Chapter 10 OXYGEN SYSTEM

LIST OF CONTENTS

TABLE

LIST OF ILLUSTRATIONS

Introduction

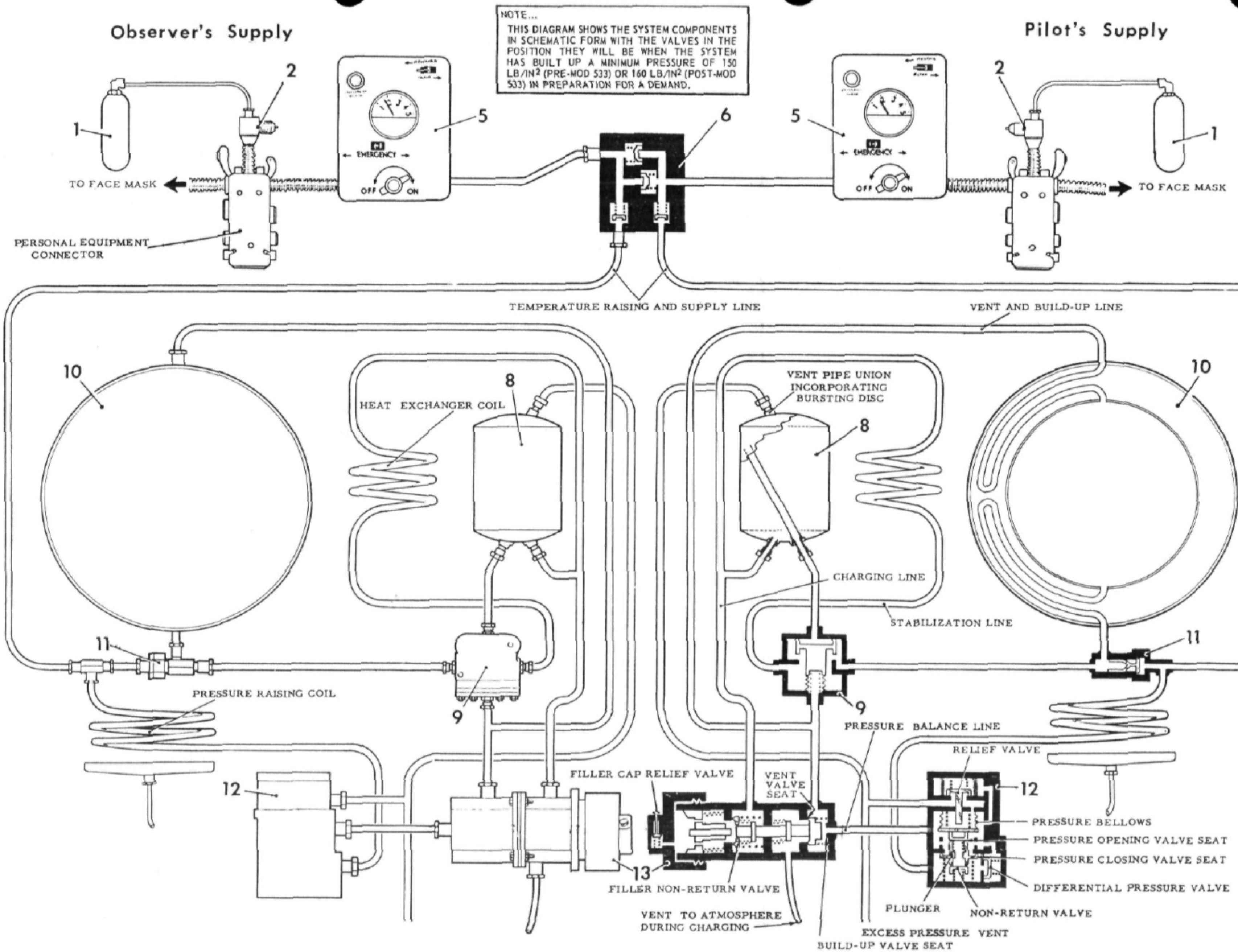
1. The oxygen system in this aircraft is part liquid and part gaseous, the principle ◀ of operation being described in A.P. 107D-0001-1. On pre-Mod 917 aircraft, the liquid ▶ forming the source of supply is stored in two 3½-litre containers housed within the radio bay. As shown diagrammatically in fig 1, this system is divided into two separate supplies – one for each crew member – and is capable of providing each of the crew with 20 litres of gaseous oxygen per minute for a period of approximately 140 minutes. An automatic cross-feed is incorporated to ensure that both crew members can obtain oxygen in the event of one supply failing.

2. With the incorporation of Mod 917, the *two storage containers and associated* valves are removed and replaced by a liquid oxygen package unit, which incorporates a single 10-litre container together with the necessary valves and piping in one easily removable component. As the container holds both the pilot's and the observer's supplies, a single delivery line is employed, dividing in the cabin to serve each crew station. Capable of supplying 20 litres of gaseous oxygen per minute to each crew member for a period of approximately 200 minutes, the package unit may be replenished either in-situ or, more conveniently, by removing it from the aircraft and replacing with a fully-charged unit. An improved type of package unit, incorporating additional components to accelerate the stabilization process after charging, is introduced by ◀ Mod 994. A further improvement, in the form of an additional pressure relief valve to protect the main container in the event of malfunctioning of the existing relief valve or blockage of the vent line, is incorporated in the package unit introduced by Mod 1203. ▶

KEY TO FIG 1 AND 2 (OXYGEN SYSTEM – PRE-MOD 917)

(Revised)

Item	Component	No. off	Manufacturer	Type or Part No.	Applicability	A.P. Ref
1	Emergency oxygen set	2	Service Supply	Mk.8C		1275G, Vol. 1
2	Excess pressure oxygen valve	2	Hymatic Eng Co Ltd	RAV151-003		109G-0302-1
3	Contents gauge indicator	4	British Oxygen Co Ltd	801535	Pre-Mod 731	112G-0508-1
3	Contents gauge indicator	4	British Oxygen Co Ltd	803161	Post-Mod 731	112G-0508-1
4	Cursor for item 3 in radio bay	2	British Oxygen Co Ltd	802874	Post-Mod 731	112G-0508-1
5	Regulator (Mk.17E)	2	Service Supply	OP.4820	Pre-Mod 633	107D-0201-1
5	Regulator (Mk.17F)	2	Service Supply	OP.6450	Post-Mod 633	107D-0201-1
6	Two-way check valve	1	British Oxygen Co Ltd	801421	Pre-Mod 533	107D-0502-1
6	Two-way check valve	1	British Oxygen Co Ltd	802900	Post-Mod 533	107D-0502-1
7	Contents gauge control unit	2	British Oxygen Co Ltd	802213		107D-0301-1
8	Stabilizing container	2	British Oxygen Co Ltd	802802	Post-Mod 289	
9	Changeover valve	2	British Oxygen Co Ltd	801919		107D-0502-1
10	Liquid oxygen container	2	British Oxygen Co Ltd	800872		
11	Check valve	2	British Oxygen Co Ltd	801419		107D-0502-1
12	Pressure control valve	2	British Oxygen Co Ltd	801427	Post-Mod 533	107D-0502-1
13	Filler and vent valve	2	British Oxygen Co Ltd	801416		107D-0502-1



BUCCANEER S MK. 1 AIRCRAFT AIR DIAGRAM 7433/MIN	
ISSUE 3	PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY MINISTRY OF DEFENCE

Fig. 1. Oxygen system diagram (pre-Mod 917)

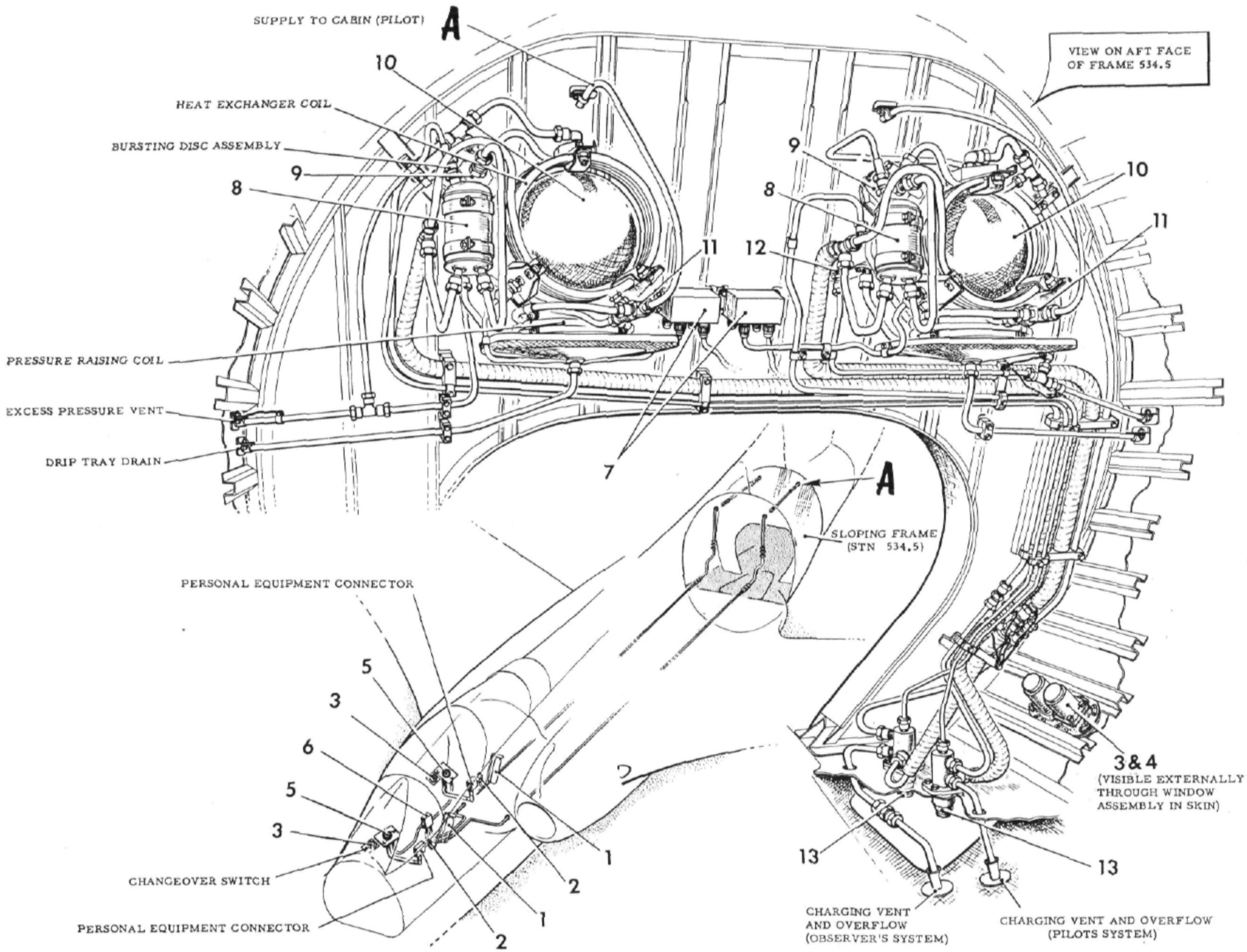


Fig. 2. Oxygen system arrangement (pre-Mod 917)

3. In the early stages of delivery on both pre- and post-Mod 917 systems, the liquid is transformed into gas and in the process develops a pressure which is controlled at a suitable operating level.

4. Conventional Mk. 17 demand regulators are fitted, one at each crew station, to control the strength and flow of oxygen in accordance with the requirements. Electro-magnetic flow indicators, controlled by these regulators, enable each crew member to verify whether or not oxygen is being supplied from each regulator.

5. On pre-Mod 917 aircraft, four electrical contents gauge indicators – one at each crew station and two in the radio bay – register the amount of liquid oxygen in the containers. The amount of liquid in the observer's container can also be registered on the pilot's indicator by depressing a push-button switch located on the pilot's starboard console. To indicate the contents of the single container fitted on post-Mod 917 aircraft, two contents gauge indicators are fitted, one at the pilot's station and one in the radio bay.

6. Emergency oxygen sets attached to the ejection seats can be operated either manually, if the main system fails, or automatically during ejection. Each set is capable of meeting a normal demand for approximately ten minutes.

Modification standard

7. This chapter includes the following ◀ modifications:- 64, 289, 301, 533, 631, 633, 657, 731, 893, 917, 994, 1106 and 1203. ▶

Controls and instruments

8. With the exception of the contents gauge indicator(s) in the radio bay (*fig* 2 *or* 5), all the oxygen system controls and instruments are located in the cabin and illustrated in Cover 1, Sect. 1, Chap. 1 and 2. They consist of:-

(1) Two electro-magnetic flow indicators at each crew station, OXYGEN, PILOT – OBS, one pair being located on the port side of the pilot's instrument panel and the other on the observer's auxiliary panel. Controlled by the regulators, these indicators show a vertical white band when the user inhales and black during exhalation. If the supply fails, the related indicators show black.

(2) *Pre-Mod 917 only.* Two contents gauge indicators, one on each crew member's starboard console, which register the contents of the respective container.

(3) *Post-Mod 917 only.* One contents gauge indicator on the pilot's starboard console which registers the contents of the container.

(4) *Pre-Mod 917 only.* A push-button changeover switch, fitted close to the pilot's contents gauge indicator, to enable him to check the contents of either container on the one indicator.

The following items are located on the face of each regulator:-

(5) An air inlet shutter, NORMAL OXYGEN – 100% OXYGEN, which can be selected to give either condition. In the case of normal supply, the oxygen/air ratio is proportionate to cabin altitude and controlled by the regulator.

(6) An emergency toggle switch. If this switch is deflected to right or left, the user is supplied with oxygen at a positive pressure. The switch can also be depressed when in the upright position for mask testing purposes.

(7) A manually-operated valve, OXYGEN SUPPLY, ON – OFF, which controls the supply into the regulator. Normally this valve is wire locked in the ON position.

(8) An electro-magnetic flow indicator similar to the remote indicators (1), all of which are operated by a diaphragm mechanism within their respective regulator.

(9) A pressure gauge indicating the pressure of the supply entering the regulator.

PRE-MOD 917 INSTALLATION

Radio bay installation *(fig 2)*

9. Except for the two filler and vent valves, all the system components in the radio bay are fitted on the rear face of frame 534.5. These components are divided into similar port and starboard installations, the port side being associated with the pilot's supply and the starboard side forming part of the observer's supply. Each installation includes the following components:-

3½-litre liquid oxygen container

Check valve

Pressure control valve

Stabilizing container

Changeover valve

Heat exchanger coil

The two filler and vent valves are located within a ground charging pocket on the starboard side of the rear fuselage (*fig* 2). Although primarily installed to provide a means of charging the liquid oxygen container, each filler and vent valve also forms part of a pressure build-up circuit, being interconnected to both the pressure control valve and the container for this purpose. Both the filler and vent valve and the pressure control valve vent to atmosphere, the former venting the liquid oxygen container during charging and the latter venting when the system pressure exceeds 200 lb/in².

10. Connecting a three-way junction, adjacent to the check valve, to the pressure control valve is a pressure raising pipe, which is coiled beneath the liquid oxygen container to provide the extra length of piping necessary for ambient heat to convert the liquid to gas before it reaches the control valve. A drip tray, incorporating a drain pipe extending to the side of the rear fuselage, is fitted directly below the pressure raising coil to collect condensation which, owing to the low temperature of the oxygen at this point, forms on the coil. The remaining pipe from the three-way junction forms both a temperature raising pipe and the supply line to the cabin.

11. The stabilizing container, changeover valve and heat exchanger coil are interconnected by pipes, forming a filling and stabilizing circuit which is interposed in the charging line between the filler and vent valve and the check valve. An interconnecting pipe between bellows in the changeover valve and the vent and pressure build-up circuit senses atmospheric pressure during charging and system pressure during stabilization. A vent pipe, extending from the top of the stabilizing container, incorporates a thin aluminium disc (*fig* 1) which will burst and vent the stabilizing circuit to atmosphere in the event of the pressure exceeding 440 lb/in².

Cabin installation *(fig 1 and 2)*

12. Inside the cabin, both the pilot's and observer's supplies are joined to a two-way check valve mounted between frame stations 151.5 and 167, beneath the observer's starboard console. The inlet and outlet pipes connected to the check valve are numbered to identify the supplies – No. 1 and 3 indicating the pilot's supply, 2 and 4 indicating the observer's supply. The delivery pipes– 3 and 4 – are routed to the regulators on the crew's starboard consoles. From the outlet side of each regulator, the supply is joined to a personal equipment connector (P E C) on the respective seat pan. The piping (flexible hose) from the P E C to the face mask also forms part of the emergency oxygen system, which joins the main system at the P E C.

Emergency sets

13. Each emergency oxygen set (Mk. 8C) is capable of meeting a normal demand for approximately ten minutes when fully charged to 2000 lb/in². Comprising a cylinder, incorporating a small regulator at its head, together with a delivery tube and operating mechanism, the sets are described in A.P. 1275G, Vol. 1. As with the main oxygen system, the emergency supply passes through the personal equipment connector to the user's face mask. The emergency supply line remains intact during an ejection and up to the point at which the occupant leaves the seat. An excess pressure oxygen valve is located in the line to prevent an oxygen overload and also to isolate the emergency system when not in use.

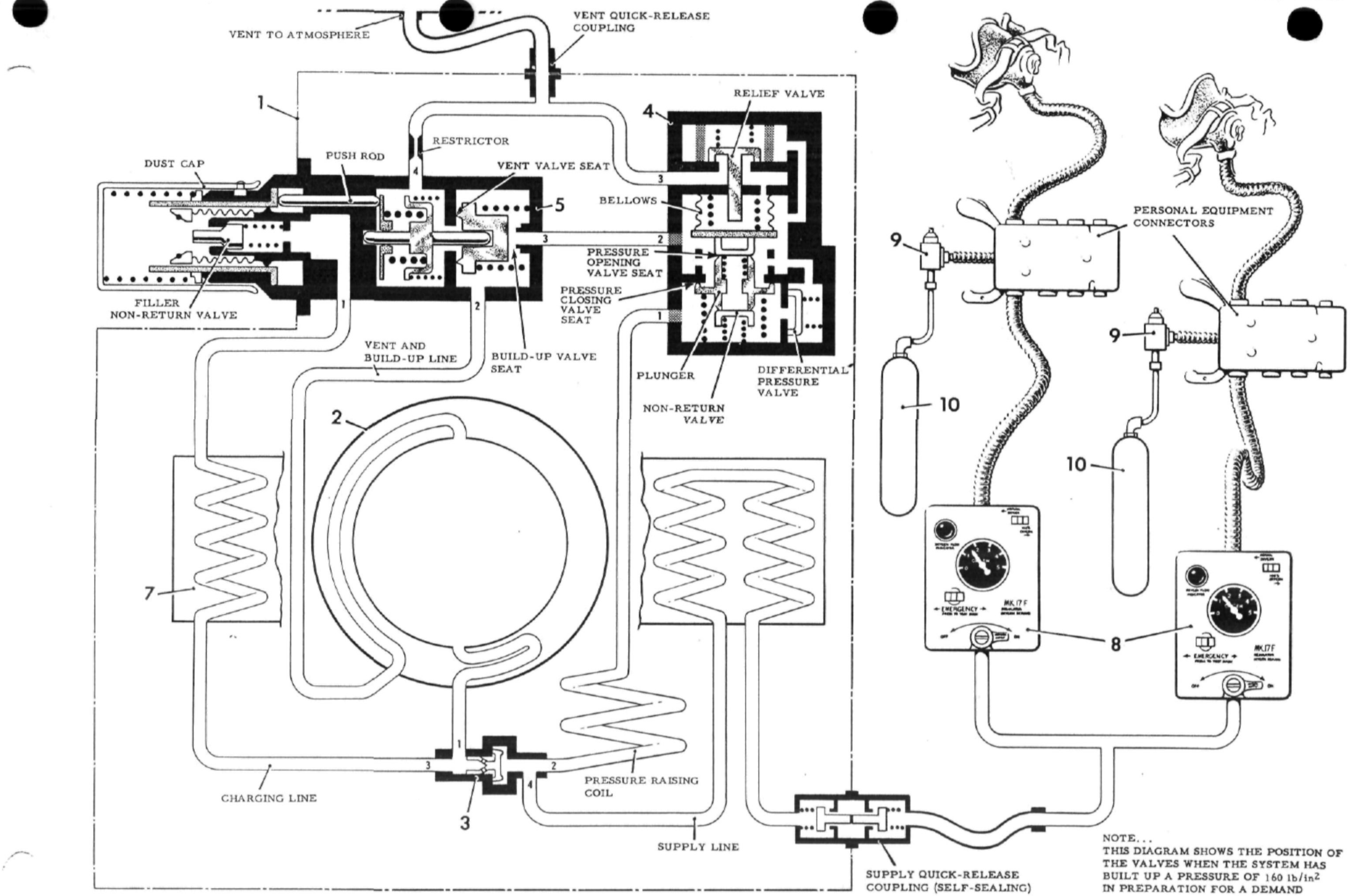
14. Both manual operation, effected by a control on the starboard side of the seat pan, and automatic operation, caused by a trip lever at the rear of the seat, sever a break-off tube in the regulator to initiate the supply. A tell-tale wire, fitted between lugs on the regulator operating mechanism, gives visual indication that the set has been operated.

15. A safety pin, provided with each installation, is inserted in the body of the regulator to lock the operating mechanism and so prevent inadvertent operation when the aircraft is on the ground. Stowage bags are provided at each crew station for pin stowage immediately prior to flight.

POST-MOD 917 INSTALLATION

General details

16. With the exception of the regulators, the main components in the system form part of a liquid oxygen package unit (*para* 19) which is located on a mounting secured to brackets on the radio bay floor immediately aft of the entrance hatch. The mounting consists of two slides riveted to a base plate, each slide having one edge bevelled to mate with similar bevelled edges on the package unit base plate. Fitted to the forward end of each slide is a mounting bolt assembly and an extractor bolt. As fig 5 shows, the mounting bolts are of a special quick-release type and locate in slots in the package unit base plate to secure the unit in its mounting.



NOTE...
THIS DIAGRAM SHOWS THE POSITION OF THE VALVES WHEN THE SYSTEM HAS BUILT UP A PRESSURE OF 160 lb/in^2 IN PREPARATION FOR A DEMAND

BUCCANEER S MK. 1 AIRCRAFT AIR DIAGRAM 7540/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF TECHNOLOGY FOR PROMULGATION BY MINISTRY OF DEFENCE

Fig. 3. Oxygen system diagram (post-Mod 917, pre-Mod 994)
◀ Pipe connection numbers added ▶

KEY TO FIG 3, 3A, 4 AND 5 (OXYGEN SYSTEM – POST-MOD 917)

(Revised)

Item	Component	No. off	Manufacturer	Type or Part No.	Applicability	A.P. Ref
1	Liquid oxygen package unit, comprising:-	1	British Oxygen Co Ltd	803844	Pre-Mod 994	107D-0802-1
2	Liquid oxygen container	1		803039		
3	Check valve	1		801419		107D-0502-1
4	Pressure control valve	1		801427		107D-0502-1
5	Filler and vent valve	1		802722		107D-0502-1
6	Contents gauge control unit	1		802213		107D-0301-1
7	Heat exchanger	1		803827		
8	Regulator (Mk.17F)	2	Service Supply	OP.6450		107D-0201-1
9	Excess pressure oxygen valve	2	Hymatic Eng Co Ltd	RAV151-003		109G-0302-1
10	Emergency oxygen set	2	Service Supply	Mk.8C		1275G, Vol. 1
11	Contents gauge indicator	2	British Oxygen Co Ltd	803161		112G-0508-1
12	Liquid oxygen package unit, comprising:-	1	British Oxygen Co Ltd	806168	Post-Mod 994	107D-0802-1
13	Liquid oxygen container	1		806180		
14	Check valve	1		801419		107D-0502-1
15	Pressure control valve	1		801427		107D-0502-1
16	Filler and vent valve	1		802722		107D-0502-1
17	Contents gauge control unit	1		802213		107D-0301-1
18	Heat exchanger	1		806295		
19	Changeover valve	1		801919		107D-0502-1
20	Stabilizing container	1		806136		
21	Bursting disc assembly	1		802259		107D-0802-1
22	Cursor for item 11 in radio bay	1		802874		112G-0508-1
23	Liquid oxygen package unit, comprising:- Items 13,14,15,16,17,18,19,20,21 and	1	British Oxygen Co Ltd	807750	Post-Mod 1203	107D-0802-1
24	Relief valve	1	British Oxygen Co Ltd	807752	Post-Mod 1203	

Note...

Numbers inside pipelines on fig 3 and 3A indicate the number stamped on the valve body adjacent to the pipe connection

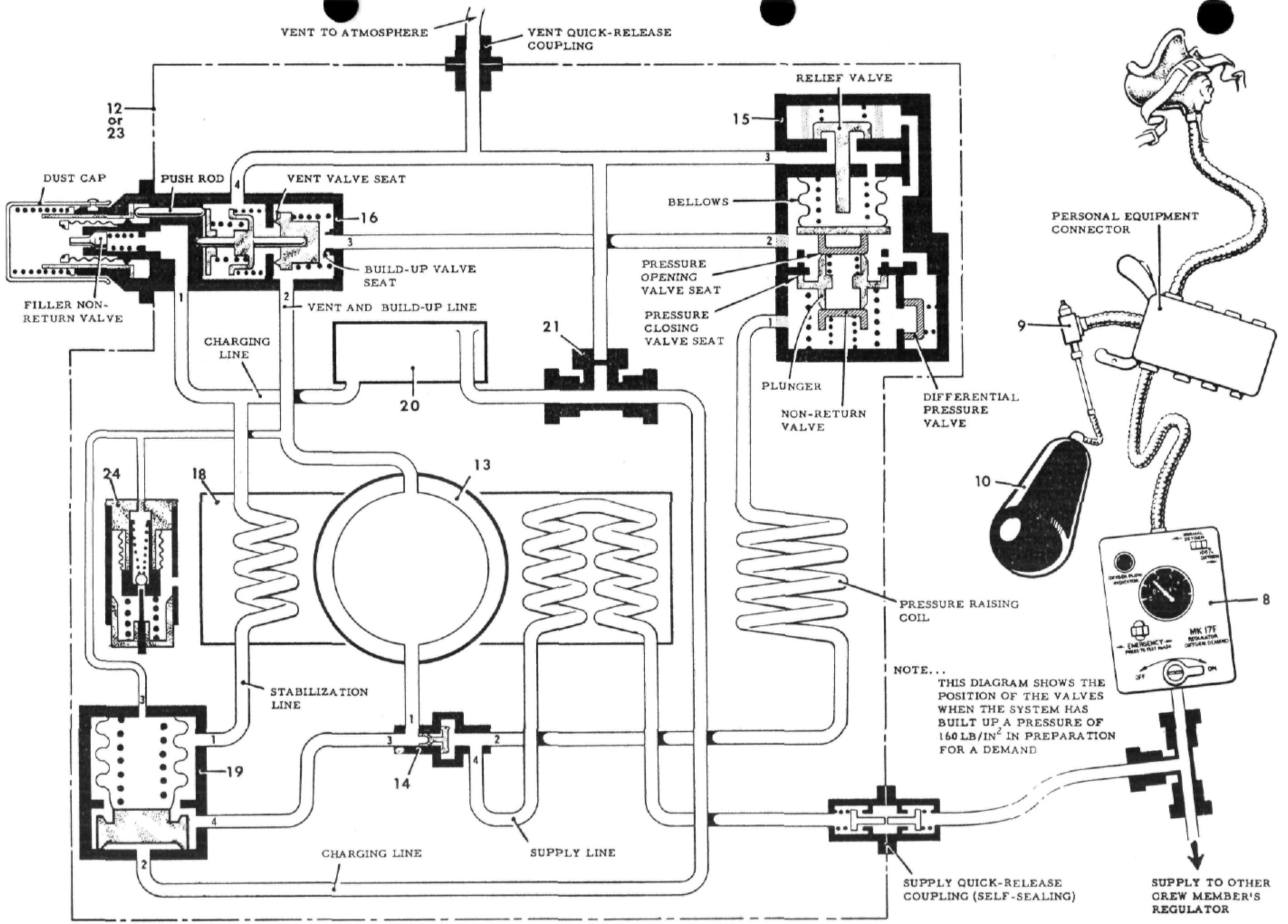


Fig. 3A. Oxygen system diagram (post-Mod 994 and 1203)

◀Pipe connection numbers added; Mod 1203 incorporated▶

BUCCANEER S MK. 1 AIRCRAFT	
AIR DIAGRAM 7544/MIN.	
ISSUE 1	PREPARED BY MINISTRY OF TECHNOLOGY FOR PROMULGATION BY MINISTRY OF DEFENCE

If, on release of the mounting bolts, the package unit does not easily disengage from the slides, the two extractor bolts can be unscrewed until their spherical ends bear against lugs on the package unit base plate, thus providing the necessary force to extract the unit. A drip tray, incorporating a drain pipe which extends to the undersurface of the rear fuselage, is fitted beneath the base plate to collect and dispose of any condensation which may form on the components of the package unit.

17. Connected to the package unit by quick-release couplings are two flexible hoses, one of which extends to a vent in the skin plating on the starboard side at station 546.9. Forming part of the supply line to the cabin, the remaining flexible hose is joined to a rigid pipeline which is routed forward, through the starboard side of the radio bay front bulkhead, along the starboard side of the bomb bay and into the cabin, where it branches to the pilot's and observer's regulators on the starboard consoles.

18. From the outlet side of each regulator, the supply is directed through a flexible hose to a personal equipment connector (P E C) on the respective seat pan. The flexible hose from the P E C to the face mask also forms part of the emergency oxygen system (*para* 24), which joins the main system at the P E C.

Liquid oxygen package unit ***(fig 5)***

19. This unit can be rapidly removed from, and installed in, the aircraft. It contains the supply of breathing oxygen in liquid

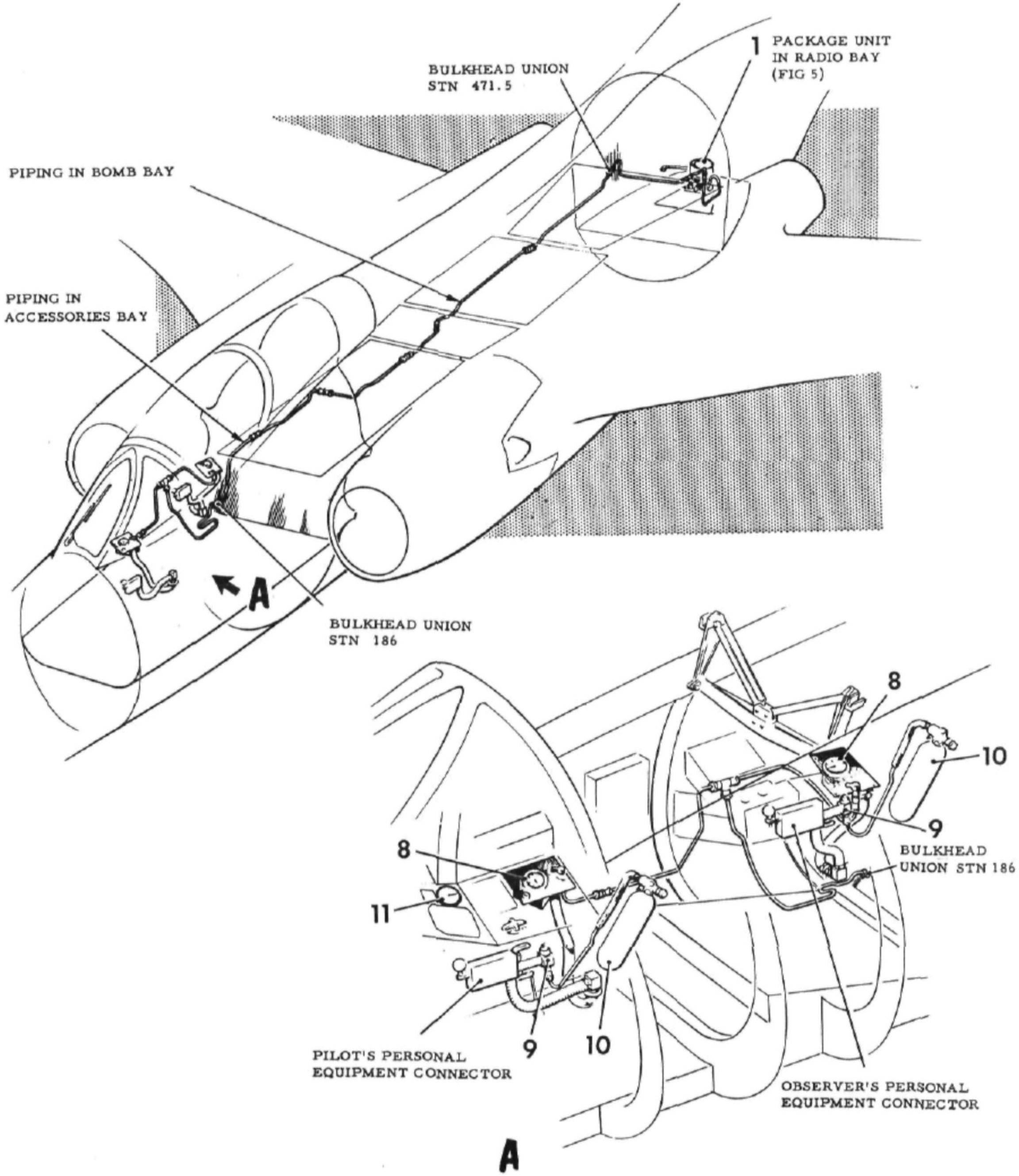


Fig. 4. Oxygen system arrangement (post-Mod 917)

form which it converts, as and when required, into gas at a pressure suitable for the supply of the crew's regulators. To reduce the length of time required for completion of the stabilization process after charging, an improved type of package unit ◀ is fitted on post-Mod 994 aircraft. An additional pressure relief valve, to afford added protection to the main container, is introduced in the improved type of package unit fitted on post-Mod 1203 aircraft. The components which make up each type of unit are listed in the key to fig 3, 3A, 4 and 5 and reference should be made to the relevant Air Publication for detailed information on each individual component. Unless otherwise stated, the following brief description applies to each type of package unit. ▶

20. The liquid oxygen container is a double walled, vacuum-insulated vessel provided with a carrying handle and containing the capacitance-type sensing element of the contents gauging system. Attached to, and completely surrounding, the liquid oxygen container is the panel-type heat exchanger incorporating a further two carrying handles, while the check valve, pressure control valve and filler and vent valve are located beneath the container. Additional components on the package unit fitted to post-Mod 994 aircraft consist of a changeover valve and a bursting disc assembly located beneath the liquid oxygen container and an annular stabilizing container mounted on top of the ◀ liquid oxygen container. The pressure relief valve, incorporated into the package unit fitted to post-Mod 1203 aircraft, is also located beneath the liquid oxygen container. All the foregoing components ▶ are interconnected by a system of rigid pipelines and are mounted on a dovetail-shaped base plate which has bevelled edges to locate beneath corresponding bevelled edges on the slides of the package unit mounting (*para* 16).

21. Reference to fig 3 or 3A shows that the heat exchanger is divided into two separate parts. On the package unit fitted to pre-Mod 994 aircraft, one part of the heat exchanger is interposed in the charging line between the filler and vent valve and the check valve, utilizing ambient heat to raise the temperature of the liquid before it enters the container during charging. The equivalent part of the heat exchanger fitted on post-Mod 994 aircraft is positioned in the branch line to the changeover valve and is used to impart ambient heat to the oxygen as it is being transferred from the stabilizing container to the liquid oxygen container after the charging procedure is completed. Serving the same purpose on both types of package unit, the remaining portion of the heat exchanger is situated in the supply line between the check valve and the quick-release coupling. It ensures, also by ambient heat transference, that the oxygen supply is at a temperature suitable for breathing before it leaves the package unit. Connecting the check valve to the pressure control valve is a pressure raising pipe which is part of the build-up circuit; ◀ this pipe is coiled beneath the liquid oxygen container to provide the extra ▶ length necessary for ambient heat to convert the liquid to gas before it reaches the control valve.

22. Both the liquid oxygen container vent pipe and the oxygen supply pipe terminate in quick-release couplings, enabling the package unit to be rapidly disconnected from the aircraft piping. The quick-release coupling in the supply line is also self-sealing when disconnected, whereas that in the vent line permits a free passage of oxygen at all times. Both couplings are provided with dust caps which should be fitted immediately a coupling is disconnected. A special feature of the vent dust cap is that, even when fitted to the quick-release coupling, venting can still take place, a path being provided through the dust cap for the flow of oxygen. The dust caps are stowed on the side of the heat exchanger when not in use.

23. Also secured to the package unit base plate is the contents gauge control unit. This unit measures the capacitance values received from the sensing element within the liquid oxygen container and applies them, in the form of a d.c. output, to the two contents gauge indicators (*para* 8).

Emergency sets

24. The arrangements for providing each crew member with an emergency supply of oxygen during ejection or in the event of failure of the normal supply are identical on both pre- and post-Mod 917 aircraft and are described in paragraphs 13, 14 and 15 of this Chapter.

SYSTEM OPERATION

General

25. For convenience, system operation is divided into the following phases:-

Charging
Build-up
Stabilization
Normal demand
Standby

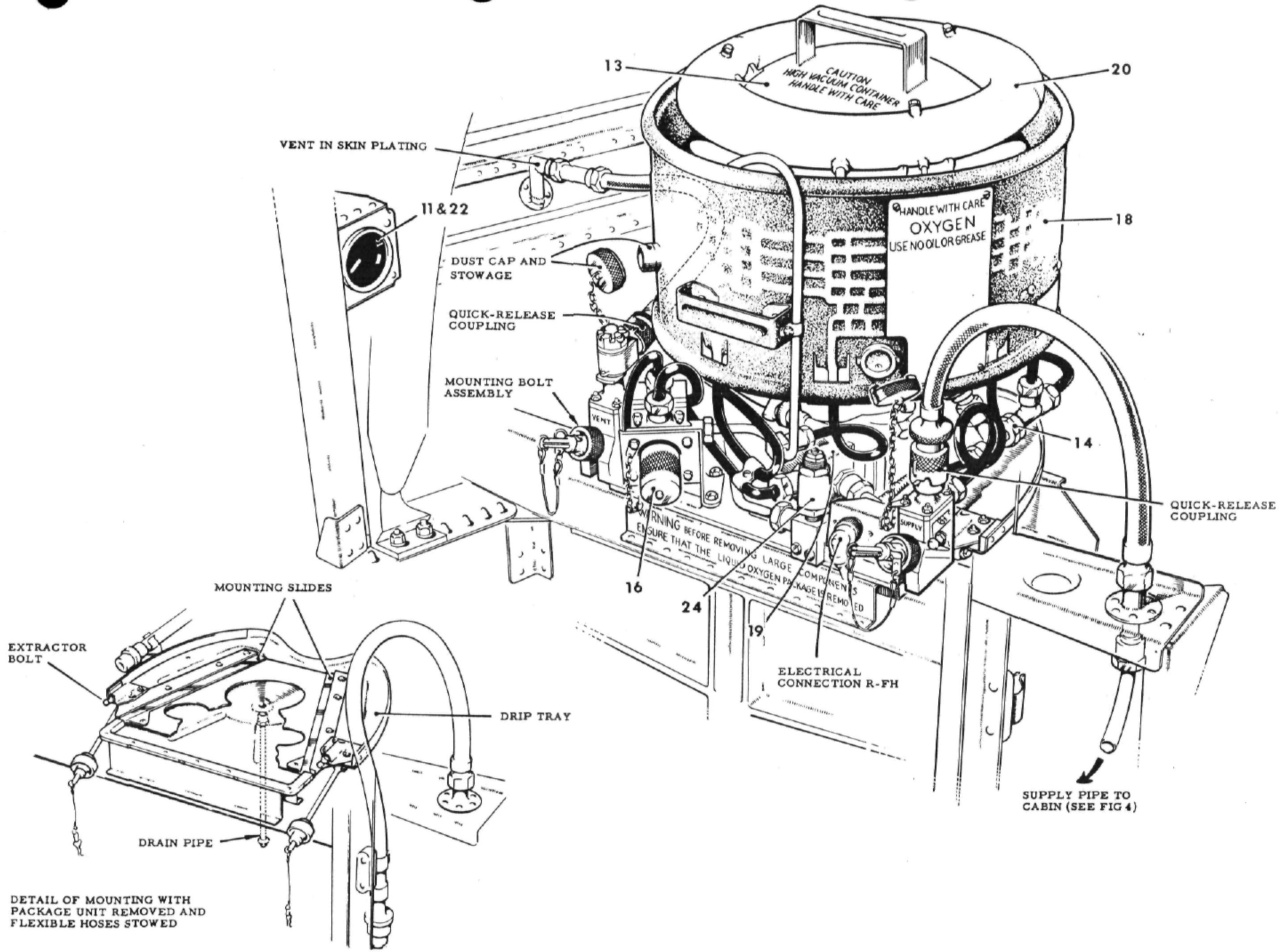


Fig. 5. Liquid oxygen package unit

◀ Mod 1203 incorporated ▶

Where the sequence of events occurring during a particular phase is dependent upon the modification standard of the aircraft, both the pre- and post-Mod versions are covered separately in the following paragraphs. Operation of the two independent systems installed in pre-Mod 917 aircraft is identical.

Charging (pre-Mod 917 or post-Mod 994)

26. When the ground connection of the replenishing hose is connected to the filler and vent valve, it opens the vent valve and the filler non-return valve within the filler and vent valve in succession, finally closing the build-up valve. Liquid oxygen under pressure will then flow from the charging rig, through the filler non-return valve to the stabilizing container, filling it to a level where it continuously spills into an internal stack pipe leading to the changeover valve. The liquid entering the system acts on a poppet-type valve within the changeover valve, opening the charging line to the bottom of the liquid oxygen container and sealing off the stabilization line for the duration of the charging procedure. The gas displaced from the liquid oxygen container vents to atmosphere via the open vent valve in the filler and vent valve.

27. During the initial period of charging, the check valve is open, allowing a trickle of liquid oxygen to pass into the pressure raising coil where the transfer of ambient heat causes vaporization of the liquid. This raises the pressure at the pressure control valve and also in the supply line. Flow in the build-up circuit, i.e., the circuit from the check valve to the top of the liquid oxygen container through the pressure raising coil, is prevented by the closed build-up valve in the filler and vent valve. Similarly, flow in the supply line is prevented by the regulators or, when charging a package unit remote from the aircraft, by the self-sealing quick-release coupling. The charging process continues until the liquid oxygen container has been filled to a pre-determined level indicated by a cursor on the contents gauge indicator, at which point charging is stopped. As soon as the replenishing hose is disconnected, pressures throughout the system are virtually equalized; this causes the changeover valve poppet to move and seal off the charging line, at the same time allowing a communication between the heat exchanger in the stabilization line and the liquid oxygen container.

Charging (post-Mod 917, pre-Mod 994)

28. When the ground connection of the replenishing hose is connected to the filler and vent valve, it opens the vent valve and the filler non-return valve within the filler and vent valve in succession, finally closing the build-up valve. Liquid oxygen under pressure will then flow from the charging rig, through the filler non-return valve to the heat exchanger in the charging line, where its temperature is raised before entering the bottom of the container. The gas displaced from the container vents to atmosphere via the open vent valve in the filler and vent valve. A restrictor within the vent pipeline, however, ensures that the pressure in the container rises to approximately 40 lb/in² during charging. This, together with the rise in temperature previously described, assists in partially stabilizing the system.

29. During the initial period of charging, the check valve is open, allowing a trickle of liquid oxygen to pass into the pressure raising coil where the transfer of ambient heat causes vaporization of the liquid. This raises the pressure at the pressure control valve and also in the supply line. Flow in the build-up circuit, i.e. the circuit from the check valve to the top of the container through the pressure raising coil, is prevented by the closed build-up valve in the filler and vent valve. Similarly, flow in the supply line is prevented by the self-sealing quick-release coupling or, if the package unit is being charged in-situ in the aircraft, by the regulators. When the system is full, excess liquid is discharged to atmosphere via the open vent valve until the replenishing hose is disconnected.

Build-up

30. The action of disconnecting the replenishing hose opens the build-up valve in the filler and vent valve and closes both the vent valve and the filler non-return valve. Gas in the build-up circuit now passes to the top of the liquid oxygen container and, due to the head of liquid in the container, further liquid oxygen flows through the check valve to vaporize in the pressure raising coil. In this way, the pressure in the build-up circuit, and thus also the liquid oxygen container, rises rapidly, compressing the bellows in the pressure control valve, until it reaches 150 lb/in² (pre-Mod 533) or 160 lb/in² (post-Mod 533). At this stage in the build-up phase, the pressure closing valve in the pressure control valve closes, the system having attained its working pressure. Any further increase in pressure between the check valve and the pressure closing valve, due to evaporation in the pressure raising coil, causes the check valve to close and prevent a further delivery of liquid to the build-up circuit.

Stabilization

31. Liquid oxygen, when stored in dispensers or storage tanks at atmospheric pressure, has a stable temperature of −183 deg C. When the container is full of liquid oxygen and the build-up process complete, the temperature of the gas above the liquid is approximately −153 deg C due to the vaporization and increase in pressure previously described. In an unstabilized system, the mass of liquid is still, however, at the lower temperature of −183 deg C. Under these conditions, any violent manoeuvres will bring the liquid into contact with the relatively warmer gas, causing condensation of the gas into liquid with a consequent drop in system pressure. To ensure a constant system pressure, it is therefore necessary to raise the temperature of the liquid by approximately 30 deg C, i.e. to −153 deg C, this process being known as stabilization.

Pre-Mod 917 or post-Mod 994 aircraft

32. Due to the natural heat intake following charging, the liquid oxygen in the stabilizing container quickly starts to boil, the generated gas pressure forcing the liquid back into the heat exchanger in the stabilization line, where it evaporates and passes into the liquid oxygen container via the changeover valve. Inside the container the gas is condensed back into liquid form, in the process giving up its latent heat to raise the temperature of the liquid within. In this way the liquid oxygen container is filled to capacity and the liquid is quickly brought up to an optimum operating temperature. A bursting disc, located in the top of the stabilizing container (pre-Mod 917) or in a tee-piece in the line between the stabilizing container and the changeover valve (post-Mod 994), will fracture to relieve any excessive pressure which may develop due to a faulty component or blocked pipeline.

Post-Mod 917, pre-Mod 994 aircraft

33. The system fitted to this aircraft is partially stabilized during charging by the heat exchanger in the charging line and the restrictor in the vent pipeline (*para* 28). The liquid undergoes a rise in temperature of approximately 18 deg C at the heat exchanger, vaporization being prevented by restricting the venting of the container to maintain the liquid at a pressure of approximately 40 lb/in^2. On completion of charging, the liquid oxygen remaining in the heat exchanger quickly vaporizes to raise the pressure to approximately 60 lb/in^2. The stabilization process is then continued by the natural intake of ambient heat, being sufficiently advanced after a period not exceeding five hours from the commencement of the charging procedure to ensure that, even during negative g conditions, system pressure will not fall below 95 lb/in^2 (minimum regulator operating pressure).

Normal demand

34. When a breathing demand is made by one or both crew members inhaling, the pressure in the supply line and also the pressure raising coil decreases, allowing the weight of liquid in the container to open the check valve. Liquid oxygen then flows into both the pressure raising coil and the supply line to vaporize and restore the system to its working pressure. The capacity of the heat exchanger in the supply line of a post-Mod 917 system is such that, when the oxygen enters the aircraft supply pipe, it is in a gaseous state at a temperature suitable for breathing. Each regulator reduces the supply pressure to the required level, which varies according to altitude.

Standby

35. Despite the highly-efficient insulation of the container inner shell, a certain amount of heat transfer does take place, causing evaporation at the upper surface of the liquid. When the system is at working pressure, i.e. a minimum of 150 lb/in^2 (pre-Mod 533) or 160 lb/in^2 (post-Mod 533), and no breathing demand is being made, this evaporation results in a rise in pressure between the top of the container and the pressure closing valve in the pressure control valve. This compresses the bellows in the pressure control valve until the pressure opening valve opens at 175 lb/in^2 (pre-Mod 533) or 185 lb/in^2 (post-Mod 533). Gas, which would otherwise be vented to atmosphere (*para* 36), can now flow from the top of the container, down the centre bore of the pressure control valve plunger, past the non-return valve and into the supply line. This is termed the economiser circuit, a reverse flow being prevented by the non-return valve.

36. If there is still no demand for oxygen by the crew, the gas pressure in the container continues to increase and the pressure control valve bellows are further compressed until, at a pressure of 200 lb/in^2, the pressure relief valve opens to prevent any additional increase in pressure. In the event of the pressure relief valve malfunctioning or the vent line becoming blocked, the additional pressure relief valve, introduced by Mod 1203, opens at a pressure of 330 to 380 lb/in^2. The differential pressure valve within the pressure control valve is set to operate at a differential pressure of 50 lb/in^2, relieving any excess pressure which may build-up in the pressure raising and supply lines. By this means, the maximum pressure attainable in the supply line is limited to 250 lb/in^2.

WARNING...

(1) In no circumstances may oil, grease or moisture be allowed to come into contact with any part of the system owing to the serious risk of explosion in the presence of undiluted oxygen.

(2) In no circumstances must the excess pressure vents (pre-Mod 917) or the package unit vent pipeline (post-Mod 917) be blanked off for any reason whatsoever. This also applies to the charging vents on pre-Mod 917 aircraft except when emptying a container (para 45). Failure to observe these precautions may result in damage to equipment and injury to personnel. These restrictions do not preclude fitting the dust cap secured to the package unit whenever the vent quick-release coupling on a post-Mod 917 system is disconnected, as this dust cap allows venting to take place.

General

37. The servicing requirements for the system are confined to visual examination, replacement of faulty parts, system tests, charging and, on post-Mod 917 aircraft, removal and installation of the package unit. If it is necessary to break down a pre-Mod 917 system for any reason, the container and system must be exhausted as described in para 45. Similarly, should it be necessary to break down a post-Mod 917 system at the package unit the container must be exhausted as described in para 46. To break down a post-Mod 917 system downstream of the package unit without exhausting the container, disconnect the flexible hose at the SUPPLY quick-release coupling and stow the hose in the clip provided. Any oxygen under pressure in the system piping may then be exhausted by depressing the emergency toggle switch on either regulator. Instructions for testing a regulator are contained ◀in A.P. 107D-0201-1.▶

38. To assist detection and rectification of defects in the system, some typical faults and remedies are listed in Table 1. If, however, a package unit is found to be unserviceable, the simplest remedy is to replace the faulty unit with a serviceable, fully-charged unit. Renewal or replacement of a component will necessitate purging the system in the manner described in ◀A.P. 107D-0001-1; this procedure should▶ also be used to clear blocked pipes.

39. To prevent damage to the drip tray and mounting slides on post-Mod 917 aircraft, it is recommended that the locally-manufactured protective cover illustrated in Cover 1, Sect. 2, Chap. 2, be fitted to the package unit mounting at all times when the unit is not installed in the aircraft. If for any reason the drip tray and slides have been removed from the aircraft, the cover may be inverted, i.e., fitted with the support blocks uppermost, to protect the mounting brackets on the radio bay floor.

Precautions

40. Servicing must be effected with the utmost regard to cleanliness, particularly when the system is broken down for repairs or during charging; in the latter case it is necessary to wear protective clothing, i.e. clean overalls, leather boots, goggles or a transparent visor and rubber gloves. Full details of all safety precautions are con-◀tained in A.P. 107D-0001-1, A.P. (N) 140,▶ Article 0628 and NAMO/GEN/G51.

41. Pipes, on testing or charging rigs, must be thoroughly clean. This also applies to system pipes that are being refitted or renewed. To clean a new pipe or union prior to installation, proceed as follows:-

(1) Blow out all dust and swarf with a jet of clean, dry air.

(2) Degrease by pouring trichlorethylene through the bore for one minute without a vapour lock. The trichlorethylene should be discarded after ten passes through the bore.

(3) Wash in clean hot water, pouring the water through the bore for one minute without a vapour lock. Discard the water after one pass through the bore.

(4) Repeat operation (3) using clean cold water.

(5) Wash in acetone, pouring the acetone through the bore for one minute without a vapour lock. Discard the acetone after twenty passes through the bore.

Blanking caps or other suitable forms of sealing must be fitted to exposed ports or components immediately after the pipes are disconnected.

42. When fitting a new pipe or component, the threads of the unions may be lightly smeared with lubricant, ZX-24, diluted if

TABLE 1 Fault diagnosis

Fault	Cause	Remedy
During charging		
(1) Container will not fill during charging	(a) Filler and vent valve hose incorrectly fitted or malfunctioning	(a) Cease charging, remove the hose connector and ensure that the valve operating spigot at the centre of the connector is not damaged or frozen in the closed position.
	(b) Blockage in filling or vent lines	(b) Cease charging and remove the filling and vent lines in turn. Purge the blocked pipe or heat exchanger as appropriate.
	(c) Faulty changeover valve (pre-Mod 917 or post-Mod 994)	(c) Cease charging, empty the system and renew the valve.
(2) Contents gauge not showing charge	Electrical failure, faulty gauge or contents gauging unit	Allow a short time lapse (approximately 10 minutes) and if the gauge ◀still reads incorrectly refer to A.P. 101B-1202-1B, Cover 2, Sect. 7, ▶ Chap. 9.
(3) No charge, indicated by gas flow from bursting disc vent line during charging (pre-Mod 917 only)	Blockage in filling line	Cease charging and remove the filling pipes from between the filler and vent valve, stabilizing canister, changeover valve and check valve. Purge the blocked pipe and renew the bursting disc.
After charging		
(4) Leakage through filler and vent valve after replenishing hose connector has been removed.	Faulty filler and vent valve	Tap the valve lightly and allow time for it to thaw. If this method succeeds in stopping the leak, the system must be emptied and refilled. If the leakage continues, empty the system and renew the valve.
5) No pressure build-up – indicated on regulator pressure gauge	(a) Frozen or faulty check valve	(a) Empty the container and allow the valve to thaw. If, on re-charging, the fault still exists, empty the system and renew the check valve.
	(b) Blockage in pressure build-up circuit	(b) Disconnect the pressure raising coil at the pressure control valve. If gas is discharging from the pipe, empty the system and renew the valve. If there is no flow from the pipe, disconnect the supply pipe from the check valve. A discharge from the check valve proves that the pressure raising coil is blocked; remove and purge the pipes. No discharge indicates a faulty check valve, which should be renewed after first emptying the system.
(6) No pressure build-up, gas flowing from vent (post-Mod 917 only)	Vent valve in filler and vent valve not seating (due to ice or foreign matter under valve seat)	Tap the valve lightly and allow time to thaw. If the leak persists, depress the outer sleeve of the filler and vent valve to operate the vent valve, taking care not to depress the filler valve. If successful, top up the container. Renew the valve if the leakage continues.

TABLE 1 *(continued)*

Fault	Cause	Remedy
(7) Pressure builds up above 200 lb/in² and will not reduce to the normal operating level of approximately 150 lb/in² (pre-Mod 533) or 160 lb/in² (post-Mod 533) on breathing down. Indicated by discharge from excess pressure vent.	(a) Container underfilled (pre-Mod 917 or post-Mod 994 only)	(a) Empty the container and re-charge (*Cover* 1, *Sect.* 2, *Chap.* 2).
	(b) Faulty pressure control valve	(b) Renew the valve.
	(c) Pressure control valve frozen	(c) Allow the valve to thaw and ensure that the filler and vent valve is not leaking. Empty the container and re-charge. A leaking filler and vent valve must be renewed.
During operation		
(8) Persistent cross-feeding taking place at the two-way check valve. Indicated by high differential between the two system pressures (pre-Mod 917 only).	(a) Fault in the electrical indication	◀ (a) Refer to A.P. 101B-1202-1B, Cover 2, Sect. 7, Chap. 9. ▶
	(b) Container overfilled, resulting in loss of stabilization	(b) Empty the container and refill to the capacity limit (*Cover* 1, *Sect.* 2, *Chap.* 2).
	(c) Leakage in piping	(c) Trace the leak and remedy.
	(d) Faulty two-way check valve	(d) Renew the valve.

necessary with either soft or distilled water. *On no account must any other type of lubricant be used.*

Replenishing the system

43. Instructions for charging a container with liquid oxygen and the procedure for removing and installing a package unit on post-Mod 917 aircraft are contained in Cover 1, Sect. 2, Chap. 2.

Emptying the system

General

44. A container can be emptied by attaching a special adapter to the system filler and vent valve and allowing the liquid to drain off under its own pressure. To avoid possible injury and to minimize the risk of fire or explosion, the discharging gas should be directed away from personnel and not towards the ground. Reference should ◀ be made to A.P. 107D-0001-1 for the ▶ safety precautions to be observed when emptying a liquid oxygen system. Owing to the type of filler and vent valve fitted, the emptying procedures for pre- and post-Mod 917 aircraft differ; both procedures are detailed in the following paragraphs.

Pre-Mod 917 aircraft

45. To empty a container on pre-Mod 917 aircraft, proceed as follows:-

Caution...
During the following procedure it is necessary to blank off the charging vent. Care should be taken to ensure that the correct vent is blanked, i.e., that annotated CHARGING VENT AND OVERFLOW *on fig 2. Under no circumstances should the excess pressure vents be blanked off.*

(1) Attach a suitable length of hose to an emptying adapter, Ref No. 6C/3038.

(2) Remove the cap from the filler and vent valve.

(3) Screw the adapter complete with hose onto the filler and vent valve, turning the adapter slowly in a clockwise direction until gas can be heard emitting from the container vent.

(4) Allow the pressure to drop sufficiently to permit safe fitment of a rubber bung (held manually if possible) over the charging vent.

(5) Finally screw up the emptying adapter to its limit and allow the liquid, which rapidly turns to gas upon contact with the atmosphere, to drain off under its own pressure.

(6) When the container is empty, remove the rubber bung and the emptying adapter and refit the cap on the filler and vent valve.

Post-Mod 917 aircraft

46. To empty the package unit fitted on post-Mod 917 aircraft, proceed as follows:-

Caution...

(1) It is important to ensure that adequate ventilation is provided if the emptying procedure is to be performed in an enclosed bay. During emptying, oxygen is discharged at an extremely high rate and lack of ventilation may result in clothing or equipment becoming impregnated with oxygen.

(2) Ensure that the vent pipeline is not *blanked off or obstructed in any way before commencing the emptying procedure.*

(1) Attach a suitable length of hose to an emptying adapter, Part No. BOC 804717.

(2) Remove the cap from the filler and vent valve.

(3) Fit the adapter complete with hose to the filler and vent valve.

Note...
The flow of liquid, which rapidly turns to gas upon contact with the atmosphere, commences immediately the emptying adapter is engaged with the bayonet fitting of the filler and vent valve.

(4) Allow the liquid to drain off under its own pressure.

(5) When the container is empty, remove the adapter and refit the cap on the filler and vent valve.

Exercising a regulator

47. It is possible for a regulator to become sluggish after a period of disuse (about three days or more), in which case a system test may indicate that the regulator is faulty. Before condemning the regulator, however, the following procedure should be performed:-

(1) With the oxygen supply valve on the regulator set to ON, the emergency toggle switch central and the air inlet shutter at NORMAL, connect a personal component of the personal equipment connector (PEC) to the seat component and connect a suction tube, Ref No. 6C/1015, or a mask, to the low pressure oxygen outlet hose of the personal component.

Note...
As the suction tube terminates in a quick-release plug, a suitable locally-manufactured adapter is required to connect it to the bayonet socket on the PEC oxygen hose.

(2) Using the suction tube or mask to apply suction, exercise the regulator by applying at least six heavy breathing cycles.

(3) Set the air inlet shutter to 100% OXYGEN and repeat operation (2).

(4) Return the air inlet shutter to NORMAL and remove the suction tube or mask and the personal component of the PEC. Fit the dust cover on the PEC.

Pipe lagging

48. On pre-Mod 917 aircraft, a number of ⅜ in. dia pipes installed above the floor in the radio bay are lagged to prevent frosting and subsequent condensation when a heavy demand is made on the system. The lagging, which is staple roving cloth, is glued to the piping by Evostick 528 (Ref No. 33C/9436947) and wrapped to a radial thickness of ⅜ in.; nylon tape (1 in. wide) is then wrapped around the cloth and the ends of both cloth and nylon bound with glass thread and sealed with Bakelite resin 17449 (Ref No. 33C/1499). Other pipes, ½ in. dia, are lagged with a single layer of tape, half over-lapped, and finished off at the ends in the same manner as the staple roving cloth.

System leak test

General

49. During and immediately after charging, frosting takes place on the joints and unlagged piping in the radio bay (pre-Mod 917) or on the components and piping of the package unit (post-Mod 917). Once the system has settled down, however, the frost should have dispersed from all but two small local areas where the vent pipe and the check valve are connected to the container on post-Mod 917 aircraft. Subsequent local frosting at any other point usually indicates a leak; this can be confirmed by wiping the suspected area and observing a fresh formation of frost. A formation of frost on either of the outlet pipes from the check valve when no demand is taking place usually indicates a faulty check valve.

50. Leaks in the supply line to the cabin may not be easily detected, in which case a bubble test, using a pure soap solution, should be effected. All traces of the solution must be removed after the test. If there are no signs of leakage in any part of the system, the loss may be due to faulty container insulation.

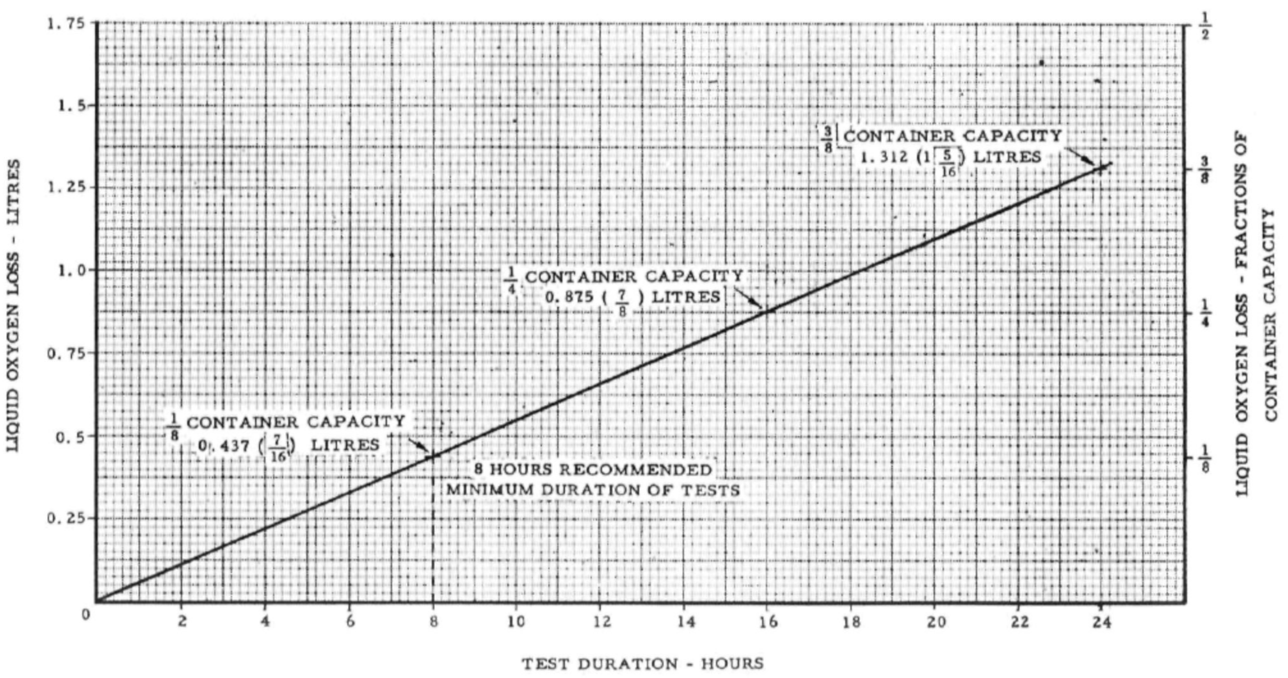


Fig. 6. **Leak test graph (pre-Mod 917)**

Test procedure

51. This test is applicable to both the pilot's and observer's portions of a pre-Mod 917 system, and may be effected on either portion separately or both portions simultaneously as desired. Testing of a post-Mod 917 system may be effected with the package unit installed and connected to the aircraft system, with the package unit installed but disconnected from the aircraft system or on the package unit alone when in the servicing bay; the permissible leak rate is the same in each case. Irrespective of the aircraft modification standard, an electrical supply will be required for operating the contents gauging system, and the oxygen supply valve on both regulators in the cabin should be set to OFF for the duration of the test unless, on post-Mod 917 aircraft, the package unit is disconnected from the aircraft system.

Note...
When performing this test on a package unit in a servicing bay remote from the aircraft, leakage may be determined on a weight loss basis instead of by reference to a contents gauge indicator.

(1) Check the contents of the container on the contents gauge indicator. If the container is less than ½ full (pre-Mod 917) or less than ⅜ full (post-Mod 917), it must be re-charged with liquid oxygen and a minimum settling period of two hours allowed before commencement of the test.

(2) Note the contents of the container and the time at the commencement of the test.

(3) Allow the system to remain pressurized for a protracted period.

Note...
The duration of the test may be of any reasonable length within the scope of the graph produced in fig 6 (pre-Mod 917) or fig 7 (post-Mod 917). For ease of reading a fractionally graduated contents gauge indicator, however, the

points at 8 hours, 16 hours and 24 hours are recommended for pre-Mod 917 aircraft and the points at 10.1 hours, 20.2 hours and 30.3 hours are recommended for post-Mod 917 aircraft.

(4) Note the contents of the container and the time at the termination of the test.

Note...
To obtain an accurate reading, the recommended minimum duration of the test is 8 hours.

(5) From operation (2) and (4), ascertain the duration of the test in hours and the loss of liquid oxygen either in litres or as a fraction of container capacity, according to the type of contents gauge indicator fitted.

(6) Transpose these results onto the graph given in fig 6 (pre-Mod 917) or fig 7 (post-Mod 917). If the point falls on or below the curve, the system is satisfactory; if the point falls above the curve, excessive leakage is indicated.

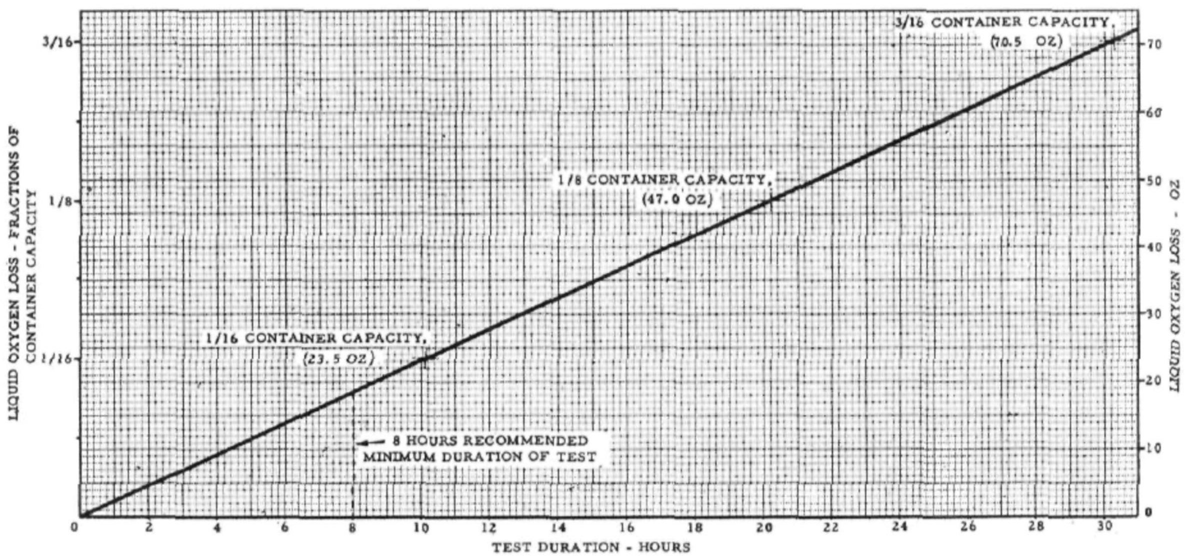


Fig. 7. Leak test graph (post-Mod 917)

(7) If applicable, set the oxygen supply valve on each regulator to ON and lock with 22 s.w.g. tinned copper wire *on completion of the test.*

REMOVAL AND INSTALLATION

Flexible oxygen hose – removal *(fig 8)*

52. To remove a flexible hose from the aircraft portion of either the pilot's or observer's personal equipment connector (PEC), proceed as follows:-

Note...
If the flexible hose is removed for any reason, it must be scrapped, since damage to the internal laminates is unavoidable during the removal process.

(1) Slacken the hose clip **4** and remove the hose connection **8** from the 90 deg hose connector.

(2) Remove the bolts **7** securing the 90 deg hose connector **5** to the aircraft structure.

Note...
It may be advisable to perform operations (1) and (2) in the reverse order, owing to inaccessibility of the hose connection.

◀(3) Disconnect the ejection release rod or cable **3** at its connection to the aircraft portion of the PEC **2**.▶

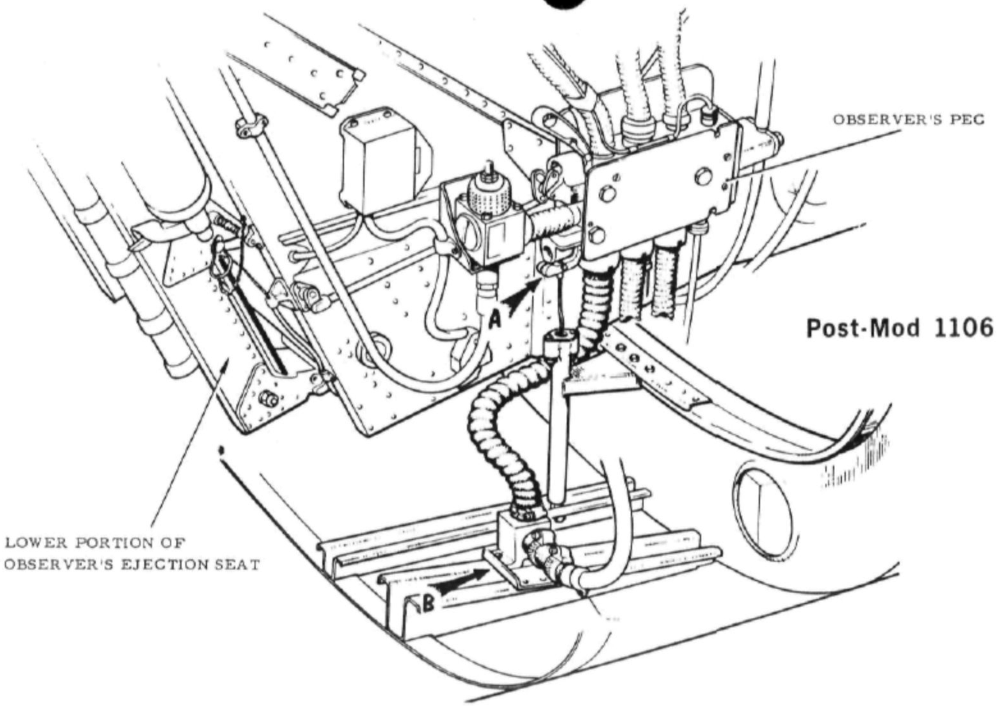
(4) Disconnect the aircraft portion **2** of *the PEC from the seat portion* **1**.

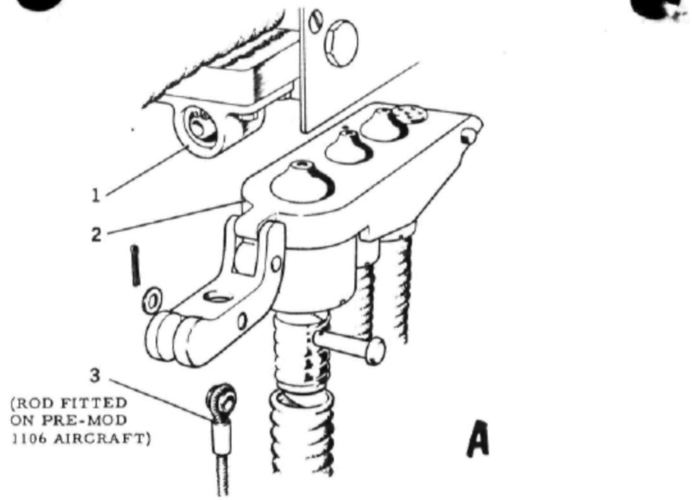
(5) Slacken the hose clip **6** and remove the 90 deg hose connector **5** from the hose.

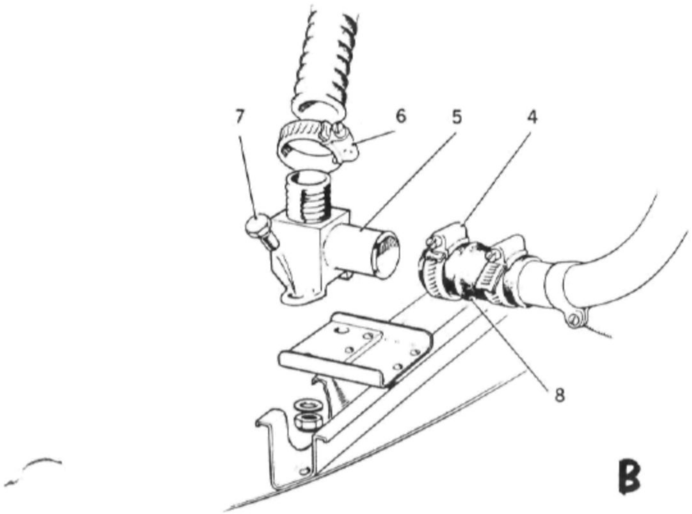
(6) Remove the flexible hose from the aircraft portion of the PEC; discard the hose.

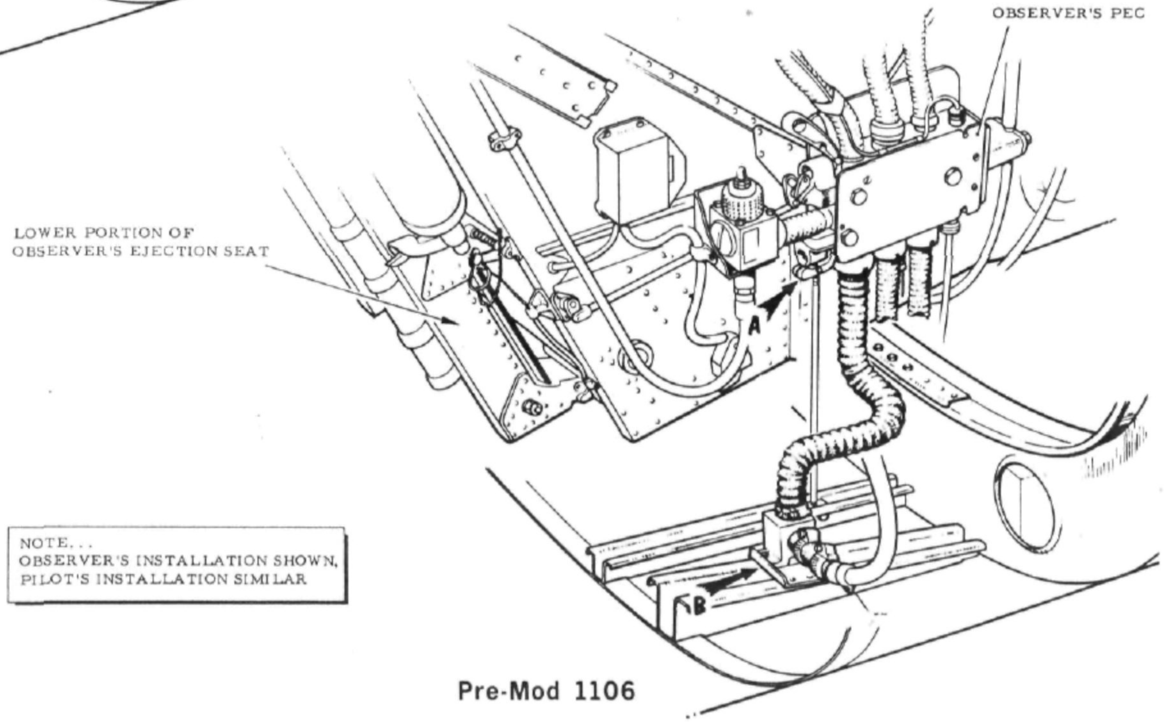
Flexible oxygen hose – installation

53. In general, the installation of a new flexible oxygen hose is mainly a reversal of the removal procedure described in the









NOTE...
OBSERVER'S INSTALLATION SHOWN,
PILOT'S INSTALLATION SIMILAR

Fig. 8. Flexible oxygen hose – removal
◀ Mod 631 and 1106 incorporated ▶

preceding paragraph; particular attention should be given to the following:-

(1) The hose must be secured onto the threaded portions of the end fittings for the full length of the tapered thread.

(2) The body of the hose must not be twisted or kinked; torque should only be applied to that end of the hose which is being screwed on to the end fitting.

(3) Lubricate the hose with a light application of silicone grease, XG-315, during assembly.

Oxygen regulators

54. The pipe carrying the oxygen supply to the regulator is secured to the regulator by an adapter, Ref No. 6D/1647. When fitting this adapter to a replacement regulator, the threads should be lightly smeared with thread sealant, ZX-22. *The use of any other type of sealant is prohibited.*