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CABIN PRESSURE CONTROL VALVES

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Introduction

1. The function of a cabin pressure control valve in an aircraft is to regulate cabin pressure by restricting the discharge of air from the cabin to atmosphere. In addition, the unit incorporates a safety valve to prevent an excessive differential pressure developing in the event of failure of the control mechanism, and an inwards relief valve to prevent the negative differential pressure which tends to occur in certain conditions of flight. The unit will also operate a cabin pressure warning device (visual or audible) in the event of serious loss of cabin pressure.

2. Several versions of the unit are available to suit the requirements of particular aircraft. A typical unit is described in the chapter, and reference should be made to the Appendices for detailed differences.

DESCRIPTION

3. The cabin pressure control valve (*fig.* 2) consists of two chambers, the upper of which contains the pressure control mechanism, a switch mechanism for the cabin pressure warning device and a discharge valve. The lower chamber carries the mounting flange, and contains a safety valve and an inwards relief valve.

Top chamber

4. The top chamber is a dome-shaped casting with a threaded recess at the apex to hold a spring housing. A discharge valve spring is located between the top of the spring housing and a shoulder on an orifice body.

Capsule assemblies

5. Two capsule assemblies (absolute and atmospheric) are mounted internally on the wall of the top chamber. The absolute capsule assembly consists of a pack of three evacuated metal capsules, with an attachment bolt soldered to one end and an end fitting soldered to the other end. The attachment bolt passes through the casting wall, and is secured on the outside by a sealing washer and nut. The end fitting passes through a slot in one end of a beam, and is prevented from disengaging by a transverse pin. A light coil spring is fitted between the capsules and the beam to maintain the beam in contact with the pin. The beam extends for a short distance beyond the end fitting, and the inwards movement of this end of the beam is limited by a beam stop.

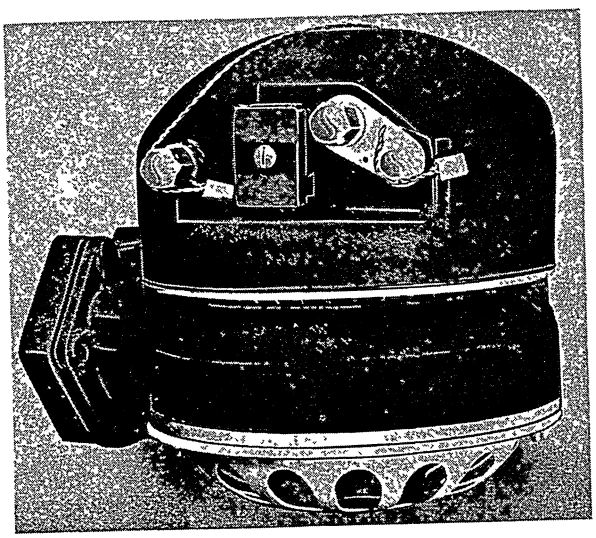


Fig. 1. Typical cabin pressure control valve

6. The atmospheric capsule assembly comprises three capsules interconnected to each other and fitted to a hollow attachment bolt, the outer end of which is protected by a fine mesh gauze. The attachment bolt passes through the casting wall, and is secured on the outside by a sealing washer and a nut which supports a filter guard. An end fitting, soldered to the inside capsule, is hinged to the other end of the beam by a pivot pin.

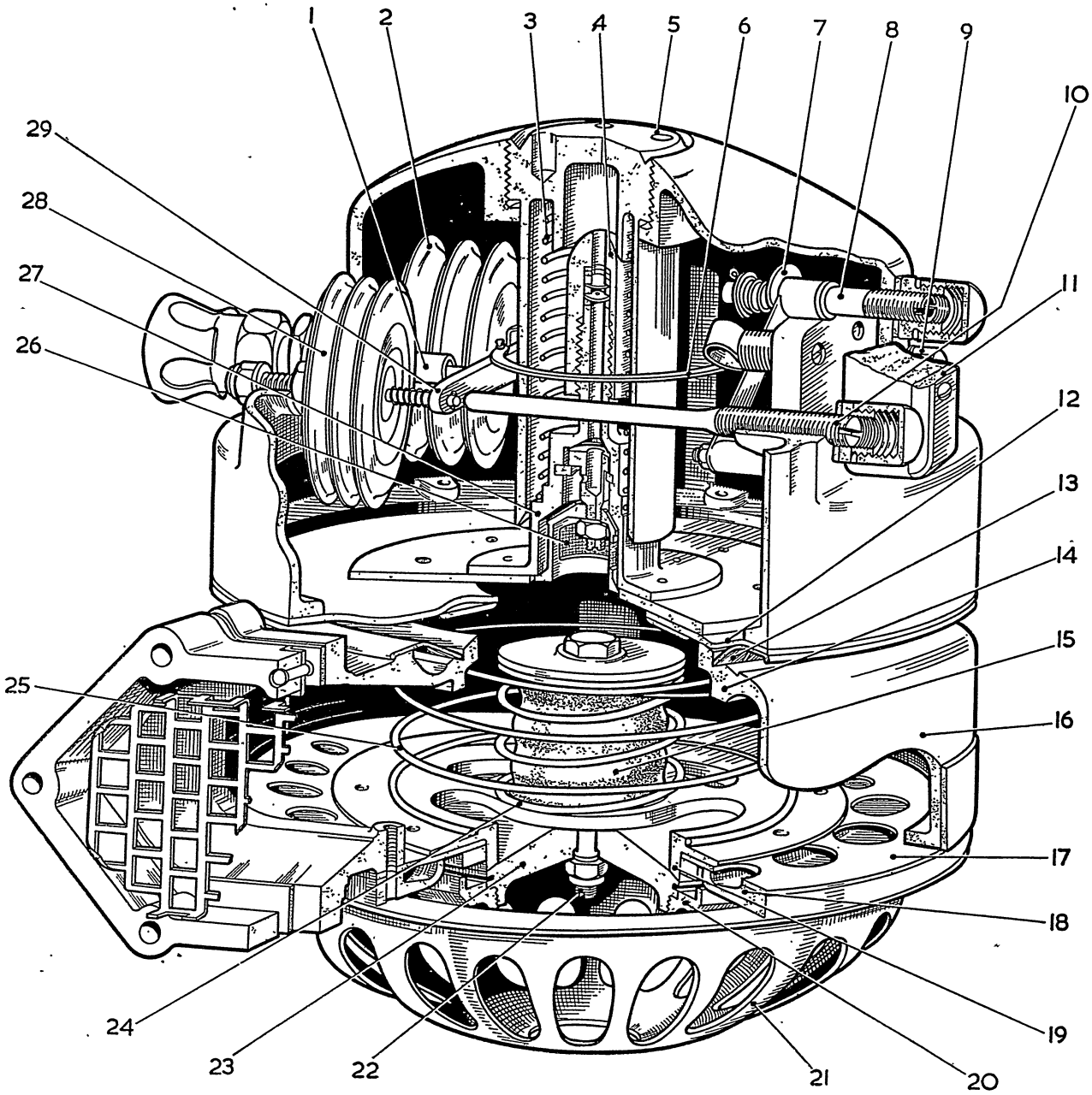
Outlet valve

7. An outlet valve is fitted into the casting between the two capsule assemblies, and controls the flow of air from the top chamber to atmosphere. A Schrader valve is fitted in a valve body which, in turn, is soldered into an adjusting screw. The adjusting screw is drilled longitudinally to provide an air passage, and is secured by a locknut, a sealing gland and a cap-nut which incorporates a fine mesh filter and a filter guard. The head of the spring-loaded Schrader valve is in contact with the centre of the beam, thus beam movement caused by contraction or expansion of the capsules will close or open the valve.

Switch mechanism

8. The switch for operating the cabin pressure warning device consists of a lower and an upper contact assembly mounted on an insulating base. The base is fixed to the internal wall of the casting diametrically opposite the capsule assemblies. The lower contact assembly is a spring strip fixed at one end to a contact support, and carrying a silver contact. The fixed end of the strip is connected electrically to one of the terminals of a terminal block mounted on the outside of the casting, whilst the other end bears against the adjusting head of an adjusting screw. The adjusting screw is used during manufacture to set the gap between the contacts. The screw is drilled longitudinally to permit the insertion of a test rod during routine tests of the warning device circuit. The screw is secured by a locknut, and sealed by washers and a cap-nut.

9. The upper contact assembly consists of a spring strip mounted on two pillars on the insulating base, and connected electrically through one of the pillars to the second terminal of the external terminal block. A contact is fitted to the strip to register with the contact on the lower contact assembly, and an insulated link anchorage is fitted on the opposite side of the strip. One end of a semi-circular contact link is attached by a pivot pin to the anchorage, and



1 OUTLET VALVE
2 ATMOSPHERIC CAPSULES
3 DISCHARGE VALVE SPRING
4 ORIFICE CAP
5 SPRING HOUSING
6 CONTACT LINK
7 ADJUSTING HEAD
8 CONTACT ADJUSTING SCREW
9 BLANKING PLUG
10 BEAM STOP
11 TERMINAL BLOCK
12 DISCHARGE DIAPHRAGM
13 DIAPHRAGM SUPPORT
14 DISCHARGE VALVE SEATING
15 DUST EXCLUDER
16 VALVE BODY
17 INWARDS RELIEF VALVE DIAPHRAGM
18 INWARDS RELIEF VALVE SEATING
19 INWARDS RELIEF VALVE
20 ADJUSTING RING
21 END COVER
22 SPRING ADJUSTING BOLT
23 SAFETY VALVE
24 SAFETY VALVE SPRING
25 INWARDS RELIEF VALVE SPRING
26 ORIFICE BODY FILTER
27 ORIFICE BODY
28 ABSOLUTE CAPSULES
29 BEAM

Fig. 2. Sectional view (Mk. 12 valve)

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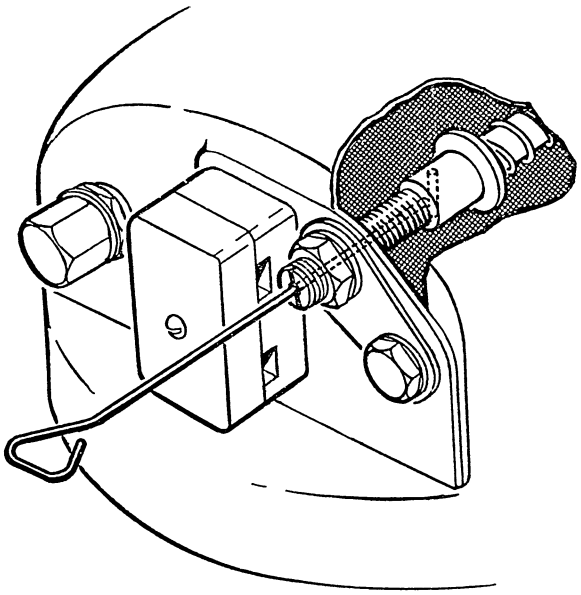

Fig. 3. Contact assembly test

the other end of the link is pivoted to the centre of the beam. Thus the movement of the beam is transmitted to the upper contact.

Discharge valve

10. The base of the top chamber is closed by a rubber discharge diaphragm, the circumference of which is clamped between a diaphragm support and the rim of the casting. The open central portion of the diaphragm is held between two support rings, so that the assembly forms a rubber faced plate valve which is held by the discharge valve spring against a seating on the bottom chamber casting. the inner circumference of the diaphragm support is cranked downwards, and slotted radially to allow the airflow from the discharge valve to pass to atmosphere.

Orifice body

11. An orifice body is riveted to the upper support ring of the discharge diaphragm. It is drilled longitudinally and carries an orifice cap screwed on to its upper end, this cap containing an orifice plate (drilled 0·012 in. dia.) and a filter gauze. A filter body, containing a second filter, is held in position in the lower end of the orifice body by a hollow retaining bolt and a circlip.

Blanking plug

12. In certain installations a control is fitted to permit the pilot to initiate or terminate pressurization at will. A tapped hole for the necessary pipe connection is provided in the casting at a point adjacent to the adjusting screw for the contact assembly. In most installations this hole is blanked off by a plug.

Bottom chamber

Valve body

13. The valve body is a circular casting, the upper and lower faces of which are open. An inlet port, cast integral with the body, carries a mounting flange for securing the unit to the aircraft structure. Three 2 B.A. clearance holes are drilled through the circumference of the casting to take the studs by which the top and bottom chambers are secured together. The lower face of the casting is drilled and tapped for attachment of a relief valves assembly. The upper face is machined to form a seating for the discharge valve, and the underside of this seating is recessed to locate an inwards relief valve spring.

14. When the unit is installed in the aircraft a rubber sealing gasket (supplied with the unit) is fitted between the mounting flange and the aircraft bulkhead. A packing plate, which supports an inlet grid, is fitted to the other side of the bulkhead. The inlet grid is secured to the packing plate by a spherical-head stud on the grid engaging in a spring clip. on the plate. The packing plate and grid are not supplied with all cabin pressure control valves.

Inwards relief valve

15. The circumference of a rubber diaphragm is clamped between the lower face of the valve body and a seating ring. The inner circumference is secured between an inwards relief valve and a

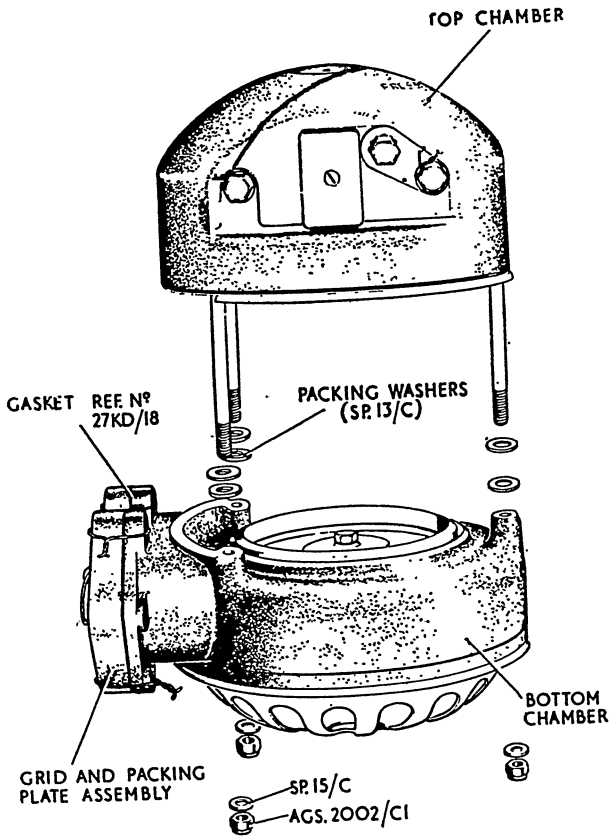

Fig. 4. Main assembly

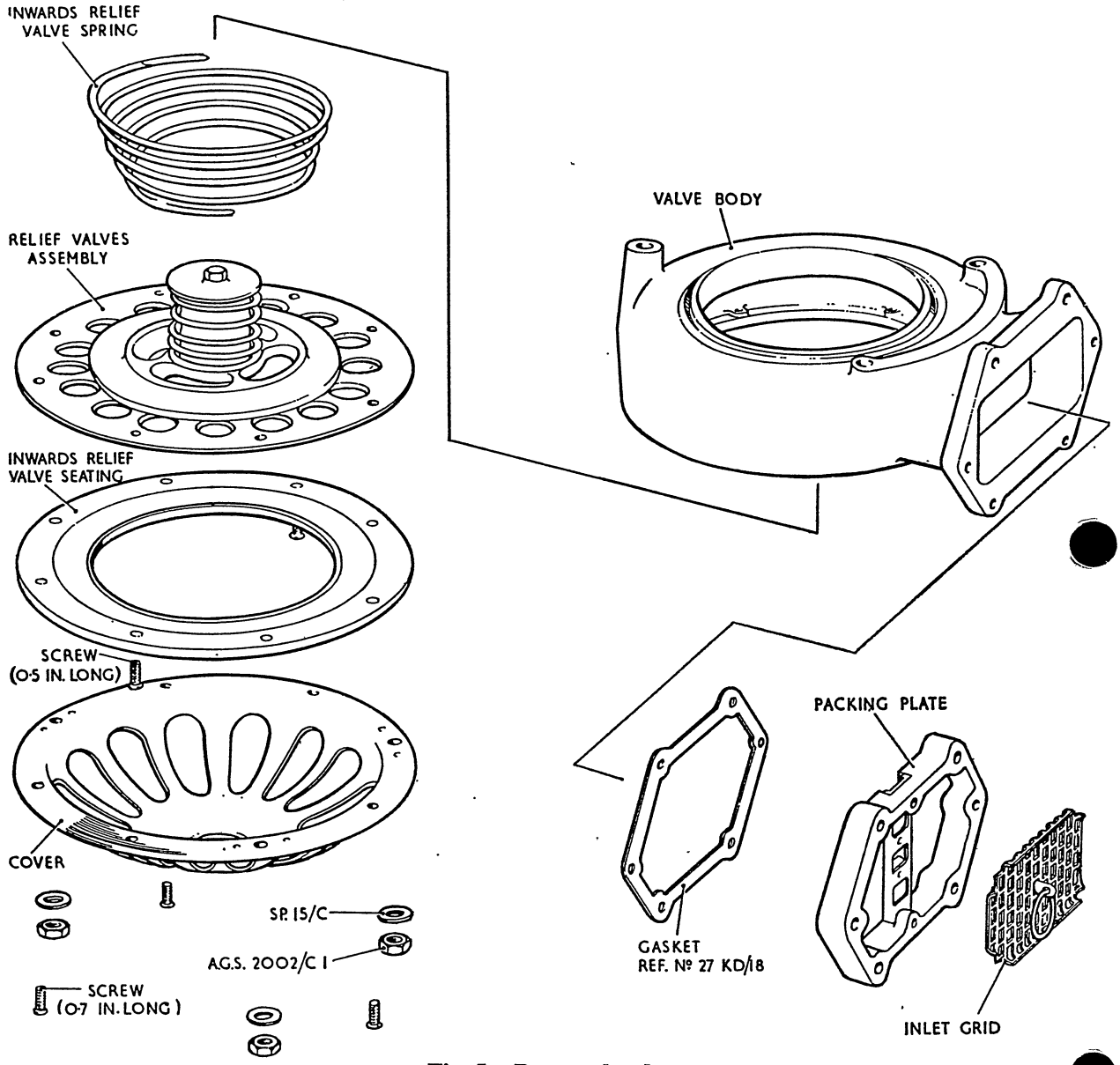

Fig. 5. Bottom chamber

support ring. The inner part of the diaphragm provides a rubber facing for the inwards relief valve, and this face is held against the seating ring by the inwards relief valve spring. The flexible portion of the diaphragm between the seating and the casting rim is perforated to permit air from the surrounding atmosphere to pass into the unit, and thence into the cabin, when the inwards relief valve is open.

Safety valve

16. The safety valve is a poppet type valve, the stem of which slides in a valve guide secured to the centre of the inwards relief valve. The safety valve seating is machined on the lower face of the relief valve. A spring adjusting bolt passes through the hollow stem of the safety valve, and a valve spring is located between a retaining plate, under the head of the bolt, and the inwards relief valve. The head of the safety valve is threaded, and an adjusting ring, locked in position by a split pin, is screwed on to this thread. The ring is used during manufacture to adjust the flow characteristics of the safety valve. The safety valve spring loading is adjusted by rotation of the nut on the adjusting bolt.

17. A ribbed-fabric dust excluder is fitted around the safety valve guide to prevent the entry of dust particles between the valve stem and the guide. The complete relief valves assembly is protected by a slotted end cover.

OPERATION

Discharge valve

18. The cabin pressure control valve is, in effect, a pressure controller and a discharge valve com-

bined in one unit. The pressure in the top chamber (bellows pressure), assisted by the discharge valve spring, acts on one side of the discharge diaphragm, and is opposed by cabin pressure acting at the centre of the other side of the diaphragm. The relationship of these two pressures causes the valve to so restrict the discharge of air from the cabin that the required cabin altitude is maintained at all aircraft altitudes.

Safety valve

19. If the discharge valve should "fail closed" the uncontrolled rise of pressure in the cabin would endanger the aircraft structure. The loading of the safety valve spring is set during manufacture so that when the cabin differential pressure reaches a value slightly above the normal flight maximum the valve lifts off its seating, and the excess cabin pressure is vented to atmosphere. The adjusting ring on the valve head tends to give a "snap open" action and a comparatively low rise of back pressure with increasing airflow.

Inwards relief valve

20. During normal flight the inwards relief valve is held on its seating by the cabin differential pressure assisted by the inwards relief valve spring. If a condition of negative differential pressure should develop, however, the valve is lifted off its seating by atmospheric pressure (the spring offering negligible resistance) and air enters the cabin from the surrounding atmosphere.

INSTALLATION

21. Before fitting a control valve in an aircraft refer to the aircraft air publication for details of the installation. If it is required to test the unit before installation apply the tests detailed in Appendix 1.

22. Mount the unit on the unpressurized side of the cabin bulkhead, with the rubber gasket (supplied with the new unit) fitted between the bulkhead and the mounting flange). Fit the packing plate on the pressurized side of the bulkhead and secure the assembly with six 2 B.A. bolts, washers and offnuts. Connect the aircraft electrical leads to the terminal block on the top chamber casting.

Note . . .

On certain aircraft the packing plate and inlet grid are part of the aircraft installation, and are not supplied with the control valve.

Post-installation tests

23. On completion of installation, test the action of the safety valve (*aircraft air publication*) and the continuity of switch mechanism (*para.* 24).

Contact assembly test (*fig.* 3)

24. (1) Switch on the aircraft electrical supply. Remove the cap-nut from the contact adjusting screw. Insert a $\frac{3}{32}$ in. dia. test rod into the adjusting screw and press the rod in *GENTLY* to permit the contacts to close. The pressure warning device should operate.

(2) If the circuit is satisfactory replace the cap-nut. Wire lock the nut, using 22 s.w.g. steel wire (D.T.D.189 or 161).

(3) If the warning device fails to operate, remove the cover from the terminal block on the top chamber casting, and short-circuit the two terminals. If the warning device still does not operate, the indication is that the fault is in the aircraft wiring. If the warning device does operate, the indication is that there is a fault in the switch mechanism, in which case the control valve should be replaced by a serviceable unit.

SERVICING

25. Routine servicing consists of examination for security of installation, and periodic cleaning of the filters.

Cleaning the filters

Outlet valve filter

26. Remove the outlet valve filter guard. Remove the circlip from the cap-nut, and withdraw the filter and the rubber washer. Wash the filter in an approved cleaning agent, dry the part and examine for damaged mesh. If necessary, renew the item (Ref. No. 27KD/545). Examine and, if necessary, renew the rubber washer (Ref. No. 27KD/543). Replace the parts in the following order: the washer, the filter, the circlip and the filter guard.

Atmospheric capsule assembly filter

27. Access to this filter is obtained by removing the filter guard from the cap-nut on the atmospheric capsules bolt. The filter cannot be removed, and must, therefore, be cleaned in situ, using a soft brush.

Orifice body filter

28. Remove the top chamber from the valve body (*para.* 30). Support the retaining bolt with a screwdriver, unscrew the nut from the centre of the orifice body and withdraw the filter. Wash the filter in an approved cleaning agent, dry the part and examine for damaged mesh. If necessary, renew the item (Ref. No. 27KD/243).

Dismantling

29. Dismantling during servicing should be confined to the extent necessary to renew sub-assemblies.

Main assembly (*fig.* 4)

30. Remove the inlet grid and packing plate assembly and the gasket. Separate the inlet grid from the packing plate. Remove the three 2 B.A. nuts and washers from the periphery of the slotted end cover, and separate the top and bottom chambers and the packing washers (the packing washers are not fitted on all units).

Bottom chamber (*fig.* 5)

31. Unscrew the three countersunk-head screws from the rim of the slotted cover, and remove the cover. Unscrew the two countersunk-head screws from the inwards relief valve seating, and remove the seating, the relief valves assembly and the inwards relief valve spring.

Assembly

32. Sealing compound No. 1751 (Ref. No. 33C/1139) is required during assembly.

Bottom chamber (*fig.* 5)

33. Insert the inwards relief valve spring, larger diameter first, into the body casting, ensuring that the lower coil seats evenly in the recess in the casting. Place the relief valves assembly in position, aligning the holes in the diaphragm with the corresponding holes in the casting. Fit the inwards relief valve seating, seating edge inwards, and align with the three 2 B.A. clearance holes in the casting. Secure the parts with the two $\frac{5}{32}$ in. dia. screws (0·5 in. long), first coating the threads of the screws with sealing compound. Fit the slotted cover, securing with the three $\frac{5}{32}$ in. dia. screws (0·7 in. long), also coating the threads of these screws with sealing compound.

Main assembly (*fig.* 4)

34. Place two packing washers (SP.13/C) over each of the three studs on the top chamber (this does not apply to all units). Fit the top chamber to the valve body casting, and secure with three washers (SP.15/C) and stiffnuts (AGS.2002/C.1).

Table 1

Fault diagnosis

Symptom	Possible fault	Remedy
1. Failure to pressurize or low cabin pressure	(1) Top chamber leaking	(1) Confirm by test (*App.* 1, *para.* 6)
	(2) Orifice body filter blocked	(2) Clean the filter (*para.* 28)
	(3) Leakage past safety valve or inwards relief valve	(3) Confirm by test (*App.* 1, *para.* 6)
	(4) Leak to atmosphere from pilot's control line (if fitted)	(4) Trace and rectify the leak
	(5) Excessive cabin leak rate combined with low airflow	(5) Test the cabin leak rate (*aircraft air publication*)
	(6) Defective outlet valve Punctured atmospheric capsule Orifice blocked	(6) If the unit fails on test (*App.* 1, *para.* 7) change the complete unit
2. High cabin pressure	(1) Atmospheric capsule filter blocked	(1) Clean the filter (*para.* 27)
	(2) Outlet valve filter blocked	(2) Clean the filter (*para.* 26).
	(3) Defective outlet valve Punctured absolute capsule Enlarged orifice	(3) If the unit fails on test (*App.* 1, *para.* 7) change the complete unit
3. Warning device operates continuously above pressurizing altitude	(1) Low cabin pressure	(1) See Fault No. 1
	(2) Short-circuit in wiring	(2) Confirm by test (*para.* 24)
	(3) Defective contact assembly	(3) If the unit fails on test (*App.* 1, *para.* 7) change the complete unit
4. Warning device operates continuously below pressurizing altitude	(1) Short-circuit in wiring	(1) Confirm by test (*para.* 24)
	(2) Defective contact assembly	(2) If the unit fails on test (*App.* 1, *para.* 7) change the complete unit
5. Cabin pressure "hunting"	(1) Safety valve setting too low	(1) Confirm by test (*App.* 1, *para.* 5)
	(2) Inlet grid obstructed	(2) Remove the obstruction

Appendix 1

STANDARD SERVICEABILITY TESTS
for
CABIN PRESSURE CONTROL VALVES

Introduction

1. The tests described in this Appendix should be applied before a control valve is installed in an aircraft, at any time when the serviceability of the unit is in doubt, and at the appropriate re-examination periods at Equipment Depots.

TEST EQUIPMENT

2. The following test equipment is required:—

(1) A 250V insulation resistance tester.

(2) A low pressure leak test rig (*A.P.*4340, *Vol.* 6, *Sect.* 14, *Chap.* 1).

(3) A Mk. 2 test rig (*A.P.1275T, Vol.* 1, *Sect.* 3 *Chap.* 15).

TEST PROCEDURE

Insulation resistance test

3. The insulation resistance between the two terminals of the terminal block, and between each terminal and the casting, should not be less than 10 megohms at 250V.

Inwards relief valve test

4. Support the unit with the inwards relief valve uppermost. Depress the valve off its seating. Check that the valve shows no tendency to stick to the seating, has an unrestrained opening of at least 0·18 in. (measured at the centre of the assembly), and returns to the seating under spring pressure only.

Safety valve test

5. Mount the unit on the leak test rig so that capacity chamber pressure is applied through the mounting flange. Blank off the outlet valve. Slowly increase the capacity chamber pressure, and note the pressure when the safety valve starts to relieve. This should be within the limits quoted in the Appendix appropriate to the unit.

Leak test

6. Mount the unit on the leak test rig. Blank off the outlet valve. Slowly increase the capacity chamber pressure until the safety valve starts to relieve, hold the pressure for approximately one minute to equalize the pressures on both sides of the orifice, then shut off the air supply. Measure the time for the capacity chamber pressure to fall from 2·75 to 2·25 lb./in^2. This should be not less than 10·4 sec. for each ft^3 of rig capacity, equivalent to a permissible leak rate of 0·015 lb./min. at 2·5 lb./in^2.

Setting test

7. (1) Mount the unit in the Mk. 2 test rig (*test rig chapter*).

(2) Set the aircraft altitude (suction altitude valve), in turn, to the values tabulated in Table 1 in the Appendix appropriate to the unit. At each check point the resulting cabin altitude should be within the corresponding limits.

(3) Switch the test rig electrical supply ON. Set the aircraft altitude, in turn, to the values tabulated in Table 1 in the appropriate Appendix. At each check point increase the cabin altitude (balance valve), at a rate not exceeding 1000 ft./min., meanwhile maintaining a constant aircraft altitude. Note the cabin altitude when the test lamp lights. This should be within the corresponding limits tabulated in the appropriate Table 1.

Adjustment

8. If the unit is found to be grossly out of limits during the setting test (*para.* 7) the indication is that there is a fault in the control mechanism, and the unit should be returned for rectification. If, however, the unit appears to be operating satisfactorily but is controlling slightly out of limits the necessary adjustments should be made. Adjustment is effected on the outlet valve and the beam stop for pressure control, and the contact adjusting screw for the warning light. The Tables 1 in the Appendices are annotated to state which adjustment is to be made at the various aircraft altitudes.

(1) *Outlet valve.* A screwdriver slot is provided on the outer end of the outlet valve adjusting screw. Access is obtained by removing the filter cap-nut, and slacking off the locknut. Screwing the valve in will increase cabin altitude.

(2) *Beam stop.* Access is obtained by removing the cap-nut located to the left of the terminal block, and slacking off the locknut. Screwing the stop in will increase cabin altitude.

(3) *Contact adjusting screw.* Access is obtained by removing the cap-nut located to the right of the terminal block. The locking tab fitted under the blanking plug will require to be removed before the locknut on the adjusting screw can be slackened off. Screwing the adjusting screw in will cause the test lamp to light at a lower cabin altitude.

Appendix 2

CABIN PRESSURE CONTROL VALVE, Mk. 2

LEADING PARTICULARS

Ref. No.	*27KD/1*
Manufacturer's Part No.	499100
Weight	4 *lb.* 3 *oz.*
Dimensions (overall)	
Height	6·1 *in.*
Maximum diameter	6·8 *in.*
Pressurization starts at (aircraft altitude)	12000 *ft.*
Maximum differential pressure (nominal)	3·5 *lb/in²*
Max. differential pressure is reached at (aircraft altitude)	38500 *ft.*
Safety valve setting	4·6 *lb/in²*

Introduction

1. The cabin pressure control valve, Mk. 2 is generally similar to the unit described in the chapter. The physical differences are of a minor nature, and are described in the following paragraphs. The installation and servicing instructions in the chapter apply.

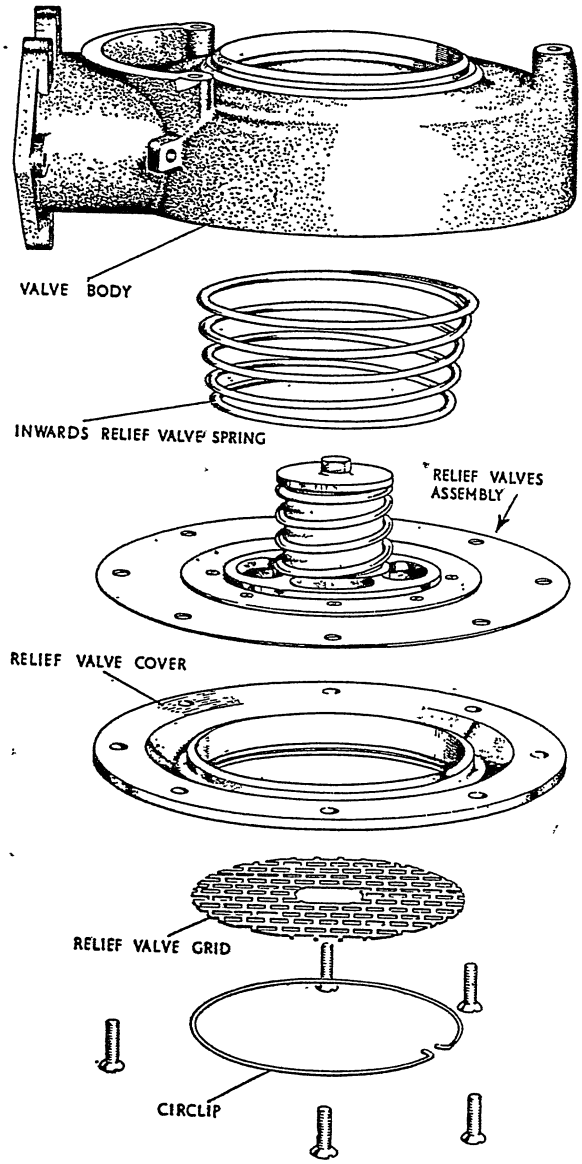

Fig. 1. Bottom chamber

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DESCRIPTION

Top chamber

2. The top chamber is as described in the chapter except that the packing washers (*fig.* 4 *in chapter*) are omitted on the Mk. 2 unit.

Bottom chamber (*fig.* 1)

3. The bottom chamber is as described in the chapter, except that the relief valve seating is shaped differently, and the slotted end cover is replaced by a grid and a circlip.

Safety valve

4. An adjusting ring is not fitted on the head of the safety valve. On Mk. 2 units of early manufacture the threaded adjusting bolt for the safety valve spring is replaced by a plain shank bolt secured by a distance piece and a split pin. On these units the loading of the safety valve spring is adjusted by fitting shim washers between the safety valve and the distance piece.

TESTING

Safety valve test (*App.* 1, *para.* 5)

5. The rig capacity chamber pressure should be 4·6 ± 0·21 lb./in². when an airflow of 3·1 lb./min. (40 ft³/min. F.A.D.) is passing through the safety valve.

Setting test (*App.* 1, *para.* 7)

6. The test altitudes are tabulated in Table 1.

Table 1

Test altitudes and limits

Note . . .

Adjust the outlet valve at 15,000 *ft. aircraft altitude, and the beam stop at the remaining altitude.*

Aircraft altitude (ft.)	Cabin altitude (ft.)	Cabin altitude limits for warning light (ft.)
15000	12700-13300	-
47500	24700-25750	29200-30450