Chapter 16

CABIN ALTIMETER, Mk. 21 SERIES

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Introduction

1. The cabin altimeters, Mk. 21 series, are used in pressurized aircraft to indicate to the crew the cabin pressure in terms of altitude for the purpose of regulating the oxygen supply. The instruments are designed to indicate altitudes between 8,000 ft. and 50,000 ft. (altimeter, Mk. 21, Stores Ref. 6A/4245) and 5,000 ft. and 50,000 ft. (altimeter, Mk. 21A, Stores Ref. 6A/5463). The instrument operates on the aneroid principle and indicates height in accordance with the I.C.A.N. law through the medium of a metallic capsule and a magnifiying mechanism.

DESCRIPTION

Altimeter, Mk. 21 (Mechanism Ltd. type)

2. The mechanism is housed in a 2 in. S.A.E. flangeless metal case, the forward portion of which forms the bezel and also supports the mechanism. The case body is butted to a flange on the bezel and secured to it through the mechanism bottom plate, three screws passing through the case and into the bottom plate. By removing these three screws the case body may be withdrawn to expose the mechanism and bezel as one unit. The instrument is held to the instrument panel by a securing clamp which fits around the case and has two lugs for attachment to the instrument panel.

3. A scale is provided on the dial plate (*fig.* 1) which covers a calibration circle of approximately $1\frac{3}{4}$ in. dia., and a single pointer moves through approximately 320 deg. in covering the normal range of operation of the instrument. This scale is divided into eight divisions representing 5,000 ft. steps of altitude from 10,000 ft. to 50,000 ft. ; these markings, and the balanced pointer, are treated with fluorescent compound. Vent holes are provided in the case to permit equalization of air pressure.

4. The mechanism is illustrated in fig. 2 and in this description is assumed to be in a vertical position with the dial uppermost, and hence the front of the instrument is referred to as the top. The mechanism can be considered as having three assemblies, the instrument frame, the capsule unit, and the rocking shaft and sector and pinion assembly.

5. The instrument frame consists of a combined bezel and instrument frame top plate (2) and a bottom plate (8), spaced apart by three frame pillars (5). The top plate is machined to form the front of the case, i.e., the bezel, and is recessed to the maximum diameter to accommodate the dial plate and cover glass (25), the latter being held in position on a sealing ring (1) by a split ring (26).

6. To provide a means of handling the instrument during installation etc., the top external edge of the

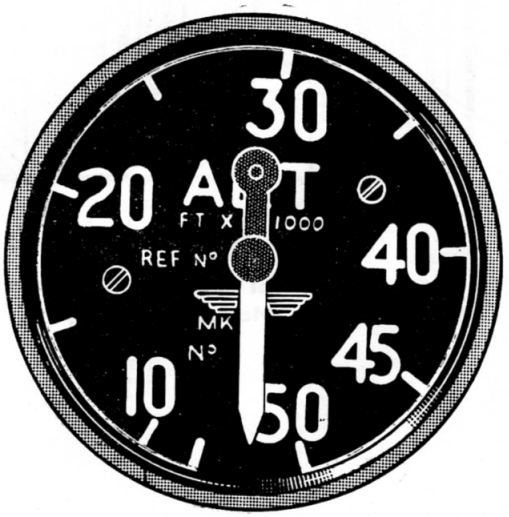


Fig. 1. Cabin altimeter, Mk. 21, front view

bezel is grooved, the underside is recessed locally to accommodate the sector and handstaff assembly. The bottom plate has a protruding flange which acts as a distance piece and prevents the capsule unit lower lock-nut (11) fouling the case. This flange also provides a means of attachment of the case to the mechanism, three cover securing screws (9) engaging three equispaced tapped holes in the flange.

7. The capsule unit (7) employs a bank of two corrugated aneroid capsules which are soldered together to act as one. A boss soldered to the lower capsule carries a screwed attachment stem (10) by means of which the capsule unit is secured to the instrument frame bottom plate. This method of attachment also permits adjustment of the capsule unit within the instrument frame by altering the positions of the lock-nuts (11).

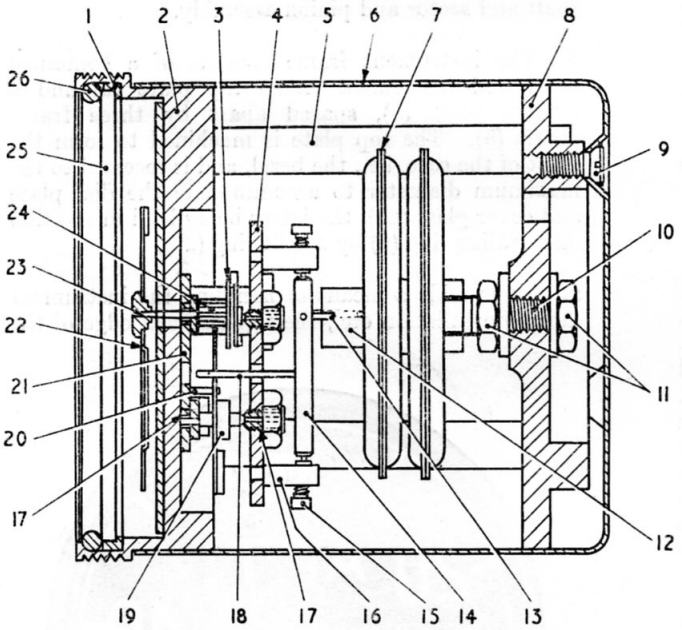
8. The upper surface of the capsule unit carries a bimetallic toe-piece (12) against which the rocking shaft actuating lever is held by a beryllium copper "U" shaped spring ; this spring is shown in fig. 2 as two dotted lines behind the toe-piece.

9. Expansion and contraction of the capsule unit in response to changes in atmospheric pressure produces a linear movement which is measured, in terms of altitude, through the magnifying mechanism, i.e., the sector and rocking shaft assembly. The capsule unit is so evacuated that expansion does not become effective until a pressure equivalent to an altitude of approximately 8,000 ft. is reached. This, therefore, is the datum from which the instrument will indicate, although the dial graduations do not commence until 9,000 ft., and the 9,000 ft. graduation is not marked as such.

10. The sector and rocking shaft assembly is arranged as a complete unit, comprising sector movement top and bottom plates (4 and 21) spaced apart by two diagonally arranged pillars (not shown in fig. 2) fitted to the top plate. The bottom plate (4) is secured to the frame pillars by pins, and two smaller support pillars (16) carry the rocking shaft pivot screws.

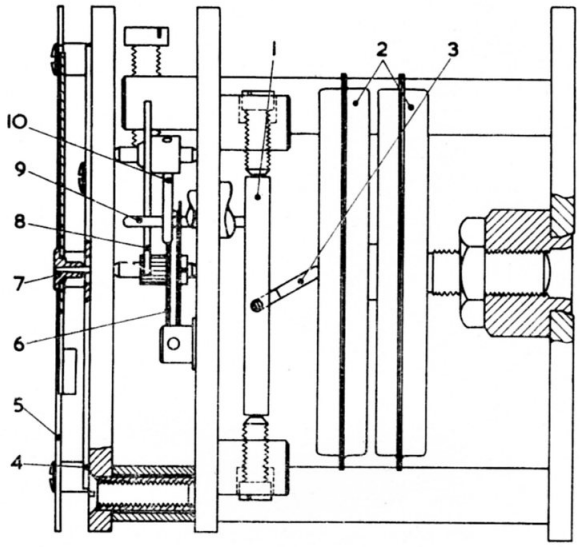
11. The rocking shaft (14) is freely mounted between the two adjustable and jewelled pivot screws (15) and carries two arms, one to receive motion and the other to transmit it to the sector. One of these arms is the rocking shaft actuating lever (13) and bears against the bimetallic toe-piece on the capsule unit, and the other is the sector actuating lever (18) which bears against the sector (19) at a point between its arbor and quadrantal rack. The sector is attached at an arbor which is pivoted in jewelled bearings (17) in the sector assembly top and bottom plates. The sector is balanced and its rack engages the pinion (24) on the pointer arbor (23), which has jewelled bearings similar to those of the sector arbor.

12. When the capsule unit expands, its linear movement is converted into angular movement of the



1 SEALING RING
2 COMBINED BEZEL AND INSTRUMENT FRAME TOP PLATE
3 HAIRSPRING
4 SECTOR MOVEMENT BOTTOM PLATE
5 FRAME PILLAR
6 CASE
7 CAPSULE UNIT
8 INSTRUMENT FRAME BOTTOM PLATE
9 COVER SECURING SCREWS
10 CAPSULE UNIT ATTACHMENT STEM
11 LOCK-NUTS
12 BIMETALLIC TOE-PIECE
13 ROCKING SHAFT ACTUATING LEVER
14 ROCKING SHAFT
15 ROCKING SHAFT ADJUSTABLE PIVOT SCREWS
16 ROCKING SHAFT SUPPORT PILLARS
17 SECTOR ARBOR JEWELLED BEARINGS
18 SECTOR ACTUATING LEVER
19 SECTOR
20 SECTOR LIMIT STOP
21 SECTOR MOVEMENT TOP PLATE
22 POINTER
23 POINTER ARBOR
24 POINTER ARBOR PINION
25 COVER GLASS
26 SPLIT RING

◀ Fig. 2. Sectional view of Mk. 21 altimeter (Mechanism Ltd. type) ▶



1 ROCKING SHAFT
2 CAPSULES
3 ROCKING SHAFT ARM (BEARING ON TOP OF CAPSULES)
4 INNER DIAL
5 OUTER DIAL
6 HAIRSPRING
7 HANDSTAFF PINION
8 SECTOR
9 ROCKING SHAFT ARM (BEARING ON SECTOR)
10 SECTOR ARM

Fig. 3. Sectional view of Mk. 21 altimeter (Kelvin and Hughes type)

rocking shaft which, in turn, imparts a similar, but increased, movement to the sector arbor. The sector then imparts rotary movement to the pointer arbor through its pinion, and the hairspring (3) takes up any backlash and ensures a smooth movement of the pointer (22). The total movement of the sector, and hence the pointer, is limited by stops, one of which is adjustable to ensure that the pointer is positioned vertically downwards when at the lower end of the scale.

◀Altimeter, Mk. 21 (Kelvin and Hughes type)

13. The presentation and the case of this instrument are as described previously. Although basically the same, the mechanism differs slightly in construction. A sectional view of the mechanism is shown in fig. 3.

Altimeter, Mk. 21A

14. The altimeters, Mk. 21A, of both the Mechanism Ltd. and the Kelvin and Hughes manufacture are similar to their respective Mk. 21 instruments, the only difference being in that the Mk. 21A instrument has a wider range of 5,000 ft. to 50,000 ft. (*para.* 1) and hence the dial scale has been extended to take in the new range, as shown in fig. 4.

OPERATION

15. The altimeters, Mk. 21 series, are designed to indicate altitude under pressurized conditions, i.e., when cabin altitude is less than actual altitude, so that the crew may regulate their oxygen supplies accordingly. At cabin altitudes of up to approximately 8,000 ft. in the case of Mk. 21, and 5,000 ft. in the case of Mk. 21A, the pointer will remain pointing vertically downwards. When the aircraft has reached the minimum altitude at which the altimeter is designed to operate, the pointer will commence to rotate in a clockwise direction and, as the height increases, will continue progressively up to a maximum of 50,000 ft. These indications, therefore, will enable the crew to adjust their oxygen supplies accordingly.▶

SERVICING

16. No routine servicing is required on this instrument but the calibration should be checked in accordance with the Standard Serviceability Test contained in Appendix 1 to this chapter.

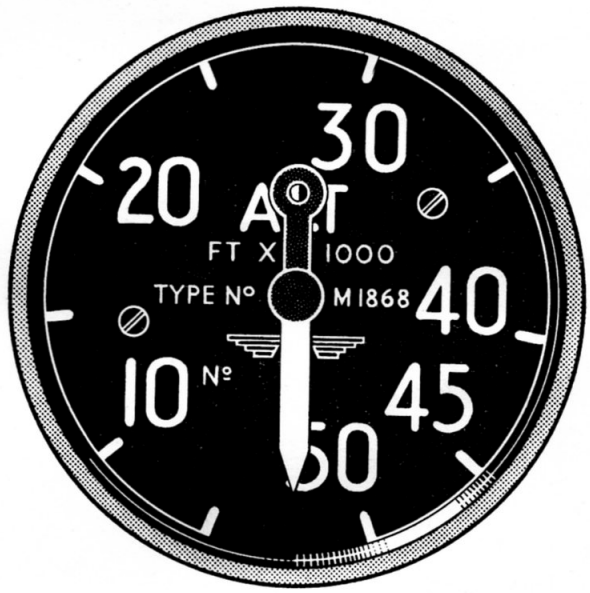


Fig. 4. Cabin altimeter, Mk. 21A, front view.

Appendix I

STANDARD SERVICEABILITY TEST

for

CABIN ALTIMETER, Mk. 21 SERIES

Introduction

1. The test laid down in this Appendix must be applied to the above mentioned altimeter immediately prior to its installation in an aircraft, and at any time that its serviceability is suspect. They are also to be applied at inspections made at Equipment Depots.

METHOD OF TEST

2. Unless otherwise stated, the instrument undergoing the tests should be mounted in the normal attitude, i.e., with the dial upright and in the vertical plane. Light tapping is permissible during the tests. At no time should sudden or violent changes of pressure be applied.

TEST EQUIPMENT

3. The equipment listed below should be used for testing purposes.

Nomenclature	Stores Ref.
Vacuum chamber Mk. 6	6C/684
Control panel	6C/706
Micro-manometer, null reading	6C/865

4. The items listed are described in A.P.1275T, Vol. 1, Sect. 3, Chap. 2 and 7, respectively.

5. When it is desired to obtain an approximate check on the instrument, the altimeter Mk. 14B, S.S. (Stores Ref. 6C/346 Naval aviation only) calibrated to I.C.A.N. law, may be used.

TESTS

Ranging

6. When the instrument is received, the pointer should be off the scale and pointing approximately vertically downwards.

7. Place the instrument to be tested in the vacuum chamber and connect the suction supply to it and to the manometer as indicated in A.P.1275T, Vol. 1, Sect. 3, Chap. 7. If the instrument is being tested with the null-reading micro-manometer, it will be necessary first to adjust the apparatus to allow for the prevailing barometric pressure. The procedure for performing this adjustment is described in A.P.1275T, Vol. 1, Sect. 3, Chap. 7.

8. During the tests, the instrument should be maintained "free" by operating the electrical buzzer in the chamber.

9. ◀Check the instrument at the points shown in the table, corresponding to the instrument range, with pressure increasing and then with pressure decreasing. Reference should be made to A.P.1275T, Vol. 1, Sect. 3, Chap. 7, for details of the method to be employed if the micro-manometer is used. The errors must not exceed the amounts shown in the table, irrespective of whether the pressure is increasing or decreasing.▶

10. The heights of the mercury column given in the table in this Appendix are for London Laboratory conditions, i.e., with the mercury at 16·6 deg. C and at a latitude of 51½ deg. When the latitude and temperature differ widely from these conditions, corrections to the height of the mercury column to give the pressures in the table must be applied. These corrections are given in A.P.1275A, Vol. 1, Sect. 22, Chap. 1.

11. The instrument is not a precision altimeter, however, and the permissible errors are relatively large. It should rarely be necessary to correct the null-reading manometer for latitude or temperature, as the effect on the reading will normally be negligible.

Height in thousands of feet (I.C.A.N.)	Pressure in inches of mercury under London Laboratory conditions Mercury at 16·6 deg. C, lat. 51½ deg.	Permissible errors in feet
5	24·96	
8	22·28	
10	20·63	
15	16·93	
20	13·78	
25	11·13	±500
30	8·91	
35	7·06	
40	5·55	
45	4·37	
50	3·43	

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