Chapter 2

PRESSURE-BREATHING EQUIPMENT

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INTRODUCTION

General

1. The use of pure oxygen with an ordinary oxygen mask will not enable full efficiency to be maintained in flight at altitudes above 38,000 ft. because under these conditions, the quantity of oxygen inhaled is insufficient for the proper functioning of the body.

2. By delivering the oxygen in the mask under a tolerable pressure, the body is supplied with sufficient oxygen to increase

the maximum operating height by approximately 4,000 ft. (with certain limitations on time, etc.) or by approximately 10,000 ft. for emergency use in the event of pressure cabin failure, providing that on loss of cabin pressure descent is commenced at maximum rate.

3. Pressure-breathing equipment consists of a special mask and an interconnected inflatable waistcoat, in both of which oxygen is maintained at a pressure above that of the surrounding atmosphere. At altitudes below that at which pressure breathing becomes necessary, the equipment performs a similar function to that of the Type H mask and economizer.

4. Other advantages of using pressure-breathing equipment are that inward mask leaks at high altitudes are prevented and the sensation of pressure imparted by the waistcoat is an assurance that the equipment is functioning correctly.

Principles

5. In normal breathing, the muscles of the chest are exerted to breathe in and relaxed to breathe out. If, however, extra pressure is applied to the inside of the lungs, the normal breathing processes are reversed, the chest muscles being relaxed during inhalation and exerted during exhalation.

6. This forcible breathing out can become tiring and therefore, for increased comfort, the pressure-breathing equipment includes in addition to a pressurized mask, an inflatable waistcoat which is kept at the same pressure as the mask. This waistcoat covers the chest and abdomen, equalizing pressures inside and outside the lungs, thus allowing more natural breathing.

LIMITATIONS

7. The equipment has certain limitations which can be summarized as follows.

Personnel at aircrew stations

Altitude limitations

8. Under normal flying conditions the waistcoat and pressure-breathing mask are used unpressurized in place of the Type H mask and economizer (i.e., up to 40,000 ft)..

9. At 35,000-40,000 ft. low-pressure breathing may be used to overcome any tendency to mask leak.

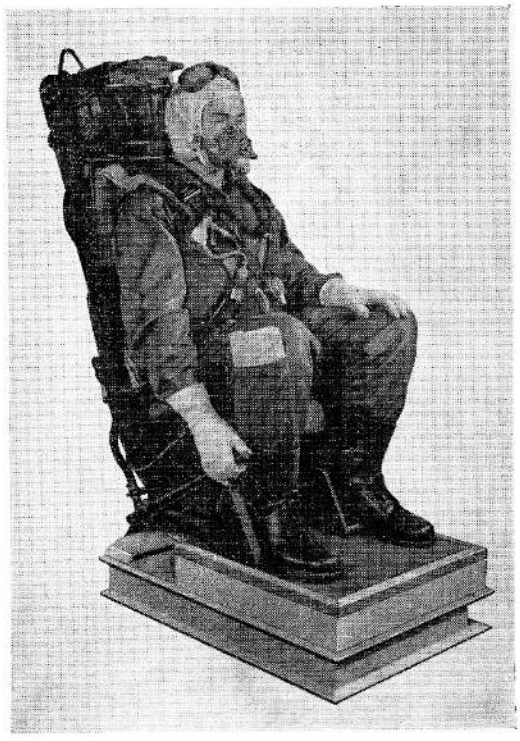

Fig. 1. Pressure-breathing equipment as worn in use

High altitude flight

10. In unpressurized aircraft the maximum permissible altitude, as indicated by the cabin altimeter, for using pressure-breathing equipment is 42,000 ft. indefinitely, or 43,000 ft. for 30 minutes or 44,000 ft. for 15 minutes. The mask knob should be at the HIGH pressure setting.

11. In pressurized aircraft, the maximum permissible *aircraft* altitude, as distinct from *cabin* altitude, is 48,000 ft. provided that on loss of cabin pressure the mask knob is immediately turned to HIGH and descent commenced at maximum rate.

Personnel moving from aircrew stations

12. The maximum permissible cabin altitude at which personnel are permitted to move about the aircraft when using pressure-breathing equipment is 37,000 ft.

13. Under these conditions, the oxygen would be supplied either through a long

Fig. 2. Waistcoat and Type J mask fitted to wearer

flexible lead or from a portable oxygen set Mk. 1B, and compares with a limitation of 30,000 ft. when using a Type H mask and economizer and 25,000 ft. when using a Type H mask supplied from a portable oxygen set Mk. 1B.

DESCRIPTION

14. The equipment (fig. 1, 2 and 3) consists of one of the masks and one of the waistcoats listed below :-

(1) Type J mask, available in three sizes :—

	Stores Ref.
Small	6D/1515
Medium	6D/1514
Large	6D/1513

(2) Type M mask, available in one size only under Stores Ref. 6D/1718.

(3) Type M, Mk. 2 mask, available in one size only under Stores Ref. 6D/1837.

(4) Pressure waistcoat, available in four sizes :—

Mk. 1 (made of rubberized cotton gabardine)

	Stores Ref.
Small	22C/1130
Medium	22C/1131
Large	22C/1132
Extra large	22C/1133

Mk. 1A (made of rubberized linen fabric)

Small	22C/1371
Medium	22C/1372
Large	22C/1373
Extra large	22C/1374

(5) Quick-release plug

Mk. 3	6D/1531 or
Mk. 5	6D/1612 or
Mk. 6	6D/1613

(6) Manual selector valve 6D/1533.

Type J mask

15. The Type J mask (*fig.* 4) varies broadly from the Type H mask in the following respects : —

(1) The expiratory valve has a spring-loading which is adjustable by the wearer to suit various conditions of flight.

(2) The strap harness has been re-designed and incorporates a webbing type of strap.

(3) The nose-piece has been re-designed

Fig. 3. Mask, Type M, Mk. 2 fitted to wearer

(A.L.59, May 56)

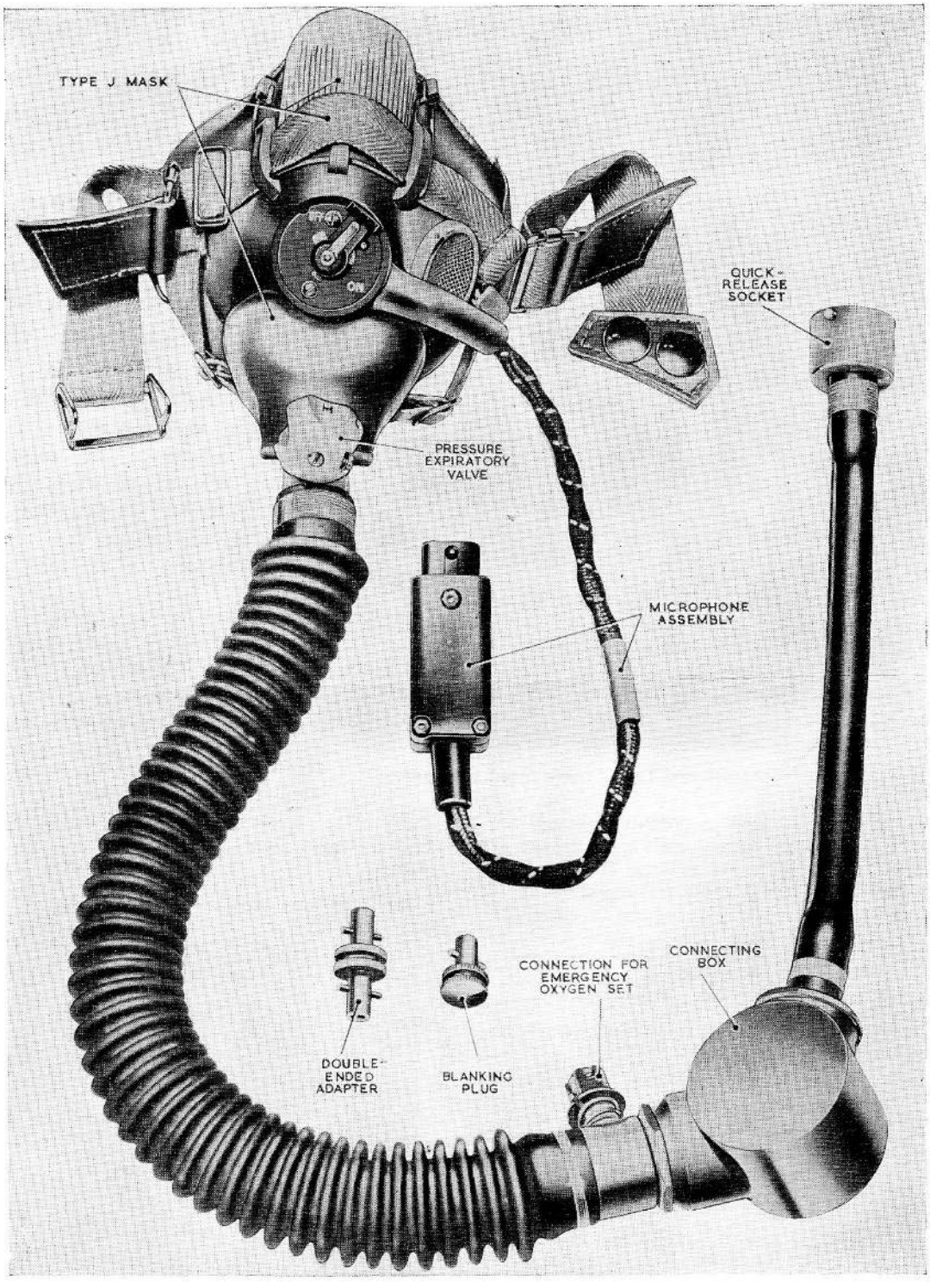

Fig. 4. Oxygen mask, Type J

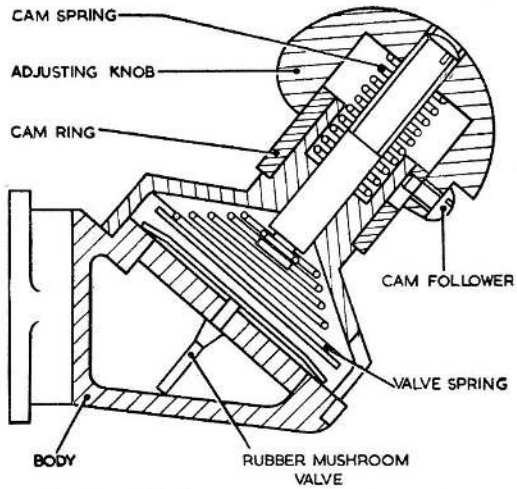

Fig. 5. Mk. 1 pressure expiratory valve

to include a rubberized fabric stiffening piece and wire frame.

(4) The lining of the mask is of cellular rubber.

(5) The mask tube assembly, Mk. 8, is integral with the mask and incorporates a connecting box for connection of the assembly to the pressure waistcoat, a quick-release socket, Mk. 2 for connection

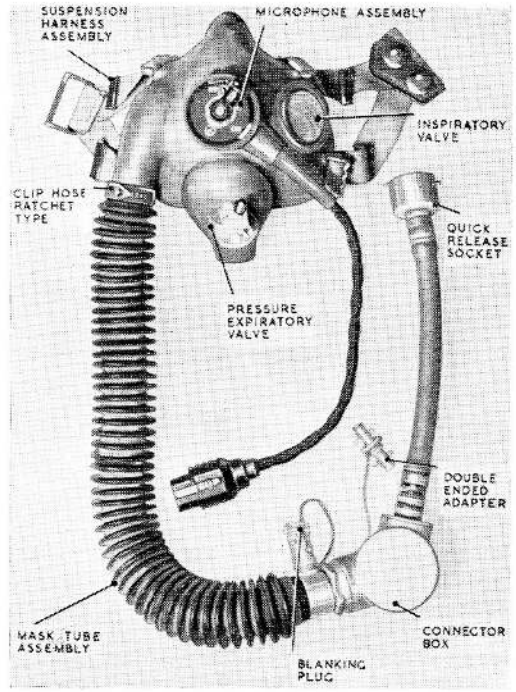

Fig. 7. Oxygen mask, Type M

to the oxygen supply, and a 3-way piece for connection of an emergency oxygen set.

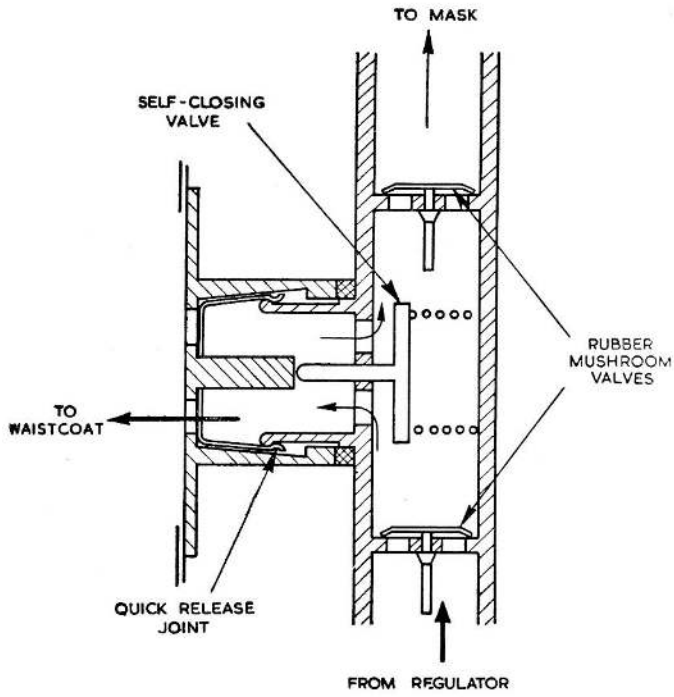

Fig. 6. Connecting box, Mk. 1

16. The expiratory valve (*fig.* 5) comprises a body which fits into the mask shape and enables the spent gases from the user to be exhaled to the atmosphere. The valve can be set in any one of three positions, (OFF, LOW and HIGH), by rotating the knob and allowing the cam follower to engage in the appropriate step in the cam ring. The LOW and HIGH positions are used for pressure breathing, and the OFF position for normal breathing.

17. In the LOW and HIGH positions the valve spring is held in compression against the rubber mushroom valve and so causes pressure to be built up in the mask. The expiratory valve will then not open until the pressure in the mask exceeds the set spring pressure. This is effected partially by the spilling of excess oxygen but mainly by forcible breathing out by the

TABLE I

Quick-release plugs

Mk.	Stores Ref.	Details	Function
3	6D/1531	Plain quick-release plug.	Used on ejection seats which are not vacated during flight and also on fixed pilots' seats.
5	6D/1612	Similar to Mk.3 quick-release plug but fitted with a "land" for stowage in a cut-off valve.	Used on ejection seats which are vacated during flight.
6	6D/1613	Similar to Mk.5 quick-release plug but fitted with a bayonet locking ring.	Used on fixed crew seats and wander leads.

user. In the OFF position, no restriction is placed on the opening of the mushroom expiratory valve.

Connecting box, Mk. 1 (fig. 6)

18. Oxygen from the regulator passes through two mushroom type non-return valves to the mask and also to the waistcoat through a spring-loaded valve. This latter valve is held open when the connecting box is attached to the waistcoat supply connection.

19. Under pressure-breathing conditions, the oxygen supply is totally taken as a direct flow from the oxygen supply tube. During normal breathing, however, when the user inhales, oxygen is drawn partly from the waistcoat and partly from the supply tube. Upon exhalation, the upper mushroom valve in the connecting box is seated while exhalation pressure is built up in the mask and mask tube.

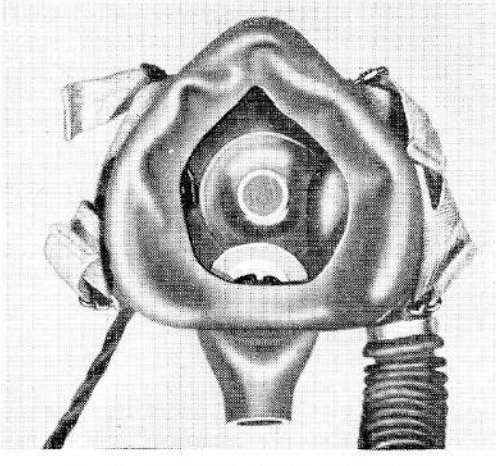

Fig. 8. Interior of Type M mask

20. When an emergency set is used, the mushroom valves in the connecting box prevent any leak back from the mask.

21. When the connecting box is disconnected from the waistcoat (in the event of the waistcoat being torn or punctured) the spring-loaded valve in the box closes the waistcoat port, but oxygen is still able to flow direct to the mask.

22. If an emergency oxygen set is not connected to the equipment, the blanking plug (*fig.* 4) must be inserted in the emergency oxygen socket. When using the Mk. 4 emergency oxygen set, the double-ended adapter must be used to make the connection.

Type M mask

23. The Type M mask (*fig.* 7) has been

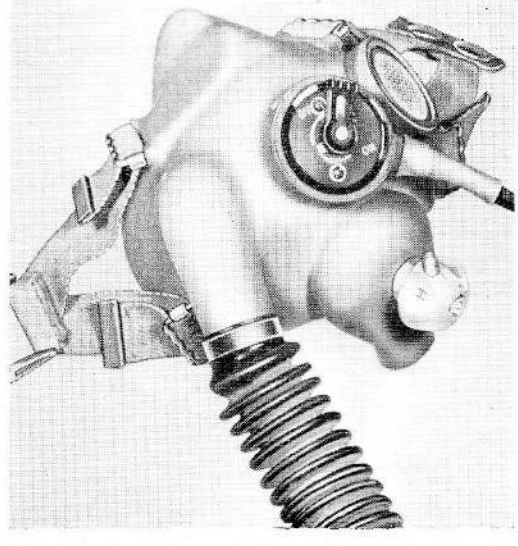

Fig. 9. Facepiece of Type M mask showing attachment harness

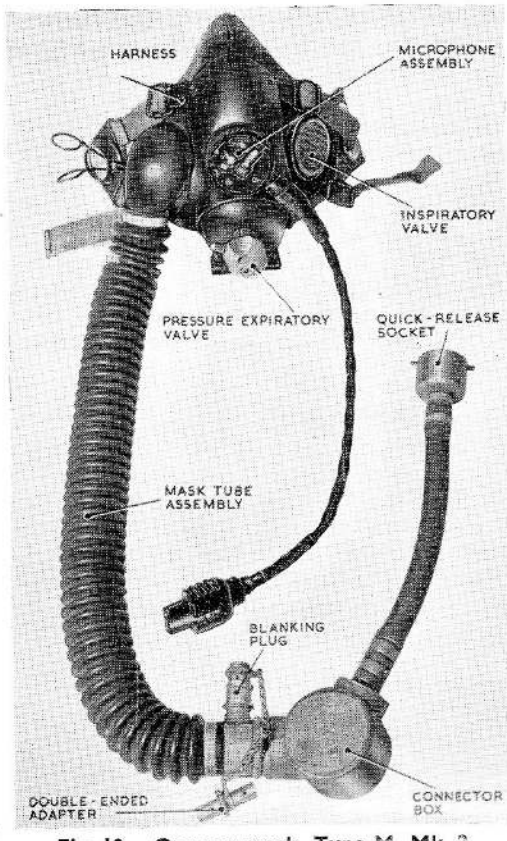

Fig. 10. Oxygen mask, Type M, Mk. 2

designed to eliminate the difficulties experienced with the Type J mask, which it will eventually replace. It is appreciably lighter in weight and more comfortable to wear.

24. Two new components have been introduced ; a redesigned facepiece 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.

25. The facepiece (*fig.* 8 *and* 9) 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 reflected edge. Incorporated in the nose area is a strip of malleable metal, which can be adjusted to improve the fit of the mask.

26. The harness is in two parts, one carries the caps of two press studs and the other carries a buckle. Self-locking buckles, two at the top and two at the bottom, are anchored direct to the facepiece, and the two straps of each part of the harness are fed through these buckles on their respective sides of the facepiece. There are, therefore, four points of adjustment, as each strap can be tensioned independently, if necessary,

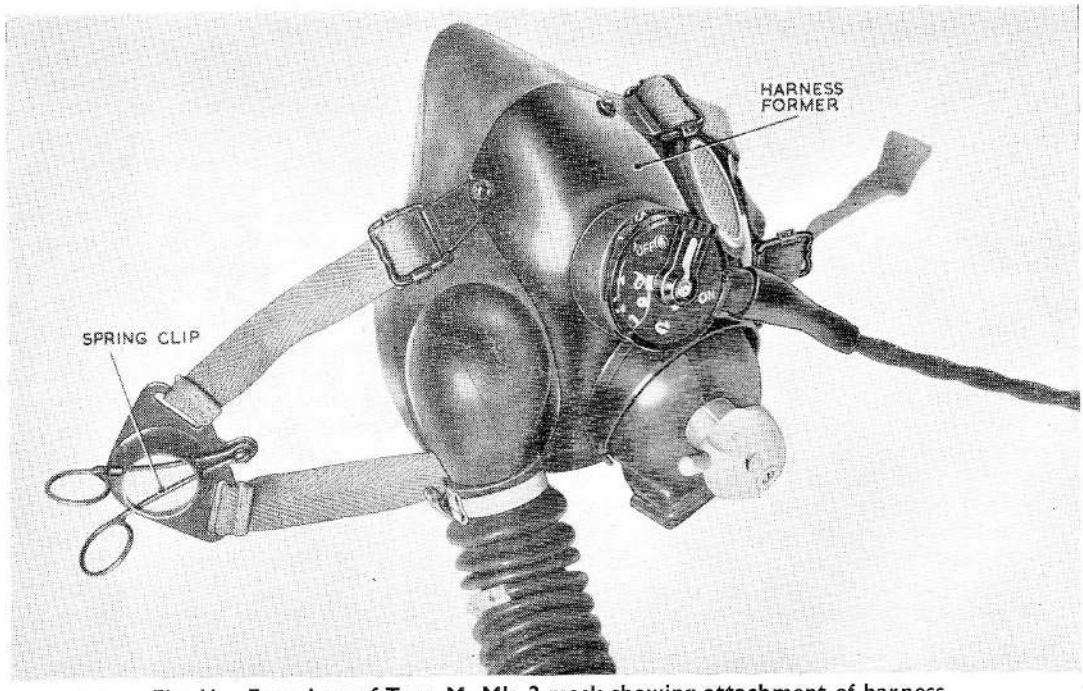

Fig. 11. Facepiece of Type M, Mk. 2 mask showing attachment of harness

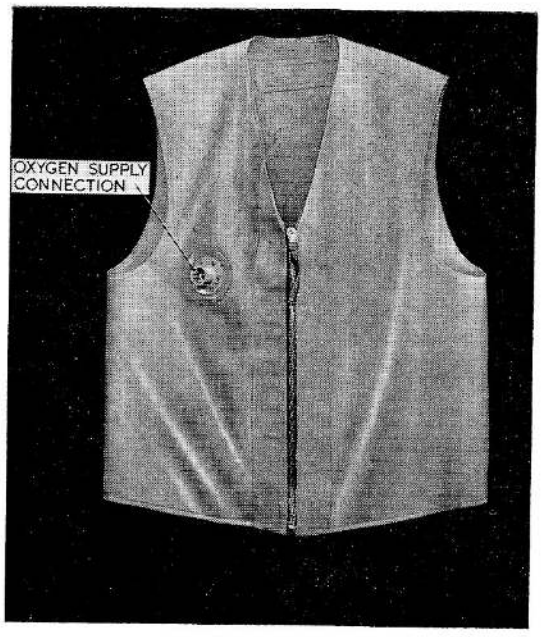

Fig. 12. Pressure waistcoat

to make the facepiece fit the contours of the nose and mouth.

Type M, Mk. 2 mask

27. This mask (*fig.* 10 *and* 11) is similar to the Type M, but embodies the following additional features :—

(1) The facepiece is of moulded rubber.

(2) The harness is mounted on a metal former fitted over the front of the facepiece.

(3) The left-hand side of the harness is permanently attached to the Type F helmet and the right-hand side is attached to the helmet by a spring clip.

The features described in sub-para. (2) and (3) enable the mask to be fitted more closely round the nose and mouth and prevent the mask being forced off the face during an ejection from the aircraft.

Pressure waistcoat

28. The waistcoat (*fig.* 12 *and* 13) is made of fabric which is rubberized on one side. The garment 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.

29. To prevent the garment from bulging when inflated, internal reeds are provided in the positions indicated by the dotted lines in fig. 13. Two coats of rubber solution KB.63 are used for all cemented areas throughout the waistcoat.

30. The supply of oxygen enters the waistcoat through a flanged socket (Stores Ref. 6D/1532) mounted on the outer layer of the waistcoat, which is reinforced locally. To prevent the flange assembly from chafing the inner layer of the waistcoat, a patch of proofed fabric is cemented to the inner surface. A piece of cord is sewn on the patch to prevent the entry from being completely closed.

Quick-release plugs (*fig. 14*)

31. There are three types of quick-release plugs associated with pressure-breathing equipment. They are secured to the Mk.5 tubing by a hose clip, Type J or S (Stores Ref. 28E/8182), the type of plug fitted depending on the required function at a particular crew station. The differences between these plugs are shown in Table 1.

Manual selector valve (*fig. 15*)

32. The oxygen system on aircraft in which pressure-breathing equipment is installed, contains, at each crew station, a manually-operated selector valve which permits isolation of the economizer when pressure breathing is adopted.

WARNING

Pressure-breathing equipment must never be used in conjunction with an economizer as the pressures involved would prevent functioning of the economizer and probably cause failure of the pressure plate or bag.

33. The valve has two low-pressure connections for the pipe-line from the regulator and pipe-line to the economizer, and two flared connections for the Mk.5 tubing from the economizer and Mk.5 tubing to the mask and waistcoat. The control handle can be set in one of two positions, P.B. or ECON., indicated on a plate fitted just beneath the handle. A small hole is drilled in each end of the plate and also in the handle, enabling the latter to be locked with wire in the selected position. To suit individual installations, the plate can be secured to the valve body in one of two positions, 180 deg. apart. Although the handle can only be secured to the valve spindle in one position, due to the spindle being splined and fitted with a keyway, the complete handle and spindle assembly can be rotated

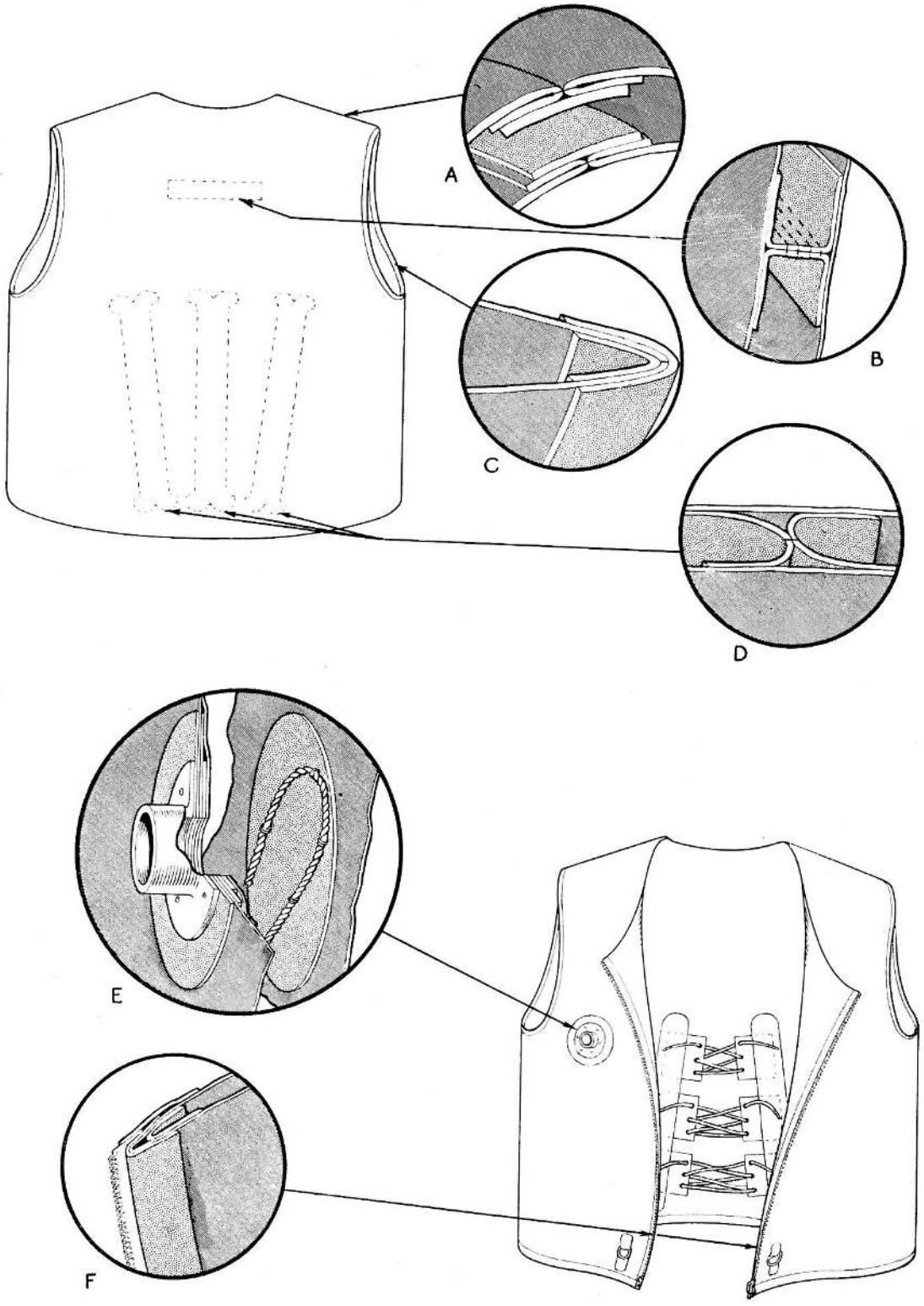

Fig. 13. Construction of pressure waistcoat

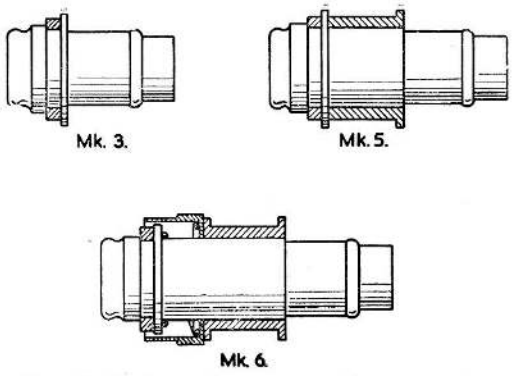

Fig. 14. Quick-release plugs, Mk. 3, 5 and 6

through 180 deg. to correspond with the desired plate position.

34. When the handle is in the P.B. (pressure breathing) position (*fig.* 16), oxygen from the regulator flows through the selector valve direct to the Type J mask and waistcoat. The connections from and to the economizer are then isolated and virtually form a closed circuit. This condition would trap any oxygen remaining in the economizer and would damage the bag and pressure plate as the aircraft ascended and the bag pressure would consequently increase in relation to the atmosphere. To prevent such a pressure build-up occurring, a small bleed-hole is drilled through the valve body and coincides with the valve channel which interconnects the economizer inlet and outlet.

35. When the handle is in the ECON. (economizer) position, oxygen flows from the regulator through the selector valve to the economizer and then from the economizer outlet to the Type H mask through the remaining channel in the valve. It will be noted that in this position the bleed-hole is blanked off.

INSTALLATION

36. In order to prevent inadvertent use of a pressure-breathing mask with an economizer, two safeguards are introduced into oxygen systems on aircraft on which pressure-breathing equipment is used :—

(1) The manual selector valve described in para. 32.

(2) The mask tube connections on pressure-breathing equipment are reversed from those associated with the Type H mask, i.e., with pressure-breathing equipment a socket on the mask tube assembly engages with a plug on the Mk.5 flexible supply tube whereas with the Type H mask, a plug on the mask tube engages with a socket on the supply tube.

37. It is intended therefore, that the selector valve be set on the ground in the required position and securely wire-locked. At the same time, the appropriate quick-release plug or socket is to be fitted to the Mk.5 tubing.

Note . . .

Changing of plugs and sockets is facilitated by the fittings being secured to the tubing by means of a hose clip, Type J or S.

FITTING

38. Prospective users of pressure-breathing equipment must have previously passed a decompression (altitude selection) test and must be fitted and instructed in the use of the equipment by an authorized Medical Officer.

Waistcoat

39. The pressure waistcoat is made in four sizes and these are individually fitted where necessary by adjustment of the lacing at the back. The waistcoat must fit loosely over the maximum amount of clothing likely to be worn. The following chest measurements recorded over flying clothing at the level of the armpits and at full inspiration will serve as a guide to size :—

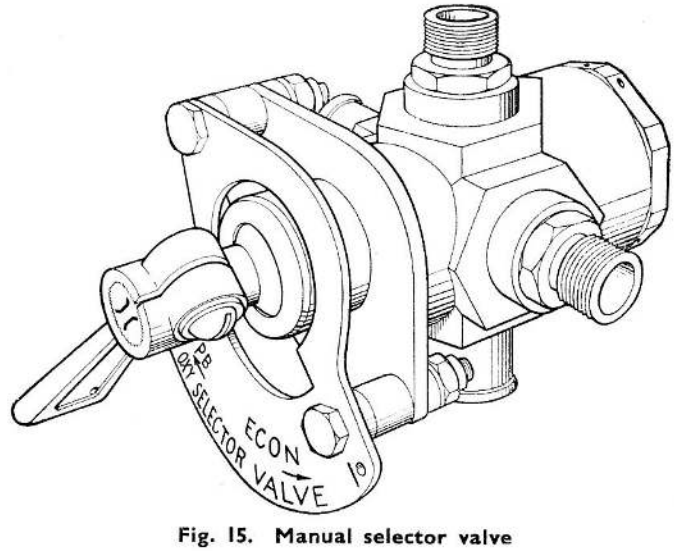

Fig. 15. Manual selector valve

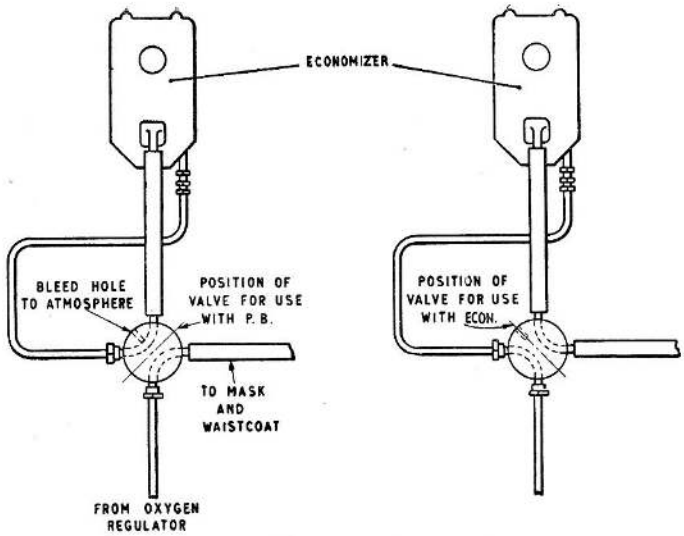

Fig. 16. Selector valve positions

Less than 37 in. —Small
37 in. to 40 in. —Medium
40 in. to 43 in. —Large
More than 43 in. —Extra large

Type J mask

40. The mask is made in three sizes and care must be taken to select the proper size.

41. The mask must be worn on a close-fitting fabric helmet, Type F, and the mask size and harness adjustment must be so chosen that no leak occurs around the mask edges when the expiratory valve is set to HIGH and the emergency connection is blanked off.

Type M Mask

42. To achieve a good seal under pressure-breathing conditions, it is essential for the following procedure to be adopted when fitting the mask initially :—

(1) Attach the caps of the press studs to the two lower studs on the left-hand side of the helmet. Ensure that the clip is riveted to the two lower studs on the right-hand side of the helmet.

(2) Put on the helmet and attach the buckle hook on the mask to the clip on the helmet.

(3) Tighten the two lower straps of the harness until light pressure is felt between the mask and the chin.

(4) Tighten the two upper straps of the harness until the mask is seating evenly on the face.

(5) Turn the expiratory valve control to "H" (HIGH) and breathe out against the back pressure. Note the position of any leak around the edge of the facepiece.

(6) Adjust the harness straps and, if necessary, reshape the nose area by lightly bending the malleable metal insert over the nose area, until there is no leakage.

(7) Return the valve control to "O" (NORMAL).

Note . . .

The position of the malleable metal insert can be seen on the inside of the facepiece.

(8) If the reflected edge of the facepiece causes discomfort by touching the lower lip, a rare occurrence, the reflected 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.

Type M, Mk. 2 mask

43. The general procedure in para. 41 is also applicable to this mask, but in addition the following should be noted :—

(1) The Type F helmet must be modified by the fitting of a metal plate carrying a boss to the right-hand cheek flap and the left-hand side of the harness on the mask must be permanently attached to the studs on the left-hand cheek flap.

(2) Make sure that the mask fits closely to the face. It may be a little uncomfortable at first, but this condition will wear off.

(3) The Type F helmet must fit as closely as possible to the head ; there are several sizes from which a selection can be made.

Altitude check

44. The fit of all equipment must be checked in a decompression chamber at 40,000 to 44,000 ft. before being used in flight.

USING THE EQUIPMENT

45. Use of pressure-breathing equipment in

aircraft is not permitted until the user has been subjected to the altitude check quoted in the preceding paragraph. This is to ensure that the equipment is correctly fitted and that users understand the function and advantages of the equipment.

Note . . .

The pressure-breathing mask and waistcoat must always be used as an assembly, and attention is again drawn to the fact that the equipment must never be used with an economizer.

Before take-off

46. Before take-off the following should be attended to :—

(1) Ensure that the selector valve is in the P.B. position and wired securely and also ensure that the appropriate quick-release plug is fitted in the flexible oxygen supply tube. On ejection seats this plug must be a Mk.3 or Mk.5 only, whilst on fixed crew seats, the Mk.6 must be fitted.

(2) Attach connecting box on mask tube assembly to connecting flange on waistcoat ensuring that the connection has clicked into position.

(3) Connect the Mk.2 socket at end of mask tube assembly to plug on supply tube.

(4) Connect emergency oxygen set either direct to the small socket on the connecting box or through the double-ended adapter depending on the type of emergency set used. If no emergency set is used, the blanking plug must be inserted in the socket.

47. After making the connections referred to in the preceding paragraph, the equipment should be checked as follows :—

(1) Inspect mask and ensure that the inlet valve on the side, and outlet pressure valve below, are free from dirt.

(2) Strap mask on face, turn expiratory valve to HIGH and breathe out forcibly to check whether leaks occur at the edge of the mask, and if necessary tighten straps to eliminate leakage.

Note . . .

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

(3) Turn oxygen flow to full EMERGENCY leaving the expiratory valve on HIGH. Pressure should then build up in the waistcoat proving that the system is satisfactory. Return the EMERGENCY setting to OFF after test. If there is no EMERGENCY setting on regulator this test can be performed by turning regulator to HIGH flow and collapsing the corrugated mask tubing.

(4) The mask knob should be returned to the OFF position, but the mask fit should not be altered. Re-connect emergency supply (*para.* 46(4)).

During flight

48. During ascent the pressure knob is kept in the OFF position leaving the system unpressurized. When 10,000 ft. is reached a check should be made to ensure that all connections are correctly made, and that oxygen is flowing.

Regulator settings

49. The following regulator settings are to be made when pressure-breathing equipment is used. These instructions should be read in conjunction with A.M.O. A.664/52, para. 1 to 8.

*Mk.*10*A**

(1) When the cabin is unpressurised :—
  (a) Set at 10,000 ft. above the actual altitude.

(2) When the cabin is pressurised :—
  (a) Set at 40,000 ft. when the indicated aircraft altitude is 40,000 ft. or above, irrespective of the height indicated by the cabin altimeter.

Mk. 11 (*All types*)

(1) When the cabin is unpressurized :—
  (a) NORMAL setting up to 20,000 ft.
  (b) HIGH setting at and above 20,000 ft.

(2) When the cabin is pressurized :—
  (a) Set to HIGH when the indicated aircraft altitude is at or above 40,000 ft., irrespective of the height indicated by the cabin altimeter.

*Mk.*16 (*All types*)

This mark of regulator is designed specifically for use in pressure cabin aircraft. However, regulator settings for the unpressurized case are given to cover all contingencies.

(1) When the cabin is unpressurized :—
  (a) NORMAL setting up to 25,000 ft.
  (b) HIGH setting at and above 25,000 ft.

(2) When the cabin is pressurized :—

(a) In the event of cabin pressure failure, the regulator will automatically change to HIGH, when the indicated cabin altitude reaches 30,000 ft.

50. When a height of 35,000 ft. is reached, the knob on the mask valve is turned 45 deg. 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 LOW position. The pressure will then be felt building up in the waistcoat.

51. Upon reaching 40,000 ft., the knob on the mask pressure valve is turned a further 45 deg. and engaged in the HIGH position.

52. The HIGH setting should not be used below 40,000 ft. as below this altitude it is unnecessary and somewhat uncomfortable.

53. The altitude advantage provided by pressure-breathing equipment depends on the amount of pressure employed. The LOW setting on this equipment gives an advantage of about 2,000 ft. The HIGH setting gives an advantage of a further 2,000 ft. thus making an overall advantage of approximately 4,000 ft. A valuable feature of the use of pressure between 35,000 and 40,000 ft. is its effect in preventing air leaks into the mask. With the HIGH setting there is no specific limit to the period of use at 42,000 ft., but at 44,000 ft. the duration is limited to 15 minutes and at 45,000 ft. it is down to a few minutes.

54. The equipment is not suitable for continuous use above 45,000 ft., but can be used in the event of cabin failure to get down from as high as 50,000 ft. to safer altitudes although the time factor here is very small, and useful consciousness at 50,000 ft., using the HIGH setting, is limited to about 10 seconds.

55. Some discomfort may be experienced when using the equipment for the first few times, but this soon disappears providing the breathing is relaxed and natural. Breathing too rapidly and too deeply must be prevented.

56. Speech may be found to be somewhat difficult at first whilst using pressure, but this may be overcome by " speaking from the diaphragm " whilst breathing out.

57. During descent the pressure knob should be turned to LOW at 40,000 ft. and OFF at 35,000 ft.

EMERGENCIES

Perforation of waistcoat

58. If the waistcoat should become torn while at high altitude and thus become 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 35,000 ft. A valve automatically closes the opening in the connecting box 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 tubes from the waistcoat.

Limiting altitudes after perforation of waistcoat

59. Without a waistcoat, the oxygen runs to waste during the time when the user is breathing out, and the economizer function of the waistcoat is lost. On breathing in, the oxygen intake is limited to the actual delivery from the regulator and the altitude ceiling for the equipment is correspondingly reduced. The maximum cabin altitude for personnel at aircrew stations wearing pressure breathing mask, waistcoat disconnected and the oxygen regulator on HIGH (EMERGENCY on Mk.10A*) is 30,000 ft., and for personnel moving from aircrew stations, 25,000 ft. The regulator should not be turned to NORMAL at heights requiring oxygen.

Fixed seat

60. If it is necessary to bale out, while oxygen is being used, pull the release cord of the emergency oxygen set, and disconnect the quick-release oxygen connection from the seat tube, leaving the mask tube 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. When the supply tube is disconnected, the oxygen is prevented from flowing out of

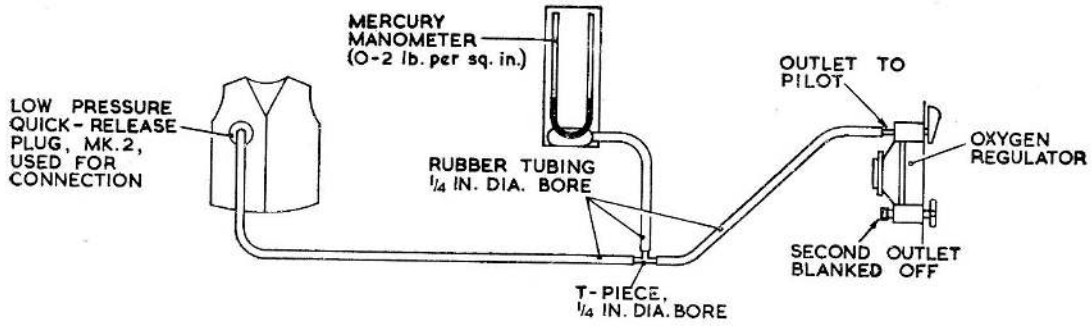

Fig. 17. Pressure test : waistcoat

the waistcoat by a non-return valve in the connecting box.

Ejection seat

61. If it is necessary to bale out from an aircraft fitted with an ejection seat, the procedure as laid down in A.P.2095, Part 4, Chap. 6 applies.

CARE OF THE EQUIPMENT

62. Since at high altitude, life may depend upon the good condition of the pressure-breathing equipment, great care must be taken in handling and protecting it. Keep it in a locker and do not allow it to be piled upon other apparatus or to have other articles piled upon it. Ensure that the equipment is kept away from direct sunlight or heat. As the mask moulds its shape to the face of the wearer it is important that it is not worn by anyone but the person to whom it is issued.

SERVICING OF THE EQUIPMENT

63. The waistcoat and pressure-breathing mask should be checked at the periods specified in the relevant servicing schedules, and the following tests applied.

Waistcoat

Pressure test

64. The equipment required is shown in fig. 17. With the sliding fastener closed, the waistcoat should be inflated with oxygen or air and subjected to a pressure of 34 in. of water for about 30 seconds. There must be no signs of failure or leakage at the seams or fastener. If one of the reeds has come unstuck, the waistcoat is unserviceable.

Note . . .

To convert inches of water to inches of mercury, multiply by 0·075. *To convert inches of water to pounds per square inch, multiply by* 0·036.

Leakage test

65. After the pressure test, the waistcoat should be inflated with oxygen or air to a

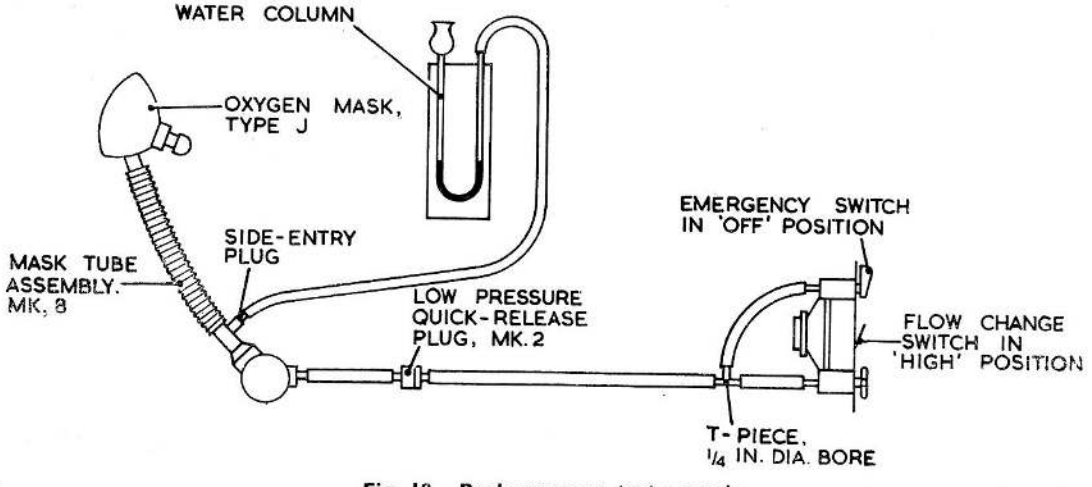

Fig. 18. Back-pressure test : mask

pressure of 15·75 in. of water, and the inlet pipe and T-connection to the manometer should be isolated from the supply at a point not more than 24 inches from the waistcoat. After 3 min. the pressure in the waistcoat should not have fallen below 11·8 in. The waistcoat should be allowed to rest freely on the bench, because any movement will cause an error in the water column reading.

66. If leaks are suspected, they should be traced by the use of soap solution.

Type J and M masks

Microphone

67. Test the microphone in accordance with A.P.2876A, Vol. 1, Sect. 4, Chap. 11, Test (a).

Inspiratory valve

68. Hold the mask in position on the face, pinch the mask tube between the fingers, and inhale. If the mask is functioning correctly, breathing should be quite easy and, at the end of the inspiration, the valve should click shut smartly. Do not remove the valve from the mask.

Expiratory valve

69. Test the expiratory valve for back-pressure at a flow of 40 litres (1·4 cu. ft.) per minute. (This is obtained from a Mk. 11D regulator with the flow change switch in the HIGH position and the emergency supply OFF, by combining the flows from both outlets through a T-piece as shown in fig. 18.) With the mask worn by the user and the equipment set up as shown in fig. 15, the back-pressure with the expiratory valve set to HIGH should be between 11 and 12·6 in. (28 and 32 cm.) on the water column. If the back-pressure is within these limits, turn the expiratory valve to LOW. The back-pressure should be between 4 and 7·9 in. (10 and 20 cm.) of water. The wearer must hold his breath while the reading is being taken.

70. If the back-pressures are incorrect, re-set the valve to 11·8 in. (30 cm) of water, for HIGH pressure, by releasing the grub screw and adjusting the centre spindle. After setting the valve for HIGH, confirm that LOW is between 4 and 7·9 in. (10 and 20 cm.) of water.

71. Care must be taken to tighten the grub-screw after this adjustment to prevent any further movement of the centre spindle.

72. No adjustment should be attempted unless suitable test facilities are available.

Connections

73. Check the breaking load between the connecting box on the mask tube and the flanged socket on the waistcoat. Attach a spring balance capable of measuring 0-15 lb. by a cord to the connection in such a way that a direct axial pull is exerted. The breaking load should be between 9 and 13 lb.

74. Make a similar check on the Mk. 2 socket connection on the mask tube, using a Mk. 3 plug (Ref. No. 6D/1531). The breaking load should be between 9 and 15 lb. The plug should be renewed when it has been used about 250 times.

Leak test

75. Apply the following leak test to the complete mask assembly:—

(1) Plug the mask inlet as shown in fig. 19.

(2) With the equipment set up as shown in fig. 20 subject the complete assembly to a pressure of 20 in. w.g. The permissible leakage, shown by drop in pressure, should not be more than 3 in. per min.

Type M, Mk. 2 mask

76. In addition to the instructions dealing with the Type M mask, which apply equally to the Type M, Mk. 2, the following should be noted:—

(1) Slight dents in the metal former do not affect the efficiency of the mask, but if the former has become mis-shapen it must be renewed.

(2) Ensure that the left-hand side of the harness is properly secured to the helmet.

(3) Ensure that the spring clip and boss over which it fits are serviceable, fit the clip over the boss and make sure that it is securely attached. If the spring clip or boss are unserviceable, they must be renewed.

Cleaning

77. The facepiece and the tube assembly become soiled due to condensation of breath and perspiration; they should therefore be cleaned at the monthly servicing, or more frequently if necessary. The tube assembly should be disconnected from the mask and from the connector box, and then immersed

◀ in clean warm water and rinsed several times. The tube should be stretched to allow the corrugations to be cleaned. The inside of the mask, and the reflected edge, should then be sponged with clean, warm water with the cloth wrung nearly dry. ▶

78. After cleaning, wipe the mask and tube with a dry clean cloth, shake or blow out excess moisture from the valves, and allow the equipment to dry naturally. Examine the valves thoroughly to ensure that moisture is not deposited in or around them.

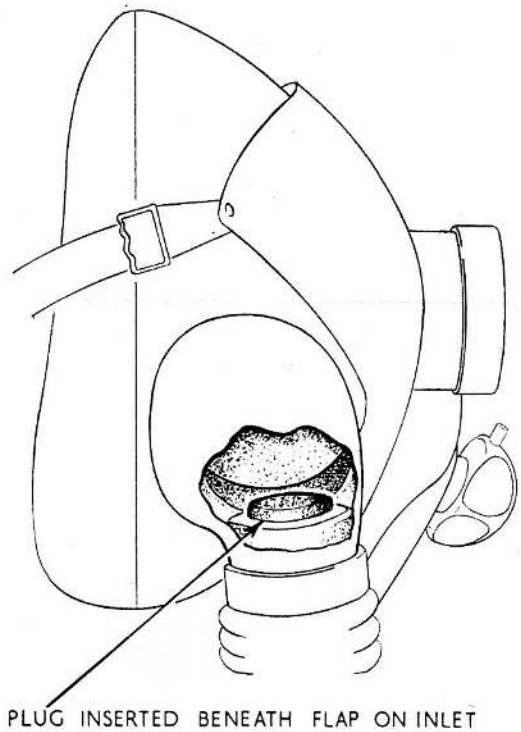

Fig. 19. *Mask plugged for leak test*

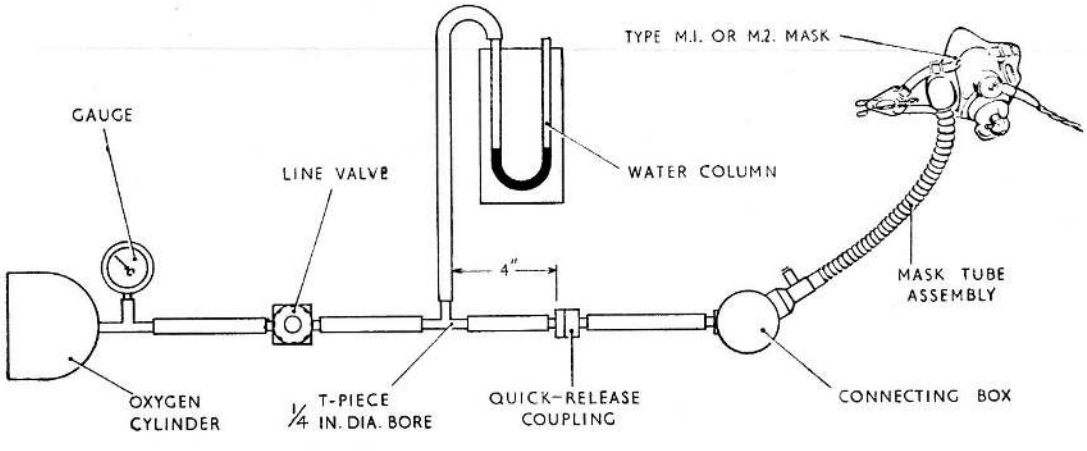

Fig. 20. *Equipment set up for leak test*

Appendix 1

This Appendix is a copy of the leaflet (Stores Ref. 6D/1695) issued with each oxygen mask, Type J

INSTRUCTIONS FOR USE AND FITTING OF OXYGEN MASK, TYPE J

LIST OF CONTENTS

Introduction

1. The Type J oxygen mask forms part of pressure-breathing equipment and therefore must only be used in conjunction with a pressure-breathing waistcoat, Mk. 1 or 1A. The mask tube assembly, Mk. 8, is integral with the Type J mask.

Description

2. The Type J mask has a rubber moulded face-piece lined with cellular rubber to relieve pressure on the face when the mask is tightly fitted. Oxygen is led (via the mask tube assembly) into the mask through two ducts which open into the face-piece cavity facing forwards and downwards so that condensation collecting in the mask will not run back down the supply tube. An air inlet valve is fitted on the left-hand side of the mask, and a microphone and switch are fitted in a moulded housing in the front of the mask. The mask incorporates a manually-operated expiratory valve which may be set to three positions—OFF, LOW and HIGH. In the OFF position the valve acts as a simple outlet valve and in the LOW and HIGH positions a spring-loading is applied to the outlet valve which causes the pressure of oxygen in the mask to be greater than that of the surrounding atmosphere.

3. The mask is fitted with a webbing harness for attachment to a flying helmet.

4. The mask tube assembly incorporates connections for the main oxygen supply, the waistcoat, and emergency oxygen.

5. The Type J mask and pressure waistcoat, Mk. 1 or 1A, must be used as an assembly and never in conjunction with an economizer as the pressures involved would prevent functioning and also probably cause failure of the economizer. For this reason the oxygen system on aircraft on which pressure-breathing equipment is used contains at each crew station a selector valve which permits the economizer to be isolated when pressure-breathing equipment is used.

Sizes available

6. The mask is available in three sizes and the size is stamped on the outside of the mask under the chin portion. The masks are stored under the following reference numbers :—

Small	6D/1515
Medium	6D/1514
Large	6D/1513

Fitting

7. Prospective users of pressure-breathing equipment must be fitted and indoctrinated in the use of the equipment by an authorized Medical Officer and must have previously passed a decompression (altitude selection) test.

8. Care must be taken in the selection of the proper size mask and the mask must be worn on a close fitting leather helmet, Type C, or fabric helmet, Type F. The mask size and harness adjustment must be so selected that no leak occurs round the face when the

mask is used on the HIGH pressure setting and with the emergency connection blanked off.

USING THE EQUIPMENT

9. Use of pressure-breathing equipment in aircraft is not permitted until the user has been subjected to an altitude check at 40,000 to 44,000 ft. in a low-pressure chamber. This ensures that the equipment is correctly fitted and that users understand the function and advantages of the equipment.

Before take-off

10. Before take-off the following should be attended to :—

(1) Ensure that the selector valve is in the P.B. position and wired securely and also ensure that the appropriate quick-release plug is fitted in the flexible oxygen supply tube. On ejection seats this plug must be a Mk.3 or Mk.5 only, whilst on fixed crew seats, the Mk.6 must be fitted.

(2) Attach connecting box on mask tube assembly to connecting flange on waistcoat ensuring that the connection has clicked into position.

(3) Connect the Mk.2 socket at end of mask tube assembly to plug on supply tube.

(4) Connect emergency oxygen set either direct to the small socket on the connecting box or through the double-ended adapter depending on the type of emergency set used. If no emergency oxygen set is used, the blanking plug must be inserted in the socket.

11. After making the connections referred to in the preceding paragraph, the equipment should be checked as follows :—

(1) Inspect mask and ensure that the inlet valve on the side, and outlet pressure valve below, are free from dirt.

(2) Strap mask on face, turn expiratory valve to HIGH and breathe out forcibly to check whether leaks occur at the edge of the mask, and if necessary tighten straps to eliminate leakage.

Note . . .

The small blanking-off plug should be in position in the 3-way piece for this test.

(3) Turn oxygen flow to full EMERGENCY leaving the expiratory valve on HIGH. Pressure should then build up in the waistcoat proving that the system is satisfactory. Return the EMERGENCY setting to OFF after test. If there is no EMERGENCY setting on regulator, this test can be performed by turning regulator to HIGH flow and collapsing the corrugated mask tubing.

(4) The mask knob should be returned to the OFF position, but the mask fit should not be altered. Reconnect emergency supply (*para.* 10(4)).

During flight

12. During ascent the pressure knob is kept in the OFF position leaving the system unpressurized. When 10,000 ft. is reached, a check should be made to ensure that all connections are correctly made, and that oxygen is flowing.

Regulator settings

13. The following regulator settings are to be made :—

Mk. 10*A**

(1) Set at 10,000 ft. above the actual altitude when the cabin is unpressurized.

(2) Set at 40,000 ft. irrespective of the actual altitude, when cabin is pressurized.

Mk. 11 (*All types*)

(1) NORMAL setting up to 20,000 ft.

(2) HIGH setting at and above 20,000 ft.

Mk. 16 (*All types*)

(1) NORMAL setting up to 25,000 ft.

(2) HIGH setting at and above 25,000 ft.

14. When a height of 35,000 ft. is reached, the knob on the mask valve is turned 45 deg. 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 LOW position. The pressure will then be felt building up in the waistcoat.

15. Upon reaching 40,000 ft. the knob on the mask pressure valve is turned a further 45 deg. and engaged in the HIGH position.

16. The HIGH setting should not be used below 40,000 ft. as below this altitude it is unnecessary and somewhat uncomfortable.

17. Some discomfort may be experienced when using the equipment for the first few times but this soon disappears providing the breathing is relaxed and natural. Breathing too rapidly and too deeply must be prevented.

18. Speech may be found to be somewhat difficult at first whilst using pressure, but

this may be overcome by " speaking from the diaphragm " whilst breathing out.

19. During descent the pressure knob should be turned to LOW at 40,000 ft. and OFF at 35,000 ft.

LIMITATIONS

20. The equipment has certain limitations which can be summarized as follows.

Personnel at aircrew stations

Altitude limitations

21. Under normal flying conditions the waistcoat and pressure-breathing mask are used unpressurized in place of the Type H mask and economizer (i.e., up to 40,000 ft.).

22. At 35,000-40,000 ft. low-pressure breathing may be used to overcome any tendency to mask leak.

High altitude flight

23. In unpressurized aircraft the maximum permissible altitude, as indicated by the cabin altimeter, for using pressure-breathing equipment is 42,000 ft. indefinitely, or 43,000 ft. for 30 minutes or 44,000 ft. for 15 minutes. The mask knob should be at the HIGH pressure setting.

24. In pressurized aircraft, the maximum permissible *aircraft* altitude as distinct from *cabin* altitude, is 48,000 ft. provided that on loss of cabin pressure the mask knob is immediately turned to HIGH and descent commenced at maximum rate.

Personnel moving from aircrew stations

25. The maximum permissible cabin altitude at which personnel are permitted to move about the aircraft when using pressure-breathing equipment is 37,000 ft. Under these conditions, the oxygen would be supplied either through a long flexible lead or from a portable oxygen set Mk. 1B, and compares with a limitation of of 30,000 ft. when using a Type H mask and economizer, and 25,000 ft. when using a Type H mask supplied from a portable oxygen set Mk.1B.

EMERGENCIES

Perforation of waistcoat

26. If the waistcoat should become torn while at high altitude and thus become 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 35,000 ft. A valve automatically closes the opening in the connecting box 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 tube from the waistcoat.

Limiting altitudes after perforation of waistcoat

27. Without a waistcoat, the oxygen runs to waste during the time when the user is breathing out, and the economizer function of the waistcoat is lost. On breathing in, the oxygen intake is limited to the actual delivery from the regulator and the altitude ceiling for the equipment is correspondingly reduced. The maximum cabin altitude for personnel at aircrew stations wearing pressure-breathing mask, waistcoat disconnected and the oxygen regulator on HIGH (EMERGENCY on Mk. 10A*) is 30,000 ft. and for personnel moving from aircrew stations, 25,000 ft. The regulator should not be turned to NORMAL at heights requiring oxygen.

Fixed seat

28. If it is necessary to bale out, while oxygen is being used, pull the release cord of the emergency oxygen set, and disconnect the quick-release oxygen connection from the seat tube, leaving the mask tube 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. When the supply tube is disconnected, the oxygen is prevented from flowing out of the waistcoat by a non-return valve in the connecting box.

Ejection seat

29. If it is necessary to bale out from an aircraft fitted with an ejection seat, the procedure as laid down in A.P.2095, Part 4, Chap. 6 applies.

CARE OF THE EQUIPMENT

30. Since at high altitude, life may depend upon the good condition of the pressure-breathing equipment, great care must be taken in handling and protecting it. Keep it in a locker and do not allow it to be piled

upon other apparatus or to have other articles piled upon it. Ensure that the equipment is kept away from direct sunlight or heat. As the mask moulds its shape to the face of the wearer it is important that it is not worn by anyone but the person to whom it is issued.

SERVICING OF THE EQUIPMENT

31. The waistcoat and pressure-breathing mask should be checked at the periods specified in the relevant servicing schedules, and the following tests applied.

Waistcoat

Pressure test

32. With the sliding fastener closed, the waistcoat should be inflated with oxygen or air and subjected to a pressure of 34 in. of water for about 30 seconds. There must be no signs of failure or leakage at the seams or fastener. If one of the reeds has come unstuck, the waistcoat is unserviceable.

Note . . .

To convert inches of water to inches of mercury, multiply by 0·075. *To convert inches of water to pounds per square inch, multiply by* 0·036.

Leakage test

33. After the pressure test, the waistcoat should be inflated with oxygen to a pressure of 15·75 in. of water, and the inlet pipe and T-connection to the manometer should be isolated from the supply at a point not more than 24 inches from the waistcoat. The pressure in the waistcoat should not fall from 15·75 in. to 11·8 in. in less than 3 minutes. The waistcoat should be allowed to rest freely on the bench, because any movement will cause an error in the water column reading.

34. If leaks are suspected, they should be traced by the use of soap solution.

Type J mask with mask tube assembly

Microphone

35. Test the microphone in accordance with A.P.2876A, Vol. 1, Sect. 4, Chap. 11. Test (a).

Inspiratory valve

36. Hold the mask in position on the face, pinch the mask tube between the fingers, and inhale. If the mask is functioning correctly, breathing should be quite easy and at the end of the inspiration, the valve should click shut smartly. Do not remove the valve from the mask.

Expiratory valve

37. Test the expiratory valve for back-pressure at a flow of 40 litres (1·4 cub. ft.) per minute. (This is obtained from a Mk. 11D regulator with the flow change switch in the HIGH position and the emergency supply OFF, by combining the flows from both outlets through a T-piece.) With the mask worn by the user, the back-pressure with the expiratory valve set to HIGH should be between 11 and 12·6 in. (28 and 32 cm.) on the water column. If the back-pressure is within these limits, turn the expiratory valve to LOW. The back-pressure should be between 4 and 7·9 in. (10 and 20 cm.) of water. The wearer must hold his breath while the readings are being taken.

38. If the back-pressures are incorrect, re-set the valve to 11·8 in. (30 cm.) of water, for HIGH pressure, by releasing the grub screw and adjusting the centre spindle. After setting the valve for HIGH, confirm that LOW is between 4 and 7·9 in. (10 and 20 cm.) of water.

39. Care must be taken to tighten the grub-screw after this adjustment to prevent any further movement of the centre spindle.

40. No adjustment must be attempted unless suitable test facilities are available.

Connections

41. Check the breaking load between the connecting box on the mask tube and the flanged socket on the waistcoat. Attach a spring balance capable of measuring 0–15 lb. by a cord to the connection in such a way that a direct axial pull is exerted. The breaking load should be between 9 and 13 lb.

42. Make a similar check on the Mk. 2 socket connection on the mask tube, using a Mk. 3 plug (Stores Ref. 6D/1531). The breaking load should be between 9 and 15 lb. The plug should be renewed when it has been used about 250 times.

Leaks

43. Examine the mask tube and connections to ensure that no leaks have developed.

Further information

44. Further information on this mask, Type J, is given in A.P.1182E, Vol. 1, Sect. 4, Chap. 2.

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Appendix 2

This Appendix is a copy of the leaflet (Stores Ref. 6D/1729) issued with each oxygen mask, Type M

INSTRUCTIONS FOR USE, FITTING, AND DAILY SERVICING OF OXYGEN MASK, TYPE M

LIST OF CONTENTS

Note . . .

PROSPECTIVE USERS OF PRESSURE-BREATHING EQUIPMENT MUST BE FITTED AND INDOCTRINATED IN THE USE OF THE EQUIPMENT BY AN AUTHORIZED MEDICAL OFFICER, AND MUST HAVE PREVIOUSLY PASSED A DECOMPRESSION (ALTITUDE) TEST.

Introduction

1. The Type M mask is intended to be used in place of the Type J mask at present issued. It is part of the pressure-breathing equipment and must only be used in conjunction with a pressure-breathing waistcoat, Mk. 1 or Mk. 1A. The mask and its tube assembly are, for the purposes of these instructions, integral with each other, though they can be separated in the servicing bay.

Description

2. The mask consists of a pure latex rubber facepiece which covers the nose and mouth, but does not include the chin. The seal is formed by a thin rubber reflected edge. An adjustable spring-loaded expiratory valve, a microphone assembly and a suspension harness, all similar to those which form part of the Type J mask, are fitted, together with a Mk. 8 mask tube assembly.

3. The suspension harness, by which the mask is attached to the flying helmet, is made from light webbing and is adjustable.

4. Incorporated in the mask tube assembly are connections to the main oxygen supply tube, the pressure-breathing waistcoat, and the emergency oxygen equipment.

5. Pressure-breathing equipment, i.e., the mask and waistcoat, must be used as an assembly and never in conjunction with an economizer. For this reason, the oxygen system in aircraft in which this equipment is to be used contains, at each crew station, a selector valve; this valve allows the economizer to be isolated when pressure-breathing equipment is used.

Sizes available

6. The mask is at present provided in one size only under Stores Ref. 6D/1718, and the design of the mask is such that it can be adjusted to fit any size or shape of face; because it can be so adjusted, it is unlikely that alternative sizes will be necessary.

Fitting the mask

7. Too much emphasis cannot be placed on the necessity for fitting the mask correctly, and it must be remembered that to achieve a good fit the helmet to which the mask is attached must itself fit closely to the head; it is, for all practical purposes, impossible to make a mask fit properly with a badly fitting helmet.

8. To achieve a good seal under pressure-breathing conditions, it is essential that the following procedure is adopted when fitting the mask initially:—

(1) Attach the mask to the two lower press studs on each side of the helmet; the clip will be permanently secured to the two lower studs on the right-hand side,

and at this stage only the press studs on left-hand side of the mask will be attached.

(2) Put on the helmet and attach the buckle hook on the mask to the clip on the helmet.

(3) Tighten the lower straps of the suspension harness until a light pressure is felt between the mask and the chin.

(4) Tighten the upper straps of the harness until the mask is seating evenly on the face.

(5) Turn the expiratory valve control to "H" (HIGH) and breathe out against the back pressure. Note the position of any leak around the edge of the mask.

(6) Adjust the harness straps and, if necessary, reshape the nose area by lightly bending the malleable metal insert over the nose part of the mask, until there is no leakage.

(7) Return the valve control to "O" (NORMAL).

Note . . .

The position of the malleable metal insert in the nose region can be seen inside the mask.

(8) If the reflected edge seal causes discomfort by touching the lower lip, a rare occurrence, the reflected edge may be trimmed back very slightly, BUT NOT MORE THAN $\frac{1}{8}$ in. This should not be done by the user, there are qualified personnel in the servicing bay, and the information is included to indicate that this type of adjustment can be made to obtain a more comfortable fit.

Using the equipment

9. Pressure-breathing equipment, of which the mask is a component, is not to be used until the user has been subjected to an altitude selection test. This ensures that he understands the function and advantages of the equipment, and that it fits correctly.

10. Instructions concerning the operation and limitations of the equipment are contained in Air Ministry Flying Orders and in A.M.O. A.664/52. The user is responsible for making himself familiar with these instructions, and with any amendments which may be issued from time to time. When it is necessary to move about the aircraft, use a long lead from the main oxygen supply or a portable oxygen set; make sure that the blanking off plug is inserted in the emergency oxygen connection.

Servicing

11. Daily servicing is the responsibility of the user; briefly, it consists of a visual examination of the mask and pre-flight checks.

Facepiece and mask tube assembly

12. Examine these components for signs of wear or other mechanical damage. Deterioration of the rubber facepiece produces a slightly sticky coating in the first instance, which eventually hardens and crumbles. Particular attention should be paid to the reflected edge of the mask, and the mask should be replaced by a serviceable one at the slightest sign of rubber deterioration. Ensure that there are no leaks round the facepiece or in the mask tube assembly.

Inspiratory valve

13. Hold the mask in position on the face, pinch the mask tube assembly between the thumb and finger, and inhale. If the valve functions correctly, breathing should be quite easy and at the end of the inspiration the valve should "click" shut smartly. The mask is to be replaced by a serviceable one if the valve does not function correctly. Ensure that the surface of the valve is free from dust and dirt.

Expiratory valve

14. Ensure that the surface of the valve is free from dust and dirt, and that the pressure adjustment knob can be turned to the three positions. Replace the mask with a serviceable item if the pressure adjustment knob fails to function correctly.

Pre-flight checks

15. Make the following connections and adjustments to ensure that the oxygen system will function:—

(1) Ensure that the selector valve is in the P.B. (Pressure-Breathing) position and wired securely. Ensure that the correct quick-release plug is fitted to the main oxygen supply tube; the Mk. 3 or Mk. 5 plug is required for ejection seats, and the Mk. 6 plug for fixed or static seats. Plugs other than those mentioned are NOT to be used.

(2) Attach the connecting box on the mask tube assembly to the connecting flange on the pressure-breathing waistcoat; ensure that the connection has "clicked" into position.

(3) Connect the socket on the end of the mask tube assembly to the plug on the main oxygen supply tube.

(4) Connect the emergency oxygen set either direct to the small socket on the connecting box or through a double-ended adapter, depending on the type of emergency oxygen set used.

16. After making the above connections, proceed as follows :—

(1) Strap the mask to the face, turn the knob on the expiratory valve to HIGH and breathe out forcibly to check whether leaks occur at the edge of the mask ; if necessary, tighten the harness straps to eliminate the leakage.

(2) Turn the oxygen flow to full EMERGENCY leaving the expiratory valve at HIGH. Pressure should then build up in the waistcoat, proving that the system is satisfactory. Return the EMERGENCY setting to OFF after the test. If there is no EMERGENCY setting on the regulator, the tests can be applied by turning the regulator to HIGH flow and collapsing the mask tube assembly.

(3) Return the knob on the expiratory valve to the OFF position, but do not alter the fit of the mask once these tests have been made.

Care of the equipment

17. Since at high altitude, life may depend on the condition of pressure-breathing equipment, great care must be exercised when handling it and it must be carefully protected. Keep it in a locker when not in use and do not allow other apparatus to be piled on it. As the mask moulds its shape to the face of the wearer, it should not be worn by anyone other than the person to whom it was originally issued.

18. The " life " of the mask can be prolonged by wiping off perspiration with a clean damp cloth ; the cloth should be moistened with fresh water and damp enough to absorb the perspiration, but not so wet that water trickles inside or round the valves and microphone. Allow the mask to dry naturally ; drying may be assisted by wiping off the moisture with a clean cloth after cleaning. Keep the equipment away from heating apparatus and direct sunlight.

Periodic servicing

19. The equipment, i.e., the mask and waistcoat, should be taken to the servicing bay at least once per month, where a more comprehensive system of checks and examinations can be made by qualified tradesmen. Make sure that your equipment is available when required ; your own interests will be best served by ensuring that the equipment receives expert attention as frequently as possible.

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