PART 1 : SECTION 7

CHAPTER 2

OXYGEN ECONOMIZER SYSTEMS

Introduction

1. In early oxygen systems a continuous flow of oxygen was available at the user's mask and, in consequence, oxygen was discharged to atmosphere when the user breathed out. By using an economizer a saving is effected by supplying oxygen to each mask only when the user inhales, and storing the oxygen in a reservoir during exhalation.

Economizer

2. The economizer is a device which converts the continuous flow from a regulator to the intermittent flow required during respiration, thereby preventing oxygen wastage during exhalation. This results in a 50 per cent. oxygen saving without the user receiving any less.

3. The economizer comprises a plastic case containing :—

(*a*) A storage bag connected to the inlet from the regulator (Fig. 1).

(*b*) A spring-loaded plate which tends to compress the bag.

(*c*) A valve in the outlet from the bag to the mask.

4. On the ground the correct functioning of the economizer can be roughly checked by setting the Mk. 10A regulator to 25,000 feet (or the Mk. 11 or Mk. 16 regulators to NORMAL) and then feeling the flow by holding the free end of the tube from the economizer vertically against the ear. The regulator should not be set to EMERGENCY. The end of the tube should not be held flat against the hand or pinched, as this is likely to cause damage to the economizer.

Flow Indicators

5. Flow indicators (Fig. 2) are fitted at all stations which are not within sight of a regulator. Each indicator shows whether or not oxygen is flowing, but gives no indication of the magnitude of the flow. It is fitted between the regulator and the economizer.

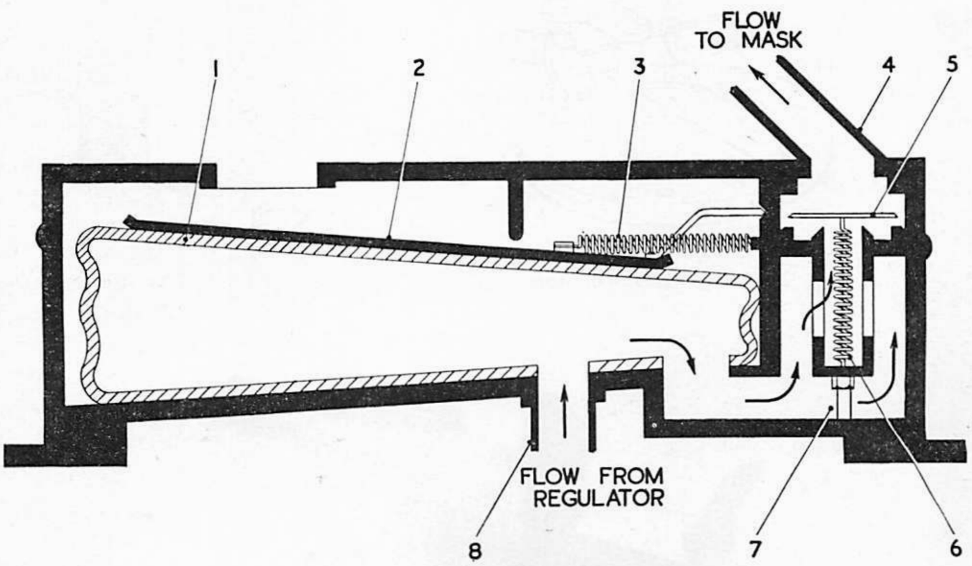


Fig. 1. Principle of Oxygen Economizer.

1. Flexible Storage Bag.
2. Moulded Breathing Plate.
3. Spring for Loading Breathing Plate.
4. Flexible Outlet Tube.
5. Mica Valve Disc.
6. Valve Spring.
7. Valve Chamber.
8. Inlet Pipe.

(*A.L.* 2, *Jan.* '55)

Cut-Off Valves

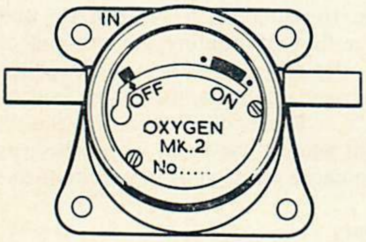
6. Where more than one economizer is supplied from a regulator, a cut-off valve (Fig. 3) is introduced to prevent wastage from the supply point when not in use. The valve is so designed that the action of stowing the end of the economizer tube in a clip, which is part of the valve, automatically cuts off the supply to that tube.

7. A small plastic plate with two luminous spots attached to the valve permits easy location in darkness.

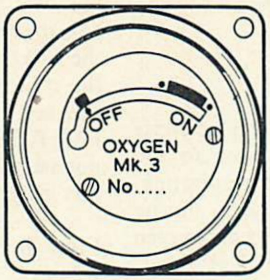
Pressure-Breathing Selector Valve

8. To provide for the use of pressure-breathing equipment, a selector cock (Fig. 4) is positioned on some aircraft between the oxygen regulator and the economizer. It is operated manually and has two positions, P.B. and ECON. It should be wirelocked in the position required. When the valve is set to P.B. the economizer is by-passed, giving a direct oxygen supply from the regulator to the crew member's supply tube.

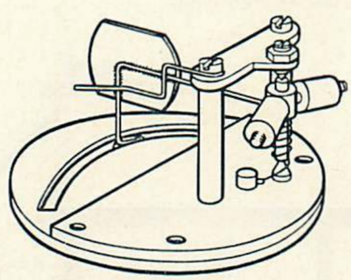
9. The use of pressure-breathing equipment necessitates the replacing of the aircrew member's quick-release socket on his supply tube by a quick-release plug. The change cannot be made during flight.



MK.2 INDICATOR (WITH UNIVERSAL MOUNTING FLANGE)



MK.3 INDICATOR (FOR DASHBOARD MOUNTING)



MECHANISM

Fig. 2. Oxygen Flow Indicators.

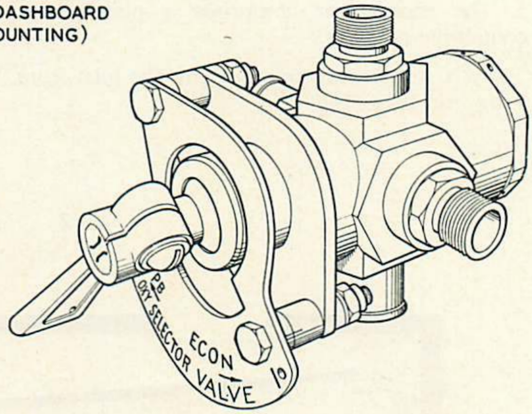


Fig. 4. Pressure-Breathing Selector Valve.

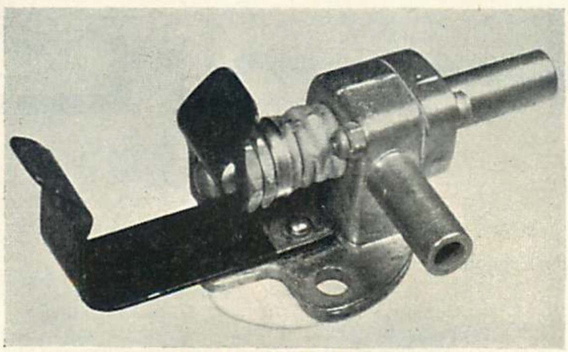


Fig. 3. Cut-Off Valve.

Mk. 10 Series Oxygen Regulators

Purpose and Components

10. Mk. 10 series regulators are designed to supply aircraft carrying up to eight men (Mk. 10A (Fig. 5)), and over eight and up to fifty men (Mk. 10A* (Fig. 6) and Mk. 10B). They embody the following components :—

(*a*) An ON/OFF valve.

(*b*) A pressure gauge graduated from FULL to EMPTY.

(*c*) A flow control knob which is adjustable, to vary the oxygen pressure to the mask.

(*d*) A flow gauge, graduated in thousands of feet, which is in fact a pressure gauge.

(*e*) Several fixed orifices, which are not part of the regulator. One orifice is required to supply each crew station, and it takes the form of a jet in a manifold. There may be several manifolds in each aircraft.

Flow Testing

11. Open the line valve before turning on the regulator valve (when closing, turn off the regulator valve before closing the line valve). With two oxygen outlets open, turn the flow control knob fully on and check that the pointer of the flow gauge moves steadily from about zero to the full EMERGENCY flow. Close the flow control knob and see that the pointer of the flow gauge returns smoothly to about zero.

Use in Flight

12. The following regulator settings should be used under the conditions listed below :—

(*a*) *In Level Flight.* The regulator should be set at the next multiple of 5,000 feet above the cabin altitude.

(*b*) *At Low Rates of Climb.* When the cabin altitude is rising at less than 2,000 feet per minute the regulator should be set at 15,000 feet when the cabin altitude reaches 10,000 feet. It should then be set in stages to the next multiple of 5,000 feet above the cabin altitude.

(*c*) *At High Rates of Climb.* When the cabin altitude is rising at more than 2,000 feet per minute, the regulator should be set at 25,000 feet from ground level up to that height, and set at 40,000 feet at cabin altitudes above 25,000 feet.

(*d*) *At High Speeds.* When flying at a true airspeed greater than 400 knots, the regulator should be set at 25,000 feet from ground level up to that cabin altitude, and set at 40,000 feet at cabin altitudes above 25,000 feet.

(*e*) *At Night.* When oxygen is used at night, the regulator should be set at 25,000 feet from ground level. When level flight is attained, or when the cabin altitude rises above 25,000 feet, the appropriate settings laid down as above for climbing, high speed, or level flight should be made.

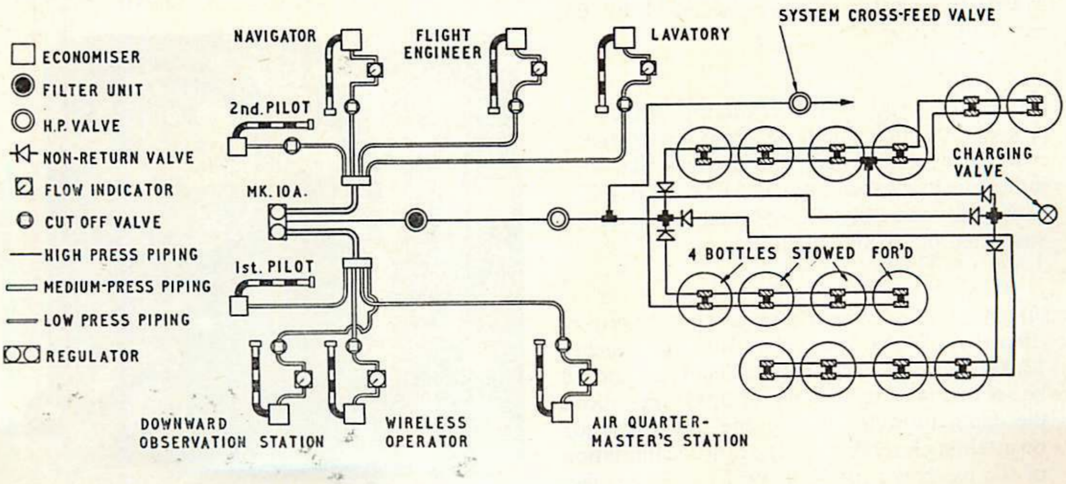


Fig. 5. Typical Oxygen System Incorporating Mk. 10A Regulator.

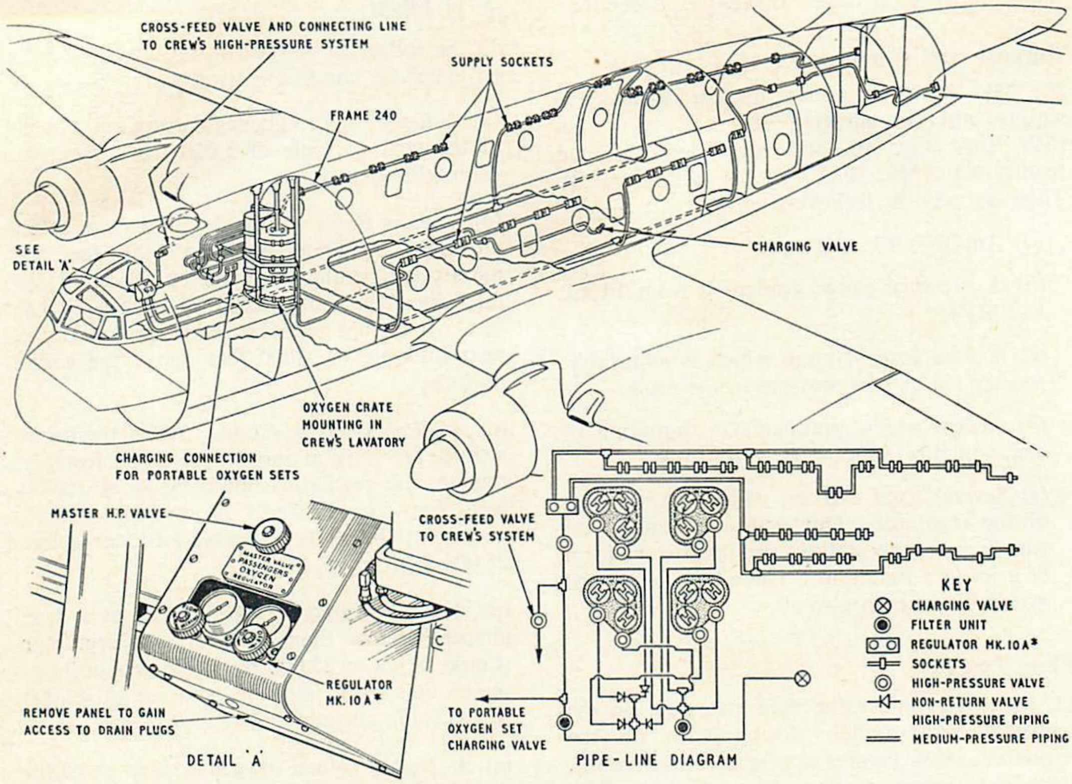


Fig. 6. Typical Oxygen System Incorporating Mk. 10A* Regulator.

(*f*) *At* 40,000 *ft. and Above*. As a precaution against sudden loss of cabin pressure, the regulator should be set at 40,000 feet when the aircraft indicated altitude is above 40,000 feet, irrespective of the altitude indicated by the cabin altimeter.

(*g*) *In Emergency*. The regulator can be set to give more than the flow of oxygen normally required at 40,000 feet, the delivery dial then indicating in the sector marked EMERGENCY. This is for use only if a shortage of oxygen is suspected or to combat fumes.

(*h*) *When Carrying Passengers in Transport Aircraft*. When the cabin altitude reaches 12,000 feet and is rising, the regulator should be set to the next multiple of 5,000 feet above the cabin altitude, and to the cabin altitude on attaining level flight. The altitude limitation of the passenger mask (Type L) is 30,000 feet cabin altitude, and its low temperature limitation is $-5°C$.

MK. 11 SERIES OXYGEN REGULATORS

Purpose and Components

13. Mk. 11 series regulators (Fig. 7) are designed to supply either one man (Mk. 11C) or

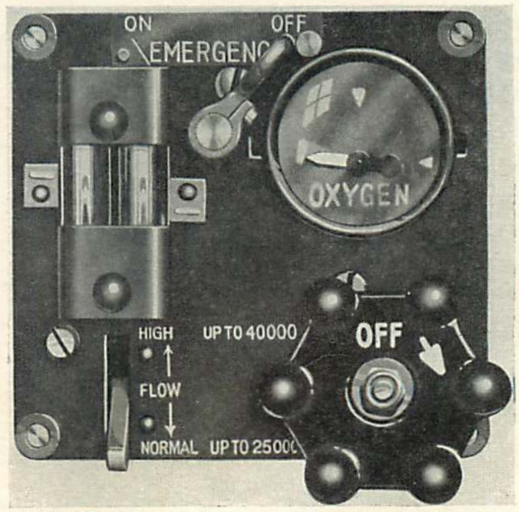


Fig. 7. Oxygen Regulator of the Mk. 11 Series.

two men (Mk. 11B, which is obsolescent, and which is being replaced by the Mks. 11D and 11E). They are primarily for use in fighter aircraft, and eliminate the readjustment for each change of height of 5,000 feet which is required by the Mk. 10 series. Mk. 11 series regulators embody the following components :—

(*a*) An ON/OFF valve.

(*b*) A contents gauge.

(*c*) A reduction valve giving constant reduced pressure.

(*d*) A flow change switch which has two positions, NORMAL up to 25,000 feet, and HIGH above 25,000 feet. In the NORMAL position, oxygen is allowed to flow through one fixed jet, and in the HIGH position through two fixed jets.

(*e*) A flow indicator, comprising two perspex tubes with a float in each. When there is no oxygen flow, the floats rest at the bottom of the tubes and are out of sight. When the oxygen flow is at NORMAL, one float is visible in the right-hand tube. When the flow is at HIGH, both floats are visible.

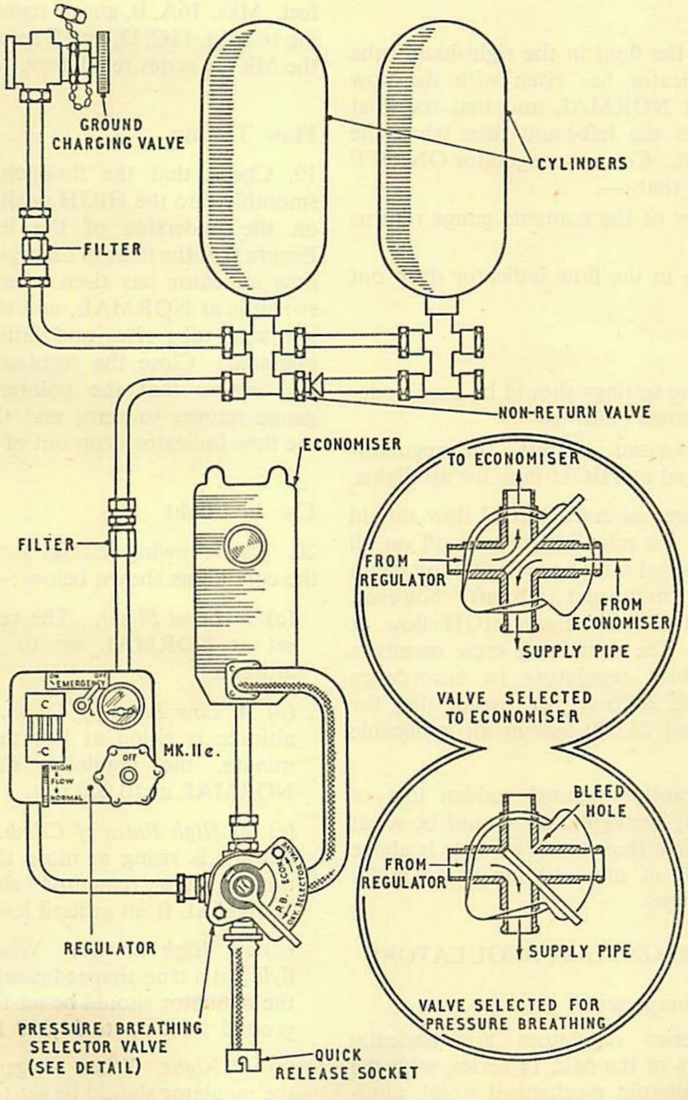


Fig. 8. Typical Oxygen System Incorporating Mk. 11 Series Regulator.

14. On Mk. 11C regulators an EMERGENCY flow control valve is fitted. This valve, when operated by the lever on the regulator, permits a much increased flow of oxygen to pass through the reducing valve to the user.

15. The Mk. 11D regulator is used in conjunction with the Mk. 11E to supply two men. The Mk. 11D is fitted with an EMERGENCY control valve, and is similar to the Mk. 11C, except that it supplies oxygen through the Mk. 11E for use by the second crew member. (The Mk. 11E has no contents gauge, reducing valve, or stop valve.)

Flow Testing

16. Ensure that the float in the right-hand tube of the flow indicator has risen with the flow change switch at NORMAL and that the float rises and falls in the left-hand tube when the switch is operated. Close the regulator ON/OFF valve and ensure that :—

(*a*) The pointer of the contents gauge returns to zero.

(*b*) Both floats in the flow indicator drop out of sight.

Use in Flight

17. The following settings should be used under the conditions shown below :—

(*a*) In unpressurized aircraft, the regulator should be locked at HIGH flow for all flights.

(*b*) In pressurized aircraft, HIGH flow should be selected by the pilot before take-off on all flights to be carried out above 25,000 feet cabin altitude. On multi-seat aircraft, however, only the pilot should select HIGH flow at ground level. The remaining crew members should use their regulators in accordance with sub-paras. 20(*a*) to (*e*), except that for 30,000 feet read 25,000 feet in all applicable sub-paras.

(*c*) As a precaution against sudden loss of cabin pressure, the regulators should be set at HIGH flow when the aircraft altitude is above 40,000 feet, or at any altitude when under combat conditions.

MK. 16 SERIES OXYGEN REGULATORS

Purpose and Components

18. Mk. 16 series regulators are basically oxygen regulators of the Mk. 11 series, with the addition of an aneroid mechanism which automatically increases the oxygen flow from NORMAL to HIGH on reaching about 30,000 feet cabin altitude. On descending below this altitude, the aneroid mechanism must be reset manually to reduce the oxygen flow to the correct value. The manual control can also be used to override the aneroid mechanism to give HIGH flow when necessary at altitudes below 30,000 feet. As, however, the cabin altitude in pressure-cabin aircraft should not normally exceed this figure, HIGH flow should usually be required in an emergency only. In comparison with Mk. 11 series regulators, the NORMAL oxygen flow of Mk. 16 series regulators is slightly increased owing to the increase in the change-over altitude from 25,000 to 30,000 feet. Mks. 16A, B, and C regulators, corresponding to Mks. 11C, D, and E respectively, supersede the Mk. 11 series regulators.

Flow Testing

19. Check that the flow change switch trips smoothly into the HIGH position when the latch on the underside of the lever is depressed. Ensure that the float in the right-hand tube of the flow indicator has risen when the flow change switch is at NORMAL, and that the float in the left-hand tube rises and falls as the switch is operated. Close the regulator ON/OFF valve and ensure that the pointer of the contents gauge returns to zero, and that both floats in the flow indicator drop out of sight.

Use in Flight

20. The following settings should be used under the conditions shown below :—

(*a*) *In Level Flight.* The regulator should be set at NORMAL up to 30,000 feet cabin altitude.

(*b*) *At Low Rates of Climb.* When the cabin altitude is rising at less than 2,000 feet per minute, the regulator should be set to NORMAL at 10,000 feet.

(*c*) *At High Rates of Climb.* When the cabin altitude is rising at more than 2,000 feet per minute, the regulator should be set to NORMAL from ground level.

(*d*) *At High Speeds.* When the aircraft is flying at a true airspeed greater than 400 knots, the regulator should be set to NORMAL from ground level up to 30,000 feet cabin altitude.

(*e*) *At Night.* When oxygen is used at night, the regulator should be set to NORMAL from ground level up to 30,000 feet cabin altitude.

(*f*) *At Heights Above* 30,000 *Feet*. If cabin pressure is lost, the regulator automatically changes to HIGH flow when the cabin altitude reaches 30,000 feet.

(*g*) *Resetting*. After the regulator has automatically changed to HIGH, as a result of a fall in the cabin pressure, it should be reset by hand to NORMAL when below 30,000 feet.

ENDURANCE

Oxygen Endurance and Regulator Settings

21. The ensurance of one full 750-litre cylinder per man is :—

(*a*) *Mk.* 10*A Oxygen Regulator.*

Height in Thousands of Feet	*Regulator Setting*	*Endurance Hours*	*Endurance Mins.*
10	10	9	0
11–14	15	6	15
15–19	20	5	15
20–24	25	4	20
25–29	30	3	40
30–34	35	2	55
35–40	40	2	55
	EMERGENCY	1	45

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

Height in Thousands of Feet	*Position of Flow-Change Switch*	*Endurance Hours*	*Endurance Mins.*
10	NORMAL	3	30
11–14	NORMAL	3	30
15–19	NORMAL	3	30
20–24	NORMAL	3	30
25–29	HIGH	1	50
30–34	HIGH	1	50
35–39	HIGH	1	50
40–44	HIGH	1	50
45–50	HIGH	1	50
	EMERGENCY	About 30	

(*c*) *Mk.* 11 *Series Oxygen Regulator* (*Using HIGH Flow from Take-Off*).

Height in Thousands of Feet	*Position of Flow-Change Switch*	*Endurance Hours*	*Endurance Mins.*
10	HIGH	1	40
11–14	HIGH	1	42
15–19	HIGH	1	46
20–24	HIGH	1	49
25–29	HIGH	1	52
30–34	HIGH	1	55
35–39	HIGH	1	55
40–44	HIGH	1	55
45–50	HIGH	1	55
	EMERGENCY	About 30	

(*d*) *Mks.* 16*A*, *B*, *and C Oxygen Regulators.*

Height in Thousands of Feet	*Position of Change-Over Switch*	*Endurance Hours*	*Endurance Mins.*
10	NORMAL	3	15
11–14	NORMAL	3	15
15–19	NORMAL	3	15
20–24	NORMAL	3	15
25–29	NORMAL	3	15
30–34	HIGH	1	55
35–39	HIGH	1	55
40–44	HIGH	1	55
45–50	HIGH	1	55
	EMERGENCY	About 30