(« Mod. 2417 »)

V.1.2'. 1560

Push-switches, rate-of-flow

When pressed, the rate-of-flow is given on the flow indicator on the second pilot's panel.

26 NO.4 ENGINE
28 NO.3 ENGINE
39 NO.1 ENGINE
41 NO.2 ENGINE

Cross-feed cock switches

Forward SHUT
Rearward OPEN

27 NO.3 and 4 ENGINES
38 PORT and STARBOARD SIDES OF AIRCRAFT
40 NO.1 and 2 ENGINES

Cross-feed cock position indicators

24 NO.3 and 4 ENGINES
25 PORT and STARBOARD SIDES OF AIRCRAFT
42 NO.1 and 2 ENGINES

Auto/manual switches

Forward - AUTO - energises sequence timer
Rearward - MANUAL - stops sequence timer

12 NO.3 TANK GROUP
13 NO.4 TANK GROUP
53 NO.1 TANK GROUP
54 NO.2 TANK GROUP

Tank pump switches

Forward - ON
Rearward - OFF

STARBOARD
6 NO.2 TANK
8 NO.1 TANK
14 NO.3 TANK

Key to Fig. 2

16 NO.4 TANK
17 NO.5 TANK
20 NO.7 TANK
22 NO.6 TANK

PORT
45 NO.7 TANK
47 NO.6 TANK
48 NO.5 TANK
50 NO.4 TANK
52 NO.3 TANK
3 NO.2 TANK
5 NO.1 TANK

Tank contents push-switches

When pressed, indicate individual tank contents on outer ring of contents gauges, (items 55, 56, 57 and 58).

STARBOARD
9 NO.1 TANK
10 NO.2 TANK
15 NO.3 TANK
18 NO.5 TANK
19 NO.4 TANK
21 NO.7 TANK
23 NO.6 TANK

PORT
43 NO.7 TANK
44 NO.6 TANK
46 NO.5 TANK
49 NO.4 TANK
51 NO.3 TANK
2 NO.2 TANK
4 NO.1 TANK

C of G. transfer pump switches

FWD. starts No.7 tank transfer pump and opens No.1 tank refuelling valve. During flight refuelling closes No.6 and 7 tanks refuelling valves.

Centre - OFF

AFT. - starts No.1 tank transfer pump and opens No.7 tank refuelling valve. During flight refuelling closes No.1 and 2 tanks refuelling valves.

1 - Port side
11 - Starboard side

Flight refuelling C. of G. switch

Stops refuelling of two tanks on side opposite to that selected.

7 PORT closes refuelling valves of No.6 and 7 tanks on starboard side.
Centre OFF.
STBD. closes refuelling valves of No.6 and 7 tanks on port side.

Contents gauge panel

Outer ring - individual tank contents
Inner ring - tank group contents

55 No.4 ENGINE GROUP
56 No.3 ENGINE GROUP
57 No.2 ENGINE GROUP
58 No.1 ENGINE GROUP

Bomb bay cylindrical tanks

Sequence timer override switches

Forward - BOMB BAY
Rearward - MAIN
29 Starboard side
36 Port side

Low pressure warning indicators

30 Starboard side
37 Port side

Tank pump switches

Forward ON
Rearward OFF

31 Forward tank forward pump
32 Forward tank centre and rear pumps
33 Rear tank forward pump
34 Rear tank centre and rear pumps

Tank pressurisation

35 Forward PRESN.
Rearward OFF

is interposed a recuperator (para.21), leads through an electrically-operated low-pressure cock and supplies the outer engine.

18. Similarly, 1½ in. dia. pipe lines lead from No.2, No.3 and No.6 tanks and converge at a 2 in. dia. pipe, fitted with a recuperator, which passes through a low-pressure cock to the inner engine. Common lines to individual engines on one side of the aircraft are interconnected by a pipe line which incorporates the engine cross-feed cock. The port and starboard sides of the aircraft fuel system are also interconnected by a pipe-line which incorporates the aircraft cross-feed cock.

19. In the event of a tank booster pump failure in flight,the fuel in the tank can still be used by switching off all booster pumps in the tank group and using engine pump suction to draw fuel from all tanks in the group. To ensure that under these conditions fuel is drawn in the correct proportions from each tank in the group (the tanks having different capacities and heads of pressure), thus maintaining the correct aircraft C.G., slightly stronger springs are fitted in the non-return valves of the tank delivery lines from No.1, No.2 and No.3 tanks, to equalize engine pump suction effect and compensate for different heads of pressure in the tanks.

20. Damage to the fuel system, caused when fuel trapped in the engine feed line expands after the L.P. cock is closed, is avoided by the inclusion of a by-pass pipe in the fuel feed system. A ¼ in. outside dia. pipe joins the engine feed line at a tapping connector below the L.P. cock. From this tapping, excess pressure passes along the pipe, through a non-return valve, to be re-introduced into the feed line above the L.P. cock, entering the fuel tank through the 1/16 in. dia.bleed holes in the tank non-return valve.

Recuperators

21. To maintain the fuel supply pressure

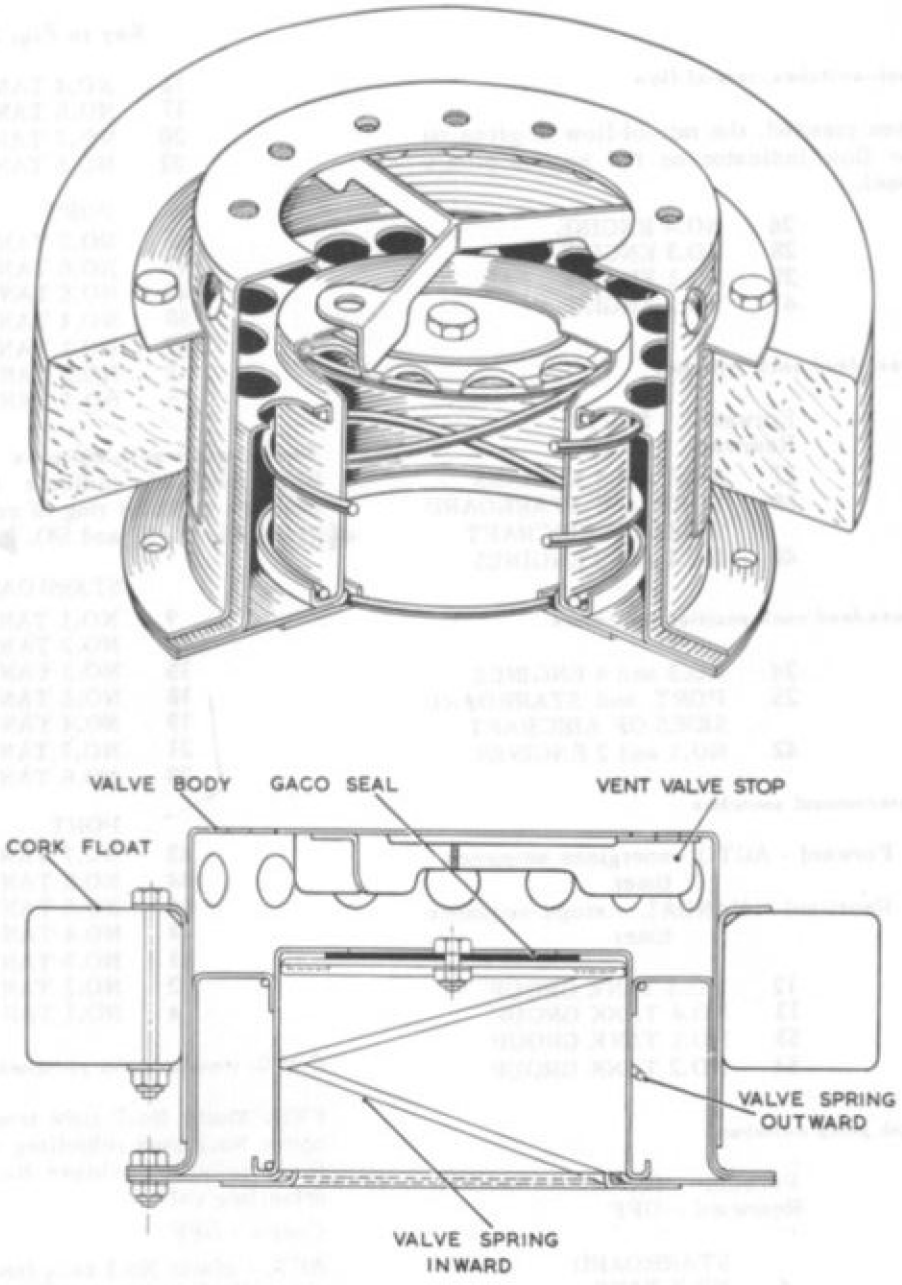


Fig.3. Float valve

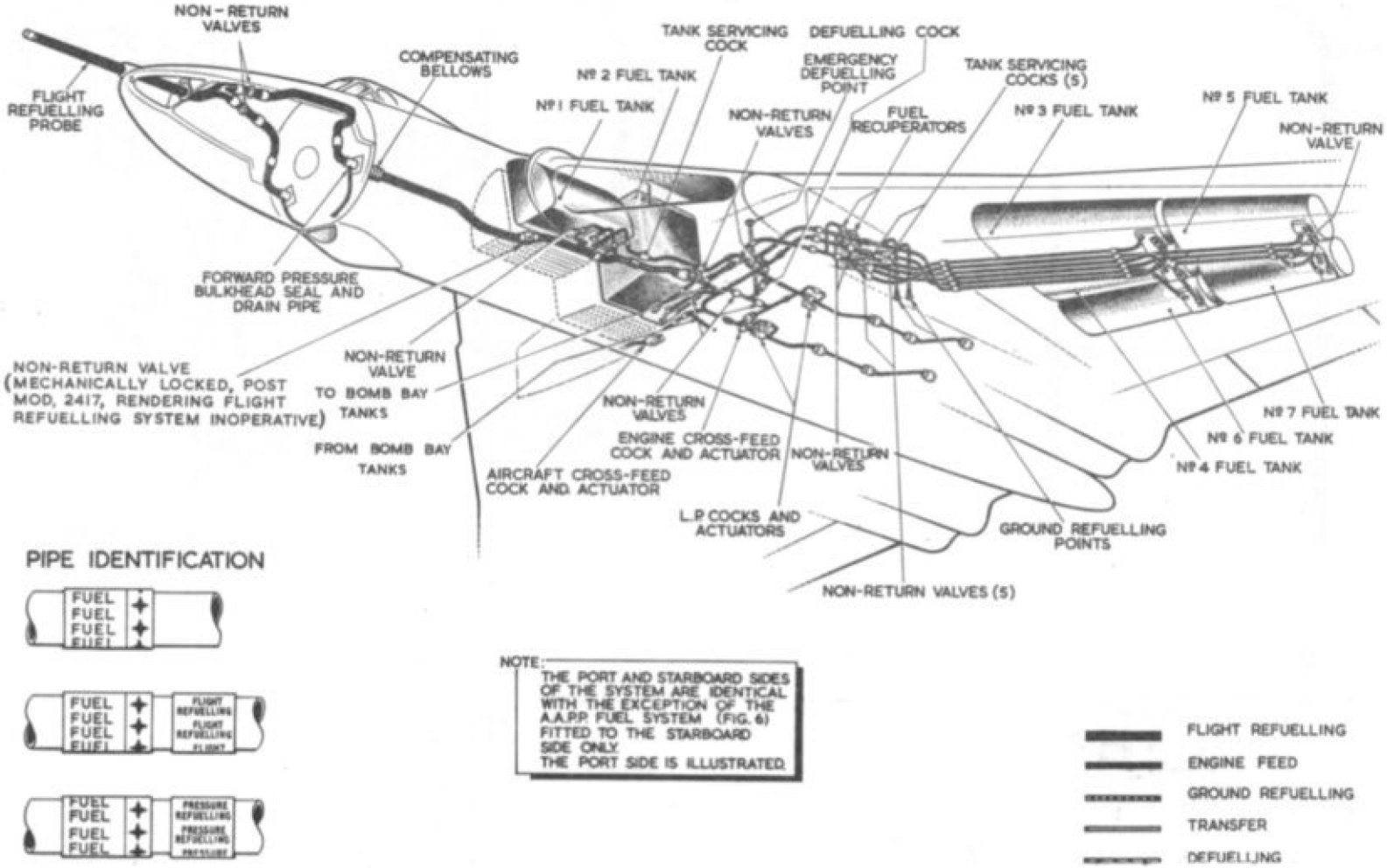


Fig. 4 Fuel system installation
(◄ Mod. 2417 ►)

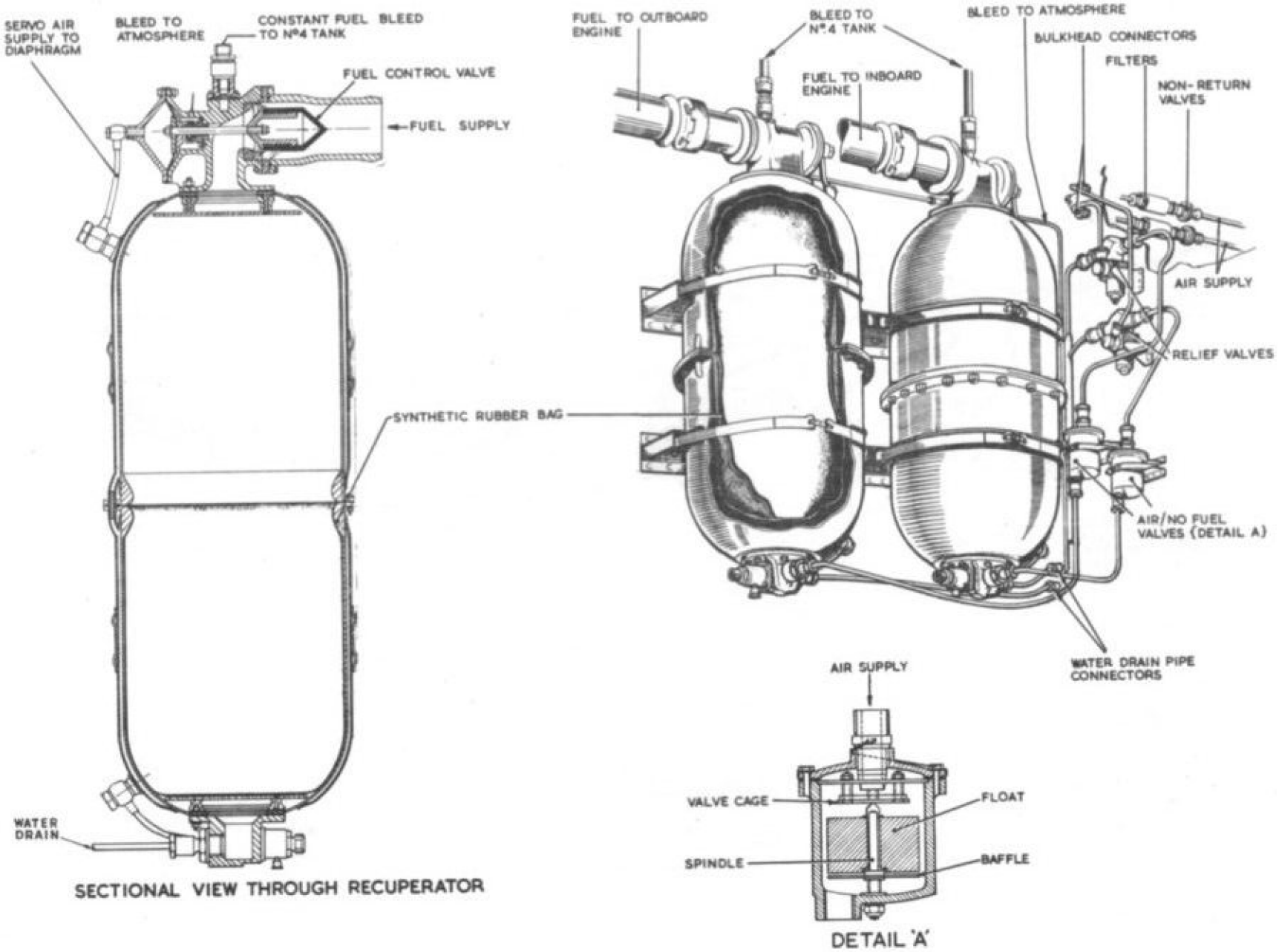


Fig. 5. Recuperator installation

to the engine when the aircraft is being flown under negative 'G' conditions a recuperator, Type P.R.C.60B, Mk.1, is incorporated in the delivery line to each engine. The recuperator, a double-walled metal cylindrical tank of approximately 6 gallons capacity, is divided internally into an upper and lower compartment by a synthetic rubber bag.

22. Two main connections are provided on the recuperator. The upper end is connected through a diaphragm-operated fuel control valve into the fuel delivery line. Air is fed to the lower end from the engine compressor casing through a non-return valve, a pressure compensating relief valve (relieving at between 6 and 10 p.s.i., depending on delivery pressures), and an air/no fuel valve. A servo-air supply, also taken from this source, is passed between the double walls of the recuperator before being piped to the diaphragm of the fuel control valve.

23. Secondary connections consist of a bleed line from the fuel control valve through a non-return valve to No.4 tanks, this is to release the air in the upper compartment when the recuperator is initially filled, and a bleed line to atmosphere from the fuel control valve to prevent fluid locking of this component.

24. When the engines are started, air passes to the lower side of the bag, and simultaneously through the double walls of the recuperator to the diaphragm of the fuel control valve (normally spring-loaded to the closed position) causing the valve to open and allow fuel to enter the upper compartment of the recuperator. Air contained initially in the recuperator passes through the bleed outlet, near the fuel control valve, to No.4 tank.

25. Passing of the servo-air through the double walls of the recuperator is a safety precaution since, should the walls be punctured by enemy action or other causes, the servo-air supply to the diaphragm of the fuel control valve exhausts through the puncture to atmosphere. This releases the pressure on the fuel control valve diaphragm and the valve closes under the influence of its spring loading to shut off the fuel supply to the recuperator, thus loss of fuel is prevented. The air/no fuel valve is fitted (Mod.1018) to limit the loss of fuel through the air system relief valve, should failure of a recuperator bag occur in flight (see fig.5). For permissible leak rate, see para.122.

26. Under normal conditions, the air pressure is about half the fuel delivery pressure consequently the rubber bag remains in the lower half of the recuperator. When the fuel pressure is lowered, due to a negative 'G' attitude of the aircraft, the air pressure raises the bag and forces the fuel contained in the recuperator through the fuel control valve and back into the fuel delivery line to the engine. Sufficient fuel is available for approximately 10 seconds negative 'G' flying.

27. A body casting at the recuperator base incorporates connections for air inlet, water drain and air supply to the space between the double walls of the recuperator. A pipe connects the water drain connection to a drain plug located on the forward bulkhead of the undercarriage bay. These recuperators are fully described in A.P.4373A, Sect.8, to which reference must be made for further information.

Refuelling and transfer lines

28. Pressure refuelling lines of 2½ in. dia. and 3½ in. dia. lead from the wing and fuselage tanks respectively to the ground refuelling points in each wheel bay. An extension to the ground refuelling system of 4 in. dia. pipes leads from the No.1 tanks to a flight refuelling point in the aircraft nose. Transfer lines between the No.1 and No.7 tanks are connected to the refuelling lines, these lines also being used for transfer purposes. Piping for the emergency defuelling system consists of a 1½ in. dia. pipe line, in which non-return valves are interposed, between the engine cross-feed line and the refuelling line, to which the emergency defuelling point in each main plane upper surface is connected. One of the non-return valves connecting the defuelling line to the engine cross-feed line incorporates a thermal relief valve.

A.A.P.P. fuel supply

29. In the starboard main plane, forward of the main-wheel bay, two 3/8 in. dia. light-alloy pipes, each of which incorporates a non-return valve, connect to the system by stub adapter unions, one to the 2 in. dia. engine feed pipe (para.17) and the other to the 3½ in. dia. refuelling pipe (para.28). The two 3/8 in. dia. pipes converge at a T-connection and a single pipe continues aft, through the main-wheel bay rear bulkhead to the A.A.P.P. system fuel tank, capacity 10 gallons, secured to the outboard rib, aft of the A.A.P.P. installation.

30. Fuel is delivered to the installation from the base of the tank, through a flexible pipe to an electrically-operated shut-off valve from which a 3/8 in. dia. light-alloy pipe conveys fuel through a Vokes fuel filter to the A.A.P.P. flow control unit.

Fuel pumps

31. An electrically-operated immersed fuel pump is mounted in each tank. The fuselage forward (No.1) tanks and the main plane rear (No.7) tanks have a second pump for the transfer of fuel. The types of pumps are quoted in Leading Particulars. Control switches for the pumps, on the pilots' central console, consist of a toggle switch for each of the fourteen pumps, an AUTO-MANUAL switch for each of the four tank groups and the two transfer switches. When an AUTO-MANUAL switch is placed

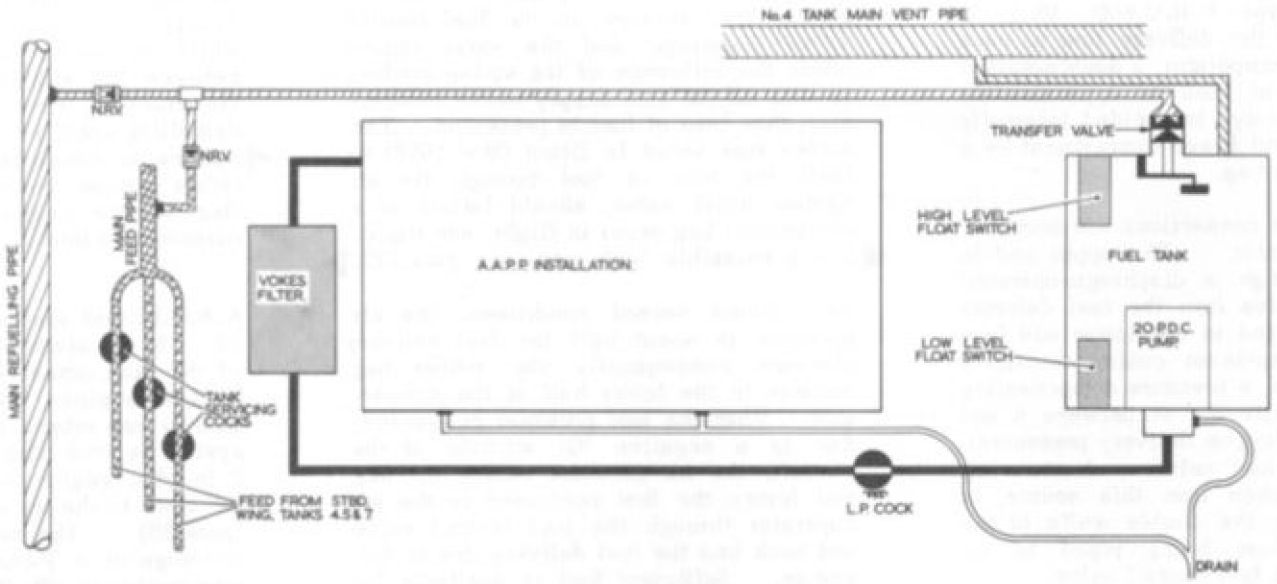


Fig.6. A.A.P.P. fuel system diagram

to AUTO, a tank pump in the group is selected electrically by a sequence timer (para.33) which ensures that fuel is pumped from each tank in correct sequence and thus the fuel centre of gravity is maintained reasonably constant throughout flight. Any further load trimming which may then be required can be accomplished by transferring fuel from the No.1 tank to the No.7 tank or vice-versa, using the transfer pumps installed in these tanks. It should be noted that during automatic conditions, as a safety precaution, all fuel pumps are rotating, the pump selected by the sequence timer running at full speed, at a rate of 1,200 gallons per hour, and the remaining pumps at half this speed. Should the pump running at full speed fail, sufficient fuel is delivered by the remaining pumps to prevent engine failure.

32. For take-off, landing and all normal flying, all pumps are switched ON and the AUTO-MANUAL switches are selected to AUTO. It has been established that even with a 'full speed' pump failed, engine fuel requirements are adequately maintained at take-off r.p.m. by the reduced-speed pumps. It will, therefore, only be necessary to use the MANUAL position in cases requiring specific fuel handling, i.e., to balance the fuel load centre of gravity.

33. Full details of the sequence timers are given in Sect.6, Chap.1 of this Volume since they are electrical in operation. Briefly a timer consists of a series of irregularly profiled cams driven by a constant speed induction motor. As the cams revolve they energise, in sequence, the change-speed relays to the fuel pumps.

Auxiliary pumps

34. Mounted in the fuel level switch tubular unit, in each wing tank, is an internal transfer auxiliary pump Type P.A.C. 100 Mk.3 (fig.7). The purpose of this pump is to prevent starvation of the main pump, which could occur at certain aircraft attitudes and maneouvres with the tank partly empty. Normally the main pump obtains its supply from the tank, through the reservoir flap valve aperture, (para.15) but in a dive, or side-slip, its supply is maintained by the auxiliary pump. This delivers fuel to the reservoir, from the opposite end of the tank, through an internal transfer line. The head of fuel which is thus created closes the flap valve.

Ground refuelling system

35. Pressure refuelling of the aircraft is

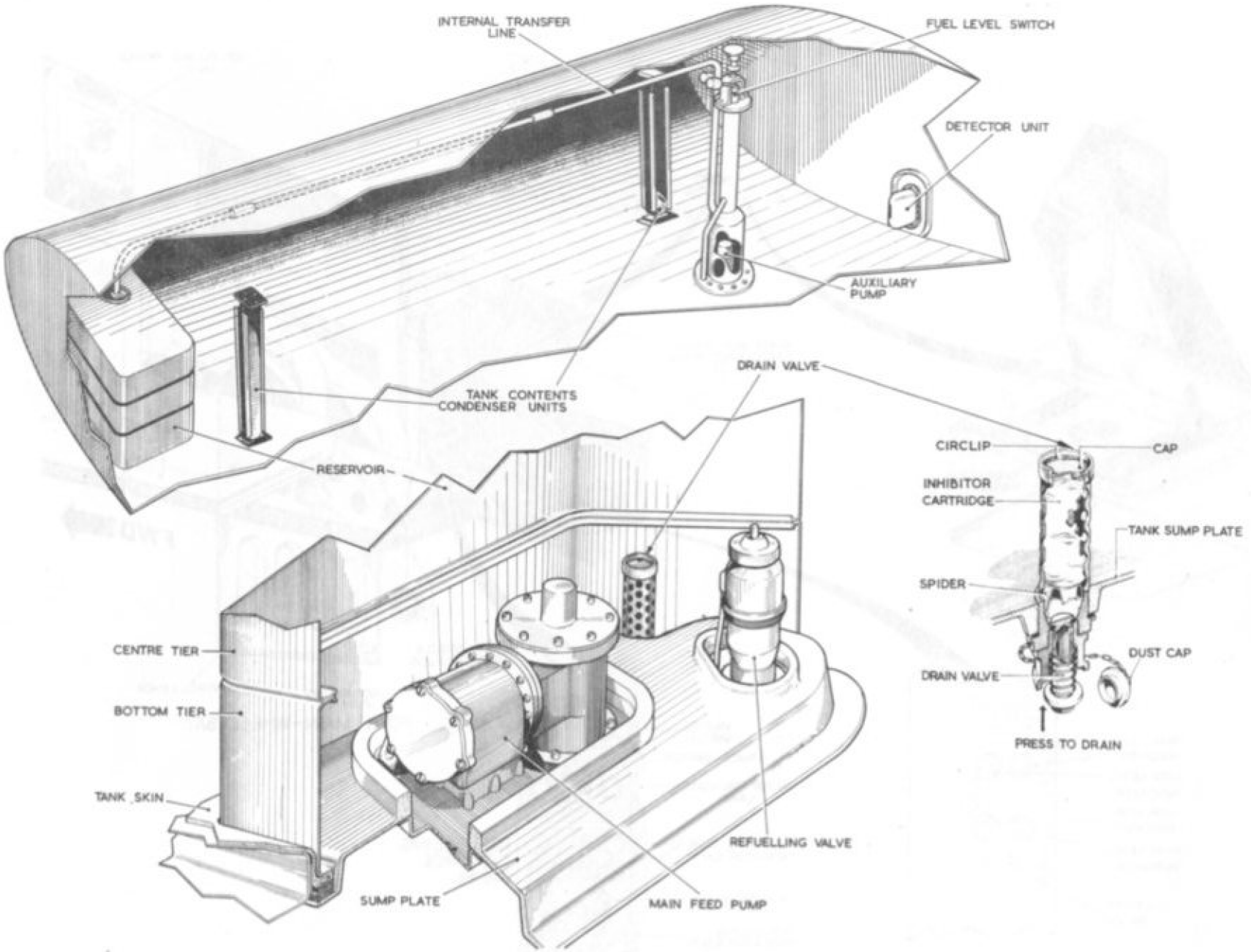


Fig. 7. Fuel tank equipment
(*Mod. 17444*)

RESTRICTED

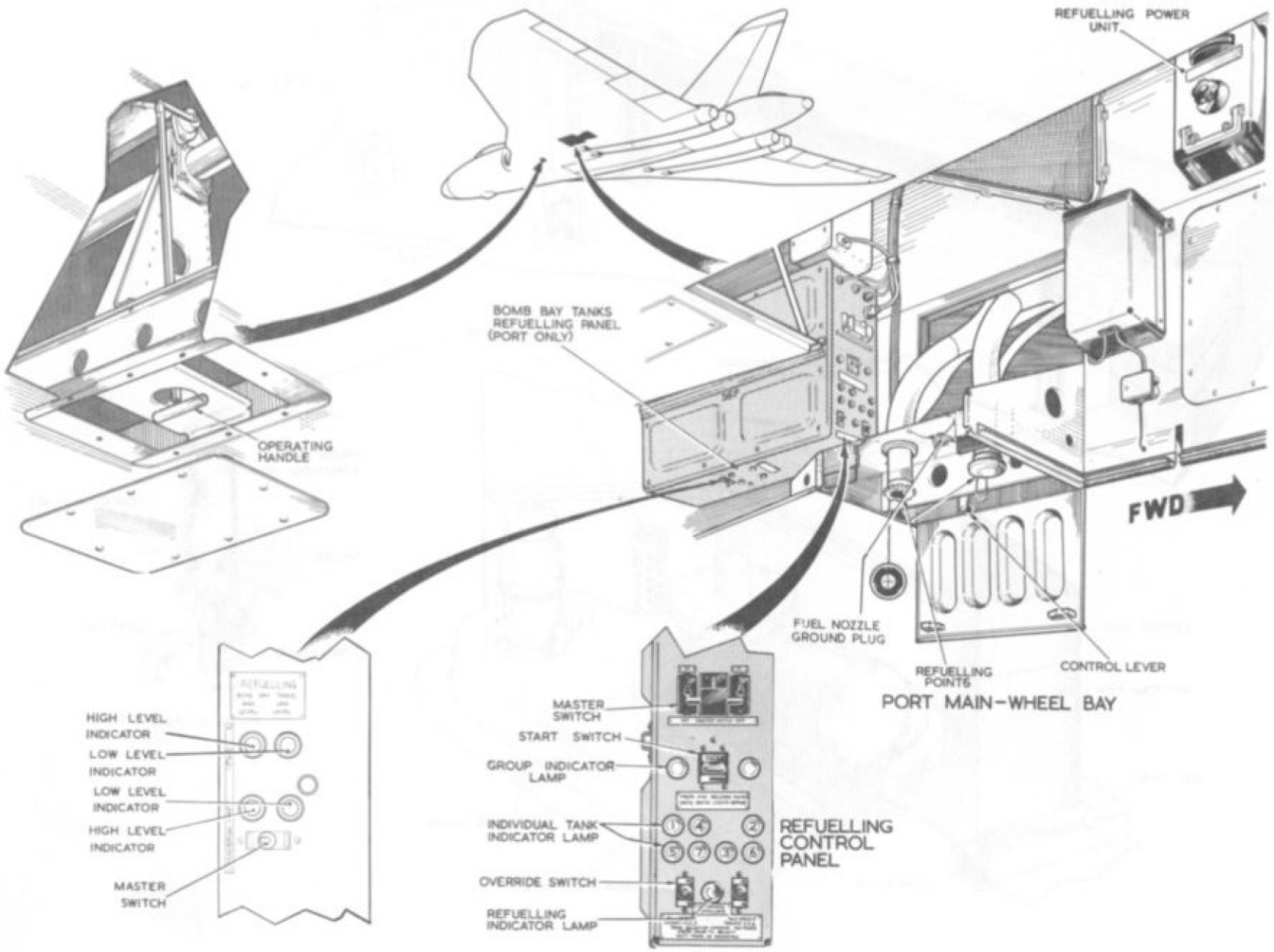


Fig. 8. Refuelling equipment
(* Bomb bay tanks panel added *)

RESTRICTED

effected through two refuelling points in each main-wheel bay, which lead to a refuelling valve, Type F.R., Mk.40, in each tank. These valves are each rated at 50 gallons per minute. Even distribution of the fuel load is accomplished by utilising the electrical output from the contents gauge transmitter. Selection from 0 to 100 per cent of the total tank capacity is possible. Refuelling procedure is described in Sect.2, Chap.2 of this publication and the equipment is illustrated in fig.8.

36. In this paragraph the operation of the refuelling system is briefly explained, reference must be made to Sect.6, Chap.1 for more detailed information on the electrical equipment involved. A control panel and refuelling points are provided in each main-wheel bay. Each panel houses two MASTER ON-OFF switches, a START switch with adjacent No.1 and No.2 group indicator lamps and an indicator lamp for each tank, and at the bottom of the panel are the two group switches with a refuelling indicator lamp. Each MASTER ON-OFF switch controls the electrical supply for the refuelling system for one group of tanks. Adjacent to the port refuelling panel is a stabilized voltage supply panel which contains refuelling selectors graduated from 0 to 100 per cent. The supply panel is energised by a control lever adjacent to the port pair of refuelling points. An indicator lamp, on the refuelling panel, is illuminated when the supply panel is warmed up. The START switches are inoperative until both rotary auto-selectors (Sect.6, Chap.1) are in the starting position. The warning indicators, at the top of each panel, light up when the associated refuelling valve is energised. The contents selector applies a voltage to a resistance network which determines the percentages of fuel contents at which the tank refuelling valve is closed. Refuelling is always started at the No.1 tanks in the No.1 and No.4 engine group or the No.2 tanks in the No.2 and No.3 engine group. As fuel enters the first tank, the current output from the No.1 tank contents gauge amplifier passes through one coil of a current sensitive relay, the other coil of the relay is connected to the resistance network. When the difference of the currents from the No.1 tank amplifier and the resistance network reaches a certain value, the relay operates the rotary auto-selector which closes the refuelling valve of No.1 tank and opens that of No.4 tank. Simultaneously the No.1 tank amplifier is shut off and the No.4 tank amplifier is connected to the sensitive relay and contents gauge transmitter. Refuelling then commences on the No.4 tank and when the selected capacity is reached, No.5 tank (followed by No.7 tank) is refuelled. When No.7 tank is refuelled, the master switches will return to the OFF position and the indicator lamps will extinguish, only the power pack will now be operating. Selection of the control lever between the port pair of refuelling points is now required to switch off the power pack.

Ground defuelling system

WARNING . . .

It is imperative that, during defuelling operations, No.7 tanks are drained before either No.1 or 2 tanks are drained. Also that No.5, 6 and 7 tanks must be drained before No.1 and 2 tanks are both drained. Unless this sequence is followed there is a danger of over-balancing the aircraft.

37. Defuelling under normal circumstances is effected by connecting bowsers to the main-wheel bay refuelling points, and, subject to certain restrictions, transferring fuel by bowser suction supplemented, as required, by the tank booster pumps. Should the refuelling points be inaccessible, as in the case of a crash landing, defuelling is effected by suction only through 2½ in dia. bayonet-type connections (Avery-Hardoll Part No. FC.246 Mk.2) in the upper surface of the main plane. Access to these connections is gained by removing the panels, labelled EMERGENCY DEFUELLING, positioned slightly aft of the front spar and adjacent to the wing roots. The correct defuelling procedure is given in para.141.

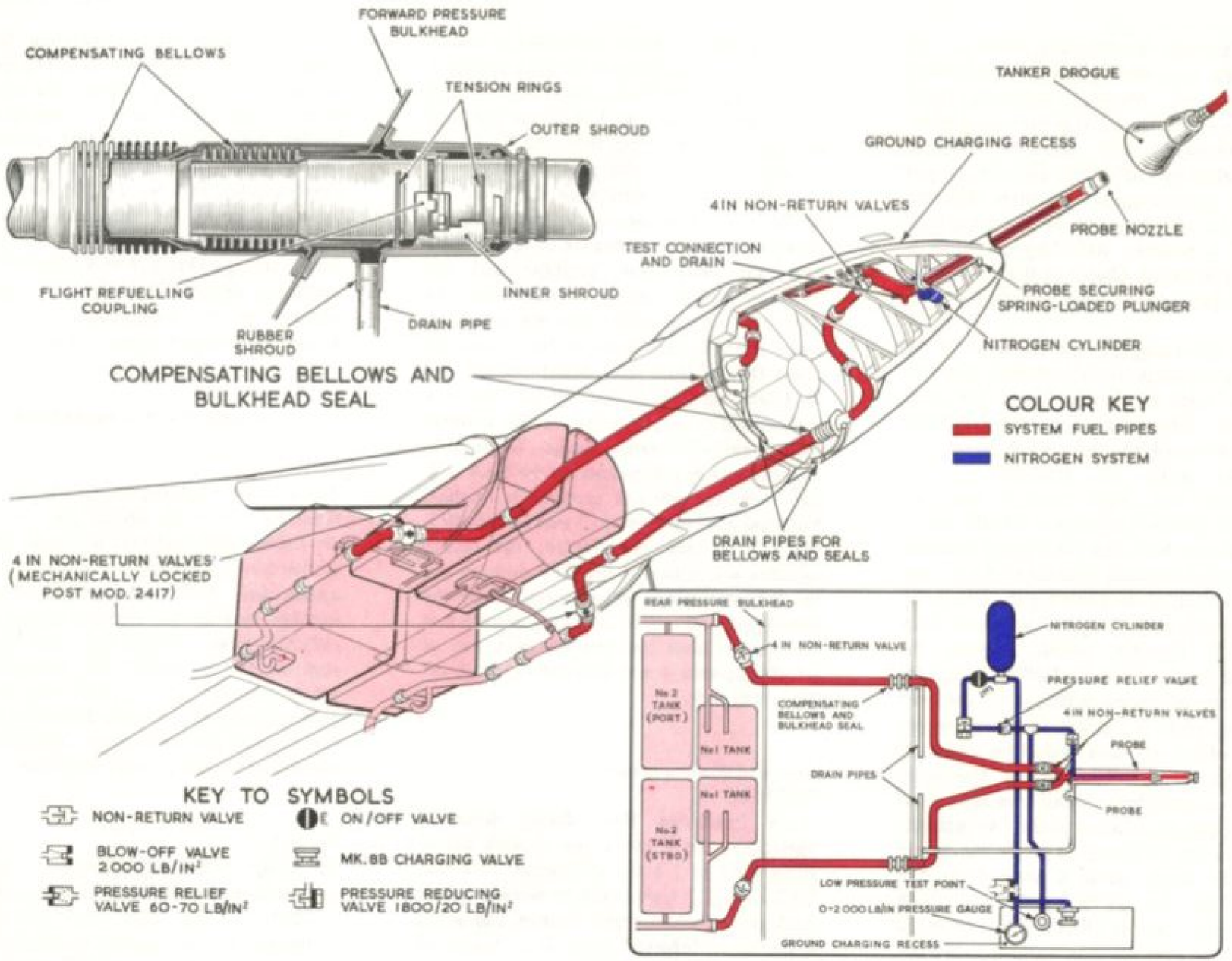
FLIGHT REFUELLING SYSTEM

◀*NOTE . . .*

The following paragraphs describe the flight refuelling system on aircraft pre. mod.2417. On aircraft post mod.2417 the flight refuelling system is rendered inoperative by removing the appropriate fuse and disconnecting and suitably stowing the nitrogen purge system ON/OFF valve electrical plug. The system is then drained of nitrogen and two non-return valves, located aft of the rear pressure bulkhead, are mechanically locked to prevent fuel seepage into the aircraft refuelling lines forward of the rear pressure bulkhead. ▶

General

38. Flight refuelling equipment is basically an extension of the ground refuelling system to a probe in the metal nose fairing. The equipment is in two groups; removable fittings to be installed and removed as required, and fixed fittings which are part of the normal fuselage equipment. The probe nitrogen purge system is described in para.52 to 57 of this chapter.



A.1837

Fig. 9 Flight refuelling system.
(* System rendered inoperative by Mod. 2417 *)

Removable fittings

Probe assembly

39. The probe is a light-alloy tube assembly which protrudes forward through the front upper portion of the metal nose fairing and contains the pipes necessary for flight refuelling. Approximately one third of its length is accommodated within the nose section where it is secured to mountings at formers 510F and 470F. This tube is streamlined to the nose fairings by a light alloy fairing incorporating a sealing ring. An adapter collar riveted to the forward end of the tube carries the refuelling nozzle assembly. Passing through the probe to the nozzle is a 4 in dia. light-alloy fuel pipe which is in two sections joined by a Flight Refuelling coupling. A $^{3}/_{8}$ in dia. light-alloy pipe is secured to and passes along the outer surface of the fuel pipe to enter the fuel pipe approximately eighteen inches from the nozzle to supply nitrogen for probe purging after a flight refuelling operation.

Probe assembly mountings

40. The probe tube assembly is mechanically locked in the mounting at former 510F, to prevent fore-and-aft and rotary movement. Two square section flanges each approximately one quarter of the circumference and diametrically opposed, are attached to the outer surface of the probe tube, which, when correctly positioned and turned through 90 deg engage the flanges in semicircular grooves in the mounting. With fore-and-aft movement thus eliminated, the pin of a spring-loaded locking device, in the base of the mounting, enters an aperture in the underside of the tube to prevent rotary movement.

41. At former 470F, the tube assembly is secured in an inverted cradle bracket and supported on a semicircular channel-section guard gripped by two flat metal straps. The straps are attached, one to each side of the cradle bracket, by bolts and distance pieces with washers and stiffnuts and tightened by a tension bolt below the tube.

Blanking accessories

42. A blanking assembly, used to seal the expansion pipe when the probe is not installed, is stowed on the front face of former 460F. A clamp Part No. 11Z/7648 is used to secure either the probe or the blanking plate to the expansion pipe.

43. When the probe is not fitted, a blanking panel is secured over the probe aperture in the top skin of the nose fairing by 13 screws. Countersunk screws are used to blank off the 18 holes which are used for probe fairing attachment.

Permanent fittings

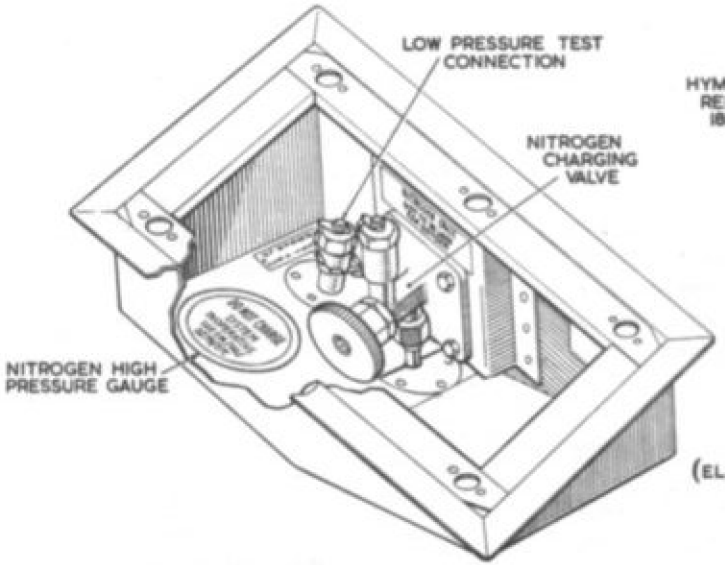
System installation

44. From the probe, fuel is delivered to the main refuelling pipes through an upward curving breeches-piece branching to two 4 in dia. light-alloy pipes which pass along each side of the nose section and through the front pressure bulkhead to the pressurised cabin. Here, owing to variation in pressure and consequently of forces acting upon them, pipes passing along each side of the crew's compartment are of stainless steel and at their forward ends, secured to the bulkhead, compensating bellows are fitted which allow the pipes to expand or contract without damage. Pressure seals are fitted integral with the pipe couplings at the front and rear pressure bulkheads. From couplings aft of the rear pressure bulkhead, light-alloy pipes continue aft, turning outboard between the front and rear false spars of the centre section wing stubs and connect to the No.1 tanks refuelling pipes aft of the rear spar.

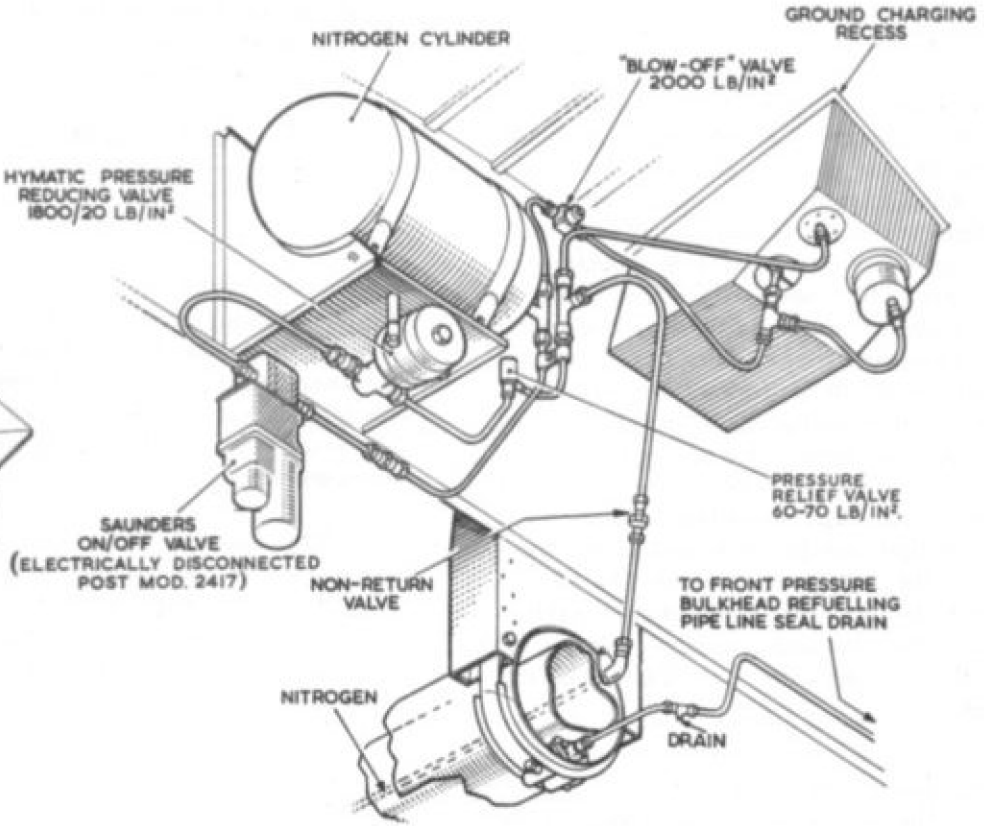
45. Four-inch diameter non-return valves, accessible through panels in the rear false spar of the centre section wing stub, prevent the return of fuel to the pipes forward of them after nitrogen purging. A non-return valve is also fitted in each of the two flight refuelling pipes immediately aft of the breeches-piece in the nose, to cater for nozzle or probe damage.

Bulkhead pressure seals

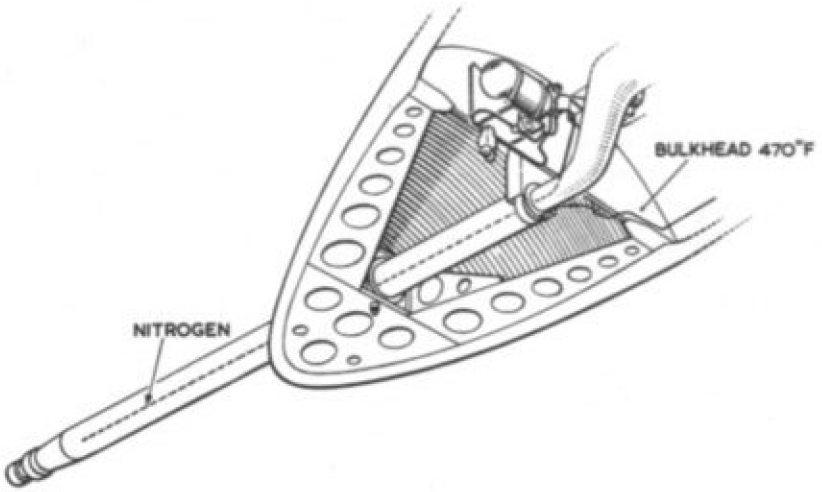
46. Protection of the pipe couplings contained in the front pressure bulkhead seals, against possible damage resulting from pipe reaction to cabin pressure variations, is provided for in the seal assembly. Two reaction rings, welded to the pipes, one at each side of the coupling, are gripped in a stainless steel split barrel type shroud with internal flanges. When the shroud is assembled, in two halves, the flanges engage on the outside of the two reaction rings on the pipe coupling, thus reducing to a minimum the amount of tension to which the coupling may be subjected. This assembly is enveloped in a moulded rubber sleeve secured to the bulkhead at one end and by a hose clip around the pipe at the other end. Covering the whole unit is a light alloy case, also assembled in two halves, secured to the pipe by a clip and, together with the rubber sleeve, attached to the bulkhead by a stiffening ring, 2 B.A. bolts and anchor nuts. Any seepage of fuel from the coupling or the compensating bellows escapes through drainage holes in the bottom of the inner shroud or the



GROUND CHARGING RECESS



VIEW ON BULKHEAD 470"F



PIPE IDENTIFICATION

A.1638

Fig. 10 Nitrogen purge system
(‹ Mod. 2417 ›)

compensating bellows sealing sleeve, to a drain pipe from the bottom of the seal to the underside of the radome surface.

47. The rear pressure bulkhead seal consists of one to three rubber-bonded cork gaskets, according to the installation requirements, compressed between the bulkhead and a bolted bearing.

Controls

48. Flight refuelling operations are controlled in the receiver aircraft by two switches labelled MASTER SWITCH ON-OFF on the flight refuelling panel (starboard console). This panel also contains fourteen refuelling valve indicator lamps, four tank pressurisation magnetic indicators, two PROBE LIGHTING control dimmer switches and two system switches, one labelled NITROGEN PURGE ON-OFF and the other TANK PRESSURISATION ON-OFF. Just forward of this panel, on the cabin conditioning control panel, is a gauge which shows fuel or nitrogen pressures inside the probe fuel pipe.

Operation

49. Before the probe enters the drogue coupling at the beginning of a flight refuelling operation, the master switches are selected ON causing the fourteen tank refuelling valves to open and the tank system to depressurise. When this occurs, fourteen lamps in the refuelling indicators will illuminate and the four pressurisation system magnetic indicators will show WHITE. As the probe and drogue engage, their union opens flow

control valves to allow an automatic flow of fuel through the probe. All tanks are refuelled simultaneously and as each tank is filled, a float level switch closes the refuelling valve and extinguishes the appropriate lamp on the refuelling indicator. Designed rate of flow is 500 gallons per minute. When all tanks are full, all indicator lamps will be extinguished and great care must be taken to ensure that the master switches are selected OFF.

50. A C.G. indicator in the lower right hand corner of the pilot's centre instrument panel registers when the master switches are selected ON. When the aircraft is not refuelling and the master switches are OFF a button switch adjacent to the indicator must be pressed before the C.G. indicator will register.

51. The aircraft C.G. can be controlled during flight refuelling by three switches on the fuel control panel. The single switch at the top of the panel, marked F.R. RECEIVER, C.G. CONTROL, PORT - STARBOARD, is used for lateral control and the two switches which normally control the transfer pumps are used for longitudinal control. With the refuelling master switches selected ON, the normal circuit of these two switches is isolated, and when FWD, is selected the refuelling valves in tanks No.6 and No.7 will close so that the fuel load will be increased forward. When AFT is selected, No.1 and No.2 tanks refuelling valves will close. In each case the refuelling valves to the remaining tanks are unaffected. When the lateral control switch is moved to PORT or STARBOARD the refuelling valves in No.6 and No.7 tanks on the opposite side to that selected are closed.

Nitrogen purge system

52. When flight refuelling has been completed, selection of the nitrogen purge switch to ON opens the refuelling valves of the two No.2 tanks and admits nitrogen under pressure to the probe, forcing fuel remaining in the nose piping aft into the No.2 tanks and preventing the formation of dangerous vapours in the vicinity of the crew's compartment. Full descriptions and servicing details of the system components are given in the following Air Publications:-

Nitrogen cylinder	A.P.1275A, Vol.1
Mk.8B charging valve	A.P.1275A, Vol.1
Hymatic pressure-reducing valve	A.P.4303C, Vol.1
Dowty non-return valve	A.P.1803D, Vol.1
Dunlop blow-off valve	A.P.4303B, Vol.1
Hymatic relief valve	A.P.4303C, Vol.1
Saunders ON/OFF valve	A.P.4373, Vol.1

Nitrogen cylinder

53. A Mk.5D, 750 litre, nitrogen cylinder (Ref.No.6D/9429890) is secured by straps to a felt-lined cradle mounted on the port side of the aft face of bulkhead 470F. A T-piece is screwed into the head of the cylinder which bears the notice NITROGEN stencilled in black. The cylinder is painted grey, with the upper half of the top hemispherical portion painted black.

Controls

54. A switch labelled NITROGEN PURGE and ON-OFF, is mounted on the flight refuelling panel (starboard console), (see fig.2). Selection to ON opens a Saunders ON-OFF valve (Part No.903/ACO.1/P8), allowing nitrogen at 1,800 p.s.i. to flow from the cylinder to a Hymatic pressure-reducing valve and also opens the refuelling valves of the No.2 tanks, allowing fuel from the forward piping to enter.

Low-pressure components

55. Pressure is reduced from 1,800 p.s.i. to 20 p.s.i. by a Hymatic pressure-reducing valve (Part No.PS.82/3) before the nitrogen passes through a Hymatic pressure-relief valve (Part No.RV.31/5) and a Dowty Mk.C non-return valve (Part No.D.446 Y) along the feed line to the forward end of the probe fuel pipe.

Charging and test points

56. A panel on the starboard forward section of the metal nose fairing, marked FLIGHT REFUELLING CHARGING, gives access to a white and red striped Mk.8B charging valve, labelled NITROGEN ONLY, NOT TO BE USED FOR OXYGEN, a pressure gauge (Ref.No.6A/2689) and a low-pressure test connection, labelled LOW PRESSURE TEST 20 p.s.i. A label, NITROGEN H.P. TEST, is adjacent to the pressure gauge and the Mk.8B charging valve, which are connected to a common pipe through a high-pressure blow-off valve (Part No.A.C.M.15318), set at 2,000 p.s.i., to the T-piece on the cylinder head. The pipe from the low-pressure test connection joins the feed line to the probe between the low-pressure relief valve and the Dowty non-return valve.

High and low pressure pipes

57. High pressure pipes from the ground charging valve to the pressure-reducing valve are either 1/4 in. dia. or 3/8 in. dia. 22 s.w.g. tungum. The low pressure pipes from the pressure-reducing valve to the probe are either 1/4 in. dia. or 3/8 in. dia. light alloy.

BOMB BAY SADDLE TANKS

General

58. The fuel system is extended to the bomb bay where provision is made for the accommodation of two non-integral type fuel tanks, one at the front and one at the rear. One or both saddle tanks may be installed, their arrangement depending on the type of store to be carried. The front tank may be fitted in either of two loca-

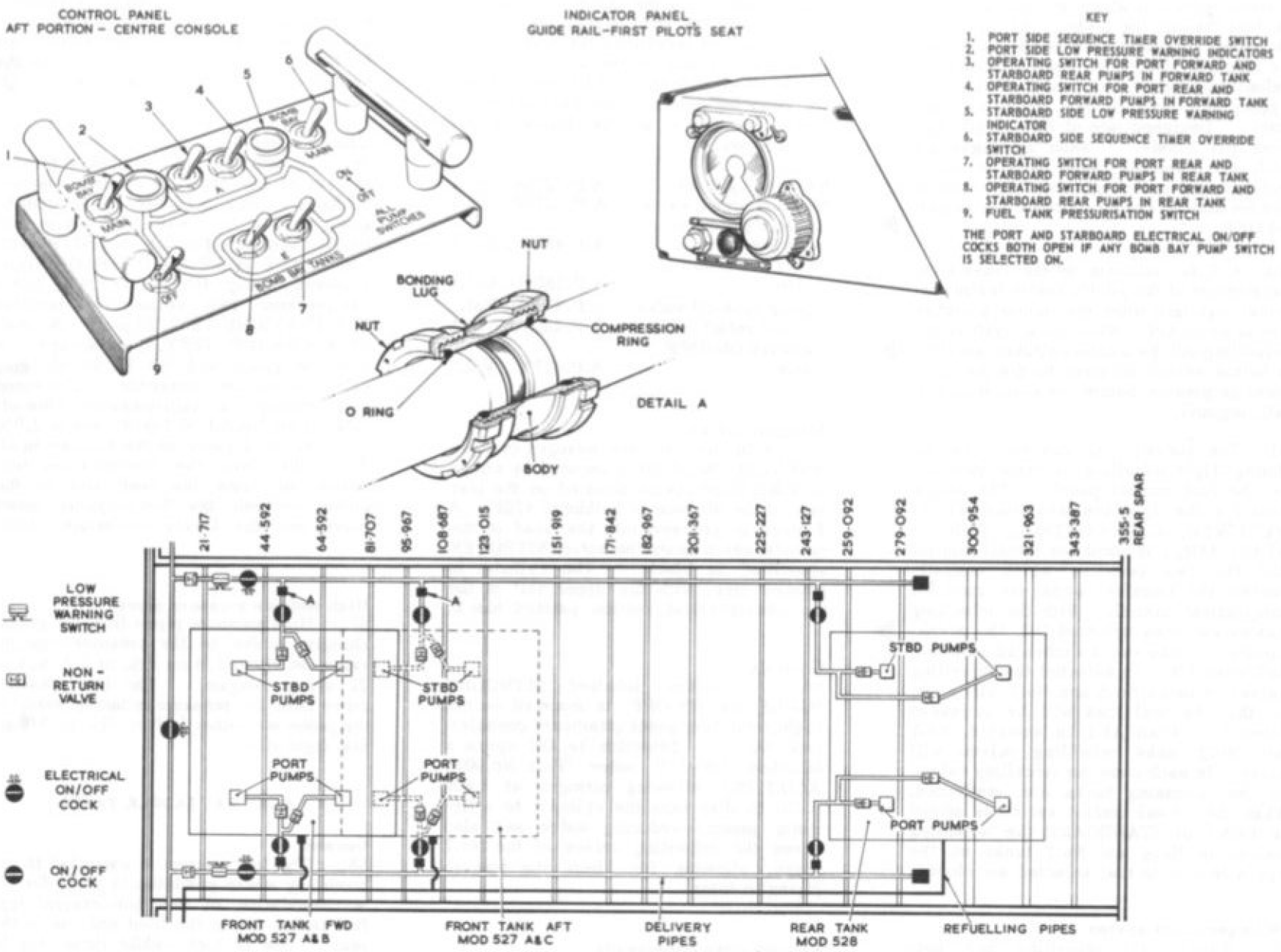


Fig. 11. Bomb bay saddle tank diagram

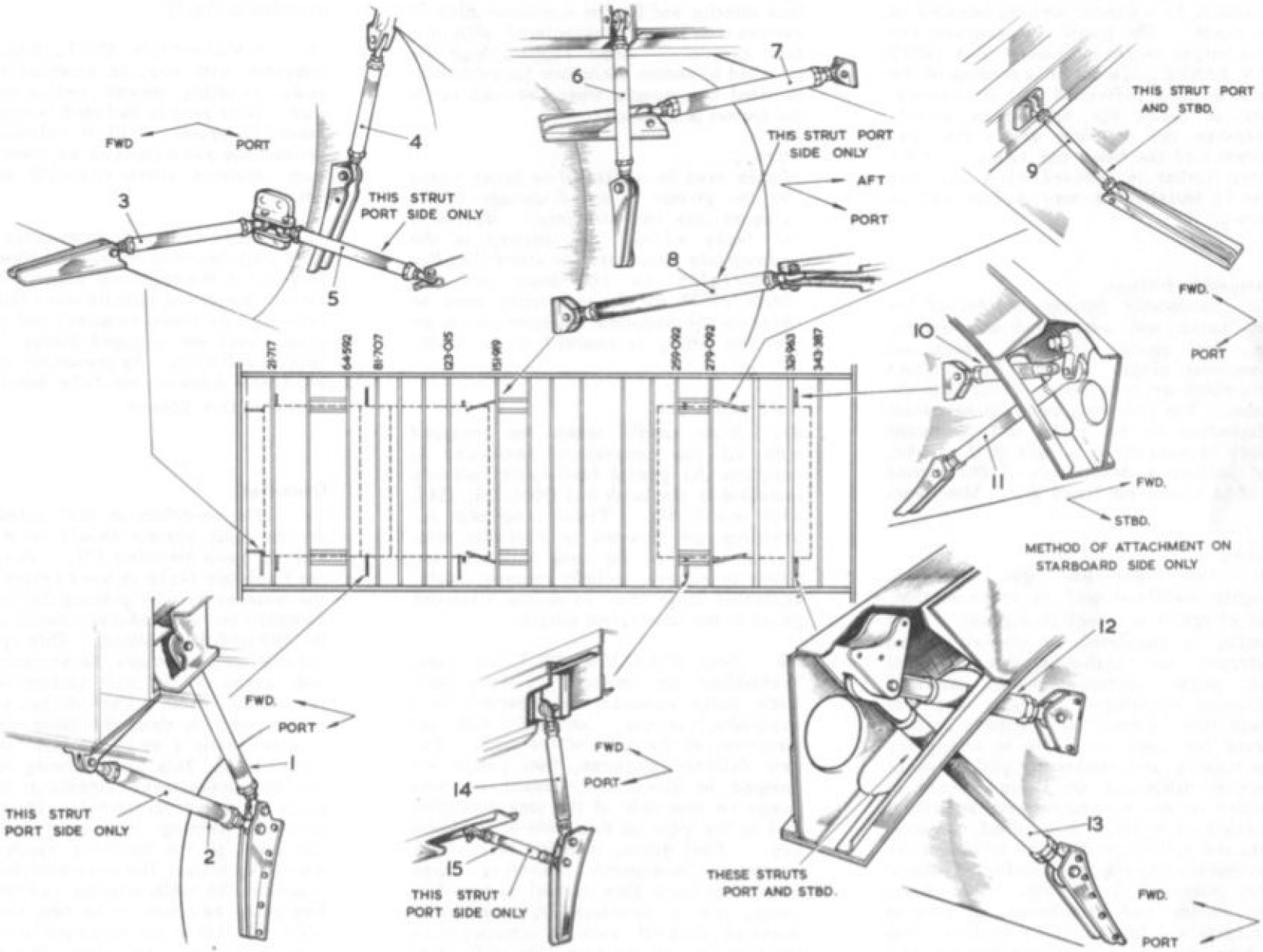


Fig. 13. Arrangement of saddle tanks

seat guide rail. The indicator is illuminated by a pillar lighting bridge which is controlled by a dimmer switch, mounted on the panel. The panel also contains two push-button switches marked E-A BOMB BAY TANKS. To obtain a reading of the contents of an individual tank it is necessary to press the appropriate switch, otherwise the indicator shows the total contents of the bomb bay tanks. If the wrong button is pressed when only one tank is installed, a zero reading will be shown.

Removable fittings

67. Removable fittings consist of the fuel tanks and associated components, i.e., fuel pipes, electrical cables and connecting plugs, tank attachment struts etc., which are permanently attached to the tanks. The following paragraphs contain information on the tanks and equipment which is essentially a part of the tanks, and include a description of the method used to secure the tanks in the bomb bay.

Tanks

68. The tanks are rigid structures, roughly saddle-shaped in cross-section, and of stainless steel throughout. Skin plating is supported on top-hat section stringers and unit-constructed channel and angle section formers, suitably stiffened diaphragms at front and rear completing the structure. Tubular bracing struts are used internally to strengthen the formers, and reinforcing plates, angle section stiffeners etc., are riveted or welded to the structure where additional strength or rigidity is required. Bolts, nuts and split pins are used to secure the internal bracing struts to reinforced attachment points on the formers. Skin seams are welded and attachment of skin to stringers and formers is by spot welding. Lifting lugs and support and bracing strut attachment brackets are fitted extemally at areas which coincide with the internal bracing or reinforcing. Suitably reinforced apertures are provided for access to the tank interior and for the accommodation of various components associated with the fuel system. Short support legs are attached to ensure clearance for externally mounted components when the tank is on the ground or in store.

NOTE...

Tanks must be empty before being rested on the ground to avoid damage to the support legs and structure. Movement of tanks without the support of the appropriate transportation stand (Ref.No. 26DC/13555 for the front tank and 26DC/13556 for the rear tank) must be kept to the absolute minimum necessary for the fitting or removal of the tanks.

Tank equipment

69. Both saddle tanks are equipped with all the components necessary to complete the partial fuel system already installed in the bomb bay (Mod.526, 1345, 1504 and 1509). These component assemblies are mounted in specially reinforced areas of the tank structure and where necessary, include gaskets, seals, stiffening rings etc., to ensure leakproof joints at the attachment points.

70. Four P.A.C.1200 Mk.3 fuel pump assemblies are provided in each tank. Each pump assembly is mounted in a sump-like recess, integral with the structure, at the base of the tank. For fuel delivery purposes, fuel pumps are grouped in pairs, the forward and rear pumps on one side of the tank supplying fuel to the pipe on that side of the bomb bay. Fuel pipes, included in the tank equipment, incorporate non-return valves to prevent back flow of fuel through any pump, and a Saunders 1½ in. manually operated shut-off cock is interposed in the fuel pipe on the tank side of the fuel system coupling (tank pipe to bomb-bay pipe). A diagram of the bomb-bay system with the tanks installed, showing the arrangement of the various valves, is provided in fig.11.

71. A Vickers ¼ in. B.S.P. drain valve, complete with cap, is provided in each pump mounting recess and a collector with a drain plug is included in each pump assembly group. Float valves, which perform the same function as those in the main systems tanks (para.10) are also fitted.

72. Fuel contents transmitter units, float switches and refuelling valves, also provided in the tanks, are connected to the aircraft electrical circuits when the appropriate plugs (tank mounted) and sockets (bomb bay) are engaged during the fuel tank installation. As previously mentioned, these systems are fully described in Sect.6 of this Volume.

Operation

73. The switches on the control panel for the main system should be at AUTO and all pump switches ON. The fuel in the bomb-bay tanks is used before that in the main system by placing the two main switches on the bomb-bay control panel in the BOMB-BAY position. This operation automatically overrides the sequence timer and causes all the main system pumps to run at half speed. Fuel is then supplied to the engines from the bomb-bay tanks together with a small quantity from the main system, this amount being so small that the proportional contents of the main tanks is almost unaffected. The two low pressure warning indicators show when the level in the bomb-bay tanks is low enough to require the main switches to be placed in the MAIN position and the bomb-bay pump switches to be switched OFF. This will bring the sequence timer back into operation and close the shut-off cocks in the delivery pipes at each side of the bomb-bay. The engines will then be

fed from the main system in the normal manner.

Refuelling panel

74. The refuelling master switch and four indicator lamps, one green and one red for for each bomb bay tank, are mounted on the base of the main system refuelling panel situated in the port nose-wheel bay. The green indicators register low-level and the red high-level. When the master switch is placed in the ON position, an electrical supply is fed to the fuel level switches in each tank which, if the tanks are not full, will energise the refuelling valves to the OPEN position and illuminate all the indicator lamps. As the capacity of each tank reaches the full position, during refuelling, the low-level contact of the fuel level switch will open to de-energise one side of the refuelling valve, to partially close the valve and extinguish the low-level indicator lamp. Fuel will continue to enter the tank at a reduced rate, until the high-level contact of the fuel level switch opens to de-energise the other half of the refuelling valve to completely close the valve and extinguish the high-level indicator lamp.

BOMB BAY CYLINDRICAL TANKS

General

75. Mods.2013, 2014 and 2015 make provision for the fitting of two cylindrical tanks in the bomb bay. These tanks, of approximately 1,000 gall. capacity each, are for use on Free Fall Role aircraft only. The cylindrical tanks occupy similar positions in the bomb bay to the front saddle tank (fwd.) position and the rear saddle tank position. Depending upon the stores to be carried, both cylindrical tanks may be fitted or one tank fitted in the front position. Subsequent to Mod. 2013 it will still be possible to install a front saddle tank in its forward position, but due to alterations to the bomb arches, it will not be possible to fit a rear saddle tank.

76. Mod.2013 Part A is applicable to aircraft embodying Mod.526 and provides for the structural alterations and fixed fittings required to install two cylindrical tanks in the bomb bay.

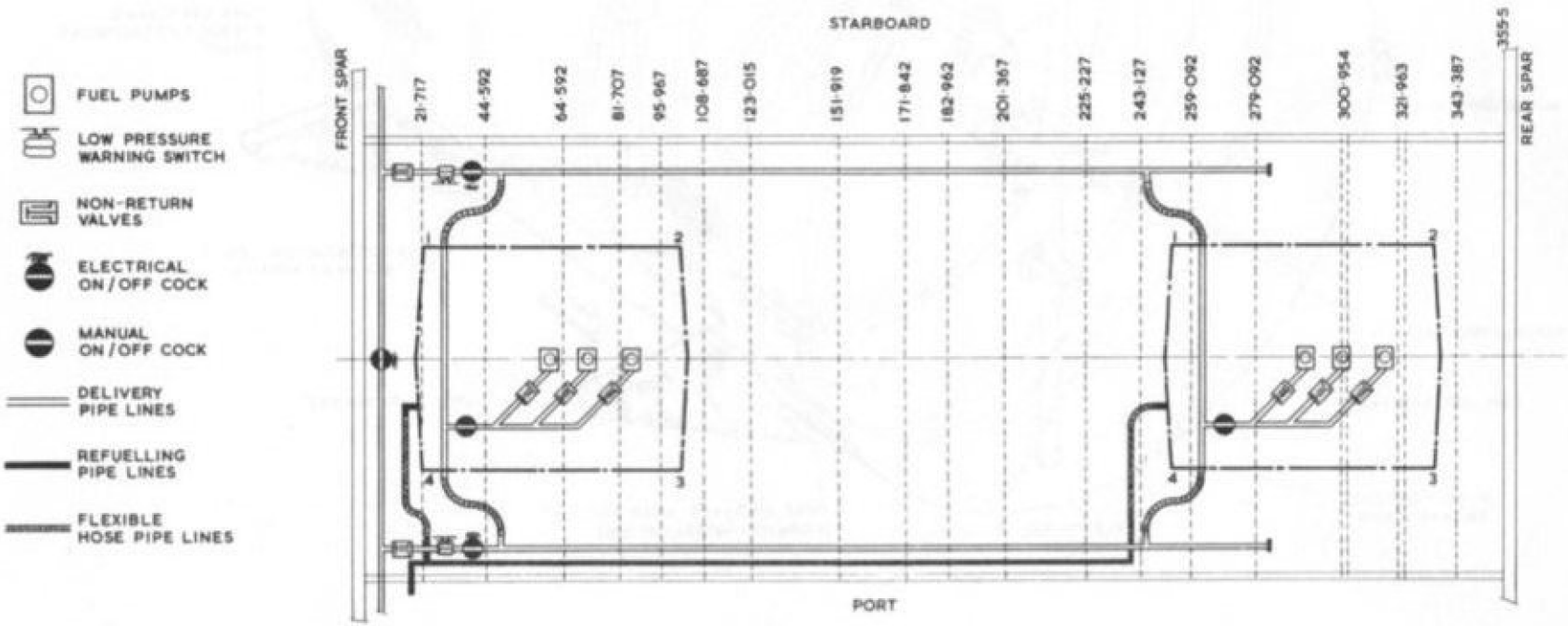


Fig.14. Bomb bay cylindrical tank diagram

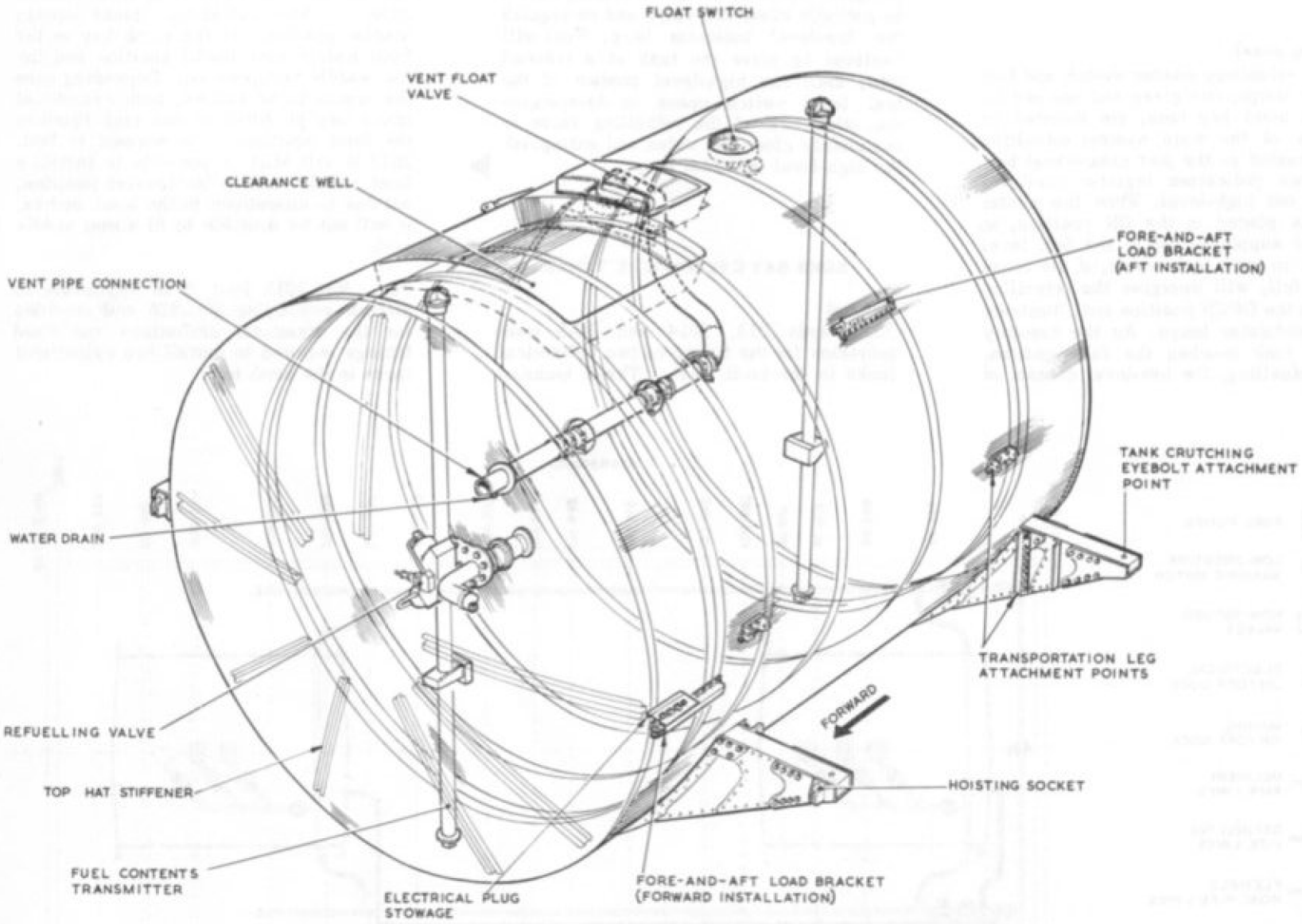


Fig. 15. Bomb bay cylindrical tank structure

77. Mod.2013 Part B, is additional to Part A, for aircraft not embodying Mod.526 and introduces those parts of Mod.526 necessary for the installation of the cylindrical tanks, i.e., the pressurisation panel, fire extinguisher bottles and cartridges, spray pipes and fire wires.

78. Mod.2014 consists of one cylindrical tank together with all the removable fittings required to install it in either the front or rear position in the bomb bay. If two tanks are to be fitted, then two modification kits will be required.

79. Mod.2015 introduces a modified fuel contents gauge to replace the existing gauge mounted on the panel attached to the rear of the first pilot's seat guide rail. The modified gauge is capable of registering the greater capacity of the cylindrical tanks and can be used in conjunction with the front saddle tank provided that Mod.2086 (change of cable box) has been applied to the saddle tank. Mod.2015 also changes the cable box fitted to the aircraft.

Fixed fittings

80. Fixed fittings introduced by Mod. 2013, i.e., bomb arches reinforcement, suspension link intercostals, fore-and-aft load brackets, a refuelling pipe, a vent pipe, fire extinguisher spray pipes and fire wires are described in the following paragraphs.

Bomb arches

81. Bomb arches 300·954A and 321·936A are reinforced by aluminium-alloy channel sections to which are riveted packing strips to form seatings for the aft crutches. Bolt holes, drilled in these bomb arch seatings, form the attachment of the crutches, nine holes in bomb arch 300·954A and seven holes in bomb arch 321·936A for each crutch. The hoisting bracket on bomb arch 321·936A, formerly used for saddle tank installation, is removed. Support blocks and packing are fitted to bomb arches 44·592A, 95·967A, 64·592A, 250·095A and 279·092A for crutch seating and two bolt holes are provided for the attachment of each crutch to each bomb arch. Anchor nuts are fitted to the bolt holes at bomb arches 64·592A and 95·967A.

Intercostals

82. Additional intercostals, bolted in position between bomb arches 300·954A and 321·936A, form the attachment points for the two rear suspension links of the two suspension beams which support the tank when installed in the rear position. Existing intercostals are used for the attachment of the suspension links in the other positions.

Fore-and-aft load brackets

83. Two brackets are fitted to bomb arch 279·092A to which are connected the fore-and-aft load struts when a tank is installed in the rear position. The bomb bay roof skins, between bomb arches 259·092A and 279·092A, are reinforced to absorb the fore-and-aft loads. Two brackets are fitted to the front spar for the attachment of the fore-and-aft load struts when a tank is carried in the front position.

Refuelling pipe

84. If Mod.526 is embodied, the rearmost pipe of the refuelling pipeline, installed in the port side of the bomb bay, is to be removed and a pipe to Mod.2013 standard fitted. Aircraft which are pre Mod.526 must have the complete refuelling pipe line assembly fitted to Mod.2013 standard.

Vent pipe

85. An additional vent pipe is provided by Mod.2013, for use with the front tank installation, and is stowed when not in use, in the bomb bay roof, forward of bomb arch 21·717A, together with the rubber hose, hose clips and bonding clips which attach it to the main vent pipe.

Spray pipes and fire wires

86. If Mod.526 is incorporated, the routeing and clipping of the fire extinguisher spray pipes and fire wires are to be altered to Mod.2013, Part A standard. If Mod.526 is not embodied the fire extinguisher system is to be installed in accordance with Mod.2013, Part B.

Removable fittings

87. The removable fittings consist of the fuel tank, two fuel delivery hoses, a refuelling hose, four suspension links, two suspension beams, four crutches, two crutch adapters, two fore-and-aft load struts, a vent pipe assembly and two pairs of hose support brackets. These fittings are described in the following paragraphs.

Tank

88. The tank is a rigid structure, cylindrical in shape with convex domed ends and is made of aluminium alloy. The tank is supported by four outriggers, two on each side of the tank. The tank is stiffened internally by double formers in line with each pair of outriggers. Each outrigger has a bolt hole by which the tank is attached by crutching eyebolts to the suspension beams in the bomb bay. The outriggers also have hoisting sockets to which the ball-ends of the minilift hoist cables are attached when installing or removing a tank. On top of the tank at the forward end is a clearance well with a dome fitted just aft of it. The dome encloses the vent float valve which is mounted inside the tank at this point. The vent pipe connection, on the forward

V.2.1A. 1157

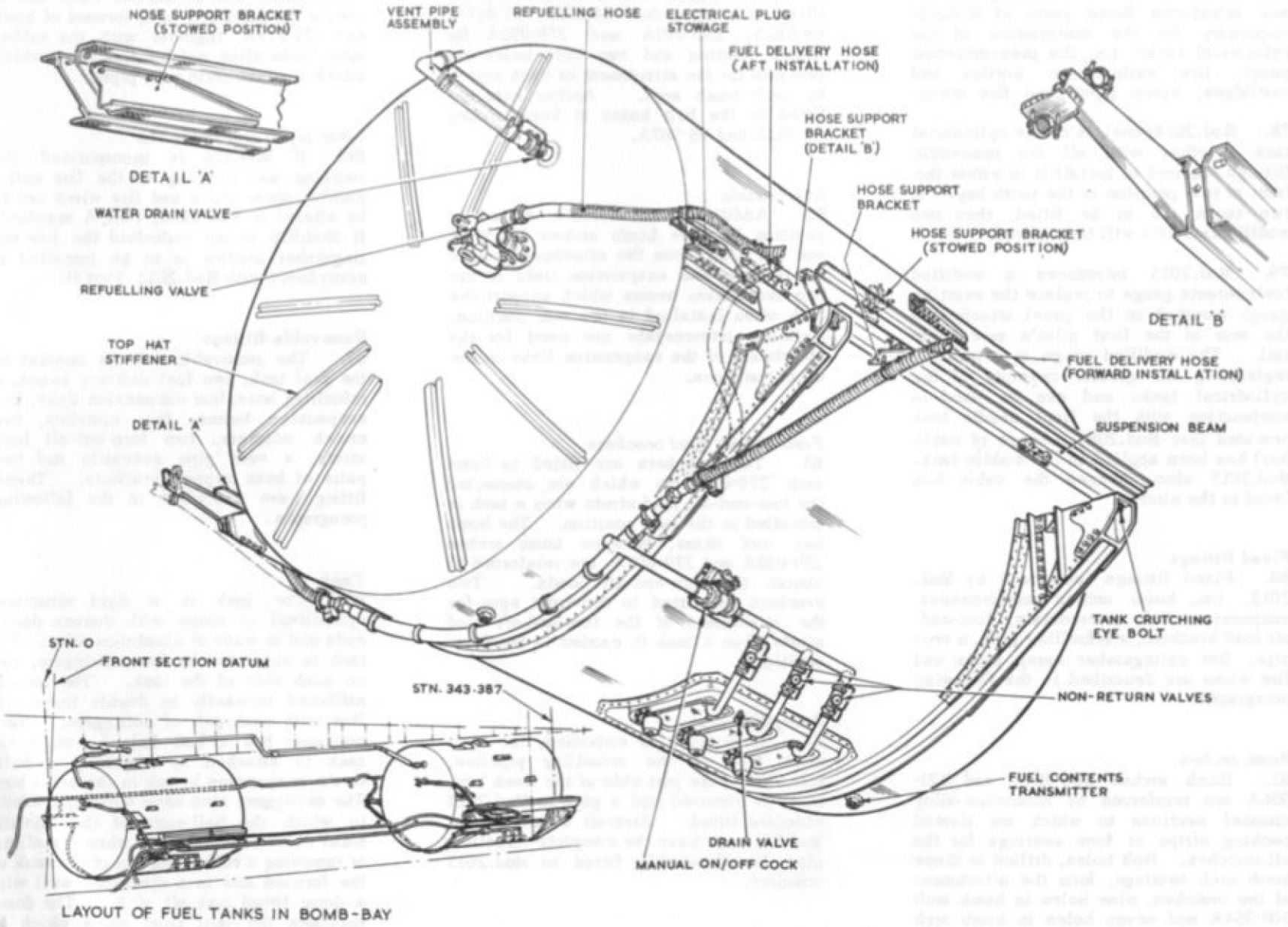


Fig. 16. Bomb bay cylindrical tank

end of the tank is fitted with a water drain cock. Two pairs of brackets are bolted to the tank walls for the attachment of the fore-and-aft load struts. The first pair are attached to the port and starboard sides of the tank at the front end, slightly below the horizontal centre line and are used when the tank is installed in the front position. The second pair are mounted midway along the tank, on its upper surfaces, port and starboard, and are used when the tank is installed in the rear position. A sump, made from a light-alloy pressing, is fitted in the base of the tank and also forms the mounting for the fuel pumps. The sump and dome are both bolted into position and may be removed to gain access to the interior of the tank. Four transportation legs, with castoring wheels, are provided by Mod.G.E.2120, which support the tank clear of the ground when it has been removed from the aircraft. The legs are attached to brackets on the outriggers and tank walls by captive drop-nose pins.

NOTE...

The transportation legs are designed only for manoeuvring the empty tanks into position beneath the bomb bay and for storage purposes. They are not to be used to transport the tanks over rough surfaces.

89. Three P.A.C.1200 Mk.4 fuel pump assemblies are installed in each tank. The pumps are mounted on the sump, along the fore-and-aft centre line of the tank. A Vickers 1/4 in. B.S.P. drain valve is mounted on the sump and a collector with a drain plug is included in each pump assembly. The pump outlets are connected by short pipes, each containing a non-return valve, to a branch pipe. A manually-operated 2 in. diameter servicing cock is fitted to the branch pipe, after which the branch pipe divides into two pipes, to port and starboard. These port and starboard pipes are connected by the delivery hoses to the delivery pipe lines, which are fixed fittings, in the port and starboard sides of the bomb bay. Each fuel delivery hose is supported by 'Fokker' type hose clips bolted to brackets attached to the tank forward outriggers or to brackets attached to the underside of the forward ends of the suspension beams, depending on whether the tank is installed in the front or rear position. The bracket at the forward end of the port suspension beam is used to support the refuelling hose in both installations. An electrical plug stowage, mounted on the top face of the forward port fore-and-aft load strut bracket on the tank, has an attachment point for another hose clip, supporting the refuelling hose and used in both installations. A diagram of the tank installations showing the various pipes, hoses, valves and cocks is provided in fig.14.

90. Two fuel contents transmitter units, a double float switch and a refuelling valve, fitted to the tank, are connected to the aircraft electrical circuits when the appropriate plugs (tank mounted) and sockets (bomb bay) are connected during a fuel tank installation. These components are fully described in Sect.6, Chap.9 of this Volume.

Suspension links

91. The suspension links have attachment holes at both ends and another at the central position, the plane of the top hole being at 90 deg. to the other two. The links are attached to universal blocks mounted on the intercostals on both sides of the bomb bay roof, two links being required for each suspension beam. For the rear tank installation, the two rear links (port and starboard) are attached to their respective suspension beams using the link centre holes. In all other positions the bottom holes of the links are attached to the suspension beams.

Suspension beams

92. The suspension beams are spar-like structures, built of light-alloy sheet metal webs and extruded angle sections. There are four link attachment holes in each beam, the outer pair of holes being used for the rear tank installation and the inner pair for the front tank installation. At the ends of the beam are attachment brackets to which the tank crutching eyebolts are secured by captive Pip-pins. Angle brackets, riveted to the top and bottom surfaces of the beam, form a stowage for the crutch adapters when they are not in use. A stowage for the spare crutch and attachment bolts is attached to the rear end of the beam. At the ends of the beam there is also an attachment point for the mini-lift hoists (Ref.No. 26DC/95088) used to install or remove a tank. The two pairs of hose support brackets, referred to in para.89, are bolted to the suspension beams, one pair extending forward from the front ends of the beams. The other pair is used in a front tank installation only and is then attached to the crutch adapter stowage brackets on the underside of the suspension beams. In a rear tank installation these brackets are transferred to the upper outboard beam brackets.

Crutches and crutch adapters

93. The crutches and adapters are bolted to the bomb arches and form the seatings against which the tanks are pressed during installation to form a solid mounting in the aircraft. The two adapters are fitted in conjunction with the two rear crutches when a tank is installed in the front position, due to the differences in the contours of the bomb arches at the front and rear tank positions. The positions of each crutch and adapter is stencilled on it, also an arrow indicating 'forward'. The curved faces of the crutches which contact the tank are covered with sponge rubber sheeting.

94. When fitting the crutches for a front tank installation, the forward crutches

must be fitted first, as the front edges of the adapters overlap the rear edges of the forward crutches, each crutch and adapter being bolted to anchor nuts on bomb arch 64·592A. The front edge of each forward crutch is attached to bomb arch 44·592A by two bolts, the rear edge of each adapter is bolted to anchor nuts on bomb arch 95·967A. Each rear crutch is attached to its adapter by twelve bolts.

95. When installing a tank in the rear position, each forward crutch is attached to bomb arches 259·092A and 279·092A by four bolts, two to each bomb arch. The front edge of each rear crutch is attached to bomb arch 300·952A by nine bolts, and the rear edge of each rear crutch is attached to bomb arch 321·936A by seven bolts.

Fore-and-aft load struts

96. The same pair of fore-and-aft load struts is used in both the front and rear tank installations. In the front tank installation, the struts connect the brackets on the front spar to the brackets mounted on the sides of the tank at the front end. In the rear tank installation, the struts connect the brackets on bomb arch 279·092A to the brackets mounted at mid-position on the top surface of the tank.

Vent pipe

97. The vent pipe is common to both front and rear tank installations and consists of two elbow pieces (Part Nos. 15P/3918 and 25P/3375), one long length of rubber hose, two short lengths of rubber hose, six hose clips, four bonding clips, three lengths of copper bonding cable, and plastic strapping to secure the cables to the hoses. The method of assembly differs between the front and rear tank installation, as detailed in para.174 and 175.

Controls and indicators

98. The bomb bay cylindrical fuel tank system is controlled from the same panel as for the saddle tank system, which is described in para.65. Because there are only three fuel pumps in each tank to control instead of four, the right-hand fuel pump switches now control the forward pumps and the left-hand fuel pump switches control the centre and rear pumps. Post Mod.2013, the panel is labelled FWD. and AFT instead of A and E.

99. The fuel contents indication is identical to that described in para.66 except that a modified gauge, capable of registering the greater capacity of the cylindrical tanks, is fitted to the panel. The labels on this panel are also changed from A and E to FWD. and AFT.

Operation and refuelling

100. The bomb bay cylindrical fuel tanks are operated and refuelled in the same way as the saddle tanks, as described in para.73 and 74.

SERVICING

WARNING...

During refuelling, defuelling and draining operations, the fire precautions detailed in A.P.4117, Vol.1, Sect.1, Chap.2 are to be strictly observed.

DRAINING OF FUEL SUMPS

101. A drain valve is mounted in the base of each fuel tank, on the sump plate, to remove any accumulation of water in the tanks (fig.7). Access to the tank sumps is through panels in the lower surface of the main plane. The method of draining is as follows:-

(1) Remove the dust cap from the valve and unscrew the locking ring.

(2) Press on the spring-loaded base of the valve.

(3) Examine the drainage, and if water is found, report in accordance with current instruction.

(4) Tighten the locking ring and refit the dust cap.

NON-RETURN VALVES

Main fuel system

102. To ensure that the non-return valves in the tank feed lines are seating correctly:-

(1) Close all cross-feed cocks.

(2) Close all engine L.P. cocks

(3) Ensure that all tank service cocks are open.

(4) AUTO-MANUAL switch to MANUAL

(5) Take gauge readings on all tanks

(6) Switch on No.4 booster pump in groups 1 and 4 and No.3 booster pump in groups 2 and 3.

(7) Leave the pumps running for three minutes and check whether No.3 or 4 tanks contents are decreasing. If this should occur, a check is to be made for a tank showing an increase in its fuel content. The

non-return valve in the feed line of any tank showing an increase is suspect as faulty.

(8) Repeat this test, running booster pumps 1 and 2 in each group and then 5 and 6.

Bomb bay saddle tank system

103. To check that the non-return valves in the bomb bay fuel feed lines and in the saddle tank pump outlets are seating correctly, proceed as follows:-

(1) Check that the saddle tanks contain at least 200 gallons each and the main tanks are at 20% capacity.

(2) Prime the system by opening the port and starboard defuelling cocks, selecting No.1 port and starboard tank refuelling valves OPEN, opening the saddle tank servicing cocks and selecting all four bomb bay pump switches ON for approximately one minute. Also prime the cross-feed lines by selecting the engine and aircraft cross-feed cocks OPEN and transferring fuel from No.7 tank port to No.1 tank starboard.

(3) Remove the electrical supply sockets from the port forward and starboard rear pumps of the front saddle tank and select the left-hand front pump switch ON. The full pressure indicators should be white.

(4) Select the AUTO-MANUAL switches to MANUAL and select one pump in each main tank inboard group ON, ensuring that the relevant tank servicing cocks are open. If either of the fuel pressure indicators turn black this will indicate a faulty non-return valve in that particular fuel feed line.

(5) Select the main system and bomb bay tank pump switches OFF. Reconnect the electrical supply sockets to the port forward and starboard rear pumps on the saddle tank.

(6) Carefully check the fuel contents of both front and rear saddle tanks.

(7) Select ON the left-hand and right-hand pump switches for the front tank and after 5 minutes check the rear tank contents. An increase will indicate that one or more of the four non-return valves in the rear tank is leaking. Switch OFF the front tank pump switches.

(8) Select ON the left-hand pump switches for the rear tank and after 5 minutes check the front tank contents. An increase will indicate that one or more of the front tank non-return valves is leaking. Switch OFF the rear tank pump switches.

(9) If leaks are discovered in op.(7) or (8), switch ON one of the pump switches in the suspect tank in addition to both switches in the other tank. In this way the suspect non-return valves can be reduced to two. Removal or blanking will be required to determine which of the two is leaking.

Bomb bay cylindrical tank system

104. To ensure that the non-return valves in the bomb bay fuel feed lines and in the cylindrical tank pump outlets are seating correctly proceed as follows:-

(1) Refuel approximately 80 gallons into each cylindrical tank and 20% into the main tanks.

(2) Prime the system by opening the port and starboard defuelling cocks, selecting No.1 port and starboard tank refuelling valves OPEN, opening both cylindrical tank servicing cocks and selecting all four bomb bay pump switches ON for approximately one minute. Also prime the cross-feed lines by selecting the engine and aircraft cross-feed cocks OPEN and transferring fuel from No.7 tank port to No.1 tank starboard.

(3) Remove the electrical supply sockets from the centre and aft pumps of the front tank and select the left-hand front pump switch ON. The fuel pressure indicators should be white.

(4) Select the AUTO-MANUAL switches to MANUAL and select one pump switch in each main tank inboard group ON ensuring that the relevant tank servicing cocks are open. If either of the fuel pressure indicators turn black then the non-return valve in that side of the fuel feed line is faulty.

(5) Select the main tank system and bomb bay tank pump switches OFF. Reconnect the electrical supply sockets to the centre and aft pumps of the front tank.

(6) Carefully check the fuel contents of both cylindrical tanks.

(7) Select ON the left-hand and right-hand pump switches for the front tank and after 5 minutes check the rear tank contents. An increase will indicate that one or more of the three non-return valves in the rear tank is leaking. Switch OFF the front tank pump switches.

(8) Select ON the left-hand and right-

hand pump switches for the rear tank and after 5 minutes check the front tank contents. An increase will indicate that one or more of the front tank non-return valves is leaking. Switch OFF the rear tank pump switches.

(9) If op.(7) or (8) reveal leaks, switch ON the right-hand switch in the suspect tank in addition to both the pump switches of the other tank. If the contents of the suspect tank remains steady, the forward non-return valve is leaking. If the contents of the suspect tank still increases, the leaking non-return valve is either the centre or rear one. To decide which of these two is leaking, disconnect the electrical supply socket from the forward pump and repeat the test with the left-hand pump switch of the suspect tank ON in addition to both pump switches of the other tank. If the contents of the suspect tank remains steady, the centre non-return valve is leaking. If the contents has increased the forward non-return valve is suspect.

FUEL FLOW TESTS

General

105. The following paragraphs detail the flow tests required after fitting or replacement of fuel system components, and when called for in A.P.101B-1902-4. The appropriate test should be extracted from the following, according to the section of the system which has been disturbed.

Equipment

106. The fuel delivered during the tests may be measured or weighed, whichever is convenient. The following equipment is required:-

(1) A 2 in. i/d. flexible hose incorporating two manually-operated on/off cocks and a 0 to 25 p.s.i. pressure gauge.

(2) A clean 40 gallon drum. If the quantity of fuel is to be measured by volume, the drum must be accurately calibrated.

(3) A second clean 40 gallon drum to receive the flow of fuel while flow rates are being set and fuel pipes primed.

(4) A stopwatch

(5) A ground electrical supply must be connected for all tests.

107. The engine fuel feed pipe must be disconnected as required, at a convenient point aft of the engine bay front bulkhead, and the flexible hose connected to it. One on/off cock must be fitted at the outlet end of the hose, the other close to the inlet end, with the pressure gauge between this cock and the connection to the engine feed line (fig.17).

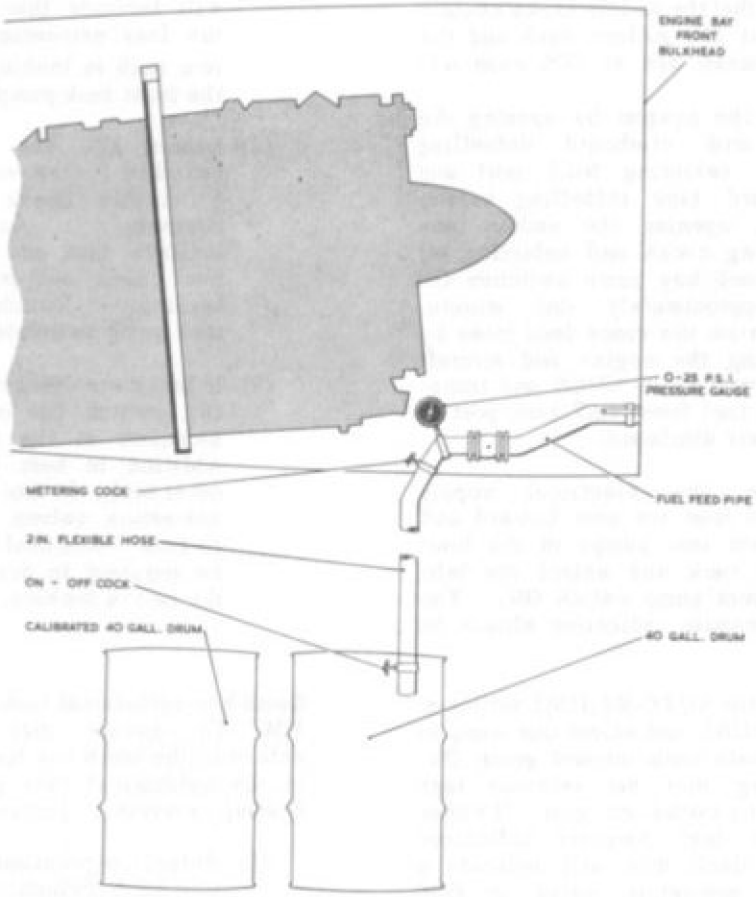


Fig.17. Flow test equipment

NOTE...
In the following paragraphs the cock at the hose inlet will be referred to as the 'metering cock' and the cock at the outlet end as the 'on/off cock'.

Fuel transfer and C.G. indicator

108. The test for port or starboard side of the aircraft is as follows:-

(1) Ensure that fuel tanks No.1 and No.7 are approximately 30 per cent full and record their contents.

(2) Select FWD. on the C.G. TRANSFER switch (main control panel).

(3) Record the quantity of fuel transferred from No.7 to No.1 tank in 15 minutes.

(4) Select AFT on the C.G. TRANSFER switch.

(5) Record the quantity of fuel transferred from No.1 to No.7 tank in 15 minutes. The minimum flow rates are:-

No.1 to No.7 tank:- 750 g.p.h. (1500 lb. in 15 minutes)
No.7 to No.1 tank:- 500 g.p.h. (1000 lb. in 15 minutes)

(6) By operation of the C.G. TRANSFER switch, trim the C.G. indicator (centre instrument panel) to read zero. Record the contents of No.1 and No.7 tanks.

NOTE...
To obtain a reading on this indicator it is necessary to press the push button switch located beside it.

(7) Select AFT on the C.G. TRANSFER switch.

(8) Immediately the C.G. indicator needle reaches the red sector of its dial, stop the fuel transfer. Record the contents of No.1 and 7 tanks. The quantity of fuel transferred should be 750 lb. ± 75 lb.

(9) Operate the C.G. TRANSFER switch to trim the C.G. indicator needle to zero.

(10) Select FWD. on the C.G. TRANSFER switch.

(11) Immediately the C.G. indicator needle reaches the red sector of its dial, stop the fuel transfer. Record the contents of No.1 and 7 tanks. The quantity of fuel transferred should be 750 lb. ± 75 lb.

Engine feed pipe and pump delivery

109. To test fuel pump delivery, engine feed pipes and sequence timer operation, carry out the following operations at each engine. Further to the equipment listed in para.106, a sequence timer test box (Ref.No.26DC/95250) will be required.

(1) Couple up the test equipment to the engine feed line as shown in fig.17. An electrical tradesman will be required to connect up the sequence timer test box (Sect.6, Chap.9) and to assist during the tests.

(2) Ensure that all tank servicing cocks in the group under test are closed.

(3) Ensure that the L.P. cock and cross-feed cocks are closed.

(4) Select AUTO on the AUTO-MANUAL switch of the appropriate group (main control panel).

(5) Switch ON all fuel pumps in the group (main control panel).

(6) Using the sequence timer test box, determine and record which pump is running at full speed.

(7) Select MANUAL on the AUTO-MANUAL switch and switch the fuel pumps OFF.

(8) Remove the three fuses from the 3-phase supply to the motor of the sequence timer governing that particular side of the aircraft (panels 59P port, 60P starboard).

(9) Open the tank servicing cock in the line from the pump recorded in op.(6).

(10) Open the L.P. cock.

(11) Place the free end of the flexible hose in the non-calibrated drum and prime the line by opening both cocks in the flexible hose and switching ON the pump recorded in op.(6). When an air-free flow has been obtained, switch the pump OFF and immediately afterwards turn off the on/off cock.

(12) Note the static pressure shown on the hose gauge.

(13) Switch the pump ON again and record the pressure shown on the hose gauge. The pump stall pressure can now be obtained by subtracting the static pressure, the result must be not less than 16·5 p.s.i.

(14) Fully open the on/off cock and progressively close the metering cock until a reading of 10·5 p.s.i. plus static pressure is shown on the hose gauge. Close the on/off cock.

(15) Transfer the hose outlet to the empty calibrated drum.

(16) Open fully the on/off cock and observe, by use of the stopwatch, the time taken for 20 gallon (160 lb.) of fuel to flow into the drum. The time taken must be not more than 58 seconds (this is equal to a flow-rate of 1,240 gallons per hour).

(17) Switch OFF the pump which has been tested and close the tank servicing cock in this line.

(18) Open the tank servicing cock of one of the half speed pumps in the same tank group and note the tank number.

(19) Select AUTO on the AUTO-MANUAL switch for the tank group.

(20) Repeat op. (11) and (12) for the chosen half speed pump.

(21) Switch ON the pump and record the hose gauge reading, correct this pressure by subtracting the static pressure. The corrected pressure must be not more than 9·5 p.s.i.

(22) Switch OFF the pump and close the tank servicing cock.

(23) Repeat op. (18) to (22) for the other half-speed pump(s) in the group.

(24) With the three fuses refitted to the power supply to the sequence timer motor and with the AUTO-MANUAL switch at AUTO, wait until the pump first tested changes to half-speed, as indicated on the test box.

(25) Remove the three fuses and carry out stall pressure and flow rate tests for the pump now running at full speed, as in op. (9) to (17).

(26) Carry out a half-speed stall pressure test on the pump first tested, as in op. (18) to (22).

(27) Carry out full-speed stall pressure and flow rate tests for the remaining pump(s) in the group, as in op. (24) and (25).

(28) Repeat op. (1) to (27) for the other three tank groups.

(29) On conclusion of tests, connect and wire-lock the engine fuel feed lines. OPEN all tank servicing cocks.

(30) Refit the three fuses to the sequence timer motor supply and leave all AUTO-MANUAL switches at AUTO.

Cross-feed pipe

110. The cross-feed pipes can be tested as follows, using the equipment listed in para.106:-

(1) With the hose (fig.17) connected to No.4 engine feed line, and the two drums available, close all tank servicing cocks except that for No.1 group.

(2) Open No.4 L.P. cock, both engine cross-feed cocks and the aircraft cross-feed cock.

(3) With No.1, 2 and 3 L.P. cocks closed, ensure that the AUTO-MANUAL switch of No.1 group is switched to MANUAL.

(4) Switch No.1 pump ON, bleed and prime the cross-feed lines in the manner described in para.109 (11).

(5) Record the static pressure shown on the hose gauge.

(6) Switch No.1 pump ON, fully open the on/off cock and progressively close the metering cock until the pump delivery pressure is 8·9 p.s.i. plus static pressure.

(7) Using the calibrated drum and stopwatch measure the rate of flow. Twenty gallons (160 lb.) must be delivered in not more than 58 seconds.

(8) If this time is exceeded it will be necessary to check the flow at No.3 engine and possibly at No.2 engine. For a clear cross-feed system the rate of flow in op.(7) should be obtained at No.3 engine with a pressure of 9·5 p.s.i. plus static pressure, and at No.2 engine with a pressure of 9·9 p.s.i. plus static pressure.

(9) On conclusion of all tests, ensure that all tank servicing cocks and L.P. cocks are in the open position. Close the cross-feed cocks, place the AUTO-MANUAL switch to AUTO and ensure that all pumps are switched OFF. Connect and wire-lock the engine fuel feed pipes.

Wing tank reservoir flap valve

111. To ensure that the reservoir flap valves of a wing tank are open when the auxiliary pump is not functioning, proceed as follows:-

(1) Ensure that the fuel contents of the tank under test is less than 40 per cent of maximum capacity.

(2) Disconnect the electrical supply plug from the tank auxiliary pump.

(3) CLOSE the appropriate L.P. cock and ensure that all cross-feed cocks are closed. Connect the flexible hose (para.106 and fig.17) to the engine feed line, positioning

the free end of the hose in the non-calibrated drum.

(4) Close all tank servicing cocks in the group except that for the tank under test. Ensure that the group AUTO-MANUAL switch is at MANUAL.

(5) Bleed and prime the engine feed line by opening both cocks on the flexible hose, switching ON the tank pump switch and opening the L.P. cock. When an air-free flow is obtained, switch OFF the tank pump and immediately afterward close the flexible hose on/off cock.

(6) Note the static pressure shown on the hose gauge.

(7) Switch ON the tank pump, fully open the hose on/off cock and progressively close the metering cock until the gauge is reading 10 p.s.i. plus the static pressure determined in op. (6).

(8) Using the calibrated drum and stopwatch, measure the amount of fuel delivered in one minute. This should be approximately 20·8 gallons (167 lb.).

(9) At the conclusion of the test, switch OFF the tank pump and connect the electrical supply plug to the tank auxiliary pump.

(10) Connect and wire-lock the engine feed line. Open the tank servicing cocks in the group.

Auxiliary pump

112. To ensure that a particular auxiliary fuel pump is functioning, proceed as follows:-

(1) Ensure that the tank fuel content is approximately 30 per cent of the maximum capacity, so that the tank fuel level is below the top of the reservoir.

(2) Unlock and operate the water drain valve to ensure that the reservoir fuel level is not higher than that of the tank.

(3) Procure a flexible hose of length sufficient to reach from the drain valve to beyond either the leading edge or the trailing edge of the main plane, and of a diameter suitable to fit over the drain valve outlet. A length of glass tube, inserted in one end of the hose, must be mounted vertically on a rigid structure forward of the leading edge or aft of the trailing edge, at approximately the same height as the tank.

(4) Attach the other end of the hose to the drain valve outlet. Operate the drain valve and adjust the height of the glass tube until the static fuel level of the reservoir is shown at the bottom of the tube. Secure the glass tube and mark the fuel level on the adjacent structure.

(5) Ensure that the cross-feed cocks and the L.P. cock of the tank group under test are CLOSED.

(6) With the drain valve open, switch ON the pumps for the tank under test. The fuel level in the glass tube should rise until the reservoir overflows, there being no outlet for fuel from the tank pump.

(7) On completion of the test, switch the tank pump OFF and open the L.P. cock. Remove the flexible hose, tighten the drain valve lock ring and fit the dust cap.

Recuperator

113. To test a recuperator proceed as follows, using the equipment listed in para.106:-

(1) Fit the flexible hose (fig.17) to the appropriate engine fuel feed line.

(2) Disconnect the fuel tank pressurisation air supply from the engine and couple up to the pipe a 60 to 200 p.s.i. air supply source.

(3) Disconnect the pressurising air line to the appropriate tank group at the aft end of its non-return valve on the outboard face of rib 162·5 (wing transport joint). See Sect.3, Chap.2, fig.8. Blank off the non-return valve.

(4) Ensure that all cross-feed cocks are closed.

(5) Close all but one of the tank servicing cocks in the group.

NOTE...
It will be found convenient to leave open No.1 tank cock for No.1 and 4 engines and a No.2 tank cock for No.2 and 3 engines.

(6) Ensure the group AUTO-MANUAL switch is selected to MANUAL.

(7) Ensure the group L.P. cock is open.

(8) Apply an air pressure of between 60 and 200 p.s.i. to the engine air outlet pipe.

(9) Open both cocks in the flexible hose and position the free end in the non-calibrated drum.

(10) Switch ON the fuel pumps of the tank selected in op.(5), bleed and prime the feed line.

(11) Close the flexible hose on/off cock, allow the tank pump to run

for a further minute to ensure that the recuperator is fully charged, then switch OFF the tank pump and close the tank servicing cock.

(12) Position the free end of the hose in the empty calibrated drum, then simultaneously open the on/off cock and start the stopwatch.

(13) Note the time taken before the fuel flow breaks down, and measure the amount of fuel in the drum. The quantity delivered must be not less than six gallons and the time taken must not exceed 20 seconds.

(14) On completion of the test, remove the test equipment and the blank. Connect up and wire-lock all disconnected pipes. Open all tank servicing cocks and select the AUTO-MANUAL switch to AUTO.

Bomb bay saddle tanks

114. Equipment required is the same as for the main system test, as listed in para.106 and illustrated in fig.17. To test the saddle tank system, couple up the test equipment to No.2 engine supply pipe in the manner described in para.107, open the aircraft cross-feed cock and close both engine cross-feed cocks.

Front saddle tank

115. To test the front saddle tank system, proceed as follows:-

(1) Check that the front tank contains at least 200 gallons of fuel, refuel if necessary to ensure that sufficient fuel is contained in each side of the saddle tank.

(2) Ensure that the front tank servicing cocks are both OPEN. Remove the wire-locking on the rear tank servicing cocks and CLOSE both cocks.

NOTE...

The on/off cocks in the fuel supply pipes on each side of the bomb bay are operated to the open position only by selecting any bomb bay tank pump ON. It is necessary, therefore, when taking static fuel head pressures to select a pump switch ON and then remove the supply sockets from the two pumps which are running.

(3) Select the front tank left-hand pump switch ON. This switches ON the port forward and starboard aft pumps in the front tank and also actuates the on/off cocks in the supply pipes.

(4) OPEN No.2 L.P. cock.

(5) With the flow directed into the uncalibrated drum, open the test hose on/off and metering cocks to prime the lines. When an air-free flow is obtained, close the test hose on/off cock and then switch OFF the pumps.

(6) Remove the electrical supply from the two pumps which were running, i.e., the port forward and starboard rear.

(7) Select the left-hand pump switch ON again. This will re-open the on/off cocks in the supply pipes. Open the on/off cock at the end of the test hose for about ten seconds to relieve the trapped pump pressure, then close the cock. The static fuel head pressure is then recorded from the test gauge.

(8) Select the pump switch OFF, then restore the electrical supply to the two pumps.

(9) Select the pumps ON again, check for leaks at all pipe joints. Check and record the stall (zero flow) pressure indicated on the test gauge.

(10) Deduct the static pressure to obtain the correct zero flow pressure. This should be not less than 16·5 p.s.i.

(11) With the flow directed into the uncalibrated drum and the test hose on/off cock fully open, adjust the metering cock until a pressure of 10.5 p.s.i., plus the static pressure, is indicated on the test gauge.

(12) When the metering cock is set, close the on/off cock in the test hose.

(13) Transfer the test hose to the calibrated drum. Fully open the on/off cock in the test hose and record the time taken to put 10 gallons of fuel into the drum. The The time should not exceed 29 seconds.

(14) Repeat the tests on the other two pumps in the front tank by selecting the right-hand pump switch ON. Again the time should not exceed 29 seconds.

(15) When tests on the front tank system are completed, switch OFF the pumps. If the rear tank is installed and its system is to be tested immediately, the front tanks servicing cocks are to be CLOSED. When the rear tank is not installed and no further tests are to be made, the front tank servicing cocks must be wire-locked in the OPEN positions.

Rear saddle tank

116. If tests on the rear saddle tank

system are to follow those on the front saddle tank, proceed as follows:-

(1) Ensure that both servicing cocks on the rear tank are OPEN.

(2) The same procedure (para.115) should be carried out on the four pumps in the rear tank system, i.e., testing two pumps at a time, as for the front tank system.

◀(3) The time taken to put 10 gallons of fuel into the calibrated drum should not exceed 29 seconds.▶

(4) On completion of tests, check that all pumps are switched OFF, tank servicing cocks wire-locked in the OPEN position, L.P. cock CLOSED and that, after the test equipment is removed, the engine fuel feed pipe is connected and wire-locked in the approved manner.

Bomb bay cylindrical tanks

117. The test equipment required is the same as used in the main system tests, as listed in para.106 and illustrated in fig.17. To test the cylindrical tank system, connect the test equipment to No.2 engine fuel feed pipe as described in para.107, OPEN the aircraft cross-feed cock and CLOSE both engine cross-feed cocks.

Front cylindrical tank

118. To test the front cylindrical tank system, proceed as follows:-

(1) Check that the front tank contains at least 100 gallons of fuel.

(2) Ensure that the front tank servicing cock is OPEN. Remove the locking wire from the rear tank servicing cock and CLOSE it.

(3) Select the left hand pump switch for the front tank ON. This will start the centre and rear pumps and also actuate the ON/OFF cocks in the fuel feed lines to ON.

(4) Open No.2 L.P. cock.

(5) With the flow directed into the uncalibrated drum, open the test hose on/off and metering cocks to prime the lines. When an air-free flow is obtained, close the test hose on/off cock and switch OFF the left-hand pump switch.

(6) Remove the electrical supply sockets from the front tank centre and rear pumps. Select the left-hand pump switch ON again. This will re-open the fuel feed line ON/OFF cocks. Open the on/off cock at the end of the test hose for about 10 seconds to relieve the trapped pump pressure, and then close the cock. The static fuel pressure is then recorded from the test gauge.

(7) Select the left-hand pump switch OFF and re-connect the electrical supply sockets to the centre and rear pumps.

(8) Select the left-hand and right-hand switches for the front tank pumps ON and check for leaks at all pipe joints. Then check and record the stall (zero flow) pressure indicated on the test gauge.

(9) Deduct the static pressure to obtain the correct zero flow pressure. This should be not less than 16·5 p.s.i.

(10) With the flow still directed into the uncalibrated drum and the test hose on/off cock fully open, adjust the metering cock until a pressure of ◀10.5 p.s.i., plus the static pressure,▶ is indicated on the test gauge.

(11) When the metering cock is set, close the test hose on/off cock.

(12) Transfer the test hose to the calibrated drum. Open the on/off cock and record the time taken to ◀put 10 gallons of fuel into the drum. The time should not exceed 29 seconds.▶

(13) Switch OFF the left-hand and right-hand pump switches for the front tank. If the rear tank is installed and its system is to be tested immediately, close the front tank servicing cock. When the rear tank is not installed and no further tests are to be made, the front tank servicing cock is to be wire-locked in the OPEN position.

Rear cylindrical tank

119. If tests on the rear tank system are to follow those of the front tank, proceed as follows:-

(1) Ensure that the rear tank servicing cock is OPEN.

(2) The same procedure (as in para.118) should be carried out on the pumps in the rear tank as for the front tank system.

◀(3) The time taken to put 10 gallons of fuel into the calibrated drum should not exceed 29 seconds.▶

(4) On completion of tests, check that all pumps are switched OFF, tank servicing cocks are wire-locked in the OPEN position, L.P. cock CLOSED and that, after the test equipment is removed, the engine fuel feed pipe is connected and wire-locked in the approved manner.

PRESSURE TESTS

NOTE...
At the completion of any pressure test it

V.1.2A 1566

will be necessary to check the connections which have been blanked off. This can be carried out during the functioning test on that particular part of the system. In the case of the main fuel lines this can be carried out with the booster pumps running and the refuelling lines can also be checked by this method by opening the defuelling cock.

Fuel tanks

120. Pressure tests on individual fuel tanks are not necessary as each group of tanks is subjected to serviceability checks during functioning tests on the fuel tank pressurisation system (Sect.4, Chap.6).

Main feed pipes

121. The main feed piping should be satisfactory when subjected to a maximum pressure of 35 p.s.i. and tested under the following conditions:-

(1) Blank off the main feed connections to the engines.

(2) Close the aircraft cross-feed cock, open the engine feed and cross-feed cocks.

(3) Blank off the engine feed pipe from each tank, except No.1, at the pump connections. The pipe from No.1 should be disconnected at the pump connection and a suitable air supply with a 0 to 50 p.s.i. pressure gauge attached to it.

(4) Disconnect the pipe which connects the A.A.P.P. fuel tank to the main feed pipe. This should be blanked off at the engine feed side of the non-return valve.

(5) Blank off the fuel pipe connections to the recuperators.

(6) Ensure the defuelling cock is closed.

(7) Apply a pressure of 35 p.s.i. to the main feed piping at No.1 tank. This pressure must be maintained for a period of 30 minutes and during this time the piping should be checked for leaks at the joints and deformation at bends.

(8) Repeat the tests with the pressure applied at each tank feed connection in turn, including the bomb bay tank system.

(9) At completion of the test, reconnect the main feed pipes to the engines and the feed pipes from the tanks, disconnected in op. (1) and (3). Relock all pipe joints.

(10) Reconnect the pipe to the A.A.P.P. fuel tank and the pipes to the recuperators. Refit all locking devices.

Air/no fuel valve

122. The air/no fuel valves must be removed from the aircraft for pressure

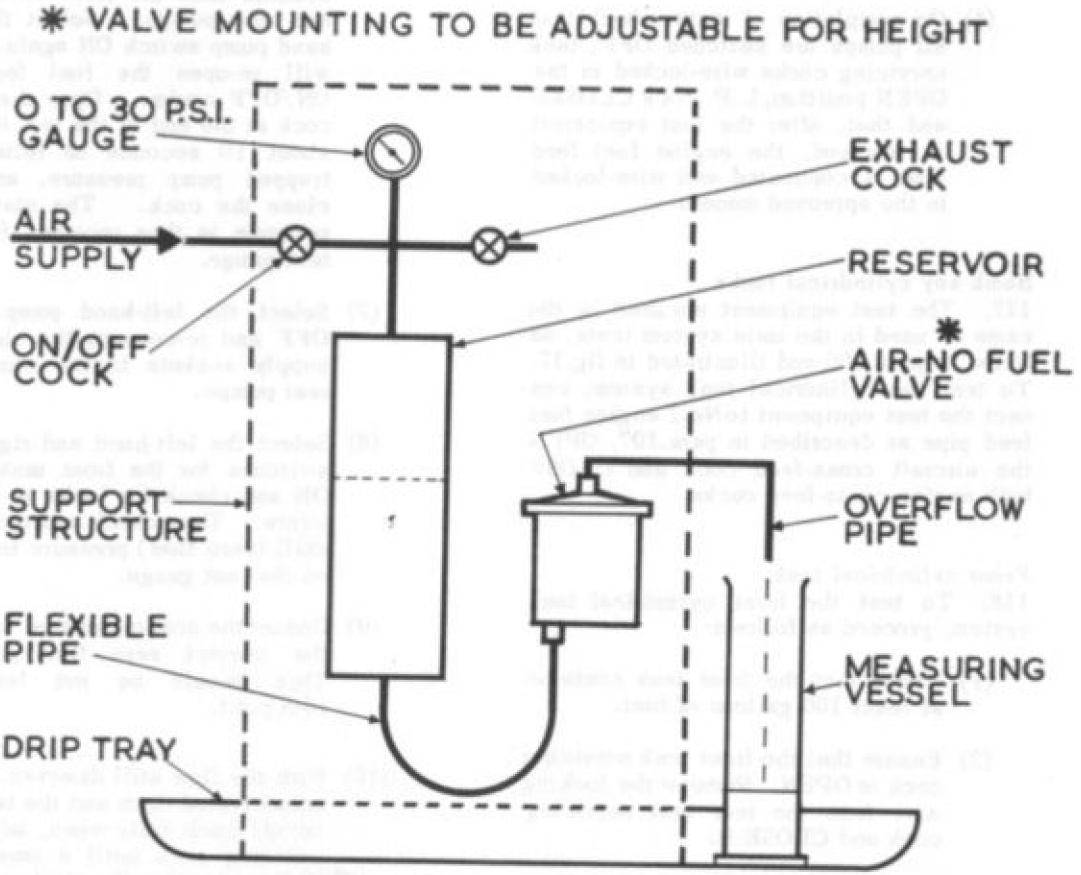


Fig.18. Air/no fuel valve leak test

testing to determine the leak rate. A test rig as shown in fig.18 should be used, the test procedure being as follows:-

(1) Partially fill the reservoir with Avtur fuel.

(2) Connect the flexible pipe to the connection in the base of the air/no fuel valve and adjust the height of the valve until the valve is flooded with Avtur.

(3) Prime the overflow pipe with Avtur and connect it to the connection on top of the valve. This will ensure that leakage past the valve seat is immediately apparent.

(4) Apply and maintain an air pressure of 20 p.s.i. at the gauge by adjustment of the ON/OFF cock.

(5) When a steady fuel leak commences to flow from the overflow pipe, check the leak rate with the measuring cylinder. Over a period of 5 minutes this should not exceed 0·1 pints, 56·8c.c.

(6) Close the ON/OFF cock and open the exhaust cock to release the air pressure from the reservoir.

(7) Raise the air/no fuel valve to allow the Avtur to drain back into the reservoir.

(8) Disconnect the flexible pipe and the overflow pipe and remove the air/no fuel valve from the test rig.

Refuelling pipes

123. The refuelling pipes should be satisfactory when the wing piping on each side of the aircraft has been subjected, in turn, to a maximum test pressure of 150 p.s.i. and the whole of the ground refuelling system piping then tested to 120 p.s.i. without leaks, as follows:-

(1) On the branch pipe to No.1 tank, disconnect the 1½ in. flexible pipe where it joins the main 3½ in. piping. Blank off the 1½ in. branch at the T-piece.

(2) Blank off the ends of the refuelling pipe connections to No.2 and No.3 tanks at the refuelling valves.

(3) Disconnect the 2 in. piping to No.4 and No.6 tanks where it joins the 4-way connector. Blank off the connector at this point.

(4) Disconnect the 1½ in. hose where it joins the T-piece to No.5 and No.7 tanks. Fit a 0 to 200 p.s.i. pressure gauge and a teed-in bleed cock to the hose.

(5) Disconnect the 1½ in. hose where it joins the non-return valve from the No.7 tank transfer pump, and blank off the N.R.V.

(6) Shut off the defuelling cock as a safeguard against N.R.V. leakage.

(7) Disconnect the pipe at the A.A.P.P. fuel tank transfer valve and blank off. Disconnect the A.A.P.P. fuel piping at the engine feed side of the N.R.V. and leave the pipe end open. If the bomb bay tanks are fitted, disconnect the refuelling piping and blank off the supply pipe from the port main-wheel bay.

(8) Remove the 3½ in. pipe (Part No. 4/P3166) at the forward end of the main-wheel bay and fit a length of 3½ in. piping, approximately 18 in. long, with one end suitably blanked. This pipe must incorporate an adapter for refuelling system hydraulic pressurisation.

(9) Fill the wing piping with fuel, using the ground refuelling point. During this operation the bleed cock on the flexible pipe to No.5 and No.7 tanks should be opened to release all air in the system. When the system is fully bled, close the bleed cock and disconnect the refueller.

(10) Using the adapter in op. (8), build up in easy stages, a pressure in the wing piping of 150 p.s.i., checking when the pressure reaches 100 p.s.i. and 125 p.s.i. that there are no leaks. The pressure of 150 p.s.i. should be maintained for 30 minutes, during which time the piping and joints should be carefully inspected for leaks and deformation of bends. The N.R.V. in the A.A.P.P. engine feed system pipe may be checked for leaks at the open end of the pipe disconnected in op.(7).

(11) When both wing piping pressure tests have been carried out and any faults corrected, release the pressure and refit the pipe removed in op. (8).

(12) If the probe is not fitted, a suitable refuelling adapter for connecting the nose and pressure cabin fuel piping to the bowser should now be attached and a means of hydraulically pressurising the refuelling system connected to the water drain connection of the 4 in. Y-piece.

(13) Fill the whole of the refuelling piping with fuel, either through the adapter op.(12) or through the probe. Adapter (Ref.No.27F/4819) is used with the Mk.8 probe. While refuelling, air is to be bled from the system by slackening off the blank on No.2 tank and opening the bleed cock on the flexible pipe to No.5 and No.7 tanks. When all

air has been expelled tighten the blank and close the bleed cock.

(14) Remove the bowser refuelling coupling from the probe or nose piping refuelling adapter, and using the hydraulic fuel supply on the water drain connection, build up the pressure by easy stages to 120 p.s.i. This pressure must be maintained for 30 minutes and the piping and joints carefully examined for leaks and deformation of bends.

(15) Internal reverse leaks through the 4 in. N.R.V.'s are detected by completely draining the fuel from the Y-piece drain and checking for a continual drip from the drain cock. The faulty valve can be traced by pressurising the system on each side of the aircraft independently.

(16) On completion of tests, release all pressure from the system and remove the test equipment. Connect and lock all joints which have been disconnected.

Recuperator air supply pipes

124. The air supply pipes from the engines to the fuel recuperators are pressure tested as follows:-

(1) Disconnect and blank off the engine feed line to the tank pressurisation system at the tank side of the non-return valve immediately after the T-piece from the common feed line.

(2) Disconnect and blank off the connection at the engine side of the Hymatic control valve (PS.60/28 Mk.2).

(3) Apply a pressure of 200 p.s.i. to the end of the piping which connects to the engine tapping, maintain for 30 minutes and ensure that there are no leaks.

(4) Reconnect the piping to the Hymatic valve and to the feed line to the tank pressurisation system, and lock all pipe connections.

Recuperator fuel drain pipes

125. To check for leaks on the recuperator fuel drain pipes the following test should be applied:-

(1) Disconnect the recuperator piping to the No.4 tank and connect a suitable air supply and pressure gauge.

(2) Apply a pressure of 15 p.s.i. to this connection for 30 minutes and check for leaks. Since the piping at the recuperator is sealed off by non-return valves, a small leak through these valves is permissible.

(3) Reconnect and lock the recuperator piping to the No.4 tank.

Recuperator air control system

126. To ensure that the recuperator air control system is functioning properly, proceed as follows:-

(1) Fit a pressure gauge at a water drain connection from the recuperator.

(2) Apply an air pressure at the engine connection until the pressure gauge reads $5\frac{1}{2} \pm \frac{1}{2}$ p.s.i.

(3) By covering the datum connection (with a finger) allow the pressure to build up until the integral relief valve cracks open at a pressure of $6\frac{1}{2} \pm \frac{1}{2}$ p.s.i.

(4) With 200 p.s.i. at the engine connection, the pressure controlled by the relief valve should not exceed $7\frac{1}{2}$ p.s.i. Check the piping between the Hymatic valve and the recuperator for leaks.

A.A.P.P. INSTALLATION

Fuel feed pipes

127. To pressure test the A.A.P.P. fuel feed piping proceed as follows:-

(1) Disconnect the A.A.P.P. fuel feed pipe at the fuel pump (Part No. P.D.G.20) and at the filter on the A.A.P.P.

(2) Connect a suitable air supply and 0 to 50 p.s.i. pressure gauge to the piping at the pump end and apply a pressure of 25 p.s.i. with the L.P. cock closed. Ensure that there are no leaks or undue deformation.

(3) Open the L.P. cock (electrically, with 28 volt d.c. supply) and note that air issues from the A.A.P.P. end of the pipe.

(4) Blank off the A.A.P.P. end of the pipe and apply 25 p.s.i. air pressure to the whole pipe with the L.P. cock open. Ensure that there is no leakage.

(5) Reconnect and lock the A.A.P.P. fuel feed pipe to the fuel pump and to the filter on the A.A.P.P.

Refuelling pipes

128. Static pressure tests on the tank refuelling system are carried out in the following manner:-

(1) Disconnect the tank refuelling piping at the transfer valve and blank off.

(2) Disconnect the piping at the junctions with the engine feed pipe (para.16) and the main refuelling pipe (para.28).

(3) Apply a pressure of 165 lb/in^2 to the pipe disconnected from the main refuelling pipe and leave the other pipe open. Examine the system for distortion or leakage. Leakage across the non-return valve (para.29) will be detectable at the open pipe end. Hold this pressure for 2 minutes, during which time there should be no leakage. When this test is complete, remove the test equipment and blank off the pipe.

(4) Apply a pressure of 52 lb/in^2 to the open pipe and maintain pressure for 2 minutes. There should be no leaks.

(5) When the tests are completed, remove pressure test equipment and reconnect the system pipes.

Fuel tank and vent pipe

129. To pressure test the A.A.P.P. fuel tank and vent pipe:-

(1) Disconnect the tank vent pipe at its connection to the main tanks vent system and fit a 0 to 10 lb/in^2 pressure gauge and low pressure air supply to it.

(2) Ensure that all tank outlets are closed off.

(3) Apply a pressure of 4.5 lb/in^2 and hold for 2 minutes, during which time there must be no leakage.

(4) Reconnect and lock the tank vent pipe to the main vent system and remake any other connections which have been broken.

Refuelling test

130. Functional tests to check the refuelling of the A.A.P.P. tank may be carried out as follows. A ground electrical supply will be required:-

(1) Drain the tank, noting that the HIGH and LOW level indicator, on the A.A.P.P. panel at the A.E.O.'s position, functions. The HIGH indication should disappear when the fuel level has fallen by one inch from maximum and the LOW indication appear when only 2 gallons remain in the tank.

(2) During normal refuelling of the starboard main tanks, ascertain by observing the indicators that the A.A.P.P. tank is being filled. The tank should be full when the main tanks are refuelled to approximately 25 per cent of their capacity. When the tank is full the transfer valve should close, against the refuelling line pressure, to prevent surplus fuel being forced into the main fuel system vent line.

(3) The A.A.P.P. fuel tank must also be filled by switching to MANUAL, the No.4 tank group switch and starting a fuel pump in No.4, No.5 or No.7 tank of that group. Observe the contents indicator and check that the transfer valve closes against booster pump pressure.

Fuel flow test

131. To test the fuel flow to the A.A.P.P. and the operation of the high and low level switches, proceed as follows, using the drums listed in para.106 and a stopwatch.

(1) Connect a ground electrical supply and position the two drums underneath the A.A.P.P. fuel tank, station a tradesman in the A.E.O.'s position to operate switches and observe the tank contents indicator on the A.A.P.P. control panel.

(2) Ensure that the A.A.P.P. fuel tank is full.

(3) Disconnect the fuel feed pipe at the A.A.P.P. and fit to the end of the pipe an adapter which incorporates a 0 to 10 lb/in^2 gauge and a 3/8 in i.d. servicing cock. The gauge must be positioned between the cock and the pipe end. A flexible hose, long enough to reach the drums at ground level, should be fitted to the cock outlet.

(4) With the L.P. cock of the A.A.P.P. and the servicing cock closed, switch on the A.A.P.P. master switch, thus starting the fuel pump. The pressure gauge in the fuel feed line should still read zero.

(5) Open the L.P. cock. The gauge pressure must be not less than 9 lb/in^2.

(6) With the free end of the flexible hose in the non-calibrated drum, progressively open the servicing cock until the pressure gauge reading falls to 7.5 lb/in^2. Transfer the end of the flexible hose to the calibrated drum and measure the

rate of flow, using a stopwatch. The rate of flow must be not less than 20 gallons per hour.

(7) When the rate of flow has been established, CLOSE the L.P. cock and fill the fuel tank by selecting No.4 tank group AUTO-MANUAL switch to MANUAL and switching ON No.4, No.5 or No.7 tank pump of that group.

(8) When the A.A.P.P. fuel tank indicator is reading HIGH, switch OFF the tank pump. Open the L.P. and servicing cocks and note as the tank is draining that the HIGH and LOW level indications are satisfactory.

(9) Close the L.P. cock and fill the tank, as in op.(7), noting the time taken between the disappearance of the LOW indication and the appearance of the HIGH indication. The time taken must be not more than 5 minutes. Switch OFF the A.A.P.P. master switch.

(10) Switch OFF the tank pump and remove the test adapter. Connect and wire-lock the A.A.P.P. fuel feed line, and return the AUTO-MANUAL switch to AUTO.

NITROGEN PURGE SYSTEM

General

132. Servicing of the system must be carried out at periods specified in A.P.101B-1902-4. Servicing instructions for the system components are contained in the relevant publications listed in para.52.

Nitrogen cylinder

133. Cylinders must be returned to Maintenance Units for test after periods of time laid down in Air Ministry Orders, as indicated in A.P.3158, Vol.2, Leaflet B1. The date of the last test is stamped on the outlet neck of the cylinder. Broken connections must be blanked off as soon as possible when a cylinder is removed.

NOTE . . .
It is dangerous to disconnect a cylinder before the pressure has been released. Nitrogen, air and oxygen cylinders are not interchangeable.

Pipe connections

134. All pipe joints must be wire-locked with 22 s.w.g. non-corrodible steel wire. Anti-seize grease ZX-13 must be used on all threads. The loadings given in Sect.4, Chap.6 of this Publication are applicable to the union nuts of this system.

System charging

135. The system is charged through the Mk.8B charging valve (para.56). Details of the charging method are given in A.P.1275A, Vol.1, Sect.10.

NITROGEN SYSTEM TESTS

General

136. The system should be tested, as in the following paragraphs, after replacement of components or installation of removable fittings. To avoid a waste of nitrogen, pressure tests can be carried out using clean, dry, compressed air, which must be discharged before filling with nitrogen for functional testing (para.138) or operational use.

Pressure test

137. To pressure test the nitrogen purge system, proceed as follows:-

(1) Ensure that the nitrogen purge switch on the flight refuelling control panel is OFF.

(2) Isolate electrically both No.2 tank refuelling valves.

(3) Fit a 0 to 100 lb/in^2 pressure gauge and a connection for an air supply to the low pressure test point on the ground charging panel. Blank off the air supply connection.

(4) Connect a dry air supply to the nitrogen charging connection and initially charge the nitrogen bottle to 400 lb/in^2.

(5) Select the nitrogen purge switch to ON. Check that the pressure-reducing valve is controlling the low pressure to 20 lb/in^2 as indicated on the gauge fitted in op.(3). Select the nitrogen purge switch OFF.

(6) Continue charging the system and check that the high pressure blow-off valves operates at 2 025 $lb/in^2 \pm 10$ lb/in^2. Shut off the air supply.

(7) With the system charged to 2 000 lb/in^2 for a period of 30 minutes examine the system for leaks and any deformation of the high pressure system.

(8) Select the nitrogen purge switch ON. The low pressure section of the system should again build up to 20 lb/in^2. Maintain this condition for 10 minutes and examine the low pressure section of the system for leaks. Select the nitrogen purge switch OFF.

(9) Disconnect the nitrogen purge pipe at the aft end of the probe and blank off the pipe.

(10) Connect an air supply to the connection fitted in op.(3) and slowly build up a pressure in the low pressure section of the system ensuring that the blow-off valve operates at a pressure between 60 and 70 lb/in^2.

(11) Disconnect the air supply. Remove the pressure gauge and air connection, finally replacing the test connection dust cap.

(12) Connect the nitrogen purge pipe to the probe aft end.

(13) Restore electrical supplies to the No.2 tank refuelling valves.

Functioning test

138. To test the nitrogen purge system, proceed as follows:-

(1) Connect a fuel bowser to the probe, using the appropriate adapter (para. 123 (14)) and, switching ON the flight refuelling master switches, refuel the aircraft until the No.2 tanks are filled to float level (indicator lights out), thereby priming the flight refuelling piping. Stop the delivery and disconnect the bowser and adapter. Switch OFF the flight refuelling master switches.

(2) Note the contents of the two No.2 tanks.

(3) Select the nitrogen purge switch ON and note that the No.2 tank indicator lamps are lit (refuelling valve open). Note probe pressure, which should rise to approximately 7 lb/in^2 initially, falling gradually to almost zero. Leave the nitrogen purge switch ON for two minutes, or until the pressure has fallen to almost zero, and switch OFF. The contents of each No.2 tank should have increased by approximately 160 lb.

(4) Remove the drain plug from the Y-piece in the aircraft nose and collect the residual fuel. This should not exceed five gallons. Refit and wire-lock the drain plug.

FLIGHT REFUELLING SYSTEM

C.G. control test

139. To test the C.G. control switches (para.51), proceed as follows:-

(1) Defuel all tanks to 50 per cent of normal content.

(2) Connect a 2 500 gallon fuel bowser to the probe, using the appropriate adapter (para.123 (14)).

(3) Isolate the flight refuelling system on the starboard side by removing the group refuelling fuses, or by removing the supply plugs from the Mk.40 refuelling valves.

(4) Select the flight refuelling master switches ON and start the delivery of fuel from the bowser at 250 to 260 gallons per minute (40 lb/in^2 probe pressure).

(5) Noting the time, select port C.G. FWD. and ensure that No.6 and No.7 tank indicator lamps have been extinguished.

(6) When the appropriate pointer on the C.G. indicator reaches the inner edge of the red sector, return the C.G. switch to the neutral position and note the time taken.

(7) Noting the time, select C.G. switch AFT and ensure that No.1 and No.2 tank indicator lamps have been extinguished.

(8) When the appropriate pointer on on C.G. indicator reaches zero, return the C.G. switch to the neutral position and note the time taken. This should be approximately one minute. Stop the bowser delivery and switch OFF the flight refuelling master switches.

(9) Repeat op. (3) to (8) on the other side of the aircraft.

(10) On conclusion of tests, restore electrical supply to the refuelling valves.

(11) To test the lateral C.G. switch, ensure that the fuel level of each tank is below the float level. Switch ON the flight refuelling master switches and note that all fourteen indicator lamps are relit.

(12) Select the lateral C.G. transfer switch to PORT. The lamps for the starboard No.6 and No.7 tanks should be extinguished, showing that these refuelling valves are closed.

(13) Select the switch to STBD., the lamps for the port No.6 and No.7 tanks should now be extinguished. showing that these refuelling valves are closed.

(14) Return the switch to the neutral position and switch OFF the flight refuelling master switches.

SUCTION TEST ON DEFUELLING PIPES

140. The defuelling pipes should be satisfactory when subjected to a maximum depression of 11 lb/in^2 under the following conditions:-

(1) Blank off the main engine feed pipe at the pump connection of each tank.

(2) Blank off the defuelling connections at No.2 tank.

(3) Open the defuelling cock.

(4) Ensure that the emergency defuelling connection is suitably blanked off.

(5) The engine cross-feed cock may be left open or closed.

(6) Disconnect and blank off the thermal relief valve pipes which bridge the L.P. cocks.

(7) Close the aircraft cross-feed cock and the engine L.P. cocks.

(8) Blank off the fuel pipe connections at the recuperators.

(9) Blanks should be fitted to the refuelling pipes in the same manner as for the pressure tests in para. 123.

(10) Fit a blank to the A.A.P.P. pipe disconnected at para.123, op.(7).

(11) With a suitable vacuum or defuelling pump connected to the refuelling valve, create a depression of 11 lb/in^2 in the system piping. This depression should be maintained for a period of 30 minutes during which time the pipes should be checked for deformation of bends.

(12) When the tests are completed, remove all blanks and restore the refuelling and defuelling systems to their original state.

DEFUELLING

WARNING . . .

It is imperative that the distribution of fuel load be correct during all stages of a defuelling programme. The following instructions must therefore be adhered to:-

(1) When defuelling bomb bay tanks, the rear tank is always drained first.

(2) Ensure that, when installed, both bomb bay tanks are drained of fuel before any attempt is made to defuel the main system tanks.

(3) **Before either No.1 or No.2 tanks are drained, ensure that the No.7 tanks are defuelled.**

(4) **Before both No.1 and No.2 tanks are drained, No.5, No.6 and No.7 tanks must be defuelled.**

Failure to comply with these instructions may result in incorrect distribution of fuel load causing the aircraft to become tail heavy and overbalance.

141. Defuelling under normal circumstances is effected by attaching a bowser to the refuelling connections in each main-wheel bay and, subject to restrictions, extracting fuel by suction. The maximum depression in the system, as indicated on the bowser gauge must not exceed 11 lb/in^2, depression in excess of this figure is liable to cause tank collapse. When a greater flow of fuel is required, bowser suction and booster pump delivery may be used, in which case defuelling time will be considerably reduced. Under these circumstances however, it is possible to create a servicing hazard by introducing air into the engine supply pipes, therefore, defuelling by means of bowser suction and booster pumps is discontinued as the fuel level in individual tanks reaches an indicated content of 500 lb. To defuel the main fuel system, proceed as follows:-

(1) Connect a ground electrical supply to the aircraft.

(2) Connect the bowser to the ground refuelling points in the main-wheel bays, ensuring that correct bonding is made at the earth clips provided.

(3) Open the aircraft defuelling cock.

(4) Close the tank servicing cocks of No.1 to No.4 tanks.

(5) Set the AUTO-MANUAL switches, on the retractable centre console, to MANUAL.

(6) Set the bowser to suck, switch No.5, No.6 and No.7 tank booster pumps ON and defuel the tanks to 500 lb. indicated contents, close the relevant tank servicing cock switch the booster pump OFF.

(7) Open the tank servicing cocks on No.1 to No.4 tank and switch ON their booster pumps. As each tank reaches the 500 lb indicated contents, close its servicing cock and switch OFF its booster pump.

(8) Shut down the bowser suction and open all the servicing cocks.

(9) Ensure that all cross-feed cocks are closed. Close the port and starboard defuelling cocks and carry out an accurate fuel contents check on all tanks.

(10) Using normal refuelling system, select No.1 tank port and starboard refuelling valves to open.

(11) Ensure that port and starboard FWD and AFT fuel transfer switches are set to OFF. Switch ON No.2, 3, 4, 5, 6 and 7 tank booster pumps, port and starboard, and allow to run for ten minutes. Monitor the C of G indicator and both No.1 tank fuel contents for any change in indication.

(12) Switch OFF all booster pumps and close both No.1 tank refuelling valves. Repeat accurate fuel contents check on both No.1 tanks. Any increase in fuel contents of No.1 tank port will indicate that the port defuelling valve is defective. Any increase in No.1 tank starboard fuel contents will indicate that either the starboard defuelling valve, or the N.R.V. in the A.A.P.P. refuelling line, is defective.

(13) Open both defuelling cocks, switch ON all booster pumps until the unusable fuel level is reached. Switch OFF all booster pumps and return the AUTO/MANUAL switch to AUTO.

142. When defuelling bomb bay tanks (both saddle and cylindrical) the procedure is much the same as that described in para.141 for the main system. When both tanks are installed in the bomb bay the rear tank must always be defuelled first. To defuel the bomb bay tanks, proceed as follows:-

(1) Connect the tanker to the refuelling points in the main-wheel bay, ensuring that correct bonding procedure is observed.

(2) Connect a ground electrical supply to the aircraft.

(3) Check to ensure that all main fuel system switches are OFF, and OPEN the aircraft cross-feed cock.

(4) Select BOMB BAY on the two switches labelled BOMB BAY – MAIN located on the bomb system control panel (retractable console).

(5) Open the defuelling cock and set the AUTO-MANUAL switches to MANUAL.

(6) Set the bowser to suck fuel from the bomb bay tanks and switch ON the rear tank booster pumps.

(7) When the fuel level in the rear tank reaches 500 lb. indicated contents, switch OFF the booster pumps and CLOSE the rear tank servicing cock(s), two cocks on a saddle tank, one only on a cylindrical tank.

(8) Switch ON the front tank booster pumps until the front tank also contains 500 lb. indicated fuel and then shut down the bowser suction. OPEN the rear tank servicing cock(s) and continue defuelling both tanks using the booster pumps only.

(9) On completion of defuelling, switch OFF the booster pumps, select the AUTO-MANUAL switches to AUTO, the aircraft cross-feed cock to SHUT and the BOMB BAY-MAIN switches to MAIN. Close the defuelling cock and disconnect the bowser and electrical supplies from the aircraft if these services are no longer required.

NOTE...
If the bomb bay tanks are to remain in the aircraft, the tank servicing cocks (four in the saddle tank installation and two in the cylindrical tank installation) are to be wire-locked in the OPEN position, i.e., in line with the fuel pipe.

FUEL TANKS

General

143. Removal and installation procedures for No.1 and No.2 port and starboard fuselage tanks are provided in para.148 to 151. With the exception of items peculiar to individual tanks, which are noted, the procedures given in para.152 and 153 are applicable to all wing tanks. Before applying these procedures, the tradesman responsible must make himself familiar with the relevant contents of:-

(1) A.P.957, Part 1 - R.A.F. Fire Manual.

(2) A.P.4117B, Vol.1 and Vol.6 - Aircraft tanks - Particularly Part 1 and Part 2, Sect.1.

(3) The defuelling warning in para.37 and in Sect.2, Chap.2.

144. If a tank is to remain empty for fourteen days or more, it must be completely blanked off after introducing approximately 5 gallons of the fuel in use, or an equivalent non-aromatic fuel, to prevent oxidation or other deterioration. Evaporation losses must be replaced at least once a month.

REMOVAL AND ASSEMBLY

145. When inserting or releasing the tank colletted studs into or from the tank bay skin, control the pressure, as excessive pressure can crack the skin.

146. A bolt of greater diameter than the others is fitted into the securing rings of the emergency fuel level switch mountings to ensure that they are positioned correctly when installed.

147. Before fuel pipes are reconnected or refitted, they must be examined to ensure all blanking devices have been removed and that the bores of the pipes are clear.

Removal of No.1 fuselage tank

148. To remove No.1 fuselage tank:-

(1) Drain No.7 tank and then No.1 tank.

(2) Remove the drip trays beneath the sump assembly.

(3) Disconnect the electrical connections from:-

(a) The sump assembly.

(b) The tank terminal box adjacent to the sump assembly.

(c) The fuel level switch. Access to the fuel level switch on the rear bulkhead of the tank is through the bomb bay and over the front spar.

(4) Place a receptacle beneath the sump assembly to receive the residual fuel.

(5) Disconnect the fuel pipe at the sump assembly.

(6) Disconnect and remove the fuel pump from the sump, this facilitates the removal of the sump.

(7) Disconnect and remove the sump assembly.

(8) Remove the nuts securing the fuel level switch attachment and support brackets to the tank bulkhead and the channel beneath the support bracket. Remove the support bracket and withdraw the switch from the tank.

(9) Remove the nuts securing the vent

outlet pipe, adjacent to the fuel level switch, to the rear bulkhead of the tank.

(10) Insert an air pipe through the sump aperture and vent the tank with a slow steady flow of air.

(11) When entering the tank, the safety precautions outlined in A.P.4117A, Vol.1 and Vol.6, Sect.1, Chap.4 must be strictly adhered to.

(12) Enter the tank and disconnect and remove:-

(a) The fuel contents gauge system. Installation and removal procedures for this equipment are provided in Sect.6 of this Volume.

(b) The vent anti-splash fittings from the roof of the tank.

(c) The clip securing the vent outlet pipe to the roof of the tank.

(d) The vent outlet pipe from the tank.

(13) Disconnect and remove the tank terminal box from the outside of the tank.

(14) Release the colletted studs from the tank bay skin, collapse the tank, and withdraw it through the sump aperture.

Installation of No.1 fuselage tank

149. To install No.1 fuselage tank:-

(1) Fold the tank in accordance with the instructions in A.P.4117A, Vol.1 and Vol.6.

(2) Check the tank bay for sharp projections and remove any waste matter.

(3) Commence inserting the tank colletted studs into the forward bulkhead of the tank bay.

(4) Working back from the forward bulkhead, insert the colletted studs by rows round the tank bay.

(5) At the sump, enter the tank and proceed as before to the rear bulkhead of the tank bay.

(6) Installation is now a reversal of the removal procedure in para.148.

NOTE...
The nuts securing the vent anti-splash fittings, the vent outlet pipe, the fuel level switch and the sump plate must be tightened to a controlled torque loading of 25 lb. in.

(7) Check all locking devices and carry out the following tests:-

(a) Refuelling test and fuel contents gauge calibration Sect.6 of this Volume.

(b) Fuel tank pressurisation functioning test (Sect.4, Chap. 6 of this Book).

(c) A fuel transfer test between No.1 and No.7 tanks (para.108 of this chapter).

(d) Engine feed and booster pump checks.

(e) Check on non-return valve seating.

Removal of No.2 fuselage tank

150. To remove No.2 fuselage tank:-

(1) Drain No.7 and then No.2 fuel tanks.

(2) Disconnect the electrical connections from:-

(a) The sump assembly.

(b) The tank terminal box and the fuel level switch. Access to the removable panels for these components, in the top of the tank bay skinning, is through the bomb bay and over the front spar.

(3) Place a receptacle beneath the sump assembly to receive the residual fuel.

(4) Disconnect the fuel pipes from the sump assembly.

(5) Disconnect and remove the nuts and bolts securing the tank servicing cock bracket to the sump plate.

(6) Disconnect and remove the fuel pump from the sump plate to facilitate the removal of the sump assembly.

(7) Disconnect and remove the sump assembly.

(8) Remove the nuts securing the fuel level switch support bracket to the tank bay skin and withdraw the switch and support bracket.

(9) Insert an air pipe through the sump aperture and vent the tank with a slow and steady flow of air.

(10) When entering the tank, the safety precautions detailed in A.P.4117A, Vol.1 and Vol.6 must be strictly complied with.

(11) Enter the tank and disconnect and remove:-

(a) The fuel gauge system.

(b) The vent outlet anti-splash fitting.

(12) Disconnect and remove the tank terminal box from the outside of the tank.

(13) Release the colletted studs from the tank bay skin, collapse the tank, and withdraw it through the sump aperture.

Installation of No.2 fuselage tank

151. The installation procedure outlined in para.149 for the No.1 tank is applicable to No.2 tank when the reverse of the removal procedure in para.150 is substituted in op.(6).

Removal of wing tanks

152. To remove a wing fuel tank:-

(1) Drain the fuel tank, observing the warning in para.37.

(2) Disconnect the electrical connections from:-

(a) The sump assembly.

(b) The fuel level switch and the internal transfer pump.

(c) The tank terminal box.

(3) Disconnect and remove the electrical junction box beneath the sump assembly (No.3 and No.4 tanks only).

(4) Place a receptacle beneath the sump assembly to receive residual fuel.

(5) Disconnect the recuperator bleed pipe and remove the light-alloy fuel pipe beneath the sump assembly (No.4 tank only).

(6) Disconnect the fuel pipes at the sump assembly.

(7) Remove the refuelling valve from the sump plate (No.3 and No.5 tanks only.

(8) Remove the fuel transfer pump from the sump plate (No.7 tank only).

(9) Disconnect and remove the sump assembly. Care must be exercised when removing No.4 tank sump assembly not to damage the adjacent fuel pipes.

(10) Disconnect and remove the internal transfer pipe support from the top of the fuel reservoir.

(11) To remove the reservoir:-

(a) Disconnect the bottom tier from the sump moulding.

(b) Disconnect the bottom tier from the centre tier, or in the case of a No.5 or No.7 tank, the top tier.

(c) Raise the tier or tiers, above the bottom tier, sufficient to permit the bottom tier to be tilted and removed with its gasket through the sump aperture.

(d) Remove the top tier in No.5 and No.7 tanks through the sump aperture.

(e) In the No.3, No.4 and No.6 tanks, disconnect the centre from the upper tier and raise the upper tier sufficient to permit the centre tier to be tilted and removed with its gasket through the sump aperture. The upper tier may now be removed.

(12) The fuel level switch, its support and the internal fuel transfer pump may be removed as a complete unit. The pump alone can be removed however, and this method permits the introduction of a second air supply pipe to ensure thorough venting. To remove the pump switch unit proceed as follows:-

(a) Remove the bolts securing the pump to the base of the switch support and withdraw the pump.

(b) The air supply pipe can now be introduced, through the hole in the side of the switch support, into the tank.

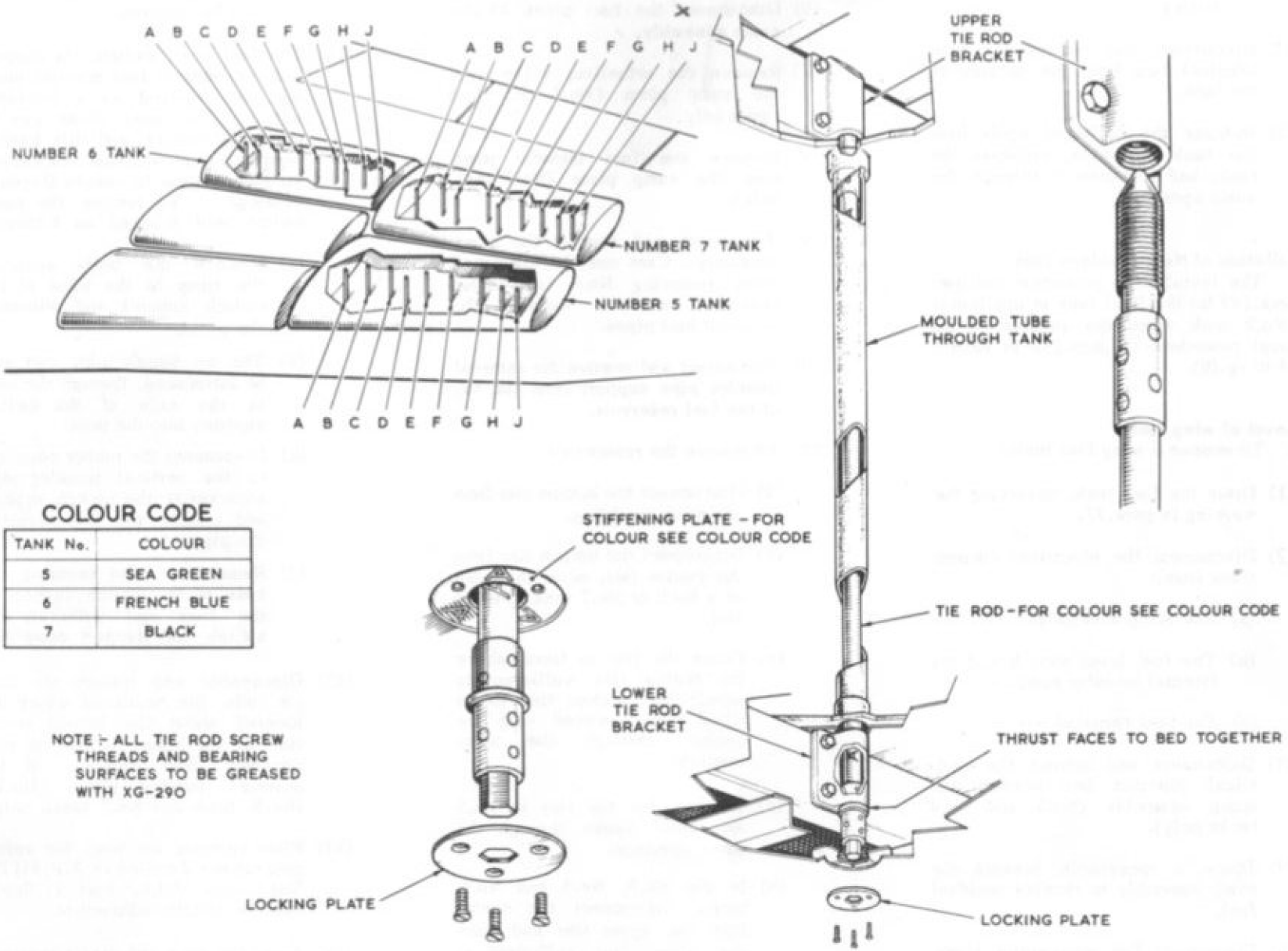
(c) Disconnect the rubber coupling on the vertical transfer pipe adjacent to the switch support and release the clip securing the pipe.

(d) Remove the nuts securing the base of the switch support to the tank and withdraw the switch and support complete.

(13) Disconnect and remove the tank tie rods, the heads of which are located about the lateral centre line of the wing. The tie rods unscrew after removal of the screwed locking plates (fig.19) (No.5, No.6 and No.7 tanks only).

(14) When entering the tank, the safety precautions detailed in A.P.4117B, Vol.1 and Vol.6, Part 1, Sect.2 must be strictly adhered to.

(15) Enter the tank and disconnect and remove:-



COLOUR CODE

TANK No.	COLOUR
5	SEA GREEN
6	FRENCH BLUE
7	BLACK

NOTE :- ALL TIE ROD SCREW THREADS AND BEARING SURFACES TO BE GREASED WITH XG-290

Fig. 19. Arrangement of wing fuel tank tie rods

(a) The vent valve from the roof of the tank. To obtain access to the securing nuts, disconnect the outward vent valve and inward relief valve from the vent valve body (fig.3).

(b) The clips securing the inner transfer pipe to the tank roof and remove the pipe.

(c) The emergency fuel level switch steady bracket.

(d) The blanking plates from the outward vent valve apertures.

(16) Disconnect and remove the tank terminal box from the outside of the tank.

(17) Release the tank colletted studs from the tank bay skin, collapse the tank and remove it through the sump aperture.

Installation of wing tanks

153. To install a wing tank:-

(1) Fold the tank in accordance with instructions in A.P.4117B, Vol.1 and Vol.6.

(2) Ensure that the tank bay is free from waste matter and sharp projections.

(3) Commence inserting the tank colletted studs into the inboard bulkhead of the tank bay.

(4) Working outboard from the inboard bulkhead, insert the rows of colletted studs around the tank bay until the sump is reached.

(5) At the sump, enter the tank and proceed as before to the outboard bulkhead of the tank bay.

(6) Installation is now a reverse of the removal procedure. The following points should be noted:-

(a) The controlled torque loading on the nuts securing components to the tank is 25 lb. in.

(b) To bench test the internal transfer pipe for leaks before installation, blank-off one end and apply a pressure of 8 p.s.i.

(c) Stiffening plates beneath the tie rod locking plates and the tie rods, are coloured and lettered to ensure that the rods are assembled in their correct positions. Colours, which are as follows:-

NO.5 TANK SEA GREEN
NO.6 TANK FRENCH BLUE
NO.7 TANK BLACK

identify the tank to which the rod belongs. The letter on the rod matches that on the stiffening plate and indicates the position of the rod in its tank. Before the tie rods are tightened to a torque loading of 20 lb. in., screw threads and bearing surfaces should be coated with grease, XG-295.

NOTE...

Whenever a wing tank reservoir is dismantled, a check must be made, prior to refitting, to ensure that the auxiliary pump delivery pipe will direct fuel away from the flap valve area. If incorrectly assembled, the force of fuel supplied by the pump may be sufficient to hold the valve closed or only partially open. This would result in serious loss of delivery pressure in the engine fuel supply pipes.

(7) Check all locking devices and proceed with the following tests:-

(a) Refuelling test and fuel contents gauge calibration Sect.6 of this Volume.

(b) Fuel tank pressurisation functioning test and a tank pressure test (Sect.4, Chap.6).

(c) If No.1 or No.7 tanks have been installed, a fuel transfer test (para.108 of this chapter).

(d) Check on non-return valve seating (para.102 of this chapter).

(e) Auxiliary pump test (para.112 of this chapter.

(f) Feed line and pump delivery test (para.109 of this chapter).

FUEL PIPE COUPLINGS

154. Care must be taken when disconnecting or assembling the fuel couplings which are manufactured by Flight Refuelling Ltd. When assembling a coupling:-

(1) Threads should be coated with colloidal graphite, ZX-30.

(2) It is important that the outer sleeve is screwed onto the inner sleeve, since the split collars are fitted to prevent any rotation and consequent distortion of the inner sleeve.

(3) Do not over-tighten the connector, as this will distort the rubber sleeve and cause leakage.

(4) Lugs are provided on the inner sleeve of the coupling and, to tighten the connectors, the following C spanners should be used:-

For connectors on pipes:-

Up to 3½ in.dia. - Universal C spanner. Part No. F.R.S.124.

Of 3½ in. dia. - C spanner, Part No. T.487806

Of 4 in. dia. - C spanner, Part No. T487805.

(5) To ensure correct assembly, red lines are painted on each side of the couplings. After tightening, the distance between the face of the coupling and the nearest edge of the line must be 1/2 ± 1/16 in.

FLIGHT REFUELLING SYSTEM

Removable fittings

155. To remove the flight refuelling removable fittings, proceed as follows:-

(1) Remove the radome (Sect.3, Chap.1).

(2) Remove the seal between the probe and the probe fairing by slackening the nuts and screws clamping the two band clips.

(3) Remove the probe fairing by unscrewing the eighteen 2 B.A. screws. Insert countersunk screws to blank off the holes in the nose fairing.

(4) At the joint between the aft end of the probe and the fuel piping, remove the two bonding clips and the cable. These should be retained for future use. Remove and retain the clamp (Ref.No. 26DC/3594), this being later utilised together with the rubber seal and Hallite joint washer, in the blanking off of the fuel piping.

(5) Disconnect the nitrogen purge and vent line pipes from the probe.

(6) Unlock and remove the tension bolt from the probe aft mounting at bulkhead 470F. Support the probe.

(7) Remove the probe by depressing the spring plunger in the base of bulkhead 510F, and turning the probe to release the outer probe fillet from the slot in the probe mounting.

(8) Remove and retain for future use the items comprising the aft probe mounting.

(9) Remove the pipe blanking assembly from its stowage (para.42) and fit to the pipe, using the seal, (Walker 64720), rubber-bonded asbestos joint washer and clamp removed in op.(4). Position the eye-ends of the two adjustable hinged links in the fork-ended heads of the bolts passing through bulkhead 470F, and insert the Pip-pins. Connect the bonding cable to the adjacent terminal on the aft face of former 470F.

(10) Remove the nitrogen purge system and probe vent lines, blanking off all pipes and components. Retain for future use.

(11) Fit the blanking panel (Part No. 250/D9502) over the probe aperture of the fixed nose fairing, using 2 B.A. countersunk screws.

(12) Fit the radome.

The reversal of these operations applies for the assembly of removable fittings.

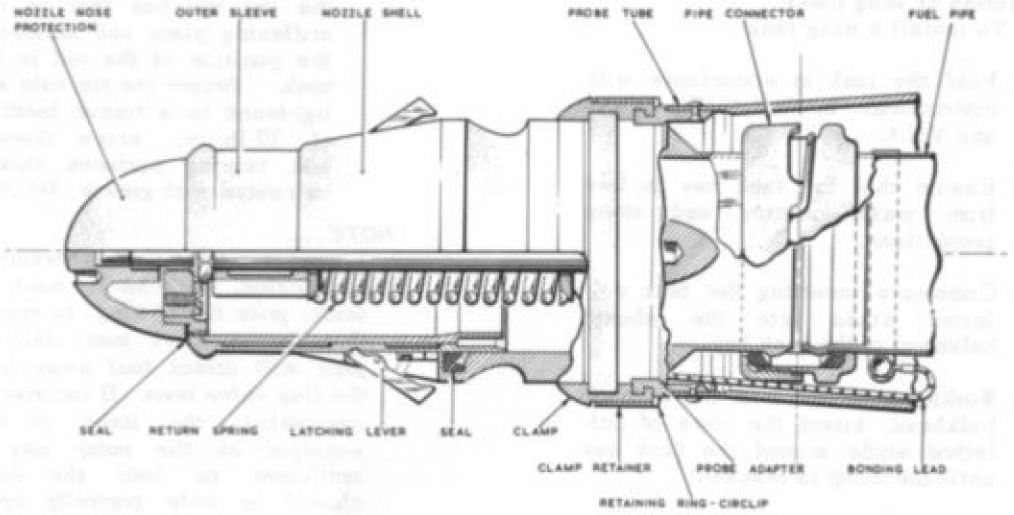


Fig.20. Flight refuelling probe nozzle

Clamp bolts are tightened to a torque loading of 6 lb. ft. Seals and joint washers must be renewed as required. As the seals in Flight Refuelling couplings are prone to damage due to rotation of the components, it is recommended that prior to assembly, all seals and the backing rings and outer sleeves which contact the seals be lubricated with kerosine.

Flight refuelling nozzle assembly

156. During assembly of the Mk.8 probe nozzle to the fuel pipe, the sealing ring between the nozzle shell and the outer sleeve must be fitted as illustrated. If, after assembly, the nozzle outer sleeve has to be depressed, Flight Refuelling loading tool (Part No.6805463) only must be used. Prior to depressing the outer sleeve, clean the nozzle thoroughly, using a clean cloth, soaked in kerosine. This removes dust and grit which could damage the seal between the outer sleeve and the nozzle nose portion and will also lubricate the seal. The Mk.8 refuelling nozzle is described and illustrated in A.P.4511, Vol.1 and Vol.6, in which servicing instructions are also included.

NITROGEN PURGE SYSTEM

Nitrogen cylinder

157. To remove a cylinder:-

(1) Slowly release the nitrogen through the charging valve in the ground access recess.

(2) Disconnect the cylinder head connection and blank off the connections, unless a new cylinder is to be fitted immediately.

NOTE...
It is dangerous to disconnect a cylinder before the pressure has been released.

(3) Remove the locking wire from the turnbuckles in the retaining straps and slacken them. Remove the cylinder from the cradle.

Nitrogen system fittings

158. Special instructions for the installation and removal of the system fittings are not considered necessary. When the system is not installed the nitrogen ON/OFF valve electrical connections must be stowed in the clip provided on the forward face of former 470F.

BOMB BAY SADDLE TANKS

Removal of a bomb bay saddle tank

WARNING...
The bomb bay tanks must be drained of fuel before any attempt is made to hoist them into or out of the bomb bay. Failure to observe this instruction will result in damage being caused to the hoisting brackets and/or the adjacent structure.

159. Defuelling of the bomb bay tank is to be carried out as detailed in para.142, noting that the rear tank must always be drained first.

WARNING...
Before the installation or removal of a bomb bay tank, ensure that the electrical supply is switched OFF.

160. The following sequence of operations may be employed to remove either of the saddle tanks. Differences do exist however, and a note dealing with these differences is inserted after the appropriate sub-paragraph. In conjunction with an electrical tradesman, proceed:-

(1) Disconnect both tank electrical plugs from the sockets in the port side of the bomb bay and fit the blanking caps to the sockets.

(2) Disconnect the bonding cable and disengage the rubber hose coupling on the pressurisation and vent connection at the top of the tank.

(3) Remove the locking wire from the manually-operated servicing cocks in the feed pipes at each side of the tank and CLOSE the cocks.

(4) Disconnect the feed pipe couplings on the aircraft side of the servicing cocks and fit blanks (Part No. F.R.S.360K, series 1) to the pipe ends.

(5) Disconnect the refuelling pipe coupling at the port side of the tank and blank off the pipe ends as in op.(4).

(6) Disconnect the fore-and-aft bracing struts, one on each side of the tank, from the aircraft structure and secure to the tank.

(7) Disconnect the side bracing struts from the aircraft structure, two on a front tank and three on a rear tank, and secure to the tank.

(8) Check all round the tank to ensure that the vertical supports are the only means of attachment.

(9) Attach the minilift hoists, two or three depending upon which tank is to be removed (see note) and engage the hoist cable hooks with the hoisting lugs on the tanks.

NOTE...
Three hoists are required to lower a front (fwd.) tank, two forward and one aft. For the front (aft) tank or the rear tank, two hoists are required, one at each end in each case. Post-Mod.1810 (Free Fall Role aircraft only) it will no longer be possible to install a tank in the front (aft) position,

because the hoisting bracket has been removed from bomb arch 151.919A.

(10) Position a suitable receiver vehicle (Ref.No.4F/2061, Trolley, Platform, G.P.) beneath the bomb bay ready to receive the tank.

(11) Operate the hoists with caution, until the hoist cables are just taking the weight of the tank.

(12) Remove the bolts which secure the four vertical support struts to the aircraft structure, secure the struts to the tank.

NOTE...
Access holes are provided in the bomb bay roof skinning where necessary, to facilitate the removal of these bolts.

(13) Check round the tank for possible obstruction, then operating the hoists slowly and simultaneously, lower the tank out of the bomb bay on to the trolley.

(14) Ensure that all necessary blanking plugs (aircraft system and tank) are securely fitted.

Installation of a bomb bay saddle tank

161. Reference to fig.13 provides the key number and shows the attachment points of struts required to install any saddle tank. The strut key number, applied to the list given, provides the Part No., position on the tank and nominal length of each strut. In all saddle tank configurations, struts are set to the dimension given and installed in the bomb bay before the tank is hoisted. On aircraft with Mod.2281 embodied, the rear struts of the rear saddle tank are shortened, lifting the rear end of the tank to provide clearance between tank and bomb doors. Nominal length of the struts concerned is given in Table – Identification and location of struts.

162. Little adjustment is required after initial setting and all struts to aircraft attachment, wire locking, fitting of spilt pins etc., is completed before the tank is offered. Struts may be adjusted to suit particular installations, provided adjustment in excess of 0.25 in. is distributed evenly over both ends and the strut adjustment safety margin is not exceeded. Check through the inspection holes provided, to ensure this condition.

Strut attachment

163. Table 1 provides the Ref.No. or Part No. of bolts, washers and nuts etc., used at attachment points in the bomb bay and on the tanks. The strut key number is used with the letter A (aircraft) or T (tank) added to identify the attachment point. When special washers are included in a group they must be fitted under the bolt head.

Preparation of aircraft

164. When a front (fwd.) tank is to be installed, two bracing struts (Part No. 5/P3595) are fitted, one on each side of the bomb bay, between the front spar and bomb arch 21.717A. These struts, set to 17 in. ± 0.05 in. between centres, are installed with the adjustable end aft. A bolt (Ref.No.28D/15562), washer (28W/9405), nut 28M/1011467) and split pin (28P/1007741) are used at each end of the strut.

NOTE...
The bomb bay tank fire extinguisher bottles (included in Mod.527) must be fitted in the bomb bay and be checked for serviceability before the bomb bay tanks are installed.

165. Before a front (fwd.) tank can be installed, the butt connectors mounted between bomb arches 44.592A and 64.592A must be removed. The cable end fitting is stowed in the stowage bracket provided.

NOTE...
When fitting tank attachment struts in the bomb bay, ensure that grease nipples are positioned so as to be accessible for subsequent 'gun' lubrication.

166. When struts required are installed engage the minilift hoists (Sect.2, Chap.4, Table 1) with the appropriate brackets as shown in fig.21.

NOTE...
Ensure that warning instructions in para. 159 are observed.

167. Remove the blanking caps from the fuel system coupling assemblies (aircraft to tank) and make a visual inspection to ensure pipe ends are clean and free from obstruction. This instruction applies to the refuelling, fuel tank pressurisation and vent system couplings. Electrical systems are involved when bomb bay tanks are fitted, therefore an electrical tradesman must be available throughout the operation.

Installation

168. It is assumed that tanks are supplied from a servicing bay and do not require more than an exterior inspection, therefore proceed:-

(1) Position the tank beneath the bomb bay and between the hoists.

(2) Carry out the external inspection of the tank and remove blanks from the fuel tank couplings.

NOTE...
When a front tank (fwd) or (aft) is to be fitted, after removing the blanks fit an Avimo coupling nut, compression ring and an 'O' ring seal to the starboard pipe stub and to main fuel pipe in the bomb bay, fit a second coupling nut, compression ring and 'O' ring seal. An avimo coupling body is then screwed to this nut and left finger tight.

(3) Engage minilift hoist cable hooks with appropriate brackets on the tank.

ensure that all necessary precautions are observed.

(12) Remove the minilift hoists and check all round the tank for possible causes of future damage, i.e., metal to metal fretting, pipe chafing etc.

BOMB BAY CYLINDRICAL TANKS

Preparation for removal

WARNING...
The bomb bay tanks must be drained before any attempt is made to hoist them into or out of the bomb bay, as the weight of a full tank is much greater than the combined capacities of the four minilift hoists. The rear tank must always be drained first.

169. Defuelling of the cylindrical tanks is to be carried out as detailed in para. 142. This will drain the tanks of all but the unusable and residual fuel. The unusable fuel (approx. 14 gallons per tank) is to be drained from the valves in the tank sump. The residual fuel (approx. 1½ gallons per tank) is to be drained after the tank has been removed.

170. Separate procedures are detailed for the removal of the front and rear tank installations. Details of the various components are shown in fig.22.

WARNING...
Before removing a bomb bay tank, switch OFF the electrical power supply.

Front tank removal

171. In conjunction with an electrical tradesman proceed as follows:-

(1) Disconnect the clips securing the electrical leads to the port suspension beam and the tank conduit. Remove the perforated plastic strip from the tank aft conduit and withdraw the electrical leads from the conduit: Disconnect the plugs from the sockets in the port side of the bomb bay and connect the plugs to the stowage at the forward port end of the tank. Stow the leads in the tank forward conduit and retain them with the perforated strip. Remove the blanking caps from the stowage pocket at the rear end of the suspension beams and fit the caps to the sockets in the port side of the bomb bay.

(2) Disconnect the vent pipe bonding cables, slacken the vent pipe hose clips and disengage the vent pipe (removable fitting) from the tank vent connection and the vent pipe line (fixed fitting) in the bomb bay roof. Fit blanks to the tank vent connection and the removable vent pipe. Disconnect the fixed fitting vent pipe from the main vent pipe and attach it, together with its rubber hose, hose clips and bonding clips, to its stowage in the bomb bay roof, forward of bomb arch 21·717A. Fit a blanking cap (Part No.F.R.S.360P) to the main vent pipe.

(3) After removing the locking wire turn the branch pipe manually-operated servicing cock to the off position.

(4) Disconnect the hose clips supporting the port and starboard fuel delivery hoses from the brackets attached to the crutch adapter stowage brackets on the suspension beams. Disconnect the bonding cables and the delivery hoses from the delivery pipe lines in the port and starboard side of the bomb bay. Fit blanking caps (Part No.F.R.S. 360K, Series 1) to the pipe line connections and the hose ends.

(5) Disconnect the hose clips securing the refuelling hose to the support bracket attached to the front end of the port suspension beam. Disconnect the bonding cable and the refuelling hose from the refuelling pipe line in the port side of the bomb bay. Fit blanking caps (Part No. F.R.S. 360K, Series 1) to the refuelling pipe connection and the hose end.

(6) Attempt to disconnect the two fore-and-aft load struts from the brackets on the front spar and from the brackets at the end of the tank. If the shackle pins are tight, remove them when the crutching eyebolt nuts have been slackened in op.(8).

(7) Attach four minilift hoists to the attachment points at each end of the two suspension beams. Engage the ball end of each hoist cable in the hoisting sockets in each outrigger and carefully take up the slack in each hoist cable.

(8) Remove the split pins from the four tank crutching eyebolts and slacken the nuts incrementally, ensuring that the load is not taken by one eyebolt, and then remove the nuts and washers.

(9) Lower the tank slowly and evenly on all four minilift hoists, ensuring that the tank crutching eyebolts disengage from the outriggers. When the outriggers are clear of the suspension beams, refit the nuts and washers to the eyebolts.

(10) Continue lowering the tank until it is at a convenient height and then attach the four transportation legs to the brackets on the outriggers and the tank walls, using the captive drop-nose pins provided. Check that the ground is free from obstruction and then lower until the transportation leg wheels are on the ground.

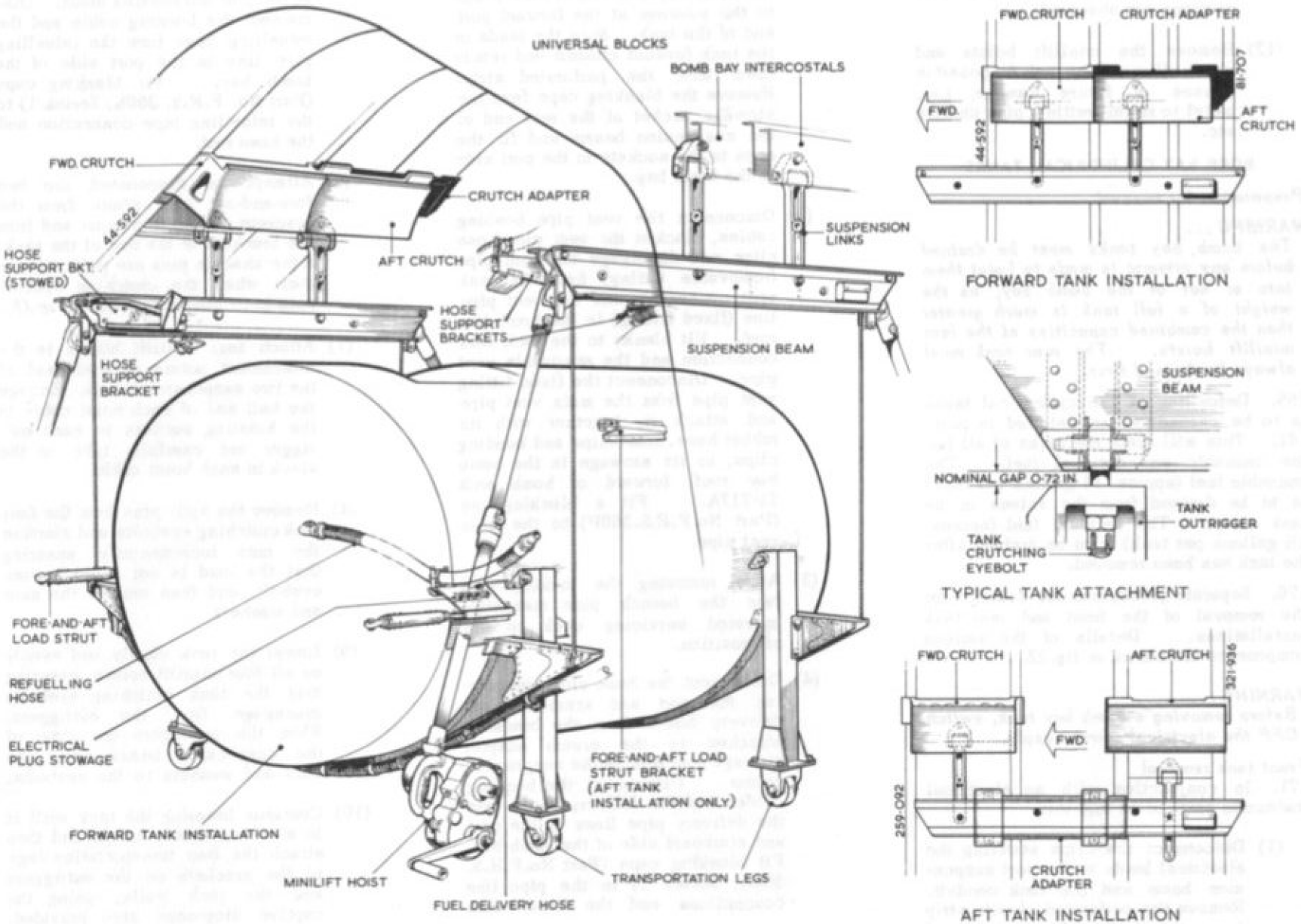


Fig.22. Installation–bomb bay cylindrical tanks

◀ (11) Remove the minilift hoists. Move the tank clear of the aircraft.

(12) Disconnect the suspension beams from the suspension links and carry them clear of the aircraft.

(13) Disconnect and remove the links and universal blocks from between bomb arches 44·592A and 64·592A and between bomb arches 64·592A and 81·707A.

(14) Disconnect and remove the rear crutches from the adapters.

(15) Disconnect and remove the crutch adapters from bomb arches 64·592A and 95·967A.

(16) Disconnect and remove the forward crutches from bomb arch 44·592A.

(17) Secure each adapter to the stowage on the inboard face of each suspension beam by means of four bolts, nuts and washers and stow the remaining nuts, bolts and washers in the pocket at the aft end of each suspension beam. If it is known that the tank assembly is to be re-installed in the front position, this action need not be done.

Rear tank removal

172. In conjunction with an electrical tradesman, proceed as follows:-

(1) Disconnect the clips securing the electrical leads to the port suspension beam and the tank conduit. Disconnect the plugs from the sockets in the port side of the bomb bay and connect the plugs to the stowage mounted above the forward port fore-and-aft load strut bracket on the tank. Remove the blanking caps from the stowage pockets on the suspension beams and fit the caps to the sockets in the port side of the bomb bay.

(2) Disconnect the vent pipe bonding cables, slacken the vent pipe hose clips and disengage the vent pipe assembly (see para.97) from the tank vent connection and the main vent pipe in the bomb bay roof. Fit a blanking cap (Part No. F.R.S. 360P) to the main vent pipe and blank off the vent pipe assembly and the tank vent connection.

(3) After removing the locking wire turn the manually-operated servicing cock in the tank branch pipe to the OFF position.

(4) Disconnect the hose clips securing the port and starboard fuel delivery hoses to the brackets extending forward from both suspension beams. Disconnect the bonding cables and the delivery hoses from the delivery pipe lines in both sides of the bomb bay. Fit blanking caps (Part No.F.R.S.360K, Series 1) to the delivery pipe line connections and to the hose ends.

(5) Disconnect the hose clip securing the refuelling hose to the support bracket extending forward from the port suspension beam. Disconnect the bonding cables and the refuelling hose from the refuelling pipe line in the port side of the bomb bay. Fit blanking caps (Part No.F.R.S.360K. Series 1) to the refuelling pipe connection and the hose end.

(6) Attempt to disconnect the two fore-and-aft load struts from the brackets mounted on bomb arch 279·092A and from the brackets mounted on the upper surface of the tank. If the shackle pins are tight, remove them when the crutching eyebolts have been slackened in op.(8).

(7) Attach four minilift hoists to the attachment points at each end of the two suspension beams. Engage the ball-end of each hoist cable in the hoisting sockets in each outrigger and carefully take up the slack in each hoist cable.

(8) Remove the split pins from the four tank crutching eyebolts and slacken the nuts incrementally, ensuring that the load is not taken by one eyebolt, and then remove the nuts and washers.

(9) Lower the tank slowly and evenly on all four minilift hoists, ensuring that the tank crutching eyebolts disengage from the outriggers. When the outriggers are clear of the suspension beams, refit the nuts and washers to the eyebolts.

(10) Continue lowering the tank and when it is at a convenient height, attach the four transportation legs to the brackets on the outriggers and the tank, using the captive drop-nose pins provided. Check that there are no obstructions on the ground and then lower until the transportation leg wheels are on the ground.

(11) Remove the minilift hoists. Move the tank clear of the aircraft.

(12) Disconnect and remove the suspension beams, complete with crutch adapters stowed on their inboard faces, clear of the aircraft.

(13) Disconnect and remove the suspension links and universal blocks from between bomb arches 259·092A and 279·092A and between bomb arches 300·954A and 321·936A. ▶

◀ (14) Disconnect and remove the forward crutches from bomb arches 259·092A and 279·092A.

(15) Disconnect and remove the rear crutches from bomb arches 300·954A and 321·936A.

Cylindrical tank installation

173. Separate procedures are detailed for the installation of the front and rear tanks. Details of the installations are shown in fig.22.

WARNING...

Before installing a bomb bay tank, switch OFF the electrical power supply.

Front tank installation

174. In conjunction with an electrical tradesman, proceed as follows:-

(1) Ensure that all bomb bay equipment liable to foul the tank is properly stowed.

NOTE...

The nuts, bolts and washers used in the following operations will be found in the stowages at the aft end of each suspension beam.

(2) Attach the front edges of the two forward crutches to bomb arch 44·592A.

(3) Remove the crutch adapters from their stowages on the suspension beams and attach them to bomb arches 64·592A and 95·967A. The front edges of the adapters overlap the rear edges of the forward crutches, so that each forward crutch and adapter is attached to bomb arch 64·592A by the same two bolts.

(4) Attach the two rear crutches to their respective adapters. Apply french chalk to the rubber facings of all four crutches.

(5) Ensure that the hose clip support bracket at the forward end of the starboard suspension beam is in the stowed position, on the inboard side of the beam. Ensure that the delivery hose clip support brackets are attached to both suspension beams at the forward outboard bracket used for crutch adapter stowage.

(6) Fit the four universal blocks to the intercostals between bomb arches 44·592A and 64·592A and bomb arches 64·592A and 81·707A, on both sides of the bomb bay. Fit the top attachment holes of the suspension links to the universal blocks (the suspension link top attachment hole is at 90 deg. to the other two attachment holes). Lock all nuts and bolts with split pins.

(7) Lift the two suspension beams into position and attach each beam to its pair of suspension links, using shackle pins, collars and split pins. The bottom holes of the links are to be attached to the inner pair of attachment holes in the beams.

NOTE...

The copper bonding cables used in op. (8), (15), (16) and (17) are to be kept as short as possible, and the bonding clips turned to remove any slack in the bonding cables.

(8) Remove the fixed fitting vent pipe from its stowage in the bomb bay roof, forward of bomb arch 21·717A. Connect it to the main vent pipe, using a rubber hose and two hose clips and secure it to the bomb bay roof with the clips provided. Fit bonding clips on each side of the rubber hose, link the clips with copper bonding cable and strap the cable to the hose, using plastic strapping.

(9) Check that the four tank crutching eyebolts are secured to the suspension beams by the captive Pip pins. Ensure that the special nuts are an easy fit on the eyebolt threads, remove the special nuts and washers and lubricate the eyebolt threads with grease, XG-295.

(10) Position the tank beneath the bomb bay, hook the four minilift hoists (Ref.No.26DC/95088) on to the attachment points at each end of both suspension beams and engage the ball-ends of the hoist cables with the hoisting sockets in the tank outriggers. Take up the slack evenly on all four hoist cables and disconnect the four transportation legs.

(11) Raise the tank evenly into the bomb bay, synchronising the operation of the minilift hoists, until the tank crutching eyebolts are just clear of the tank outriggers. Each eyebolt must then be guided into its outrigger attachment hole while the tank is raised slowly until all the eyebolts are engaged.

(12) Fit the special nuts and washers to the tank crutching eyebolts and handtighten them incrementally. Remove the mini-hoists clear of the aircraft.

(13) To determine the order in which the crutching eyebolt nuts are tightened, refer to fig.14 where the eyebolts are identified by numbers ▶

and proceed as in the following example:-

(a) Select the eyebolt whose nut has least threads engaged.

(b) Assuming that this is eyebolt No.1, check the thread engagement of eyebolts No.2 and No.4.

(c) If No.2 eyebolt has less threads engaged than No.4, then the tightening order will be:- 1, 2, 3, 4, (clockwise).

(d) If No.4 eyebolt has less threads engaged than No.2, then the tightening order will be:- 1, 4, 3, 2, (counter-clockwise).

(e) The above procedure will apply whichever eyebolt is first selected, i.e., if No.2 eyebolt is selected, check No.1 and No.3 eyebolts for least engagement and tighten in that direction.

(14) Incrementally torque load the eyebolt nuts in the order determined in op.(13) in three stages, to 10 lb. ft., 15 lb. ft., and finally 20 ± 3 lb. ft. Lock the nuts with split pins. If the split pins will not fit within the above tolerance, all the nuts must be slackened incrementally, a thin washer fitted to the eyebolt(s) concemed and op. (13) and (14) repeated.

(15) Connect the two fore-and-aft load struts to the brackets at the forward end of the tank and to the brackets on the front spar using shackle pins, collars and split pins. The struts are adjustable, the nominal pin centre length being 13·45 ± 0·8 in. After adjustment, check that the screw threads are in safety, tighten the lock-nuts and wire-lock them to the end fittings, using 22 s.w.g. stainless steel wire (Ref.No.30A/3339).

(16) Connect the long length of rubber hose (see para.97) to the fixed fitting vent pipe and secure it with a hose clip. Connect the elbow piece (Part No. 15P/3918) to the other end of the long length of hose and secure it with a hose clip. Connect the elbow piece (Part No. 25P/3375) to elbow piece (Part No. 15P/3918) using a short length of hose and two hose clips. Connect elbow piece (Part No.25P/3375) to the tank vent connection by the other short hose and secure with two hose clips. Fit bonding clips to vent pipe, elbow pieces and tank vent connection and link the clips, using copper bonding cables. Strap the cables to the hoses, using three straps on the long hose.

(17) Connect the port and starboard fuel delivery hoses to the delivery pipes in the bomb bay. Fit bonding clips and copper bonding cables to the hose-to-pipe line couplings. Secure each hose to its support bracket on the lower inboard face of each outrigger, and by P clips to the lower forward face of the outrigger.

(18) Secure the port fuel delivery hose to the hose support bracket on the undersurface of the port suspension beam. No clipping is provided for the starboard hose.

NOTE...
On a rear tank installation the hose support bracket on the suspension beam is removed from the undersurface and stowed on a bracket on the top surface.

(19) Connect the refuelling hose to the refuelling pipe in the port side of the bomb bay. Fit bonding clips and a copper bonding cable across the connection. Secure the hose to the hose clips on top of the electrical plug stowage and on top of the hose support bracket extending forward from the front of the suspension beam.

NOTE...
The hose support bracket on the starboard suspension beam must be stowed as shown on fig.16.

(20) Turn the manually-operated cock in the tank branch pipe to the on position and wire-lock.

(21) Remove the blanking caps from the electrical sockets in the port side of the bomb bay and stow them in the stowages on the suspension beams. Withdraw the perforated strip from the tank forward conduit and remove the electrical leads from the conduit. Disconnect the electrical plugs from the tank stowages and connect them to the sockets in the port side of the bomb bay. Insert the electrical leads in the tank aft conduit and fit the perforated strip to the conduit. Secure the leads to the upper surface of the port suspension beam with P clips.

Rear tank installation

175. In conjunction with an electrical tradesman, proceed as follows:-

(1) Ensure that all bomb bay equipment liable to foul the tank is properly stowed.

(2) Attach both forward crutches to bomb arches 259·092A and 279·092A.

V.1.2A 1571

(3) Attach the front edges of both rear crutches to bomb arch 300·954A, and the rear edges of both rear crutches to bomb arch 321·936A. Apply french chalk to the rubber facings of all four crutches.

(4) Fit the four universal blocks to the intercostals between bomb arches 259·092A and 279·092A and bomb arches 300·954A and 321·936A on both sides of the bomb bay. Fit the top attachment holes of the suspension links to the universal blocks (the suspension link top holes are at 90 deg. to the other two attachment holes). Lock all nuts and bolts with split pins.

(5) Lift the two suspension beams into position and attach each beam to its pair of suspension links, using shackle pins, collars and split pins. The bottom holes of the front suspension links and the centre holes of the rear suspension links are to be engaged with the outer pair of attachment holes in each suspension beam. Transfer the hose support brackets used in the front tank installation from the underside to the upper outboard brackets on the beams. Attach a crutch adapter to the inboard brackets of both suspension beams, using four bolts, nuts and washers per stowage.

(6) Ensure that the hose clip support brackets are attached to the forward inboard faces of both suspension beams.

(7) Connect the fore-and-aft load struts to the brackets on bomb arch 279·092A, using shackle pins, collars and split pins. Strap the struts to the bomb bay roof.

(8) Check that the four tank crutching eyebolts are secured to the suspension beams by the captive Pip pins. Ensure that the special nuts are an easy fit on the eyebolt threads, remove the special nuts and washers and lubricate the eyebolt threads with grease, XG-295.

(9) Position the tank beneath the bomb bay, hook the four minilift hoists (Ref.No.26DC/95088) on to the attachment points at each end of both suspension beams. Engage the ball-ends of the hoist cables with the hoisting sockets in the tank outriggers. Take up the slack evenly in all four hoist cables and disconnect the four transportation legs.

(10) Raise the tank evenly into the bomb bay, synchronising the operation of the minilift hoists, until the tank crutching eyebolts are just clear of the tank outriggers. Each eyebolt must then be guided into its outrigger attachment hole, while the tank is raised slowly until all four eyebolts are engaged.

(11) Fit the special nuts and washers to the tank crutching eyebolts and incrementally hand-tighten them. Remove the minilift hoist and carry them clear of the aircraft.

(12) To determine the order in which the crutching eyebolt nuts are tightened, refer to para.174(13).

(13) Incrementally torque load the eyebolt nuts in the order determined in op. (12) in three stages, to 10 lb. ft., 15 lb. ft. and finally 20±3 lb. ft. Lock the nuts with split pins. If the split pins will not fit within the above tolerance, all the nuts must be slackened incrementally, a thin washer fitted to the eyebolt(s) concerned and op.(12) and (13) repeated.

(14) Connect the two fore-and-aft load struts to the brackets on top of the tank, using shackle pins, collars and split pins. The struts are adjustable, the nominal pin centre length being 13·45 ± 0·8 in. After adjustment, check that the screw threads are in safety, tighten the lock-nuts and wire-lock to the end fittings, using 22 s.w.g. stainless steel wire (Ref.No.30A/3339).

NOTE...
The copper bonding cables used in op.(13), (14) and (15) are to be kept as short as possible, and the bonding clips turned relative to each other to take up the slack in the bonding cables.

(15) Remove the blanking cap (Part No. F.R.S.360P) from the rear end of the vent pipe line in the bomb bay roof. Connect the elbow piece (Part No.25P/3375) of the vent pipe assembly (see para.97) to the vent pipe line, using a short rubber hose and two hose clips. Connect the long hose to elbow piece (Part No.25P/3375) and secure with a hose clip. Connect elbow piece (Part No.15P/3918) to the other end of the long hose and secure with a hose clip. Connect elbow piece (Part No.15P/3918) to the tank vent connection, using a short hose and two hose clips. Fit bonding clips to the vent pipe line, the elbow pieces and the tank vent connection and link the bonding clips together, using copper bonding cables twisted round the elbow pieces and hose and secured by straps.

(16) Connect the two fuel delivery hoses to the delivery pipes in the

◀ port and starboard sides of the bomb bay. Fit bonding clips and copper bonding cables to the hose-to-pipe couplings. Secure each hose to its support bracket on the lower inboard face of each outrigger and by P clips to the lower forward face of the outrigger.

(17) Secure both delivery hoses to the hose support brackets secured on the bottom surface of the brackets extending forward from the front of the port and starboard suspension beams.

(18) Connect the refuelling hose to the refuelling pipe in the port side of the bomb bay. Fit bonding clips and a copper bonding cable across the connection. Secure the hose to the hose clips on top of the electrical plug stowage and on top of the hose support bracket extending forward from the front of the suspension beam.

(19) Turn the manually-operated servicing cock in the tank branch pipe to the on position and wire-lock.

(20) Remove the blanking caps from the electrical sockets in the port side of the bomb bay and place them in the stowages on the suspension beams. Disconnect the electrical plugs from the tank stowages and connect them to the sockets in the port side of the bomb bay. Secure the electrical leads to the upper surface of the port suspension beam with P clips.

176. The tanks are to be checked for leaks and correct operation of the fuel contents gauge, refuelling valve and float switch during refuelling. Fuel flow and pressurisation tests are to be done when required by the Vol.4 of this publication. ▶

TABLE 1

Allocation of bolts, nuts, washers, etc.

Strut	Bolt		Washer	Nut	Split pin	Special washer *	Bush
1A	28D/1711		28W/9419477	28M/1011476	28P/1007741	-	9/P3390
1T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
3A	4/P3390	N.I.V.	28W/9419405	28M/1011467	28P/1007741	3/SS/4667	8/SS/4647
3T	4/P3390	N.I.V.	28W/9419405	28M/1011467	28P/1007741	3/SS/4667	8/SS/4647
4A	4/P3390	N.I.V.	28W/9419405	28M/1011467	28P/1007741	3/SS/4667	8/SS/4647
4T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
5A	28D/9435055		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
5T	4/P3390	N.I.V.	28W/9419405	28M/1011467	28P/1007741	3/SS/4667	8/SS/4647
2A	3/P3390	N.I.V.	28W/9419405	28M/1011467	28P/1007741	3/SS/4667	8/SS/4647
2T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
6A	A/59/20J	N.I.V.	28W/9419477	28M/1011476	28P/1007741	3/SS/4667	19/P3390
6T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
7A	A/59/7J	N.I.V.	28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
7T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
8A	28D/9435055		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
8T	28D/18779		28W/9419477	28M/1011476	28P/1007741	3/SS/4667	8/SS/4647
9A	12/P3375	N.I.V.	28W/9419405	28M/13266	28P/1007741	2/SS/4667	8/SS/4647
9T	28D/16975		-	28M/13267	28P/1007741	2/SS/4667	9/SS/4645
10A	9/P3375	N.I.V.	28W/9419405	28M/13266	28P/1007741	3/SS/4667	-
10T	8/P3375	N.I.V.	28W/9419477	28M/12312	28P/1007741	3/SS/4667	-
11A	10/P3375	N.I.V.	28W/9419405	28M/13266	28P/1007741	3/SS/4667	-
11T	11/P3375	N.I.V.	28W/9419479	28M/1011001	28P/9429652	-	-
12A	9/P3375	N.I.V.	28W/9419405	28M/13266	28P/1007741	3/SS/4667	-
12T	8/P3375	N.I.V.	28W/9419477	28M/13412	28P/1007741	-	-
13A	A/59/33J	N.I.V.	28W/9419477	28M/13412	28P/1007741	3/SS/4667	-
13T	11/P3375	N.I.V.	28W/9419479	28P/9429652	28P/9429652	-	-
14A	32/P3586	N.I.V.	28W/9419491	28M/1011001	28P/9429652	7/SS/4667	-
14T	11/P3375	N.I.V.	28W/9419491	28M/1011001	28P/9429652	-	-
15A	28D/17116		28W/9419477	28M/13412	28P/1007741	3/SS/4667	-
15T	28D/17116		-	28M/13412	28P/1007741	-	* 11/SS/4647 12/SS/4647

* To fit under bolt head