

Chapter 10 OXYGEN SYSTEM
(completely revised)

LIST OF CONTENTS

DESCRIPTION	Para.
<i>Introduction</i>	1
<i>Main system</i>	
<i>General information</i>	2
<i>Liquid oxygen container</i>	3
<i>Fill and vent valve</i>	4
<i>Contents gauge indicators</i>	5
<i>Check valve</i>	6
<i>Isolating valve</i>	7
<i>Demand regulator...</i>	8
<i>Personal equipment connector (P.E.C.)</i>	9
<i>Remote magnetic indicator</i>	10

	Para.
<i>Low pressure switch</i>	11
<i>Stabilized replenishing circuit</i>	
<i>General information</i>	12
<i>Replenishing and stabilizing</i>	14
<i>Gas generation</i>	
<i>Pressure build-up</i>	16
<i>Pressure venting</i>	17
<i>Economizer circuit</i>	18
<i>Pressure relief</i>	19
<i>Emergency system</i>	
<i>General information</i>	20
<i>Selection</i>	21
<i>Supply upon ejection</i>	22

	Para.
<i>Demand regulator...</i>	23

SERVICING

<i>General information</i>	24
<i>Replenishing the system</i>	25
<i>Topping up the system</i>	26
<i>Emptying the system</i>	27

REMOVAL AND ASSEMBLY

<i>Liquid oxygen container</i>	
<i>Removal</i>	28
<i>Assembly...</i>	29

LIST OF TABLES

	Table
<i>List of components</i>	1

LIST OF ILLUSTRATIONS

	Fig.
<i>Arrangement of system</i>	1
<i>System diagram</i>	2

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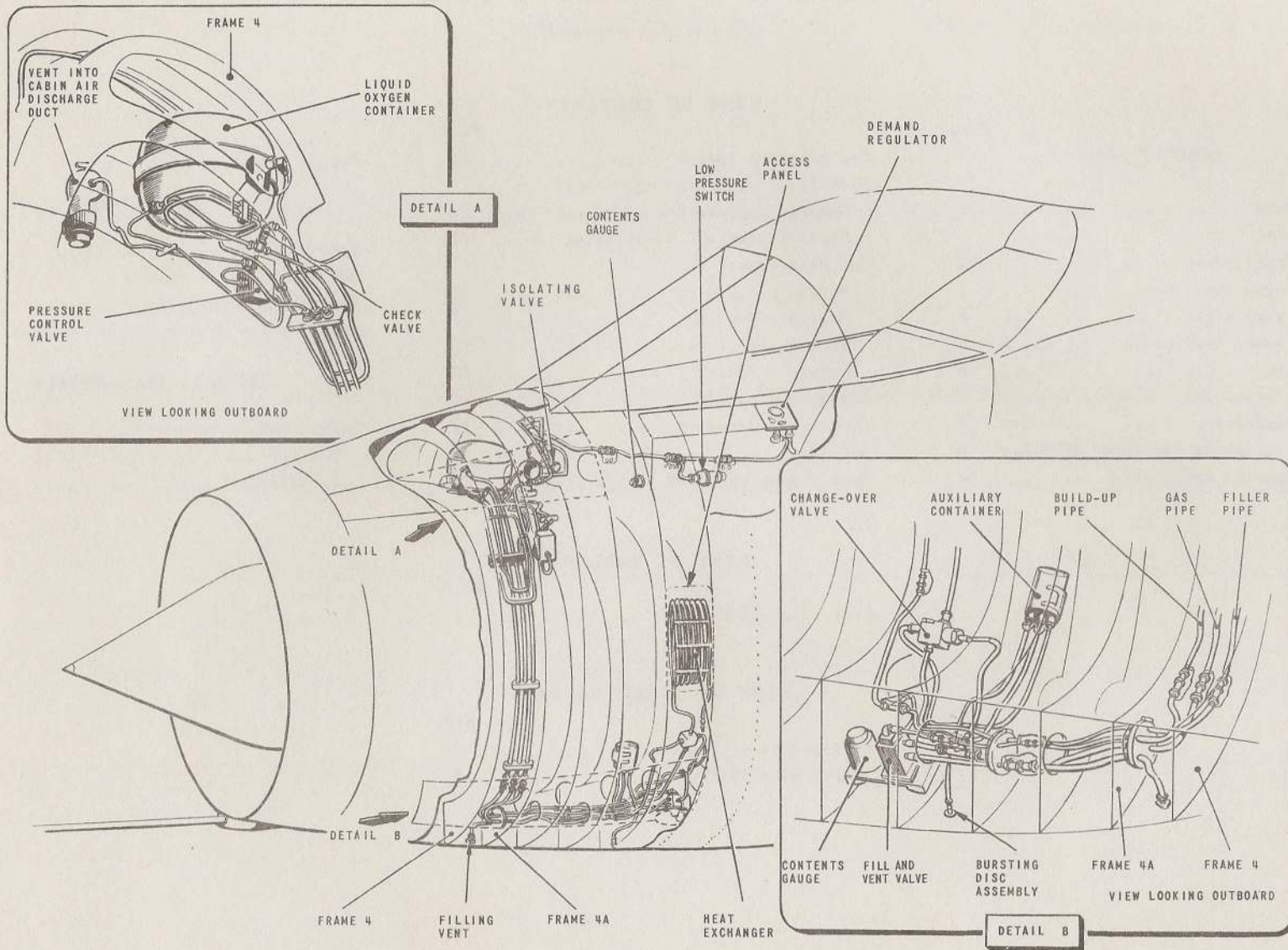


FIG. 1. ARRANGEMENT OF SYSTEM

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◀ PRESSURE SWITCH ADDED ▶

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DESCRIPTION

Introduction

1. Both systems (main and emergency) are the pressure demand type used with a face mask or partial pressure helmet. Oxygen for the main system is stored in liquid form in a 3½-litre container in the forward equipment bay and is vaporized by transfer of ambient heat to supply the demand regulator mounted on the starboard console. A low-pressure pipe conducts oxygen from the regulator to the personal equipment connector (P.E.C.) and a flexible pipe connects the P.E.C. to the pilot's mask. A 70-litre emergency oxygen cylinder and a demand regulator are mounted on the ejection seat for use if the main system fails or when the pilot abandons the aircraft. Replenishing instructions are given in Sect.2, Chap.2.

MAIN SYSTEM

General information (fig.1)

2. The aircraft installation comprises a single container liquid oxygen system (A.P.1275G, Vol.1, (2nd Edn.) Part 1, Sect.3), with a stabilized replenishment circuit. Most of the equipment and piping is installed between frames 3 and 8 on the port side of the fuselage within the cavity formed by the duct skin and fuselage skin, all being accessible behind detachable panels (Sect.2, Chap.4). Container contents are indicated on two gauges, one near the filling connection and one in the cockpit (Sect.1, Chap.1).

Liquid oxygen container

3. The 3½-litre capacity liquid oxygen container, fitted in the forward equipment bay, comprises three concentric stainless steel shells, the space between the middle and outer shells being highly evacuated. The inner shell is perforated and this, in conjunction with the middle shell, constitutes the electrical capacitor for the contents-indicating system.

Fill and vent valve (fig.2)

4. The fill and vent valve, accessible behind access panel 6P, is used to fill the liquid oxygen container. The inlet connection of the valve is protected by a screwed cap which must be removed before the dispenser hose can be connected. The valve is an assembly comprising a fill valve and a vent valve connected in tandem by a spindle. Connection of the dispenser hose automatically opens the fill valve, closes the balance line from the pressure control valve, and connects system pressure to atmosphere. When the dispenser hose is disconnected the fill valve closes, the balance line is connected to the gas line, and the vent valve closes. This arrangement ensures that the system is never pressurized when filling takes place.

Contents gauge indicators

5. Two contents gauge indicators are fitted; one is next to the fill-and-vent valve (access panel 6P) for use when servicing, and the other is on the starboard instrument panel, for use by the

pilot. The indicators are calibrated 0-¼-½-¾-F, and at the top and bottom ends of the scale are red failure arcs to which the pointer moves if there is a capacitance or power failure respectively. The indicator adjacent to the fill-and-vent valve is fitted with a cursor and the lining up of the pointer with the cursor during filling of the system indicates that the filling operation is complete and the filling hose can be disconnected.

Check valve

6. The check valve, screwed on to the container, consists of a free-moving poppet valve functioning as a non-return valve to control the supply of liquid oxygen to the breathing system. If pressure on the breathing side of the check valve exceeds that in the container the valve closes to check the supply of liquid oxygen into the system.

Isolating valve

7. The isolating valve, fitted between frames 6 and 7 on the starboard side of the cockpit, is intended for ground servicing use to enable the regulator to be removed without losing oxygen from the system. The valve must always be locked in the OPEN position using 22 s.w.g. locking wire, D.T.D.189.

Demand regulator

8. A demand and inflation regulator is fitted on the starboard console. The regulator has three manual controls, these are the supply valve ON-OFF control, (normally wire-locked in the ON

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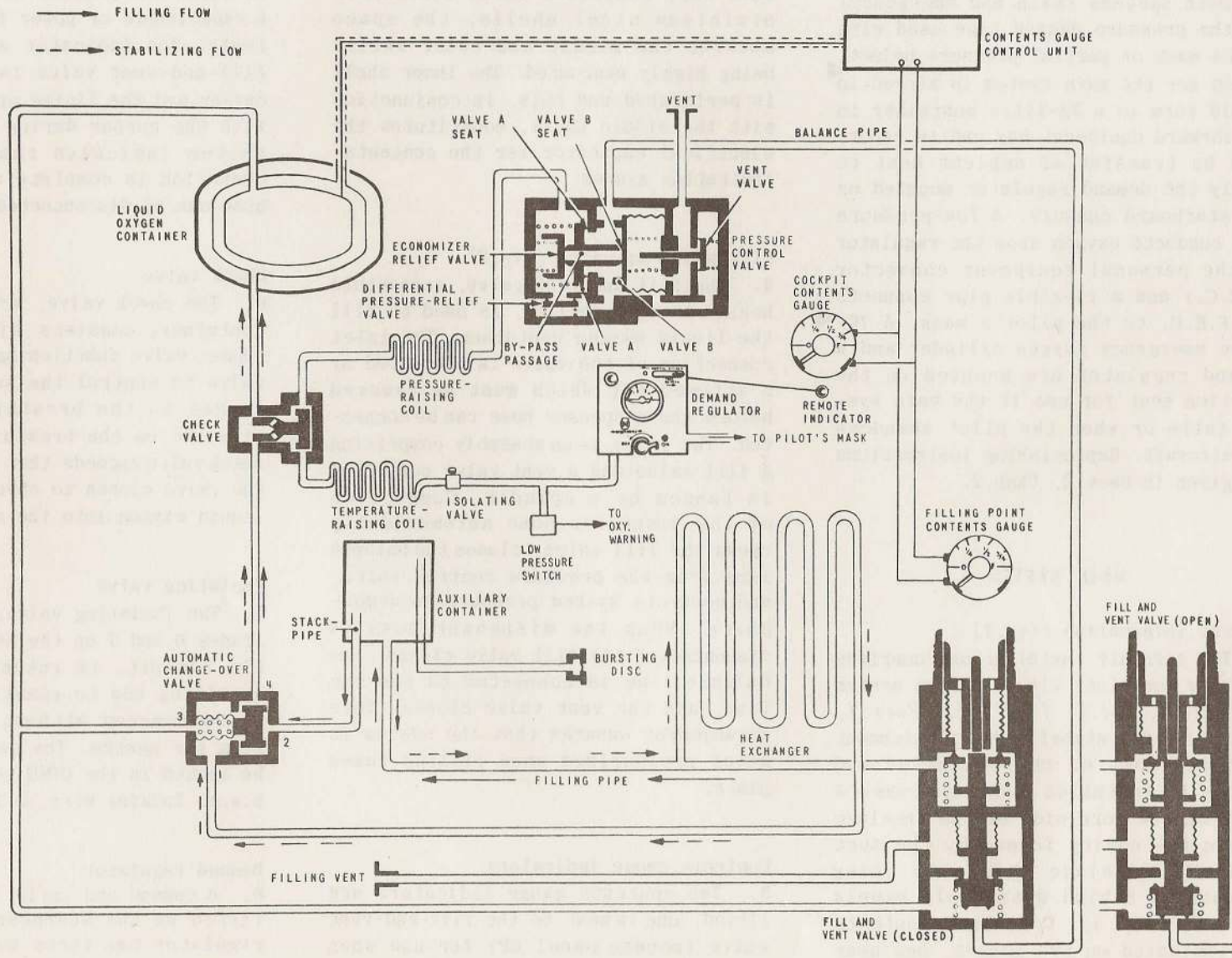


FIG. 2. SYSTEM DIAGRAM

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position), the NORMAL OXYGEN - 100% OXYGEN air inlet shutter control, and the EMERGENCY push button control with a mask press-to-test facility incorporated. A 0-500 lb/in² gauge shows the pressure at which oxygen is being supplied to the regulator. A magnetic indicator operates each time oxygen flows from the regulator and a 3-pin plug provides a connection for the remote indicator (*para.10*); the whole circuit is suppressed to prevent interference with the aircraft radio services.

Personal equipment connector (P.E.C.)

9. The P.E.C. consists of three main parts:- the aircraft component, seat component and personal component. When the pilot connects his personal component to the seat component, which is bolted to the starboard side of the seat pan, the oxygen system is completed. It is important that the dust cover, stowed on the starboard side of the seat pan, is always fitted to the seat component when the personal component is disconnected. The P.E.C. is fully described in A.P.109A-0001-1.

Remote magnetic indicator

10. A magnetic indicator above the flight instrument panel provides an additional indication of oxygen flow through the regulator. The indicator, in common with the indicator in the regulator, is in electrical circuit with contacts in the regulator, the contacts opening and closing in response to movement of a diaphragm during each breathing cycle.

Low pressure switch

11. The low pressure switch in the oxygen delivery line to the regulator, connects an electrical supply to the OXY warning lamps of the S.W.P. when the pressure falls below 128 to 125 lb/in².

Stabilized replenishing circuit

General information

12. It is essential that, for immediate stable operation of the system after replenishing, liquid oxygen in the aircraft container is rapidly raised in temperature from the ground storage temperature to the system storage temperature. The stabilizing system does this, by passing pressurized gaseous oxygen through the liquid content of the container; the gas, in condensing, gives up heat to the liquid thus raising its temperature.

13. The system consists of a non-insulated auxiliary container, an automatic change-over valve, and a heat exchanger, inserted in the replenishing pipeline of the main system.

Replenishing and stabilizing (*fig.2*)

14. Connecting the tanker hose to the fill and vent valve displaces the valve spindle to open the filling pipe to the auxiliary container, close the balance circuit and vent the main container to atmosphere. Liquid oxygen at 50-55 lb/in² pressure enters the auxiliary container and overflows through the stackpipe to the change-over valve which operates to allow fluid to enter the

main container. When the tanker hose is disconnected, the fill and vent valve spindle returns to its closed position and the change-over valve operates to isolate the stackpipe from the system. Shortly afterwards the fluid in the auxiliary container boils and builds up pressure which expels the remaining liquid through the filler pipe to the heat exchanger. In the heat exchanger the liquid evaporates rapidly and passes in gaseous form through ports 1 and 4 of the change-over valve, and through the check valve to the bottom of the main container and bubbles up into the liquid.

15. A bursting disc will rupture at 325 lb/in² if the pressure in the auxiliary container should rise excessively. Possible causes of excessive pressure are ice blockage in the auxiliary container or malfunctioning of the relief valve in the pressure control valve.

Gas generation

Pressure build-up (*fig.2*)

16. Liquid oxygen, under the effect of the gravity head in the main container, bleeds through the check valve into the pipes to the pressure control-valve and pressure regulator, where it evaporates, by the transfer of ambient heat, and begins to build up pressure. The pressure is transmitted through the open valve A in the pressure control valve, the balance pipe, and the fill and vent valve to the top of the container, and to the regulator through the temperature-raising coil. As pressure increases,

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the bellows in the control valve is compressed until, at 160 lb/in², valve A closes under the influence of its spring and isolates the balance pipe from the pressure-raising coil. Pressure continues to increase in the latter however and, when it exceeds the combined effect of pressure above the surface of the liquid in the container and the gravity head of the liquid, the check valve closes to prevent further liquid entering the pressure-raising coil. The supply pressure is thus controlled at 160 lb/in² and, if it falls below this value due to pilot demand, the check valve opens, with each inhalation, to admit a small quantity of liquid into the pressure-raising coil.

Pressure venting

17. When no demand is made on the system the transfer of ambient heat will continue to evaporate oxygen in the container, the resultant increase in balance pressure being matched in the pressure-raising coil by slight liquid leakage through the check valve. The continuing increase in balance pressure compresses the bellows in the control valve until, at 200 lb/in², the vent valve is lifted from its seat allowing excess pressure to relieve to atmosphere.

Economizer circuit

18. The reduction in balance pressure effected by leakage of liquid through the check valve during demand, would normally be insufficient to allow the vent valve (*para.17*) to reseal, resulting in constant wastage. To eliminate this wastage the economizer relief valve

is incorporated. During pressure increase (*para.17*) the bellows is sufficiently compressed, at 170 lb/in², to lift valve B from its seat and allow balance pressure to be applied to one side of the economizer relief valve through the by-pass passage. As long as balance pressure and supply pressure are equal, the relief valve spring holds the valve closed. Immediately a demand is placed on the system however, the valve opens and gaseous oxygen from the balance pipe flows into the pressure-raising coil to help satisfy the demand and also reduce balance pressure below its venting value.

Pressure relief

19. If at any time when the system pressure is above 160 lb/in² a heavy demand is placed on the system and then suddenly removed, a rapid increase in system pressure will occur, due to the evaporation of excessive liquid which has entered the pressure-raising coil. If this pressure exceeds balance pressure by 50 lb/in² the differential pressure relief valve opens to balance the pressures.

EMERGENCY SYSTEM

General information

20. A demand emergency oxygen system is installed on the starboard side of the ejection seat and is connected to the P.E.C. The system provides an emergency oxygen supply capable of meeting both pressure jerkin and breathing requirements of the pilot in the event of failure of the main supply or when

abandoning the aircraft. The equipment is described in A.P.1275G, Vol. 1, (2nd Edn.) Part 2, Sect. 4, Chap. 11.

Selection

21. If the main system fails, the emergency supply is made available by pulling a yellow-and-black striped knob at the front of the ejection seat.

Supply upon ejection

22. When ejection occurs the emergency system is automatically brought into use by a trip mechanism on the back of the ejection seat. The P.E.C. components are separated by a static line and a non-return valve in the seat portion prevents loss of emergency oxygen to the atmosphere.

Demand regulator

23. A demand emergency oxygen regulator is mounted on the starboard side of the ejection seat and operates in conjunction with a 70-litre emergency oxygen cylinder.

SERVICING

WARNING

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

Oil and grease combine explosively with undiluted oxygen. To prevent injury to personnel or equipment, do not use these materials on or near the oxygen system.

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General information

24. The servicing necessary to maintain the system in an efficient working condition consists mainly of keeping the installation free from oil, grease and moisture, checking that the container is full and testing the system for leaks. An examination of the system should also be made for damage and security and to check that the flexible hose to the P.E.C. is fitted correctly. The emergency cylinder should be checked to ensure that the shear-wire is intact and the lever undisturbed; if the wire is found broken and the lever disturbed refer to A.P.1275G, Vol.1, (2nd. Edn.) Part 2, Sect.4, Chap.11 for resetting instructions. The testing of standard components is also given in A.P.1275G, Vol.1, The precautions to be observed, and protective equipment to be used, when handling liquid oxygen, are given in A.P.4765A, Vol.1 and 6.

Replenishing the system

25. The replenishing procedure is described in Sect.2, Chap.2.

Topping up the system

26. Topping up the system is the same as for replenishing with the following exceptions:-

- (1) The bowser liquid-valve must be OPEN before the bowser is connected to the system. If this is not done, pressure surge may cause failure of the bowser rupture discs.

- (2) Gas will be discharged through the filler vent (frames 4 - 4A port) when the bowser connection to the system is made.

- (3) During filling, the contents gauge readings will fall before starting to rise, and topping up will often take longer than completely filling the system from empty.

Emptying the system

27. If it is necessary to break down the system at any point before the isolating valve all liquid oxygen must be removed from the system by either of two methods:-

Method 1

This method is slow and would be used only if the system contents were low.

With the personal component connected to the P.E.C., select EMERGENCY on the regulator and wait until oxygen ceases to flow.

Method 2

Observe the precautions detailed in A.P.4765A, Vol.1 and 6.

- (1) Blank off the filler vent (between frames 4 and 4A port) with an expanding plug.

- (2) Remove access panel 6P.

- (3) Fit to the fill and vent valve an

emptying cap Ref.No.6C/3038 to which has been fitted about 18 in. of metallic hose and a stop valve of at least $\frac{1}{4}$ in. bore. Keep the stop valve closed.

WARNING

The operator must keep well clear of the filler vent (sub-para.(1)) as the plug is subjected to system pressure and may be blown out followed by spillage of oxygen.

- (4) Direct the stop valve towards the ground, away from personnel and equipment and open the stop valve. Refer to A.P.4765A, Vol.1 and 6, Sect.1, Chap.1.

- (5) When the system is empty remove the vent plug and emptying cap assembly and replace the sealing cap on the fill and vent valve.

Note...

If, during the emptying operation, the vent plug is dislodged, system pressure will be lost and the system will slowly empty by gravity.

REMOVAL AND ASSEMBLY**Liquid oxygen container****Removal**

28. To remove the liquid oxygen container:-

- (1) Empty the oxygen system (para.27).

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(2) Open access panel 3 (Sect.2, Chap. 4).

(3) Disconnect the fill and vent valve, and check valve pipes, and the contents gauge control unit cable, at the container.

(4) Blank off the pipe ends and connections.

(5) Unscrew the two ¼ in. B.S.F. bolts securing the container support bracket to frame 4.

(6) Manoeuvre the container to disen-

gage the two spigots, on the base of the container, from the spigot housings on frame 4A and remove the container.

Assembly

29. Installing the container in the aircraft is the reverse of the removal procedure.

TABLE 1

List of components

Component	Ref. No.	Quantity	A. P. Reference
Container, liquid oxygen, 3½-litre, Mk.6	6D/2159	1	1275G, Vol. 1, (2nd Edn) Part 3, Sect. 3, Chap. 1
Container, stabilizing	26DK/11532	1	
Cylinder, oxygen, 70-litre	6D/2794	1	1275G, Vol. 1, (2nd Edn) Part 2, Sect. 4, Chap. 11F
Regulator, demand and inflation	6D/2671	1	107D-0201-1, Chap. 6
Regulator, demand, emergency oxygen	6D/2285	1	1275G, Vol. 1, (2nd Edn) Part 2, Sect. 1, Chap. 11A
Valve, fill and vent	6D/2161 or 6D/3455	1 1	107D-0502-1, Chap. 1
Valve, pressure control	6D/2160 or 6D/2699	1 1	107D-0502-1, Chap. 2
Valve, change-over	6D/2319	1	107D-0502-1, Chap. 4
Valve, relief	26DK/11554	1	
Valve, check	6D/2162	1	107D-0502-1, Chap. 3
◀ Valve, isolating, Type 1 ▶	6D/2244775 ▶	1	107D-0500A-1, Chap. 1
Gauge, oxygen contents	6D/2605	2	1275G, Vol. 1, (2nd Edn) Part 3, Sect. 2, Chap. 2
Control unit contents gauge, Type CMB2, Mk.3	6D/2248458	1	1275G, Vol. 1, (2nd Edn) Part 3, Sect. 2, Chap. 1
Switch, low pressure	6D/2764	1	1275G, Vol. 1, (2nd Edn) Part 2, Sect. 7, Chap. 3
Indicator magnetic	5CZ/6551	1	113F-0615, Chap. 1

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