

RESTRICTED

AP 52758

BOOK No.5

CHAP. No. 1

TITLE

ECONOMIZER

TYPE

Mk 4

PART No.

60 1444

FITTED TO

VAMPIRE

RESTRICTED

Chapter 1

OXYGEN ECONOMIZER, Mk. 4

LIST OF CONTENTS

	Para.		Para.
<i>Introduction</i>	1	<i>General</i>	13
<i>Description</i>	3	<i>Dismantling</i>	14
<i>Operation</i>	8	<i>Examination</i>	17
<i>Installation</i>	11	<i>Assembling</i>	18
<i>Servicing</i>			

LIST OF ILLUSTRATIONS

	Fig.
<i>Oxygen economizer, Mk. 4</i>	1
<i>Valve components</i>	2
<i>Schematic diagram</i>	3

LIST OF APPENDICES

	App.
<i>Standard serviceability tests</i>	1

Introduction

1. Oxygen economizers, Mk. 4 (Ref. No. 6D/1444), are installed in certain continuous flow, aircraft oxygen systems to eliminate wastage of oxygen. In earlier continuous flow systems not equipped with an economizer, a continuous flow of oxygen was available at the user's mask and, in consequence, oxygen was discharged to atmosphere when the user exhaled.

2. When using an economizer, a saving is

effected by supplying oxygen to each mask only when the user is inhaling, and storing the oxygen in a reservoir while the user is exhaling. This saving is achieved without reducing the efficiency of the system or affecting the comfort of the user.

DESCRIPTION

3. The components of the economizer (fig. 1) are housed in a moulded case comprising a body

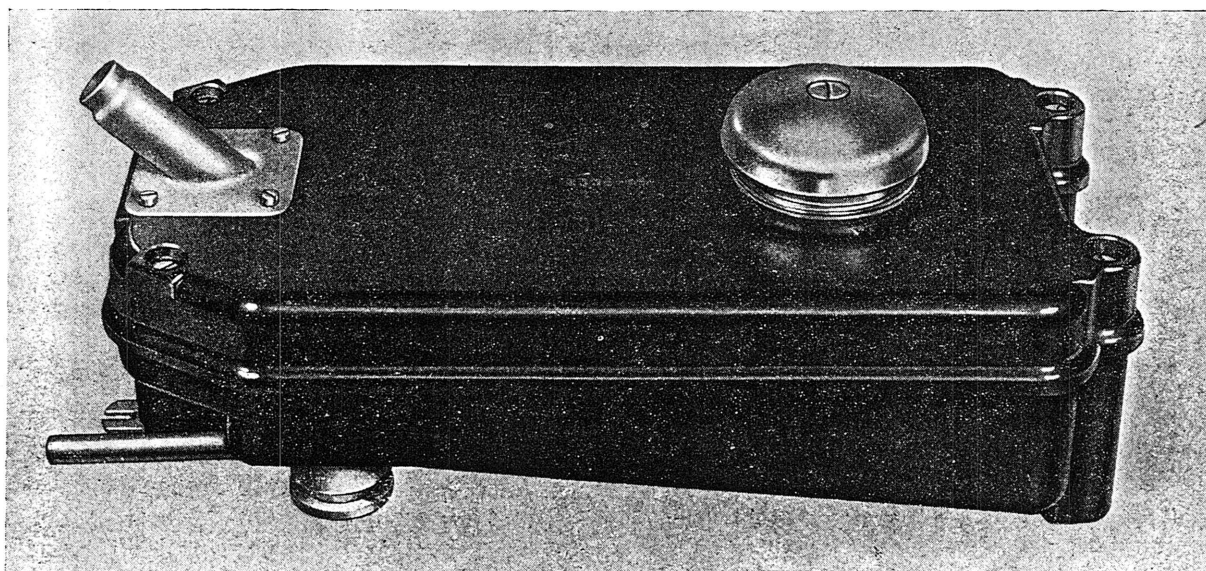


Fig. 1. Oxygen economizer, Mk. 4

RESTRICTED

assembly and a cover assembly. The body assembly carries three external fixing lugs, and an inlet pipe which can be rotated through 180° for installation purposes. The cover assembly incorporates an outlet tube which can be located in any one of four positions and, when the economizer is installed, is connected to the user's mask by a flexible hose. Also incorporated in the cover assembly is a vent, or breather, fitted with a screen which can be removed to visually check the operation of the economizer.

4. The components housed within the economizer case consist principally of a rubberized fabric bag, a valve assembly and a valve housing. The fabric bag fits into the body assembly and is attached, by an outlet port, to a moulded outlet channel, and by an inlet port, to the inlet pipe. The valve body (fig. 2) comprises a brass body and spring support which is held on a valve housing by a threaded brass ring. The inner and outer valve seatings are machined in one piece on the valve body and afterwards lapped flat

and true to prevent distortion of the inner seat. The valve disc assembly is guided by a brass insert on the valve housing. The spring of the valve disc assembly is attached to a spring anchorage. Two locknuts secure the anchorage in the valve body and permit valve adjustment.

5. The gauze filter is separate from the housing and is soldered to a cylindrical, conical-ended brass support. The seal between the valve housing and the moulded outlet channel is effected by a rubber ring which is compressed between the conical end of the filter and the underside of the threaded brass ring. The annular space between the inner and outer valve seating is vented to the economizer casing by small holes drilled in the valve body and the brass ring.

6. The cover assembly has two metal sockets which locate metal rocker arms secured to the pressure plate assembly. The plate is spring-loaded away from the cover by two coil springs, each of which is attached to a pin on an arm

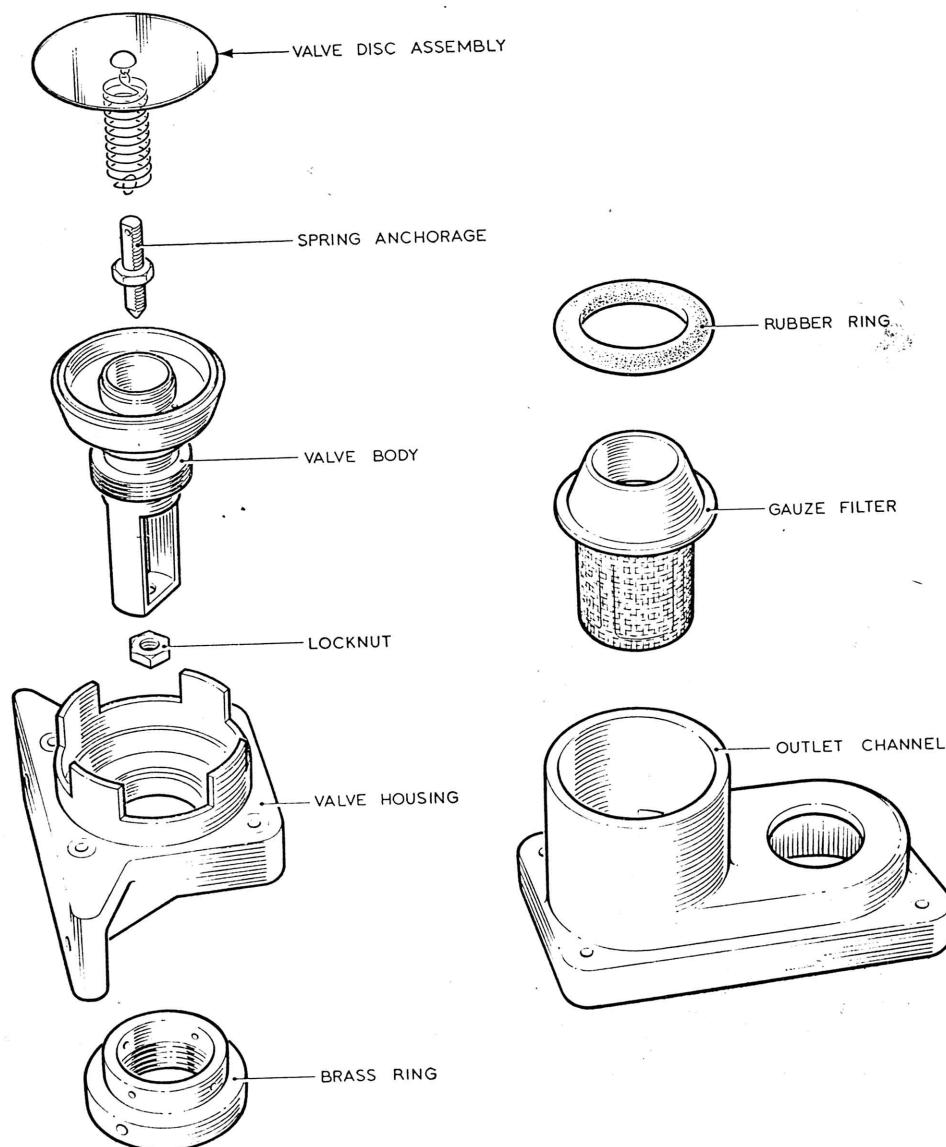


Fig. 2. Valve components

RESTRICTED

forming part of the valve moulding. When the cover and body assemblies are assembled, the pressure plate assembly is spring-loaded upon, and compresses, the storage bag. The pressure plate is restrained from excessive upward movement by a stop in the form of a projection moulded in the cover assembly of the economizer case. Excessive downward movement of the pressure plate is prevented by stops which engage with a bracket fitted to the cover assembly.

7. A cover, fitted over the breather plate, prevents direct ingress of moisture on to the breather gauze, and a number of drain holes are drilled in the base so that any moisture can drain away.

OPERATION

8. The following description should be read in conjunction with fig. 3. When the oxygen regulator is turned on, oxygen enters the flexible storage bag (1) through the inlet pipe (8). The gas is then stored in the bag under light pressure imparted by the spring (3) on the pressure plate (2). The mica valve disc (5) is held on the seating by the spring (6), this spring being of a strength sufficient to prevent a flow of oxygen from the bag into the outlet pipe during the period that oxygen is stored in the bag.

9. The outlet tube (4) leads to the oxygen mask, and the suction created in this tube when the user inhales, lifts the valve disc against the pressure exerted by the spring (6) thereby allowing oxygen to pass from the storage bag to the user.

10. At low altitudes, the volume of oxygen supplied fills only a portion of the lungs at each breath and the bag empties before the user has finished inhaling. As the user continues to breathe in, the increased suction opens the inspiratory valve in the oxygen mask, and the lungs then receive air through this valve. When the user starts to exhale, the rubber expiratory valve in the mask is forced open, in an outward direction, and his breath escapes through it to atmosphere. While still exhaling, the mica valve disc in the economizer remains closed and the bag therefore refills ready for the next inhalation. This cycle of operations is then repeated as the user breathes.

INSTALLATION

11. The economizer is secured to an aircraft by three fixing lugs and can be fitted horizontally, either supported on the mounting lugs or in the inverted position.

12. The inlet pipe to the economizer is connected to the low-pressure supply pipeline in the aircraft by a low-pressure union. The inlet pipe connection can be used in any position over approximately 180°. The outlet tube can be positioned in any one of four directions. The flexible supply hose fits over the outlet tube and must be pushed over the tube far enough to ensure that the metal end projects inside the wire helix in the hose. The hose is secured to the outlet tube by an Aerolex clip, Type B.

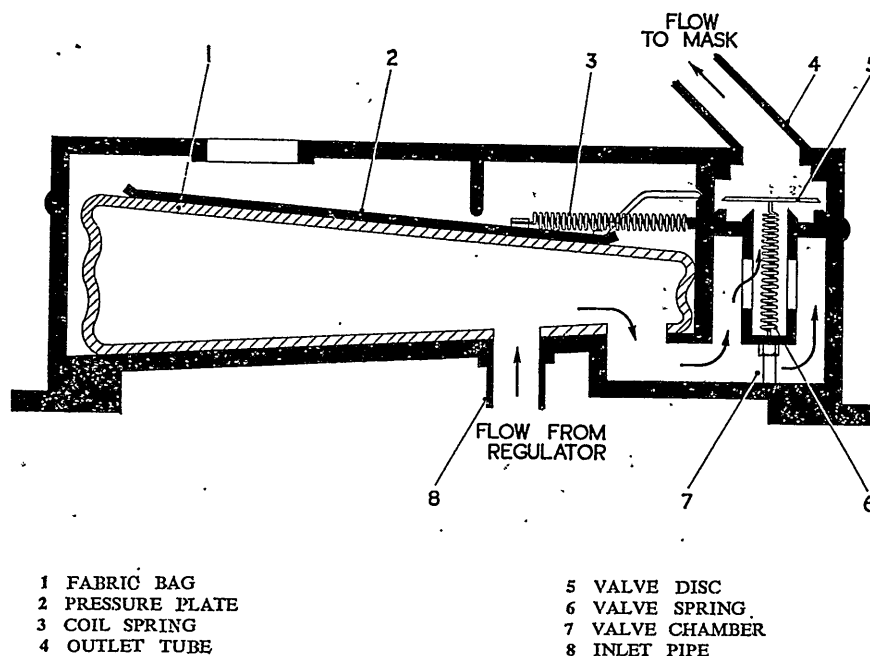


Fig. 3. Schematic diagram

RESTRICTED

Note . . .

In some economizers a paper packing tube is inserted between the mica valve disc and the outlet connection of the economizer to prevent the edges of the valve being damaged in transit. This practice has been discontinued as it is no longer considered necessary. On those economizers fitted with packing pieces, a label bearing the words 'Before using economizer remove paper packing tube under outlet connection' is attached to one of the screws of the outlet connection. Before the economizers are brought into use, the paper packing tube must be removed.

SERVICING

General

13. Routine servicing consists of examining the unit for freedom from damage and deterioration, and security of installation.

WARNING . . .

Many materials, particularly oil and grease, are subject to spontaneous combustion when exposed to undiluted oxygen under pressure. Precautions must be taken, therefore, to exclude oil, grease, dust and metal particles from the economizer.

Dismantling

14. The unit can be dismantled for the renewal of the valve disc assembly and the economizer bag, provided that the unit is subjected to the standard serviceability tests after assembling. It is recommended that all washers and seals removed during dismantling are renewed during assembling.

15. (1) Note the position of the outlet tube and then remove the four screws and washers securing the tube. Detach the tube and outlet washer.

(2) Remove the four screws and washers securing the cover assembly to the body assembly and separate the assemblies.

(3) Detach the two springs of the pressure plate assembly from their pin anchorages on the valve housing, and withdraw the pressure plate assembly.

(4) Remove the four screws securing the valve housing to the cover, detach the valve housing, complete with the valve disc assembly, and the housing washer. Remove the two spring anchorage pins from the valve housing.

(5) Remove the lower 4 BA locknut on the valve spring anchorage and extract the valve disc assembly and the spring anchorage. Detach the spring anchorage from the valve disc assembly.

16. (1) Note the position of the inlet pipe. Remove the securing nuts and washers locating the inlet and outlet ports to the economizer bag.

(2) Detach the inlet pipe and washer from the inlet port.

(3) Withdraw the economizer bag and separate the inlet and outlet ports, the bag washers and the bag.

Examination

17. All components should be examined for corrosion and damage, and cleaned with an approved cleaning agent. The small vent holes in the valve body and the threaded brass ring should be checked for freedom from obstruction. The bag should be checked for deterioration, and its service life checked against the date inscribed on the economizer cover.

Assembling

18. (1) Insert the inlet and outlet ports (Part No. W8225-4) in the replacement bag (Ref. No. 6D/1778), position a washer (Ref. No. 6D/1635) over each port and insert the outlet port through the hole in the outlet channel, and the inlet port through the hole in the base of the body.

Note . . .

The flats on the ports should fit against the flats of their locating holes.

(2) Fit a banjo washer (Ref. No. 6D/1636) over the inlet port, position the inlet pipe over the port and secure with a washer (Ref. No. 6D/1637) and securing nut (Part No. W8225-5).

(3) Secure the outlet port with a further washer and securing nut.

19. (1) Attach the replacement valve disc assembly (Ref. No. 6D/2348) to the spring anchorage (Part No. W8264-7), ensuring that the loop of the spring is fully closed and the centre of the loop is on the axis of the spring.

(2) Position the valve disc assembly in the valve body (Part No. 1N7038), so that the mica disc rests on the seat and the end of the spring anchorage passes through the hole at the base of the valve body. Secure the adjuster using the brass 4 BA locknut.

Note . . .

The flat on the spring anchorage should fit against the flat of the locating hole in the valve body.

(3) Position a washer (Part No. W82361) and secure the valve housing, complete with the valve body and valve disc assembly, to the cover using four screws (Part No. S.M.E.35670-1).

RESTRICTED

(4) Insert the two spring pins (Part No. W.8236-8) in the valve housing. Hook the spring loops through the pins and ease the pressure plate assembly in position so that the rocker arms are located in their sockets and the two stops on the pressure plate are resting on the bracket fitted to the cover.

(5) Insert a new rubber ring (Ref. No. 6D/2456) over the filter located in the outlet channel.

(6) Fit a new washer (Ref. No. 6D/2346) to the outlet tube (Ref. No. 6D/610) and secure the two components to the cover

using the four 6 BA screws and spring washers.

(7) Locate the cover assembly on the body, ensuring that the valve body fits into the filter well. Secure the cover with four 2 BA screws, spring washers and brass plain washers.

(8) Apply the standard serviceability tests (App. 1). If adjustment of the valve disc assembly is required, remove the cover and adjust the tension of the spring by means of the two brass 4 BA locknuts. Repeat the appropriate serviceability tests.

RESTRICTED

Appendix 1

STANDARD SERVICEABILITY TESTS

for

OXYGEN ECONOMIZER, Mk. 4

Introduction

1. The tests detailed in this appendix should be applied before the economizer is installed in an aircraft, when the serviceability of the economizer is in doubt and at the appropriate examination periods at Equipment Depots.

Test equipment

2. The equipment required is as follows:—

- (1) Ground tester, Mk. 3, for oxygen economizers (Ref. No. 6C/779)
- (2) Hose, low pressure, Mk. 5 (Ref. No. 6D/1714)
- (3) Socket, bayonet union, Mk. 4 (Ref. No. 6D/527)
- (4) Pressure regulator (Ref. No. 6C/3040)
- (5) Control valve, Mk. 10A (Ref. No. 6D/2313)
- (6) Flow tester, Mk. 5A* (Ref. No. 6C/475)
- (7) Pipeline filter, Mk. 1 (Ref. No. 6D/574)
- (8) A water U tube of the following dimensions:—
 - (a) Bore of tube—6 mm
 - (b) Length of vertical arms—200 mm
 - (c) Distance between vertical arms—30 mm
 - (d) Vertical distance between bottom of the tube and the liquid level—100 mm
 - (e) The bend at the base must be semi-circular and unrestricted.

Particulars of test

3. The tests are to be applied under normal room temperature (+15°C) and pressure (29.92 in. Hg) conditions. The gas supply for the tests must be breathing oxygen. Except where otherwise stated, the economizer must stand on its fixing lugs and with the Mk. 5 hose disconnected.

4. For the application of the tests, the unit should be connected to a test rig as shown in

fig. 1. Before connecting the economizer, a flow tester Mk. 5A* should be connected to the pipeline and the flow requirement established as follows:—

- (1) With the flow tester fitted to the test rig, in lieu of the economizer, adjust the pressure regulator to establish a flow of 2 litres/min. on the flow tester.
- (2) Close the control valve. Remove the flow tester and connect the economizer.

5. Economizers not conforming to the test requirements are to be disposed of in accordance with current Service procedure.

WARNING . . .

Many materials, particularly oil and grease, are subject to spontaneous combustion when exposed to undiluted oxygen under pressure. Precautions must be taken, therefore, to exclude oil, grease, dust and metal particles from the economizer and the test equipment.

TEST PROCEDURE

Valve tripping pressure (fig. 1)

6. Open the control valve. The tripping pressure (that is, the maximum pressure indicated on the U tube at the instant the economizer valve operates) should be between 54 and 66 mm of water. Close the control valve.

Normal functioning test

7. With the economizer connected to the test rig (fig. 1), fit a Mk. 5 low-pressure hose, terminating in a Mk. 4 socket, to the outlet of the economizer and connect the hose to the ground tester, Mk. 3. Open the control valve and operate the ground tester as follows:—

- (1) Depress the lever arm fully until the spring catch engages the arm.
- (2) Position the ground tester with the indicator tube vertical and support the economizer flexible tube to relieve any strain on the connector.
- (3) Allow the red ball to jump repeatedly.

RESTRICTED

(4) Press the trip lever and observe the position at which the pointer halts momentarily between the red marks.

Leak test

8. The following test should be applied with the unit connected to the test rig (fig. 1) after completing the normal functioning test. The procedure is as follows:—

- (1) Set the cursor arm of the ground tester to the halt position of the pointer.
- (2) Depress the lever arm fully until the

spring catch engages the arm.

(3) Close the control valve.

(4) Allow the red control ball to come to rest and, after 60 seconds, depress the trip lever.

(5) The leakage from the economizer is acceptable only if the pointer halts between the two arms of the cursor.

(6) Disconnect the economizer from the test rig.

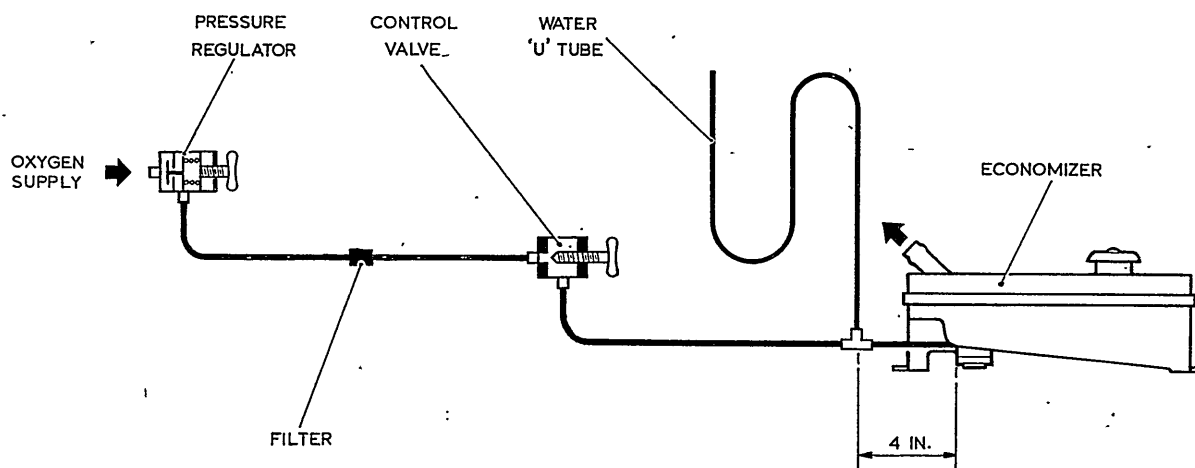


Fig. 1. Diagram of test rig

RESTRICTED

Chapter 6

OXYGEN ECONOMIZER, Mk. 4

LIST OF CONTENTS

	Para.		Para.
Introduction	1	Installation	10
Operation... ..	2	Testing	12
Description	4		

LIST OF ILLUSTRATIONS

	Fig.		Fig.
Oxygen economizer, Mk. 4... ..	1	Components of valve	3
Diagram showing principle of oxygen economizer...	2		

LIST OF APPENDICES

Standard serviceability Test (S.O.4)	App. 1
---	--------

Introduction

1. Oxygen economizers are for use in aircraft, and are provided, as their name implies, to eliminate wastage of oxygen without in any way reducing either efficiency or comfort. In earlier oxygen systems a continuous flow of oxygen was available

at the user's mask and, in consequence, oxygen was being discharged to atmosphere when the user was breathing out. By using an economizer a saving is effected by supplying oxygen to each mask only when the user is breathing in, and storing the oxygen in a reservoir while he is breathing out.

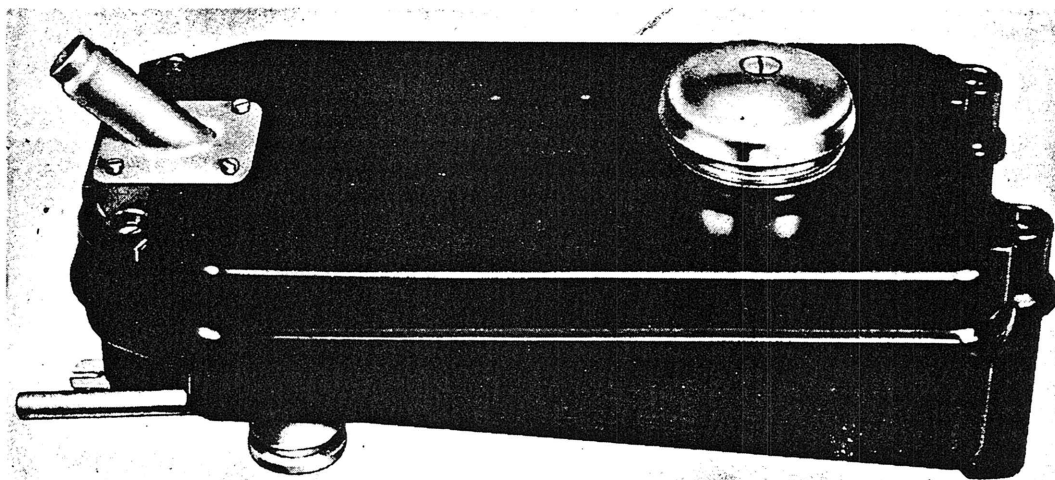


Fig. 1. Oxygen economizer, Mk. 4

(A.L.24, Feb. 56)

RESTRICTED

FC/1

OPERATION

2. The economizer operates as follows:— when the oxygen regulator is turned on, oxygen enters the flexible storage bag (1, *fig. 2*), through the inlet pipe (8). The gas is then stored in the bag under light pressure, imparted by the spring (3) on the breathing plate (2). The mica valve disc (5) is held on the seating by the spring (6), this spring being of a strength sufficient to prevent a flow of oxygen from the bag into the outlet pipe during the period that oxygen is stored in the bag.

3. The outlet pipe (4) leads to the oxygen mask, and the suction created in this pipe when the user breathes in, lifts the valve disc against the action of the spring (6) thereby allowing oxygen to pass from the storage bag to the user.

DESCRIPTION

4. The economizer, a general view of which is given in *fig. 1*, is constructed of moulded material and is divided into an upper section and a lower section. The lower section carries three external fixing lugs and an inlet pipe; the inlet pipe can be swung through approximately 180 degrees for purposes of installation. The upper section carries, externally, the outlet tube which can be attached in any of four positions. A flexible outlet tube is fitted between this tube and the user's mask. There is also a screened vent hole or breather which, when the screen is removed, permits observation of the interior.

5. The components of the economizer include a flexible, rubberized fabric bag

which fits into the lower section of the case and is attached by one ferrule to a chamber formed in the case below the valve chamber, and by another ferrule to the inlet pipe. The valve housing consists of a brass valve body (9, *fig. 3*), and spring support which is held on a moulded housing (14) by a threaded brass ring (13). The inner and outer valve seatings are machined in one piece on the valve body and afterwards lapped flat and true to prevent distortion of the inner seat. The valve disc is guided by a brass insert on the housing.

6. The gauze filter (11) is separate from the housing and is soldered to a cylindrical conical-ended brass support. The seal between the valve housing (14) and the moulded outlet tube (12) is effected by a rubber ring (10) of round section which is compressed between the conical end of the filter and the underside of the threaded brass ring. The annular space between the inner and outer valve seating is vented into the economizer casing by small holes drilled in the valve body and threaded brass ring.

7. The upper section of the case has two metal sockets which locate metal rocker arms secured to the moulded breather plate. The breather plate is spring-loaded away from the cover by two coil springs, each of which is attached to a pin on an arm forming part of the valve moulding. When the upper and lower sections are assembled, the breather plate is spring-loaded upon, and compresses, the storage bag. The pressure plate is restrained from excessive upward movement by a stop in the form of a projection moulded in the upper section of the economizer case.

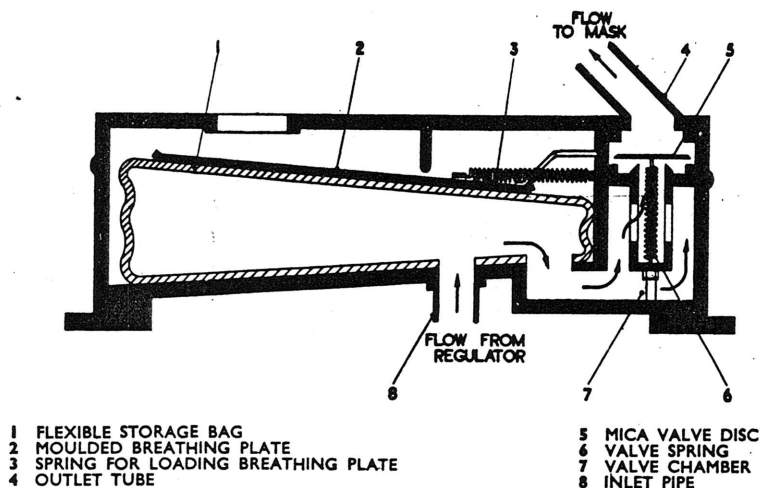


Fig. 2. Diagram showing principle of oxygen economizer

RESTRICTED

8. A cover, fitted over the breather plate, prevents direct ingress of moisture on to the breather gauze, and a number of drain holes are drilled in the base so that any moisture can drain away.

9. At low altitudes the volume of oxygen supplied fills only a portion of the lungs at each breath and the bag empties before the user has finished inspiring. As he continues to breathe in, the increased suction opens the inspiratory valve in the oxygen mask, and the lungs are topped up with air through this valve. When the user starts to exhale, the rubber expiratory valve in the mask is forced open, in an outward direction, and his breath escapes through it to atmosphere. While still breathing out, the mica valve disc in the economizer remains closed and the bag therefore re-fills ready for the next inspiration; this cycle of operations is then repeated for each complete inspiration.

INSTALLATION

10. The economizers are secured to the aircraft at each crew station in suitable positions, by three fixing lugs. They may be fitted in the aircraft horizontally, either standing on the mounting lugs or in the inverted position.

11. The inlet supply pipe to the economizer is connected to the low-pressure supply pipeline in the aircraft by means of a low-pressure union. The inlet pipe connection can be used

in any position over approximately 180 degrees. The outlet union is designed to face in any one of four directions. The flexible supply tube fits over the outlet union, and must be pushed over the union far enough to ensure that the metal end projects inside the wire helix in the flexible tube. It is fastened over the rubber by means of an Aerolex clip, Type B.

Note . . .

In some economizers a paper packing tube is inserted between the mica valve disc and the outlet connection of the economizer to prevent the edges of the valve being damaged in transit. This practice has been discontinued as it is no longer considered necessary. On those economizers fitted with packing pieces, a label bearing the words "Before using economizer remove paper packing tube under outlet connection" is attached to one of the screws of the outlet connection. Before the economizers are brought into use, the paper packing tube must be removed.

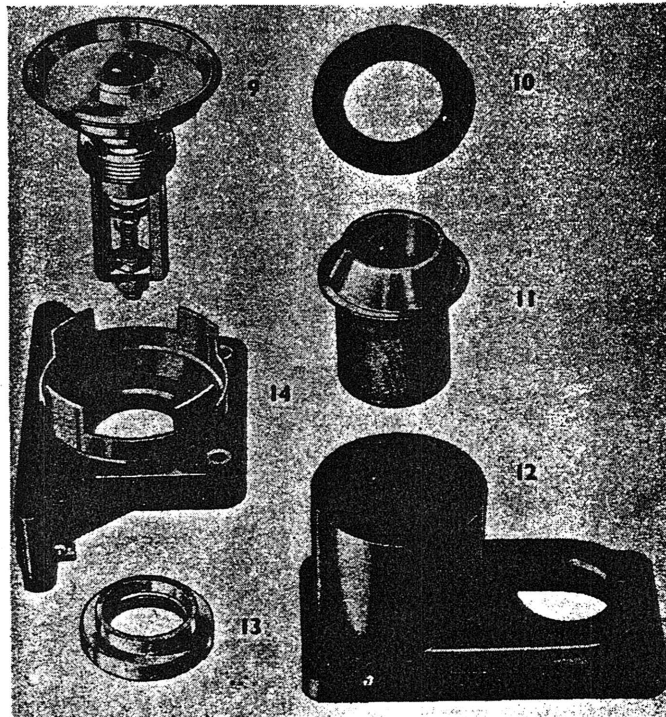
TESTING

12. The economizer tester Mk. 3, which is a device for testing economizers in situ, has been developed and is now available to the Service. To carry out the tests, it is necessary first to remove the bayonet socket from the cut-off valve (or stowage clip) and connect it to the inlet of the tester. Full details of the tests which are to be made with the tester are given in the lid of the tester.

RESTRICTED

(A.L.24, Feb. 56)

F.S./2



- | | |
|--------------------|------------------------|
| 9 BRASS VALVE BODY | 12 MOULDED TUBE |
| 10 RUBBER RING | 13 THREADED BRASS RING |
| 11 GAUZE FILTER | 14 MOULDED HOUSING |

Fig. 3. Components of valve

RESTRICTED

Appendix I
STANDARD SERVICEABILITY TEST (S.O.4)
for
OXYGEN ECONOMIZER, Mk. 4

Introduction

1. The tests laid down in this Appendix must be applied to the above-mentioned economizers immediately prior to installation in aircraft, and at any time when their serviceability is suspect. The tolerances specified must not be exceeded.

METHOD OF TEST

2. Except where otherwise stated, the economizer undergoing test must stand on its fixing feet without the Mk. 5 tubing connected. Only breathing oxygen or other clean dry gas, strictly in accordance with the Standard Serviceability Test (S.O.1) given in A.P. 1275A, Vol. 1, Sect. 8, Chap. 1, App. 2, may be used.

TEST EQUIPMENT

3. The following equipment is required when testing these economizers:—

Description		Stores Ref.	Remarks
Felt pad filter		6D/630	Used with air or nitrogen
Pipe-line filter, Mk. 2A		6D/1660	For use with oxygen when regulator is used
Pipe, connecting, straight end		6D/1446	} Fitted between pipe-line filter Mk. 2, and regulator
or			
Pipe, connecting, elbow end		6D/1599	} May be used instead of Mk. 2 filter if using reducing valve and oxygen
Pipe-line filter, Mk. 1		6D/574	
Either	{ Oxygen regulator, Mk. 10A	6D/512	
	{ Oxygen manifold, Mk. 1A	6D/515	
	{ L.P. manifold blanking caps	6D/428	
	{ A suitable reducing valve and a flowmeter for giving a steady gas supply of 2 to 6 litres per min.		
or			
Cut-off valve, Mk. 1		6D/480	
Bayonet union socket, Mk. 4		6D/527	
Flexible tubing, Mk. 5		6D/531	
Ground tester, Mk. 3, for oxygen economizer		6C/779	For further information see A.P. 1275T, Vol. 1, Sect. 6, Chap. 3

In addition, a water "U" tube is required and should be manufactured locally to the following dimensions:—

Bore of tube = 6 mm.

Length of vertical arms = 200 mm.

Distance between vertical arms = 30 mm.

Vertical distance between bottom of the tube and liquid level = 100 mm.

The bend at the bottom must be semi-circular and unrestricted.

Test rig

4. Connect the regulator inlet to the test supply via the filter. Connect the outlet of the Mk. 10 regulator to the Mk. 1A manifold. Seal the second outlet of the regulator and all except one of the outlets of the manifold by means of a blanking union and blanking caps respectively.

(A.L.24, Feb. 56)

RESTRICTED

F.S./I

5. Connect the outlet of either the manifold or any other regulator and flowmeter used, to the *outlet* of the cut-off valve (this is the reverse way of connecting it to normal procedure) and connect the *inlet* of the cut-off valve to the economizer. The water "U" tube should be teed in between the cut-off valve inlet and the economizer, using a $\frac{1}{4}$ in. bore tee piece, and should be installed at a point 4 in. before the economizer inlet.

TESTS

6. The following are the tests to be applied:—

Valve tripping pressure

- (1) Adjust the delivery to the economizer to 2 litres per minute (i.e., "15" setting on the Mk. 10 regulator). The tripping pressure (that is, the maximum pressure indicated on the "U" tube at the instant when the economizer valve operates) must be between 54 and 66 mm. of water.

Automatic functioning

- (2) Adjust the delivery to the economizer to about 6 litres per min. (EMERGENCY setting on the Mk. 10A regulator). Remove the breather gauze in the cover and watch the movement of the pressure plate inside. The plate should rise until it touches the cover and then fall to within $\frac{1}{4}$ in. of its lowest position. This cycle should be repeated automatically.

Leakage

- (3) Fill the economizer until the plate is about $\frac{1}{4}$ in. away from the cover. Cut off the supply by inserting a Mk. 4 socket in the cut-off valve. The plate should not fall more than $\frac{1}{4}$ in. in the ensuing 30 seconds.

Note . . .

Any indicator which is used to show the pressure plate movement must not apply a load of more than 1 oz. to the plate and must not obstruct the breather hole appreciably.

7. The following tests are alternative to those given in para. 6 and should be performed using the ground tester, Mk. 3:—

Valve tripping pressure

- (1) Procedure as for the test detailed in para. 6, sub-para. (1).

Normal functioning

- (2) Fit a Mk. 5 tube, terminating in a Mk. 4 socket to the outlet of the economizer. Connect the tube to the ground tester and perform the "Normal ground test" according to the instructions given with the tester. Then set the cursor on the tester for the leakage test.

Leakage

- (3) Perform the leakage tests according to the instructions given in the tester. Insert the Mk. 4 socket in the cut-off valve to shut off the supply.

RESTRICTED