PART 1 : SECTION 7

CHAPTER 3

PRESSURE-BREATHING EQUIPMENT

NOTE.—The use of pressure-breathing equipment without previous training, or the use of the Type J and Type M pressure-breathing mask without a pressure-waistcoat, is prohibited.

Introduction

1. The purpose of pressure-breathing equipment is to provide oxygen *under pressure*, in the absence or failure of a pressure cabin, at altitudes between 35,000 feet and 48,000 feet in addition to providing the normal oxygen supply up to 35,000 feet, usually supplied by the economizer system. It can be used up to 44,000 feet if no pressure cabin is available, and also up to 48,000 feet as an emergency measure in case of cabin failure. The equipment described has, in addition to a pressurized mask, an inflatable waistcoat which is kept at the same pressure as the mask when pressure-breathing is in use. The waistcoat acts as a reservoir for oxygen and performs a similar function to that of the economizer system, in addition to giving counter-pressure to the chest. Oxygen is supplied in the normal manner from the oxygen regulator. Oxygen economizers are still fitted for use as an alternative to pressure-breathing equipment. To enable the pilot to select, before flight, the appropriate system, a selector cock is fitted in the aircraft. As the connecting fitting on the pressure-breathing equipment is different from the connecting fitting used with the economizer system, the change-over of fitting is made by ground personnel when the selector cock is changed over and wire-locked in position.

Fig. 1. Pressure-Breathing Waistcoat and Mask.

Principles

2. Normally, the muscles of the chest are used to breathe in and are released to breathe out. If, however, extra pressure is applied to the inside of the lungs by using a pressure mask, this normal breathing process is reversed, and the chest muscles are relaxed during inhalation, and brought into use during exhalation. This forcible breathing can become tiring if a useful amount of pressure is used in the mask, and, therefore, in order to increase comfort, the pressure-breathing equipment has an inflatable waistcoat which is kept at the same pressure as the mask. This waistcoat (Fig. 1) covers the chest and abdomen making the pressure inside and outside the lungs equal and thus allowing almost natural breathing to continue. It is possible, however, in an emergency to use a pressure-breathing system without a counter-pressure waistcoat, accepting some loss of comfort

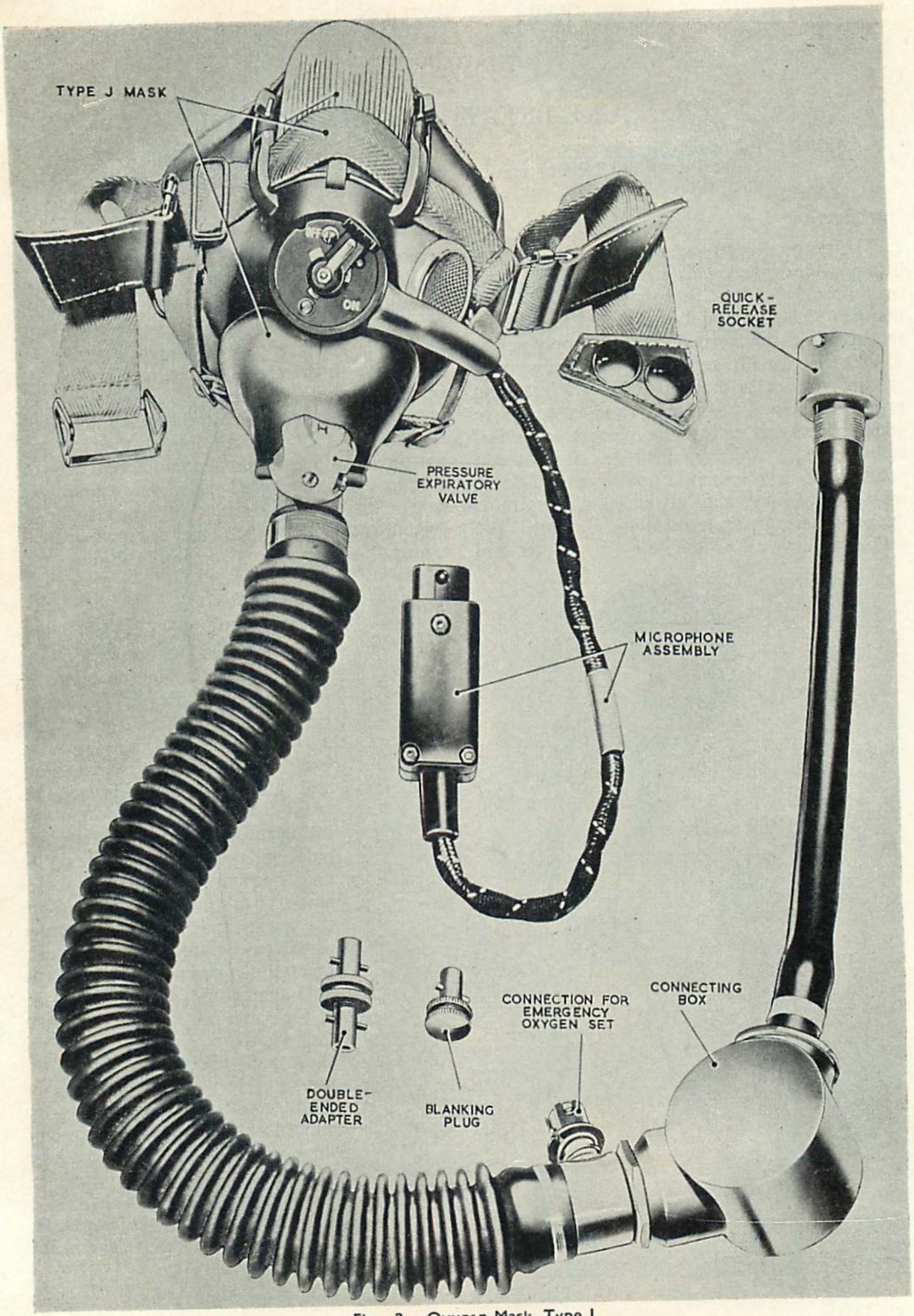


Fig. 2. Oxygen Mask, Type J.

(but see note at head of chapter). Some discomfort may be experienced when using the equipment for the first time, but this soon disappears provided that the breathing is relaxed and natural. Breathing too rapidly and too deeply must be avoided. Speech may be found to be somewhat difficult at first whilst using pressure, but this may be overcome by speaking from the diaphragm while breathing out.

Waistcoat

3. The waistcoat, which is obtainable in four sizes, is made of fabric, rubberized on one side. It is constructed in two layers, the rubberized surfaces of the fabric facing each other to form the oxygen compartment. The waistcoat is fastened at the front by a sliding fastener and final size adjustments are made by lacing on the inside of the back. Internal reeds prevent the waistcoat from bulging when inflated. It is important to have a good fit; if the jacket is too small, the oxygen reservoir will be too shallow; if it is too large, it will not exert pressure over the trunk, even when fully inflated. It should be chosen and fitted so that when the chest and waist are fully expanded, the uninflated waistcoat is close-fitting but does not restrict this expansion. The supply of oxygen enters the waistcoat through a flanged socket mounted on the outer layer of the waistcoat which is reinforced locally.

Oxygen Mask Type J

4. The mask illustrated in Fig. 2 is the Type J mask and is made in three sizes. It varies from the Type H mask in the following respects :—

(*a*) A spring-loaded outlet valve has been introduced.

(*b*) The strap harness has been redesigned.

(*c*) The nose-piece has been redesigned and includes a stiffening piece and wire frame.

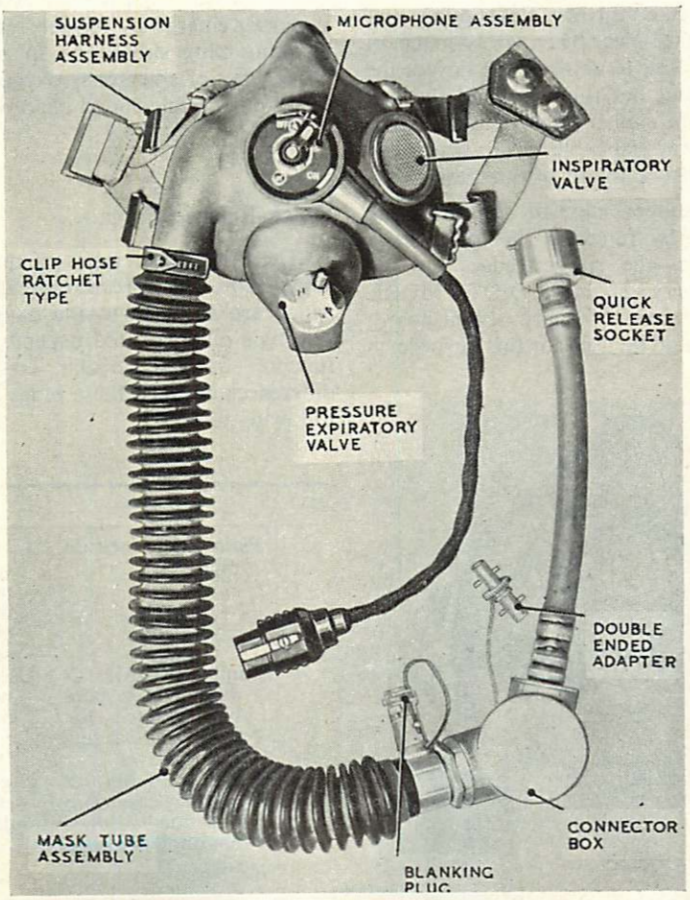


Fig. 3. Oxygen Mask, Type M.

5. **Outlet Valve.** The outlet valve is fitted with a knob on the outside, adjustable to three positions, Off (O), Low (L), and High (H). These settings correspond to 0, 5 inches, and 12 inches of water pressure in the mask and waistcoat. The Low and High positions are used at the higher altitudes and the Off position at all altitudes up to 35,000 feet cabin altitude. The Low and High positions are used for pressure-breathing, and the Off position for normal breathing.

Oxygen Mask Type M

6. The Type M mask (Fig. 3) has been designed to eliminate difficulties experienced with the Type J mask, which it will eventually replace. It is appreciably lighter in weight and more comfortable to wear. Two new components are introduced; a redesigned face-piece and suspension harness. Other components such as valves and the mask tube assembly are identical with those used with the Type J mask or so similar as to make further description unnecessary. The face-piece (Fig. 4) is made of pure latex rubber and is unlined. It covers the nose and mouth but not the chin, and the seal is formed by a thin rubber edge. Incorporated in the nose strip is a malleable metal, which can be adjusted to improve the fit of the mask.

Note.—If the rubber edge of the face-piece causes discomfort by touching the lower lip—a rare occurrence—the rubber edge may be trimmed back very slightly, NOT MORE THAN $\frac{1}{8}$ in. A pair of sharp, blunt-nosed, curved scissors should be used for this purpose.

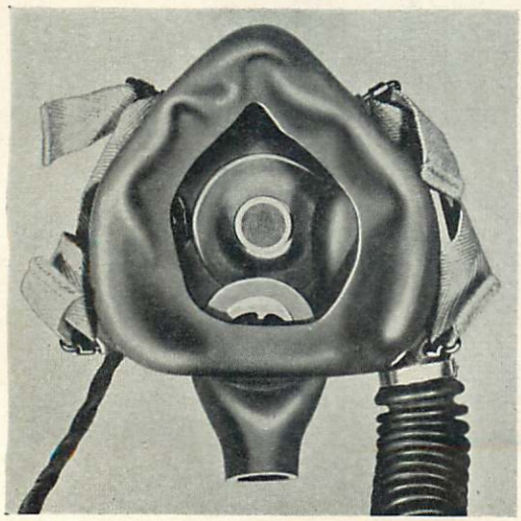


Fig. 4. Interior of Type M Mask.

Mask Tube Assembly

7. The mask tube assembly is integral with the mask and incorporates a T-piece box for connection of the assembly to the pressure waistcoat, a quick-release socket for connection to the oxygen supply, and a three-way piece for connection of an emergency oxygen set. In the T-piece box, oxygen from the regulator passes through two mushroom-type valves to the oxygen mask. It also passes via a spring-loaded valve to the waistcoat. When the T-piece is disconnected at the waistcoat, the spring-loaded valve closes under the action of its spring. When the emergency oxygen set is used the mushroom valves prevent any leak-back from the mask-tube into the waistcoat. Normally, when the wearer inhales, the oxygen supply is taken partly from the waistcoat, and partly from the oxygen supply tube through the mushroom valve. On exhalation the upper mushroom valve becomes seated and pressure builds up until released by the spring-loaded expiratory valve in the mask. When *no* emergency oxygen set is available, the blanking plug should be in position (Fig. 2). Later types of emergency oxygen sets require the use of the double-ended adaptor.

Quick-Release Plugs

8. There are three types of quick-release plug associated with pressure-breathing equipment which are attached to the oxygen supply tube. The type of plug fitted depends on the required function at a particular crew station. The differences between these plugs are shown in the following table.

MK.	DETAILS	FUNCTION
3	Plain quick-release plug.	Used on ejection seats* which are not vacated during flight and also on pilot's non-ejectable seat.
5	Similar to Mk. 3 quick-release plug but adapted for stowage in a cut-off valve.	Used on ejection seats which are vacated during flight.
6	Similar to Mk. 5 quick-release plug but fitted with a bayonet locking ring.	Used on non-ejectable crew seats and wander leads.

*See para. 9 (c).

Tests Before Flight

9. The following tests should be completed before flight :—

(*a*) Ensure that the low-pressure selector cock (for pressure-breathing equipment or economizer) is wire-locked in the pressure-breathing position, and that the correct oxygen supply fitting is attached to the main supply tube.

(*b*) Attach the T-piece (coupling box) on the mask tube assembly to the connecting flange on waistcoat, making sure that the connection has clicked into position.

(*c*) Connect the socket at the end of the mask to the main supply, noting that the correct fitting is used as follows :—

(i) *Non-Ejectable Seats.* Connections must be locked by bayonet ring after the quick-release connection is made.

(ii) *Ejection Seats.* Connection must be made by the quick-release plug and socket only, and *no locking ring should be on the seat tube connecting plug.*

(*d*) Connect the emergency oxygen set supply tube to the socket in the three-way piece. If there is no emergency oxygen set, the blanking-off plug must be inserted in the three-way piece.

10. The equipment should be checked as follows :—

(*a*) Inspect the mask to see that the inlet valve on the side, and the outlet valve below, are free from dirt. The inlet valve can be tested by holding the mask in position on the face, pinching the mask tube between the fingers, and then inhaling. If the valve is functioning correctly, breathing should be quite easy, and at the end of inhalation the valve should click shut smartly.

(*b*) Strap the mask on to the face, turn the outlet valve to High and breathe out forcibly to check whether or not leaks occur at the edge of the mask, and if necessary tighten the straps to eliminate leakage.

Note.—The small blanking-off plug should be in position in the three-way piece for this test.

(*c*) Turn oxygen flow to EMERGENCY, leaving the mask outlet valve on High. Pressure should then build up in the waistcoat, proving that the system is satisfactory. Return the regulator setting to Off after test. If there is no EMERGENCY setting on the regulator,

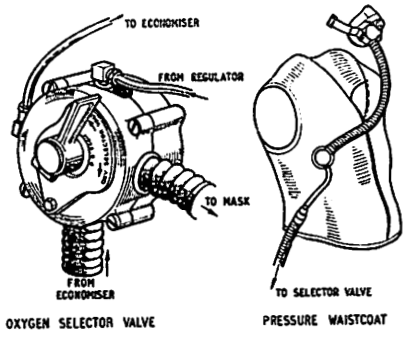
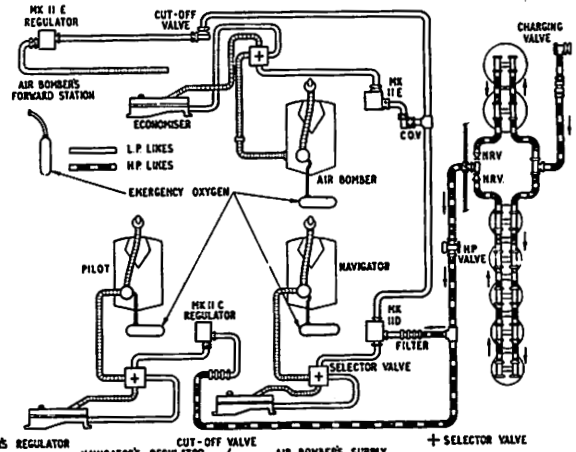
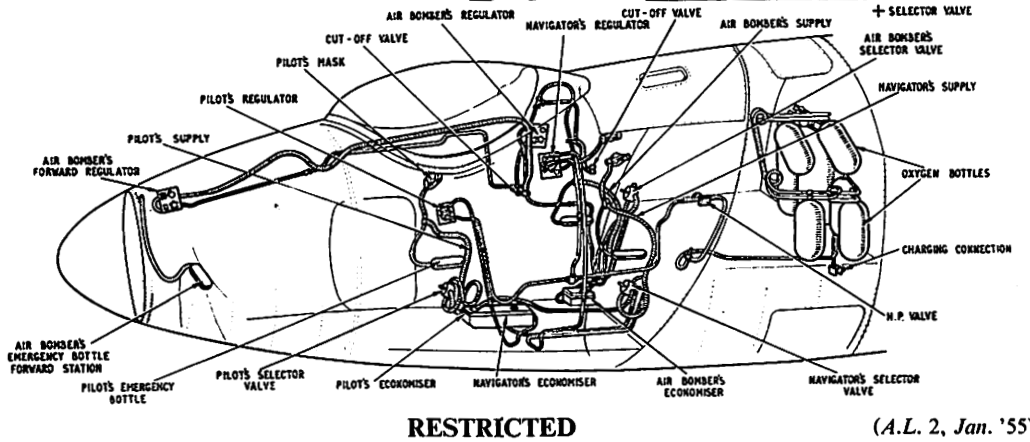


Fig. 5. Typical Pressure-Breathing System.





this test can be performed by turning to High *flow* and collapsing the corrugated mask tubing.

Use in Normal Flight

11. Pressure-breathing may be fitted in unpressurized aircraft, in which case the knob on the mask outlet valve should be turned from Off to Low at 35,000 feet and from Low to High at 40,000 feet. In practice however the equipment is usually fitted in pressurized aircraft only, where the cabin altitude should never exceed 35,000 feet except in an emergency such as cabin pressure failure. In such an event the knob should be turned direct to High from Off. The regulator Mk. 11 or Mk. 16 should be set to High.

12. The following instructions are applicable therefore only when the equipment is fitted in an unpressurized aircraft :—

(*a*) During ascent the knob is kept in the Off position.

(*b*) When a height of 35,000 feet is reached, the knob on the mask valve is turned 45° in a clockwise direction (as viewed from the front). The knob will move in slightly and a catch will engage to hold the knob in the 45° position. This is the Low position, and pressure should be felt building up in the waistcoat.

(*c*) On reaching 40,000 feet cabin altitude, the knob on the mask valve is turned a further 45°, and engaged in the High position. This setting should not be used below 40,000 feet, as it is unnecessary and uncomfortable at lower altitudes.

(*d*) During descent the knob should be turned to Low at 40,000 feet and Off at 35,000 feet.

13. **Regulator Settings.** The following regulator settings are to be made when pressure-breathing equipment is used (these instructions should be read in conjunction with A.M.F.O. 370) :—

(*a*) *Mk.* 10*A* Series.*

(i) Unpressurized aircraft : set at 10,000 feet above the aircraft altitude.

(ii) Pressure cabin aircraft when pressurized : set at 40,000 feet when the indicated aircraft altitude is 40,000 feet irrespective of the height indicated by the cabin altimeter.

(*b*) *Mk.* 11 *Series.*

(i) Cabin unpressurized : HIGH setting must be used from take-off.

(ii) Cabin pressurized : HIGH setting must be used when the *indicated aircraft altitude* is at or above 40,000 feet.

(*c*) *Mk.* 16 *Series.*

(i) Cabin unpressurized: NORMAL setting must be used up to 25,000 feet, and HIGH setting at and above 25,000 feet.

(ii) Cabin pressurized: NORMAL setting must be used. If the pressure cabin fails, the regulator will automatically change to HIGH when the cabin altitude reaches 30,000 feet.

Use in Emergency

14. **Emergencies.** If the waistcoat should become torn while at high altitude and therefore useless as an oxygen reservoir, it is necessary to disconnect immediately the oxygen line from the waistcoat and turn the oxygen flow to EMERGENCY, or as high as possible if there is no EMERGENCY setting, while descending to 30,000 feet aircraft altitude. A valve automatically closes the opening in the T-piece when the latter is disconnected from the waistcoat, so that there is a direct flow to the mask. In the absence of the oxygen reservoir, however, a higher oxygen flow is necessary. The automatic valve closure also acts as a safeguard against accidental disconnection of the coupling box from the waistcoat. The oxygen regulator must not be turned to NORMAL at heights at which oxygen is required.

Abandoning the Aircraft

15. **Fixed Seat.** If it is necessary to bale out while oxygen is being used, operate the emergency oxygen-set operating cable, and disconnect the quick-release oxygen connection from the aircraft supply, leaving the mask assembly attached to the waistcoat. If there is no emergency oxygen set, the oxygen in the waistcoat will last for a few breaths, especially if the pressure has been on. The oxygen is kept from flowing out of the waistcoat when the quick-release is disconnected by a non-return valve in the T-piece. The aircraft may then be abandoned in the manner outlined in Pilot's Notes for the aircraft type.

16. **Ejection Seat.** On ejection, all connections between the aircraft and the seat are severed automatically, while the occupant's emergency oxygen set is automatically turned on. When leaving the seat of the non-automatic type, it is only necessary to release the safety harness before pitching forward out of the seat. The remaining portions of the oxygen supply and intercom. leads will be disconnected from the pilot automatically.

Endurance

17. The oxygen endurance when using pressure-breathing equipment is the same for the Mk. 10A, Mk. 11, or Mk. 16 series regulators as with the economizer system. (See tables in Chapter 2, para. 21).