SMITHS

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Description and Maintenance Instructions for RATE OF CLIMB INDICATORS

SMITHS AIRCRAFT INSTRUMENTS LIMITED · CRICKLEWOOD · LONDON · NW2

THE AVIATION DIVISION OF S. SMITH & SONS (ENGLAND) LIMITED

AMENDMENT RECORD SHEET

A.L. No.	Signature	Date	Details
1		16.4.56	Revision of Pages 1 and 2
2			
3			
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Information contained in this manual affecting safe operation and maintenance has been verified and approved by the Air Registration Board in accordance with Chapter A6-2 of British Civil Airworthiness Requirements.

Amendments to this publication invalidate the approval statement unless issued by the manufacturers with the concurrence of the Air Registration Board.

CODES AND LEADING PARTICULARS

Code No.	Range (ft/min)	Scale	Case	Data Sheet (Appendix 1)	Tests No. (Appendix 1)
5 RC/PC	0-4000	Linear	$3\frac{1}{4}''$ A.M.	—	1 and 3
20 RC/PC	0-2000	Linear	$3\frac{1}{4}''$ S.B.A.C.	A	1 and 3
21 RC/PC	0-4000	Linear	$3\frac{1}{4}''$ S.B.A.C.	A	1 and 3
24 RC/PC	0-4000	Linear	$3\frac{1}{4}''$ A.M.	—	1 and 3
27 RC/PC	0-4000	Graded	$3\frac{1}{4}''$ S.B.A.C.	B	1 and 2
29 RC/PC	0-4000	Linear	$3\frac{1}{4}''$ S.B.A.C.	C	1 and 3
30 RC/PC	0-4000	Graded	$3\frac{1}{4}''$ S.B.A.C.	B	1 and 2
31 RC/PC	0-4000	Linear	$3\frac{1}{4}''$ S.B.A.C.	C	1 and 3

TESTS AND TOLERANCES

RATE OF CLIMB INDICATORS

Case Leakage Test

1. The equipment required for this test is described in para. 15 of the Description and Maintenance manual. Open the air-bleed, turn on the compressed air supply and let air into the chamber until the internal pressure reaches 15 lb/sq. in. (This pressure must be maintained throughout the test). Allow at least a minute for the air inside the instrument case to expand or contract due to temperature variations, then close the air-bleed and supply taps. Observe the water in the U-tube for one minute, during which any leakage of air from the chamber into the instrument case will be shown by a fall in the level in the arm connected to the indicator. If any leakage does occur, it must not exceed 0.5 c.c./min. For this leakage the permissible fall of water in the U-tube for various tube bores is given in the following table :

Bore of U-tube (m.m)	Permissible fall in water level for 0.5 c.c/min leakage (m.m.)
5	6.25
6	5.70
7	5.10
8	4.55
9	4.05
10	3.60
11	3.20
12	2.90

Calibration Test (Graded Scale Instruments)

2. The equipment required for this test is described in para. 20 of the Description and Maintenance manual. Having checked that the pointer is set to zero, adjust the vacuum and atmosphere controls until the instrument indicates exactly 4,000 ft/min climb and accurately measure the time taken by the level of the vacuum indicator to fall through an interval of 4,000 ft. (This interval must be selected within the altitude range 0 to 10,000 ft.). Repeat the test at rates of climb of 3,000, 2,000, 1,000 and 500 ft/min. Then check the instrument in rates of dive by repeating the processes, taking the time for the level of the vacuum indicator to rise instead of fall.

The average recorded times of three tests in each direction at all rates of climb and dive must lie between 54.5 and 66.7 seconds.

Calibration Test (Linear Scale Instruments).

3. The equipment required for this test is described in para. 20 of the Description and Maintenance manual. Having checked that the pointer is set to zero, adjust the vacuum and atmosphere controls until the instrument indicates exactly the maximum rate of climb shown on its dial and accurately measure the time taken by the level of the vacuum indicator to fall through an altitude interval equivalent to the maximum rate of climb, *e.g.* for a maximum rate of climb of 4000 ft/min, the altitude interval will be 4000 ft. (This interval must be selected within the altitude range 2,000 to 8,000 ft.). Then check the instrument in rates of dive by repeating the process, taking the time for the level of the vacuum indicator to rise instead of fall.

The average recorded times of three tests in each direction must lie between 57.1 and 63.2 seconds.

Overload Tests

4. When applying overload tests, the following maximum rates of climb and dive may be applied :

Linear scale instruments—35,000 ft/min. climb.
40,000 ft/min. dive.

Graded scale instruments—60,000 ft/min climb and dive.

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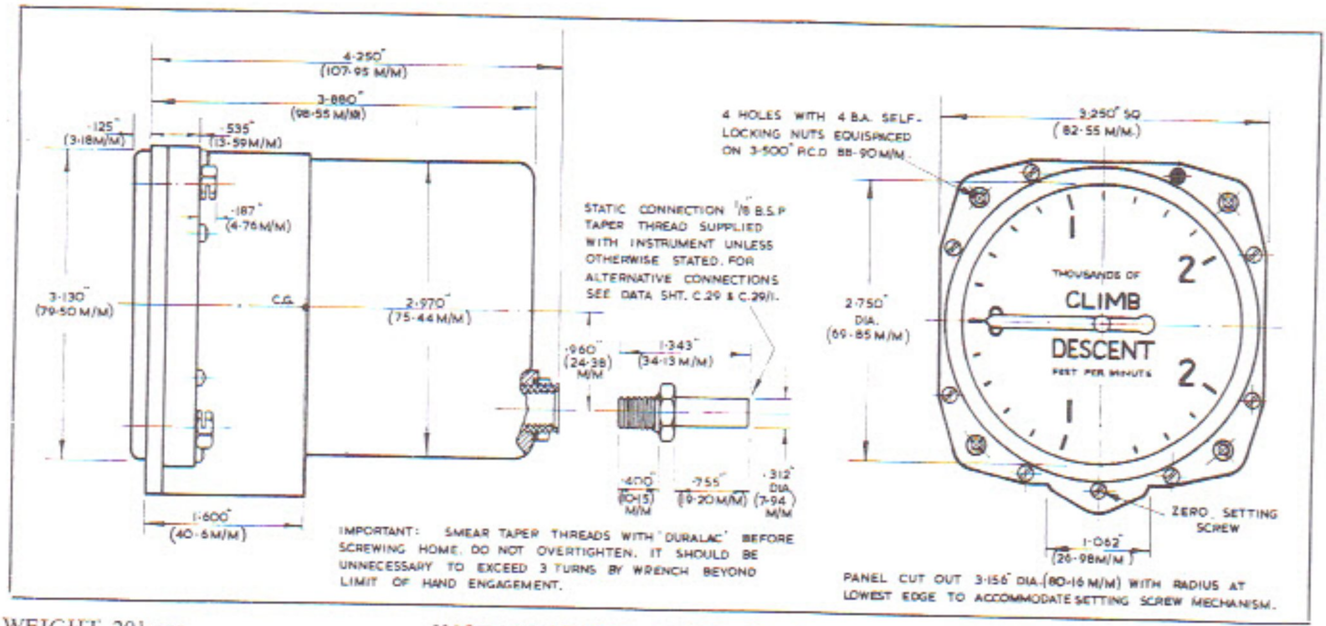
APPENDIX I

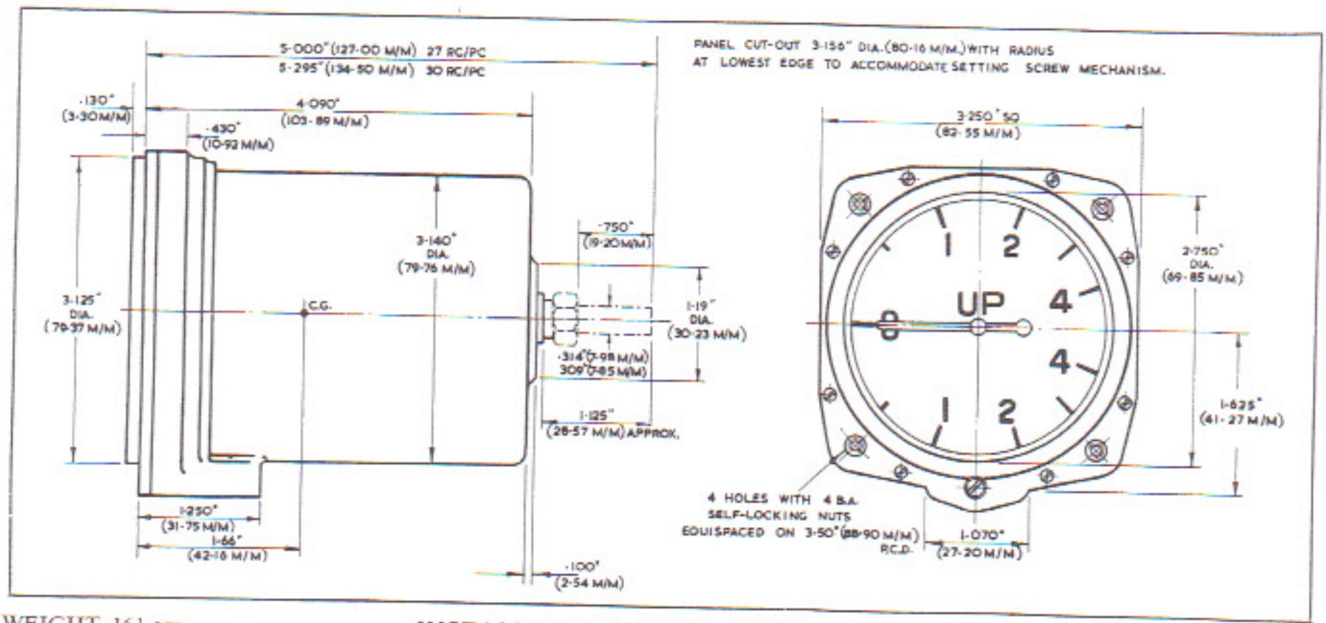
RATE OF CLIMB INDICATORS



WEIGHT 20¼ ozs.
575 grms.

INSTALLATION DATA SHEET "A"

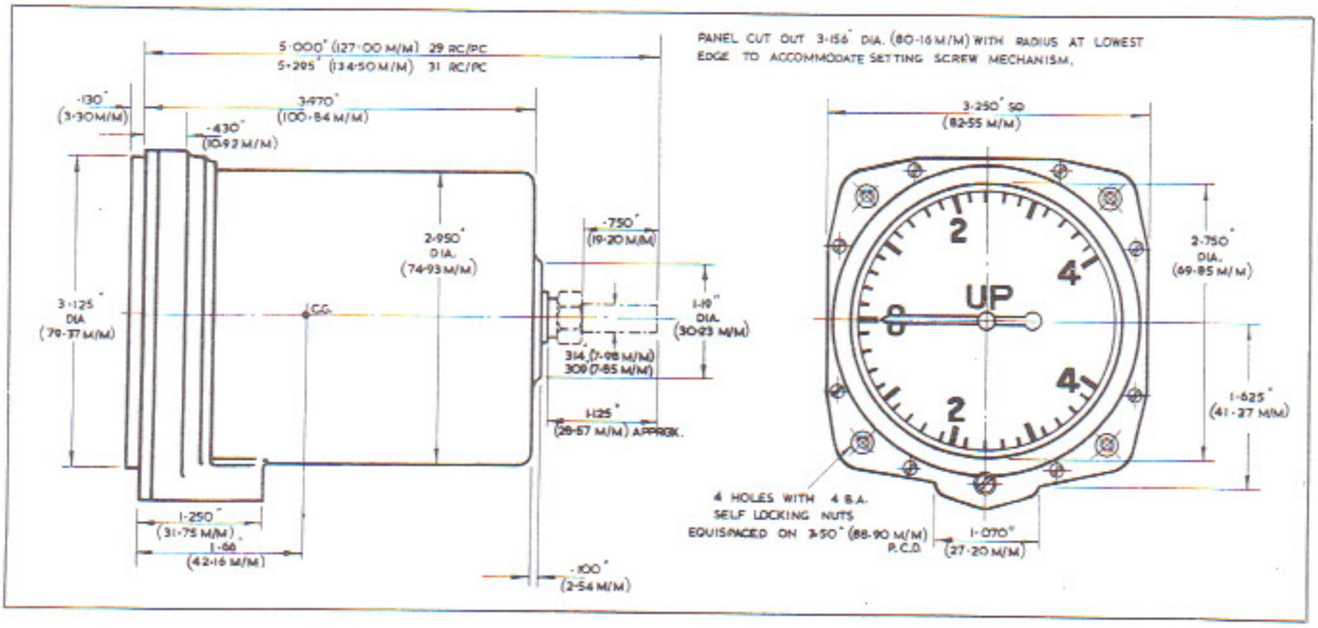
Codes—20 RC/PC. 0-2,000 FT/MIN.
21 RC/PC. 0-4,000 FT/MIN.



WEIGHT 16½ ozs.
468 grms.

INSTALLATION DATA SHEET "B"

Codes—27 RC/PC. 0-4,000 FT/MIN.
30 RC/PC. 0-4,000 FT/MIN.



WEIGHT 15¼ ozs.
433 grms.

INSTALLATION DATA SHEET "C"

Codes—29 RC/PC. 0-4,000 FT/MIN.
31 RC/PC. 0-4,000 FT/MIN.

SMITHS

DESCRIPTION AND MAINTENANCE INSTRUCTIONS

FOR

RATE OF CLIMB INDICATORS

GENERAL

1. Rate of Climb Indicators indicate the rate of climb or descent of an aircraft by measuring the rate of change of atmospheric pressure with change of altitude. They have been designed to operate in pressurised and non-pressurised aircraft and give indications of rate of change of altitude up to 4,000 feet per minute.

2. Fig. 1 shows a diagrammatic version of the indicator. It consists essentially of a capsule type differential pressure gauge in which the capsule is caused to move by the pressure drop across a choke, or leak, connecting the airtight instrument chamber to the atmosphere. When the atmospheric pressure is constant, *i.e.* when the aircraft is flying level, there will be no flow through the leak, as the atmospheric pressure will equal the pressure in the instrument chamber. However, when the aircraft climbs or dives the pressure in the chamber will tend to follow the external pressure causing a flow through, and hence a pressure drop across, the leak. The resultant capsule movement is transmitted by magnifying levers and gears to a pointer.

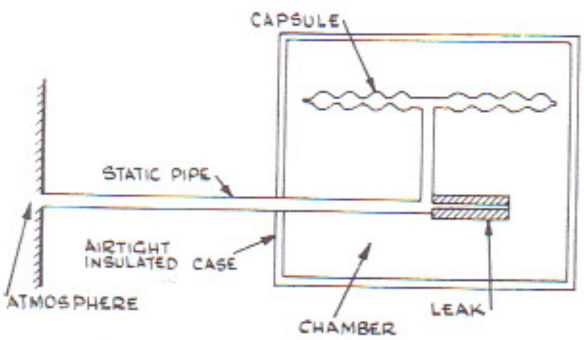


FIG. 1. Principle of Operation

3. The pressure differences operating the instrument must be indicated as rates of change of height, but to ensure uniformity the conversion must be made according to an accepted standard. The standard I.C.A.O. atmosphere is, therefore, assumed.

DESCRIPTION

4. The indicator movement is mounted on a frame consisting of front and rear plates separated by three pillars. In earlier designs of instrument (fig. 2), the frame is of brass with three round pillars, while later instruments (fig. 3) have a Duralumin frame with one square and two round pillars. The whole is contained in either a 3¼" S.B.A.C. case or a 3¼" A.M. case, made from a plastic of good heat resisting properties, and sealed, except for a static pipe line, against an external pressure of 15 lb/sq. in. For improved thermal insulation the majority of instruments with Duralmin frames also have a thin polished metal cover outside the plastic case, thus creating an airgap. The static line is connected to the inside of a sensitive beryllium copper capsule by a long capillary tube, looped to provide high frequency damping, and to the inside of the chamber by way of a leak (see para. 11). In brass frame instruments the static connection nipple is to one side of the case, while in Duralumin frame instruments it is in the centre. In the latter type the nipple may be either fixed or it may be unscrewed.

5. A slotted boss is soldered to the capsule and transmits movements of the capsule to a short adjustable arm attached to a rocking shaft. (In the earlier instruments a link connects the boss to the short arm). The rocking shaft, which is balanced by an adjustable counterweight on an arm, is supported in a bracket attached in later instruments, to the square frame pillar, and, in earlier instruments, to the front plate. The rocking shaft actuates a long arm, which transmits movement to a balanced sector on the front plate, which in turn rotates the pointer pinion. Stops are fitted on each side of the sector to limit the travel of the pointer, while a hairspring takes up any backlash. Since the movement of the capsule is small (maximum deflection is about 0.025 inch), the mechanism is fully jewelled.

6. On the earlier instruments an overload stop, in the form of a shoe, is suspended on a rod from

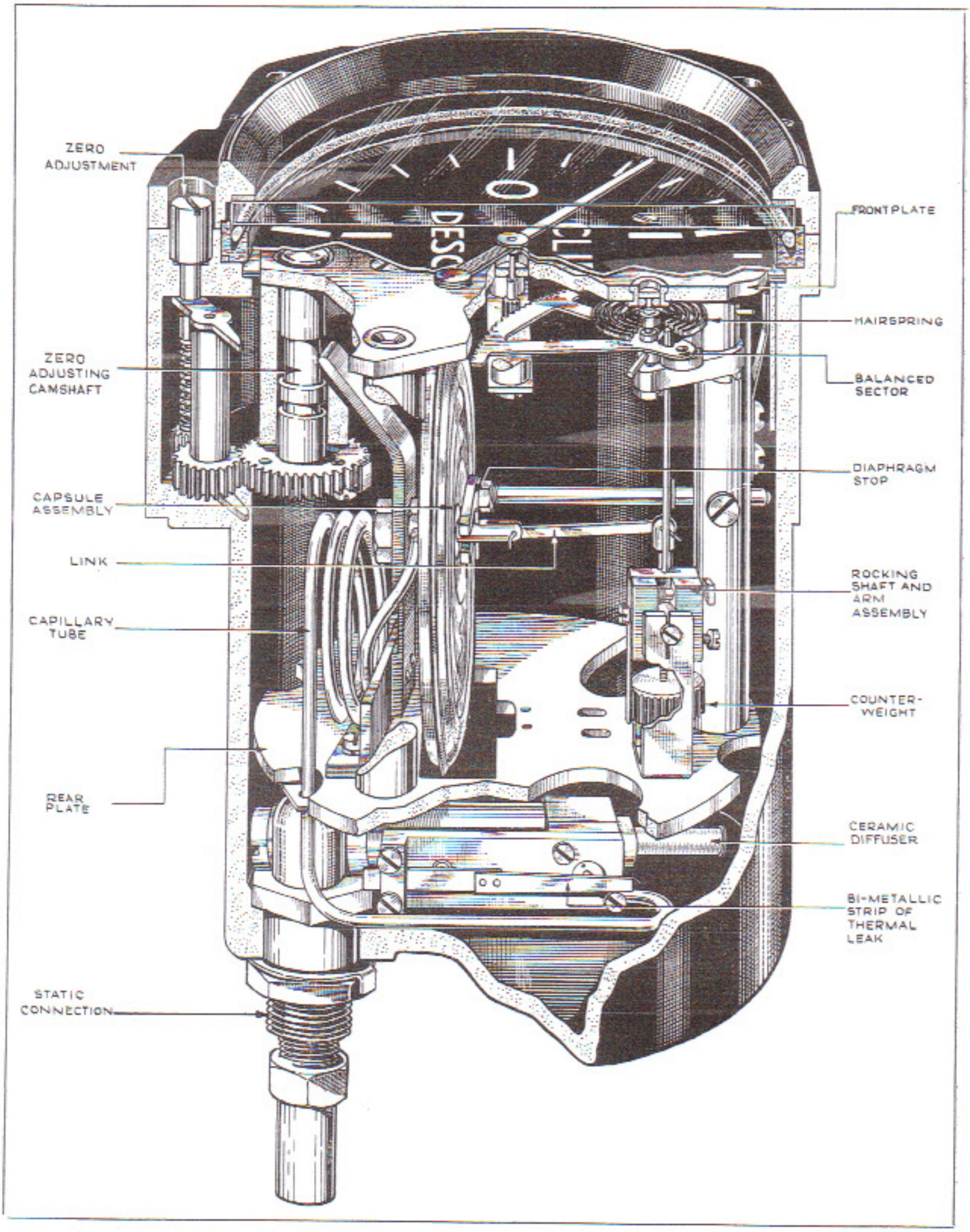


FIG. 2 Brass Frame Type Indicator

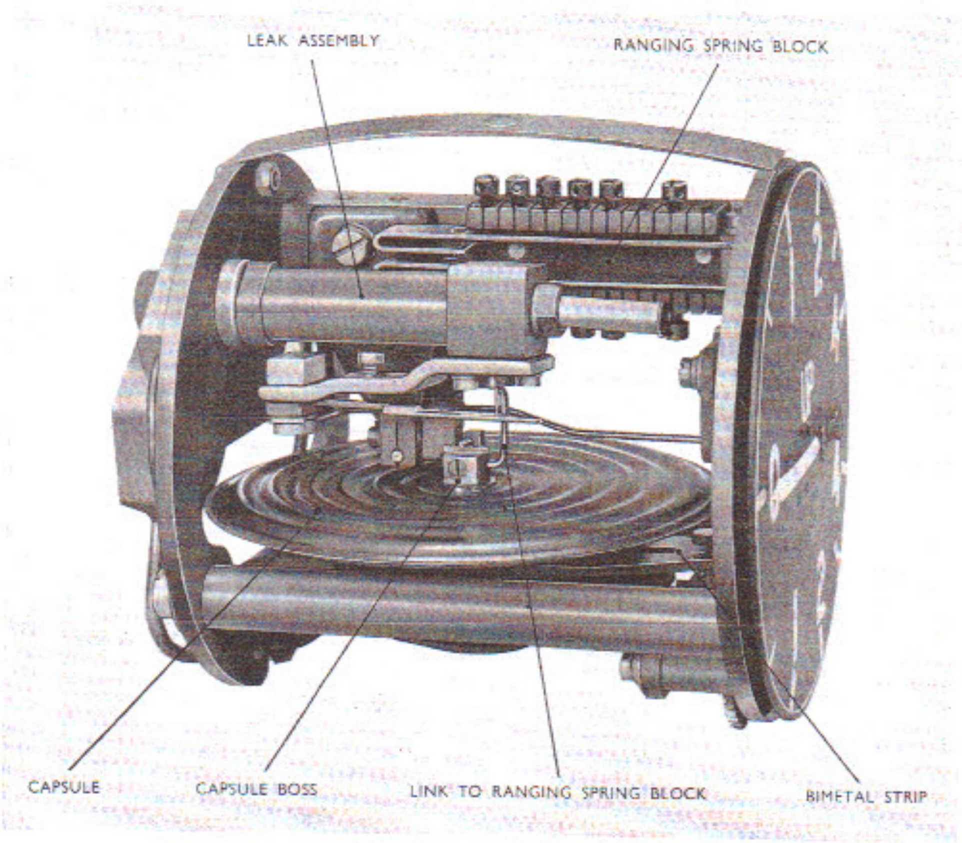


FIG. 3A
Duralumin Frame Type Indicator (case removed) showing Leak Assembly and Ranging Spring block.

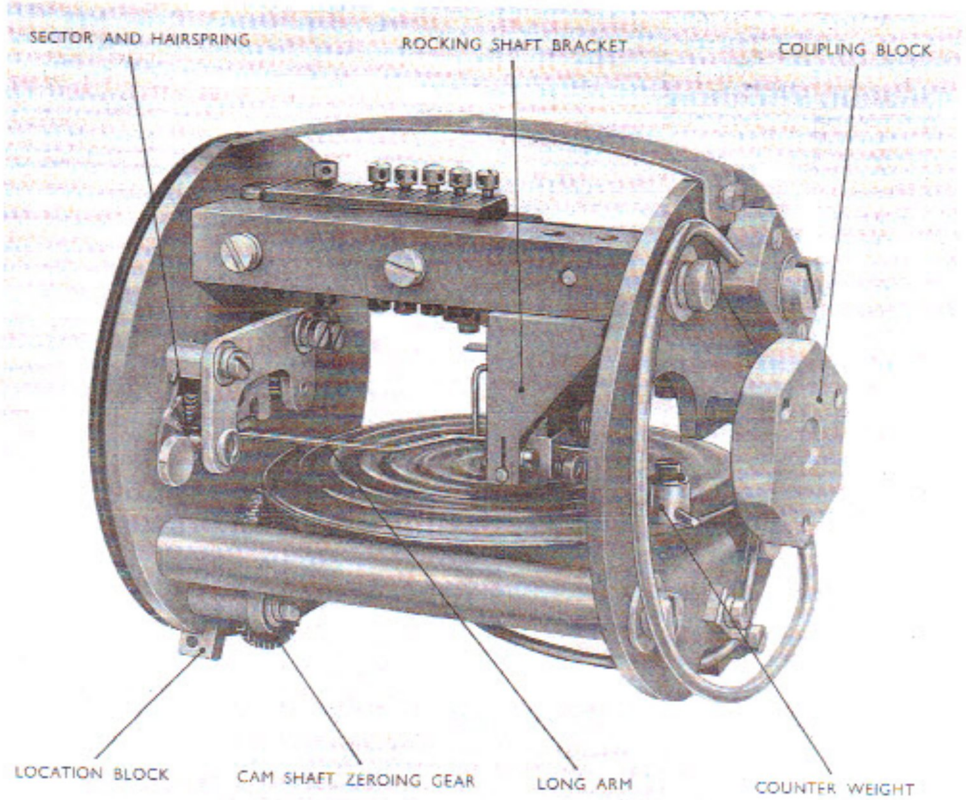


FIG. 3B
Duralumin Frame Type Indicator (case removed) showing sector and hairspring.

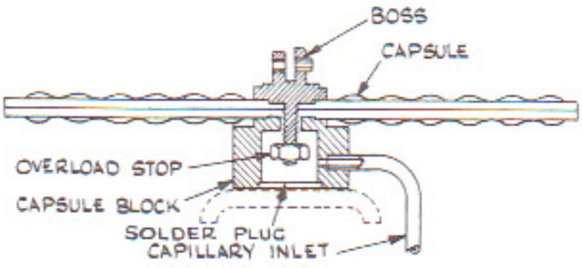


FIG. 4. Section through capsule showing overload stop. Duralumin frame instruments.

one of the pillars. This fits round the capsule boss and limits the movement of the capsule by abutting against the capsule on one side and a pin through the boss on the other. In the later instruments the overload stop is as shown in the diagram fig. 4.

7. Zero adjustment is provided by a pinion operated from outside the case by a spindle sealed against leakage. In later instruments, the pinion drives a camshaft gear, whose cam displaces a follower screwed to the end of a bimetal strip which adjusts the capsule datum when the spindle is rotated. Once "zeroed" the bimetal strip provides compensation for ambient temperature fluctuations. In the earlier instruments the pinion drives a gear which moves an angled metal strip, thus providing datum adjustment for the capsule. Temperature compensation is not provided at this point, but by means of a small Invar strip soldered to the long arm of the mechanism.

8. The dial scales may be either linear or graded, the graded scales being more open, and therefore more accurate, at lower rates of climb or descent. On both types of dial the rate of climb is shown on the upper half and rate of descent on the lower, with a common zero at nine o'clock.

9. Scale grading is achieved by fitting an additional device (fig. 5) within the instrument. This consists of a ranging spring block, attached to the square frame pillar, in which are housed two flat calibrating springs. A link, pivoted at the capsule boss, terminates in a collar placed between the springs and presses against one or other as the capsule expands or contracts. Movement of the calibrating springs, and hence of the capsule, is regulated by a number of screw stops.

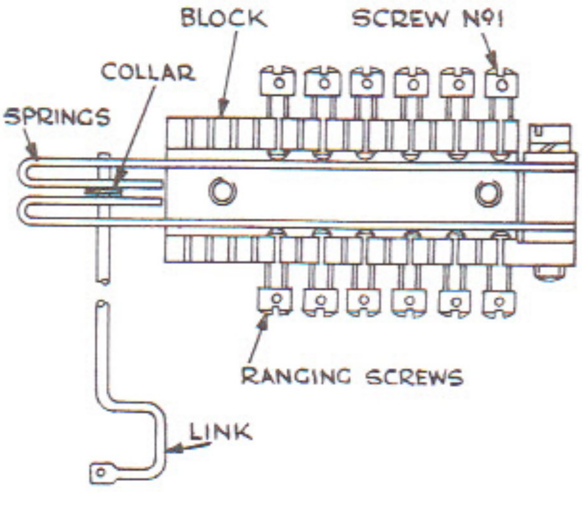


FIG. 5. Ranging spring block.

10. The movement slides into the case on two parallel ridges running down the inside of the case, and is kept steady by a flat spring fitted along its side. It is located and prevented from rotating by a small block attached to the front plate which fits into a slot in the case. This type of suspension has been designed to allow the movement to be removed and replaced without upsetting the calibration.

The Leak

11. This is constructed as shown in fig. 6. It consists of a tubular body into which are screwed two porous ceramic diffusers, and a spring loaded valve controlled by a bimetallic strip which bypasses the outer diffuser and provides temperature compensation. To prevent dust getting into the assembly a fine gauze filter is fitted into the inner end of the instrument's static connection block. The diffusers are calibrated so that, over a wide altitude range, the pressure difference across the leak is proportional to the rate of climb or descent.

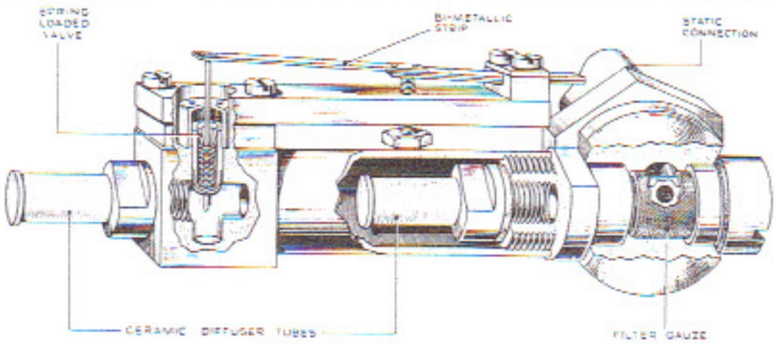


FIG. 6 The Leak Assembly

INSPECTION BEFORE INSTALLATION

12. Rate of climb indicators are extremely sensitive instruments, and if not packed in Smiths specially designed containers, are liable to be damaged during transit or while in store. Immediately before the instruments are installed, they must be examined visually to see if their general condition is satisfactory and then tested for case leakage and calibration (see paras. 15 to 22), in that order.

13. When testing indicators, the rate of increase or decrease of pressure must be gradual. The instruments are designed to withstand rates of pressure change in excess of those experienced in use, but although overload stops are fitted to the movement, to avoid damaging the capsule, the pointer should not be allowed to move beyond the scale limits. However, when applying an overload test, a specially adapted indicator indicating overload values may be used in parallel with the instrument under test. This should take the form of another indicator fitted with a specially calibrated capillary leak and a dial capable of reading up to 60,000 ft/min. It is then permissible to apply the overload rates of pressure given on the Tests and Tolerances Sheet.

14. Whenever possible the temperature of the indicator should be allowed to stabilise for about half an hour before testing. It should then be tapped lightly and the pointer set to zero.

Case Leakage Test

15. A diagram of the equipment required in this test is shown in fig. 7. This consists of a compressed air supply, pressure chamber and a water filled U-tube graduated in millimetres. Place the indicator under test in the chamber and bring out a tube from the static connection to one arm of the U-tube. (Note. The tubing inside the chamber must be capable of standing up to a pressure of 15 lb/sq. in.)

16. Open the airbleed, turn on the compressed air supply and let air into the chamber until the internal pressure reaches 15 lb/sq. in. (This pressure must be maintained throughout the test). Allow at least a minute for the air inside the instrument case to expand or contract due to temperature variations, then close the air bleed and supply taps. Observe the water in the U-tube for one minute, during which time any leakage of air from the chamber into the instrument case will be shown by a fall in the level in the arm connected to the instrument under test. If any leakage does occur, it must not exceed the volume given on the Tests and Tolerances Sheet. The distance that the water in one arm if the U-tube falls when displaced by a volume of air will depend on the bore of the tube and the pressure due to the difference of levels of the water in the two arms. The greatest permissable fall of water for various tube bores is given in the table on the Tests and Tolerances Sheet of Appendix 1.

17. If the leakage is greater than the permissible value, first check that the bezel is firmly tightened down. If it is not, tighten the eight countersunk screws securing it, tightening each screw in rotation and a small amount at a time to avoid uneven stressing of the glass. If this is not effective, renew the rubber sealing ring behind the glass.

18. If the instrument has been in use for a long time a leak may occur at the zero control spindle, which will entail renewing the sealing rings. It is also possible that the plastic case may be cracked ; if it is, it must be renewed.

19. Since the instrument case forms the capacity on which the functioning of the instrument depends, even a slight leak will cause a serious error. It is essential therefore, that no leakage in excess of that given in this test, is allowed.

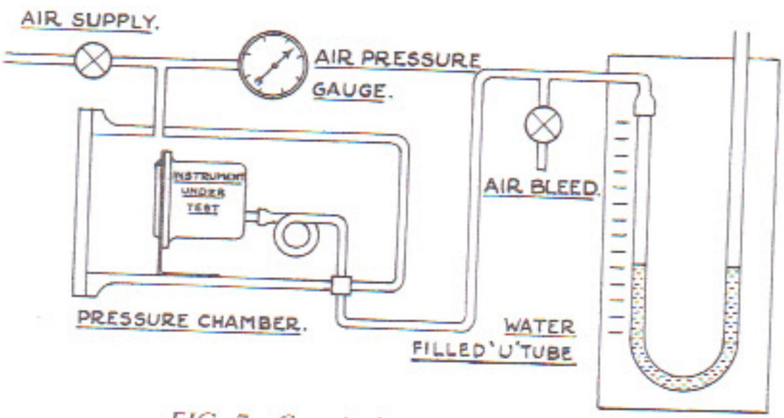


FIG. 7 Case leakage test equipment.