Chapter 3

(completely revised)

CONTROLS, THERMOSTATIC INCHING, TYPE FDF SERIES

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Introduction

1. Thermostatic inching controls are automatic controls in which a sensing element responds to a change in temperature to operate a switch which energizes a relay. The relay controls the power supply to a temperature regulating mechanism, and causes the mechanism to operate in such a direction as to correct any deviation from the

2. Movement of the regulating mechanism is transmitted back to the instrument and operates the inching control to oppose the movement caused by the original change in temperature. The control circuit is thus broken after a short time and the mechanism ceases to operate until the sensing element responds to a further change in temperature.

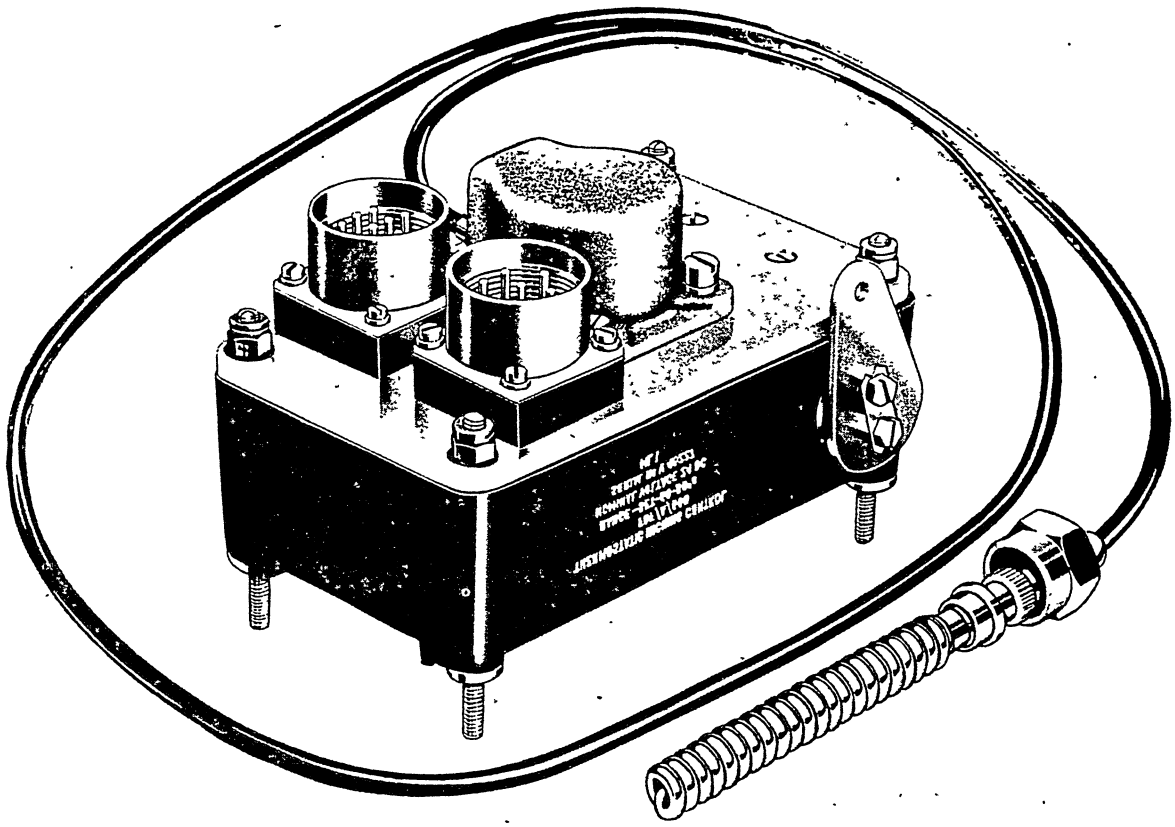


Fig.1. Typical thermostatic inching control

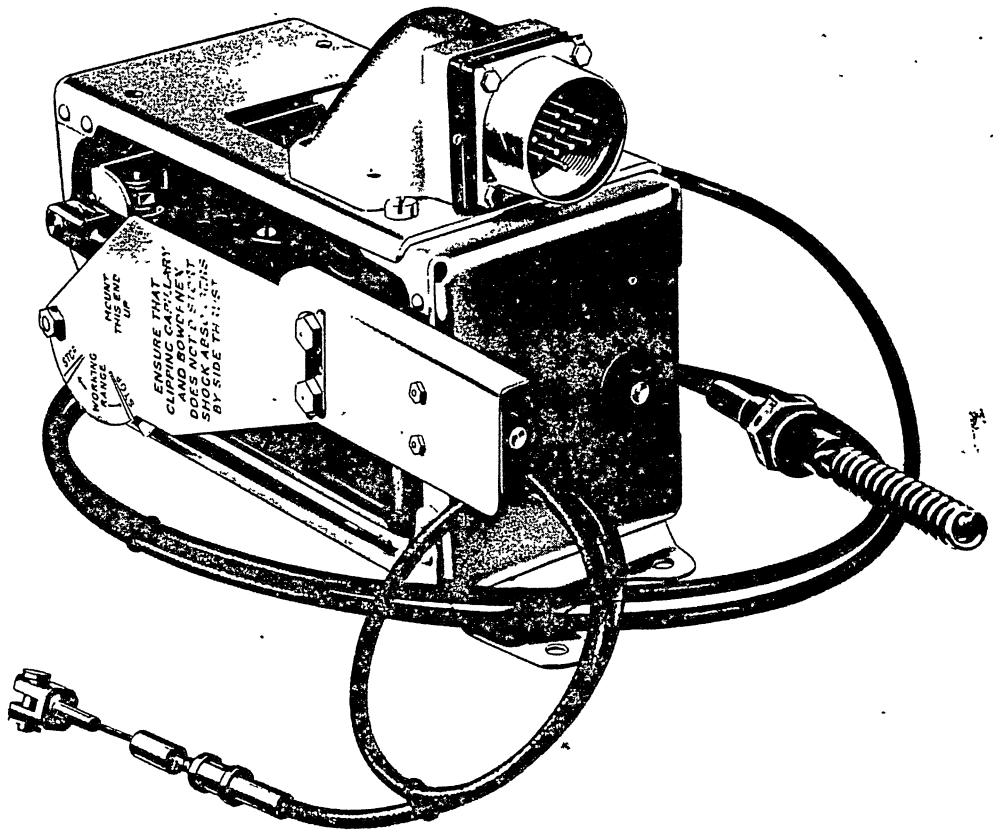


Fig. 2. Flexibly mounted thermostatic inching control

3. There are two basic types of control; step and non-step inching controls. The non-step type resets the regulating mechanism to correspond with each small change of temperature but the step-inching type, once it becomes energized, causes the regulating mechanism to move through a specific distance before switching off.

DESCRIPTION

Inching control, non-step inching

4. Typical non-step inching controls are shown in fig.1 and 2. The unit shown in fig.2 is a flexibly-mounted inching control. The housing for this unit is identical with that shown in fig.1, but it is carried in a cradle which is suspended in a light-alloy frame on anti-vibration mountings. In this unit the electrical plug is mounted externally on the frame and a synthetic rubber bellows between the frame and the unit housing provides a shield for the leads.

5. Referring to fig.3, a bellows assembly (8) is soldered to a mounting plate (14) and enclosed in a light-alloy housing (52) which is mounted on a baseplate (51). One end of a capillary tube (11) is connected, via a hole in the mounting plate, to the inside of the bellows. The other end of the capillary tube is soldered to the end of a temperature sensing phial (13). The phial consists of a spiral of copper or tungum tube wound around a cylindrical support tube. The phial, capillary tube and bellows together form the thermal sensing unit which is charged with fluid and sealed.

6. The bottom plate of the bellows is recessed and locates above a hole in the baseplate. Fitted in the hole is a flanged bush (42) which carries a tapered spring (7) in a recess in its face. An operating rod (6) which extends through the bush is biased by the spring towards the bellows bottom plate. The bore of the bush is slotted for part of its length and a pin (46) through the operating rod rides in the slot to limit movement of the rod towards the bellows.

7. A slotted washer (48) fitted over the pin (46) seats a compression spring (5) which bears on a switch operating lever (10). Knife edges on the lever bear on a thrust washer (3) which is held in position by an adjusting nut (2) screwed over the threaded portion (1) of the operating rod. Adjustment of this nut controls the working range of the instrument.

8. The switch operating lever is pivoted at one end (4 fig.6) to another lever, the following lever (12) which is also pivoted at another point (9fig.6) between two plates.

9. The follower lever terminates in a cage containing a steel ball (56) which is held by a spring (57) against an eccentric cam (15) secured to a shaft (16) which is driven, through a slipping clutch (55), by a mechanical linkage from the regulating mechanism. A control segment (49) on the shaft limits rotation of the shaft by abutting a stop plate (50).

10. The follower lever (12) is bimetallic and in addition to its mechanical function it compensates for variations in ambient temperature.

11. The slipping clutch (55) is fitted to prevent mechanical damage being caused to the instrument by the motor attempting to rotate the follower shaft (16) beyond the set limits. It is spring loaded and is so adjustable as to grip the shaft sufficiently, without slipping under vibration conditions in service, and yet be free enough to slip when the cam reaches the limit stop.

12. The free end of the switch operating lever (10) bears on the plunger (22) of a single pole double throw switch. The plunger in turn bears on the contact arm (23) of the switch which carries the moving contact (19) and is biased by a spring (21) towards one of the fixed contacts (20). The position of the other fixed contact (18) is adjustable and adjustment of this contact controls the operating differential of the instrument, i.e. the change of temperature required to cause the temperature regulating mechanism to reverse in direction.

13. The moving contact of the switch is connected to the 24V d.c. supply and the fixed contacts (18) and (20) to the operating coils (24) and (26) of a relay (53). The relay contacts (25) and (27) are in series with the power supply to the regulating mechanism.

14. The relay may be one of two types; either Type FDN/A/173 or Type FDN/A/210, depending on the type of control. The relay, Type FDN/A/173 has two separate windings on a split core, arranged to attract either end of an armature rocking on a fulcrum at its centre. When the coils are de-energized the armature

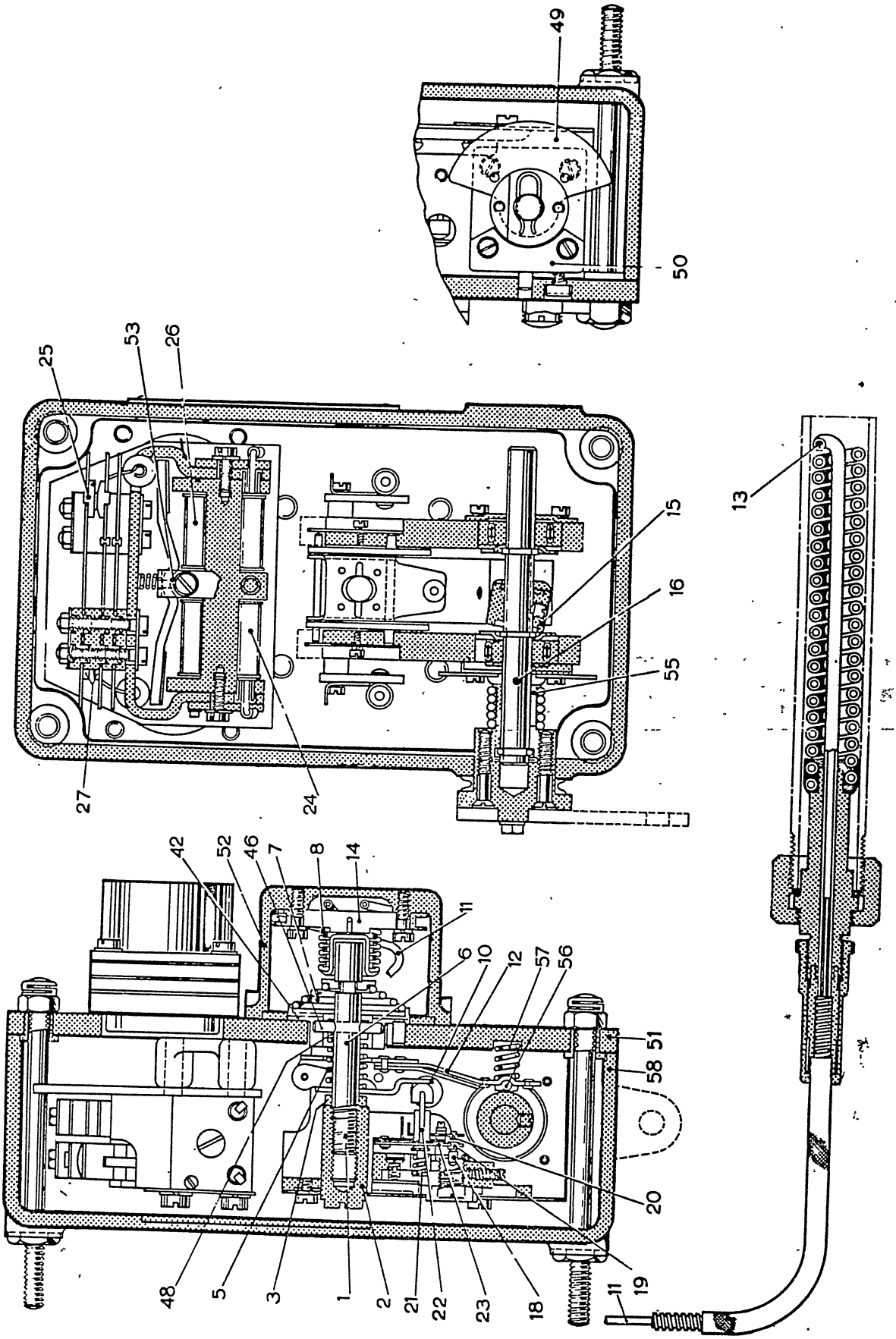


Fig. 3. Inching control, general arrangement of mechanism (non step inching)

1. THREADED PORTION OF ROD 6
2. ADJUSTING NUT
3. THRUST WASHER
5. SPRING
6. OPERATING ROD
7. SPRING
8. BELLOWS
10. SWITCH OPERATING LEVER
11. CAPILLARY TUBE
12. FOLLOWER LEVER
13. PHIAL
14. BELLOWS MOUNTING PLATE
15. ECCENTRIC CAM
16. FOLLOWER SHAFT
18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
21. SPRING
22. SWITCH PLUNGER
23. CONTACT ARM
24. RELAY COIL
25. RELAY CONTACTS
26. RELAY COIL
27. RELAY CONTACTS
42. BUSH
46. PIN
48. WASHER
49. CONTROL SEGMENT
50. STOP PLATE
51. BASEPLATE
52. BELLOWS HOUSING
53. RELAY, TYPE FDN/A/173
55. SLIPPING CLUTCH
56. STEEL BALL
57. SPRING
58. MAIN COVER

KEY TO FIG. 3

assumes a neutral or midway position. Each section carries a pair of contacts which are open when the coil is de-energized. Relay, Type FDN/A/210, has two separate armatures operated by two coils on a common core. Each section carries one set of changeover contacts and one pair of normally open contacts.

15. Electrical connections to the unit are made by one or two plugs, the type of plug depending on the particular unit.

16. The unit is enclosed in a light-alloy cover (58) secured to the baseplate by four bolts and nuts. On instruments not mounted in anti-vibration brackets the bolts extend beyond the nuts and are used as studs for installation purposes.

Inching control, step-inching

17. In an inching control incorporating step inching (fig.4) the control segment on the follower shaft is replaced by a notched cam (43). One end of a pivoted arm (44) engages in the teeth of the cam and the other end bears on a push rod (45) which operates a snap-action switch (47). The fixed contacts (39 and 41 fig.8) of the switch are both connected to the negative of the d.c. supply and the moving contact (40 fig.8) is connected to the negative side of the relay coils.

18. The relay used in step inching controls is the relay, Type FDN/A/210. The contacts are wired in such a way that when one section of the relay becomes energised it remains energized until the snap-action switch (47) is operated by the step inching mechanism or until the other section of the relay becomes energized.

OPERATION

Inching control non-step inching

19. The operation of the unit can be followed from figs.6 and 7. The motor and its field coils and limit switches shown in fig.7 are not part of the instrument. A typical application of the instrument is in controlling an electrically operated radiator flap and this description applies to the operation of such an installation.

20. Assume that the phial (13 fig.6) is at the required temperature. The bellows (8), operating rod (6) and switch operating lever (10) are in such a position that the moving contact (19) of the thermally operated switch is midway between the fixed contacts (18) and (20). In this condition both coils (24) and (26) of the relay are de-energized and consequently the power supply to the motor (32) is broken so there is no movement of the flap.

21. A fall in the temperature of the phial (13) causes the charge to contract. This in turn causes the bellows (8) to retract. The operating rod (6), under the influence of the tapered spring (7), follows the movement of the bellows. The thrust washer (3) moves the switch operating lever (10) in such a direction as to relieve the pressure on the switch plunger (22) and the contact arm (23) moves under the loadings of its spring (21) to close contacts (19) and (20) and energize relay coil (26). Contacts (27) close and complete the circuit to the motor armature (32) via field winding (31). The motor now runs in the direction required to close the flap.

22. Movement of the flap is transmitted by a mechanical linkage to the follower arm (17) and shaft (16) which carries the eccentric cam (15).

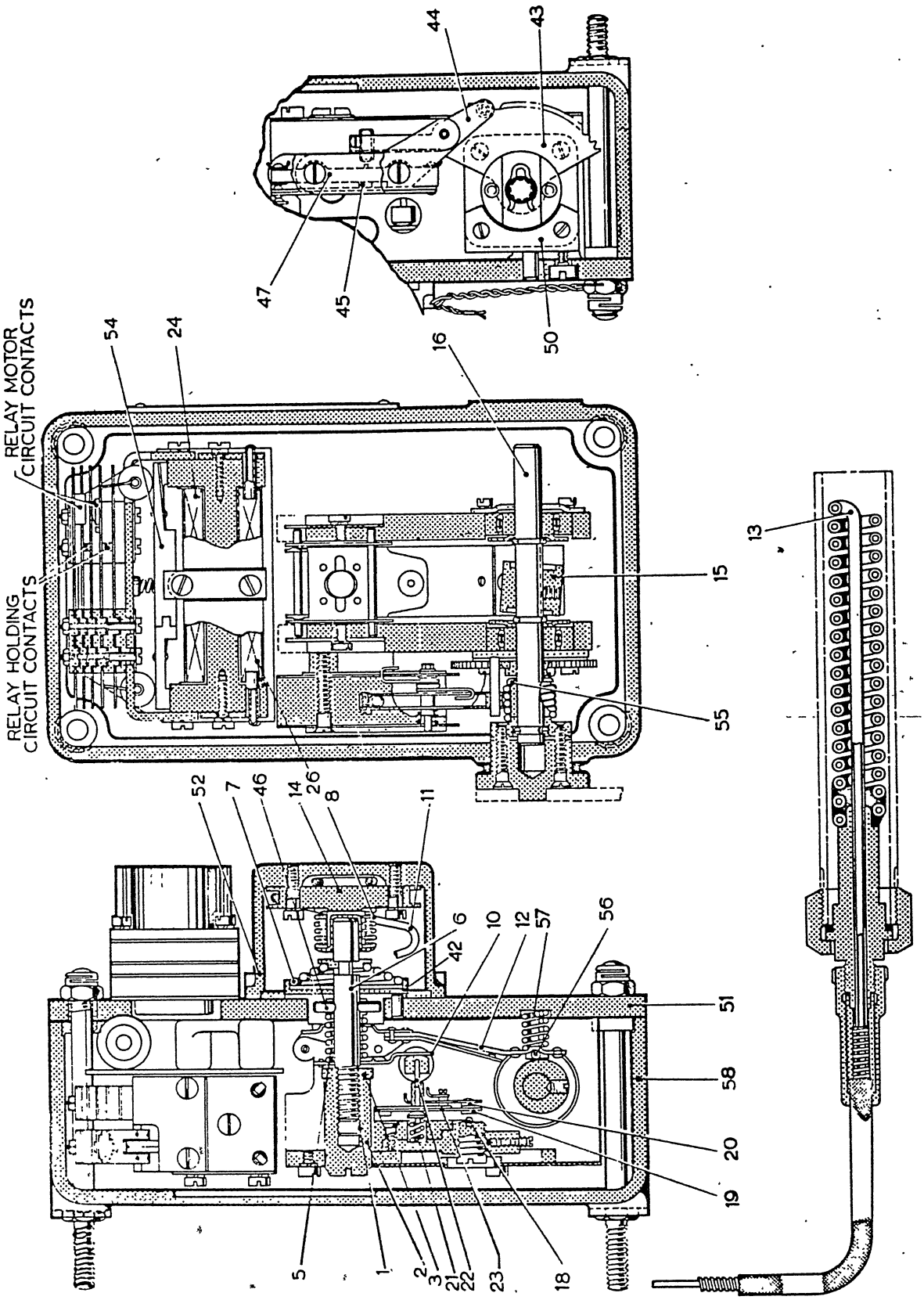


Fig. 4. Inching control, general arrangement of mechanism (step inching)

1. THREADED PORTION OF ROD 6
2. ADJUSTABLE NUT
3. THRUST WASHER
5. SPRING
6. OPERATING ROD
7. SPRING
8. BELLOWS
10. SWITCH OPERATING LEVER
11. CAPILLARY TUBE
12. FOLLOWER LEVER
13. PHIAL
14. BELLOWS MOUNTING PLATE
15. ECCENTRIC CAM
16. FOLLOWER SHAFT
18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
21. SPRING
22. SWITCH PLUNGER
23. CONTACT ARM
24. RELAY COIL
26. RELAY COIL
42. BUSH
43. NOTCHED CAM
44. PIVOTED ARM
45. PUSH ROD
46. PIN
47. SNAP-ACTION SWITCH
48. WASHER
50. STOP PLATE
51. BASEPLATE
52. BELLOWS HOUSING
54. RELAY, TYPE FDN/A/210
55. SLIPPING CLUTCH
56. STEEL BALL
57. SPRING
58. MAIN COVER

KEY TO FIG. 4

The cam moves in an anti-clockwise direction and the follower lever (12) moves to the left about pivot point (9) This movement causes pivot point (4) to move to the right and the free end of the switch operating lever (10) to move to the left to increase the pressure on the switch plunger (22) which moves the contact arm (23) against the pressure of the spring (21) until the moving contact (19) is midway between the fixed contacts (18) and (20). This breaks the supply to the relay coil (26) which de-energizes to open contacts (27) and break the supply to the motor.

23. On an increase in temperature a similar action takes place but in the reverse direction. Bellows (8) expands against the load of spring (7). Its movement is transmitted by the operating rod (6) to the switch operating lever (10) and the switch plunger (22). The plunger overcomes the pressure of spring (21) to move the contact arm (23) to the left and close contacts (18) and (19). This energizes relay coil (24) and contacts (25) close to complete the circuit to the motor armature (32) through field coil (30) and causes the motor to turn in the direction required to open the flap.

24. Movement of the flap is transmitted to the follower arm (17), the shaft (16) and cam (15). The cam, turning in a clockwise direction, moves follower lever (12) to the right about pivot point (9), pivot point (4) moves to the left and the free end of the switch operating lever (10) moves to the right and relieves the pressure on the switch plunger (22). The contact arm (23) is moved to the right by the pressure of spring (21) to carry the moving contact (19) away from fixed contact (18) and de-energized relay coil (24). Contacts (25) open to break the supply to the motor. The instrument is now in a quiescent condition until another change in temperature in either direction initiates a further sequence of operations.

Inching control step inching

25. The basic principles of operation of an inching control incorporating step inching are similar to those of the non-step type. The sequence of operations can be followed from fig.8 and 9.

26. On a decrease in the temperature of the phial (13) the bellows (8), operating rod (6) and switch operating lever (10) operate as in the non-step type to close contacts (19) and (20) and energize relay coil (26). Contacts (27) and (38) close and complete the circuit to the motor armature (32) via field coil (31), causing the motor to turn in the direction required to close the flap. Contacts (35A) and (36A) also close when the coil (26) becomes energized and the d.c. supply is now fed by an alternative path, via contacts (33 - 34) and contacts (35A - 36A) to the relay coil (26). With this arrangement of the contacts the relay remains energized when contacts (19) and (20) open due to the action of the inching mechanism and the motor continues to turn until an increase in temperature causes contacts (18) and (19) to close and energize relay coil (24) or until the connection between the relay coils and the negative of the d.c. supply is broken for an instant by operation of the snap action switch (47).

27. The follower arm (17), shaft (16) cam (15) and follower lever (12) all operate as in the non-step type to open contacts (19) and (20), but the relay coil remains energized through the hold on circuit described in para. 26. The notched cam (43) rotates with the shaft (16) and the motor continues to run until the notched cam

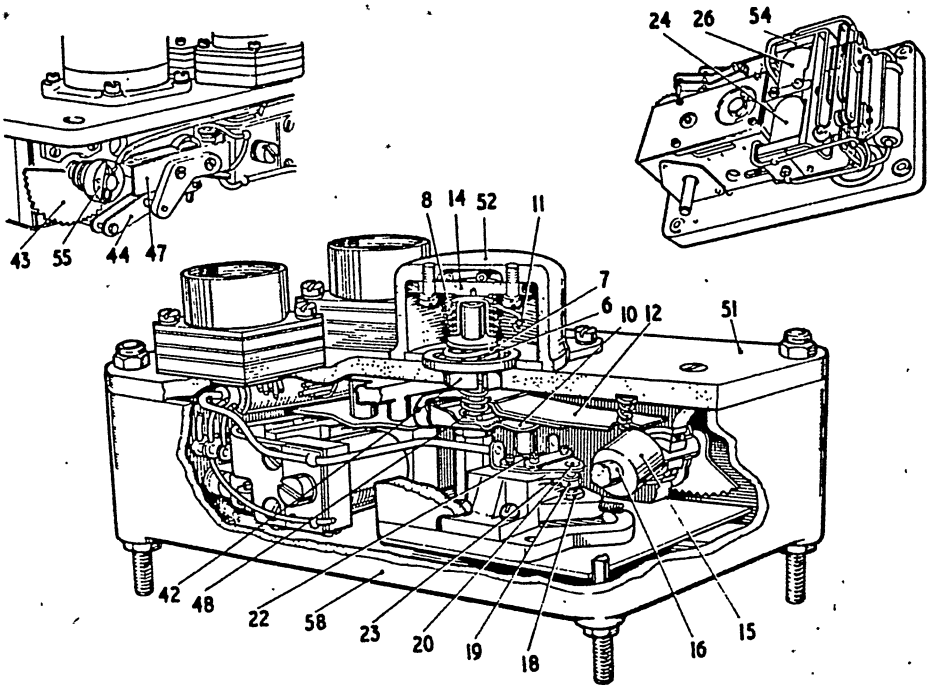


Fig. 5. Inching control, internal view of mechanism (step inching)

6. OPERATING ROD	16. FOLLOWER SHAFT	42. BUSH
7. SPRING	18. ADJUSTABLE CONTACT	43. NOTCHED CAM
8. BELLOWS	19. MOVING CONTACT	44. PIVOTED ARM
10. SWITCH OPERATING LEVER	20. FIXED CONTACT	47. SNAP-ACTION SWITCH
11. CAPILLARY TUBE	22. SWITCH PLUNGER	51. BASEPLATE
12. FOLLOWER LEVER	23. CONTACT ARM	54. RELAY, TYPE FDN/A/210
14. BELLOWS MOUNTING PLATE	24. RELAY COIL	55. SLIPPING CLUTCH
15. ECCENTRIC CAM	26. RELAY COIL	58. MAIN COVER

KEY TO FIG. 5

(43) moves the pivoted arm (44) far enough to operate the snap action switch (47). Operation of this switch momentarily breaks the connection from the relay coils to the negative of the d.c. supply and de-energizes the relay coil (26). Contacts (27) and (38) open to break the supply to the motor and contacts (35A) and (36A) open to break the relay hold-on circuit so the relay now remains de-energized until another change in temperature initiates a further similar cycle of operations.

INSTALLATION

28. The route selected for the capillary tube should be that which involves the least risk of mechanical damage. The capillary tube should never be twisted and all sharp bends should be avoided. No bend should have a radius of less than 1·5 in.

29. Special care should be taken not to damage the phial, which is 'solid charged'. Any deformation will alter its cubic capacity and affect the temperature setting of the instrument. The phial protector should be removed only for installation and testing.

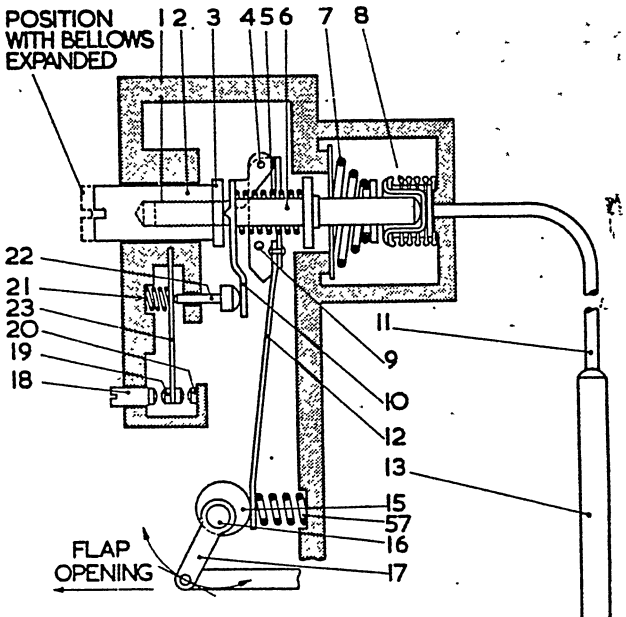


Fig. 6. Simplified working diagram (non-step inching)

1. THREADED PORTION OF ROD 6
2. ADJUSTING NUT
3. THRUST WASHER
4. PIVOT
5. SPRING
6. OPERATING ROD
7. SPRING
8. BELLOWS
9. PIVOT
10. SWITCH OPERATING LEVER
11. CAPILLARY TUBE
12. FOLLOWER LEVER
13. PHIAL
15. ECCENTRIC CAM
16. FOLLOWER SHAFT
17. FOLLOWER ARM
18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
21. SPRING
22. SWITCH PLUNGER
23. CONTACT ARM

KEY TO FIG. 6

Note . . .

When removing the inching control from the aircraft no attempt is to be made to separate the phial and the capillary from the main assembly. Only the main cover is to be removed for testing and adjusting.

Alignment

30. The alignment of the flap or any other controlled part with the mechanism of the inching control when the latter is fitted with a slipping clutch can be made by moving the flap manually over its full operating range. Any initial misalignment will be corrected automatically by the slipping of the clutch in this manual operation.

SERVICING

31. The instrument should be examined at the periods laid down in the Servicing Schedule of the relevant aircraft handbook, checking as follows:-

(1) Ensure that the control is fastened to its mountings by means of the four fixing bolts protruding from its cover.

(2) Inspect the mounting and ensure that it is securely fastened to the airframe.

(3) Check the security of the follower arm and its connection to the mechanism it controls.

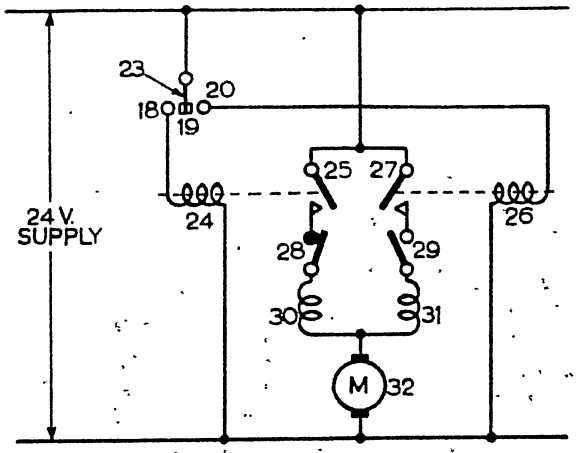


Fig.7. Circuit diagram (non-step inching)

18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
23. CONTACT ARM
24. RELAY COIL
25. RELAY CONTACT
26. RELAY COIL
27. RELAY CONTACT
28. LIMIT SWITCH
29. LIMIT SWITCH
30. 'FORWARD' FIELD
31. REVERSE FIELD
32. MOTOR ARMATURE

KEY TO FIG. 7

(4) Examine plug and socket connections and the cable leading to the operating motor.

(5) Examine the capillary tube throughout its route to ensure that all clips and the fastenings holding it are secure and that it is free from chafing.

(6) Ensure that the phial is securely installed in the correct place.

32. If the serviceability of an inching control is in doubt apply the tests detailed in Appendix 1. If a unit fails to meet the requirements of the functional test *(App.1)* carry out the adjustments detailed in Appendix 1 para 13 to 21.

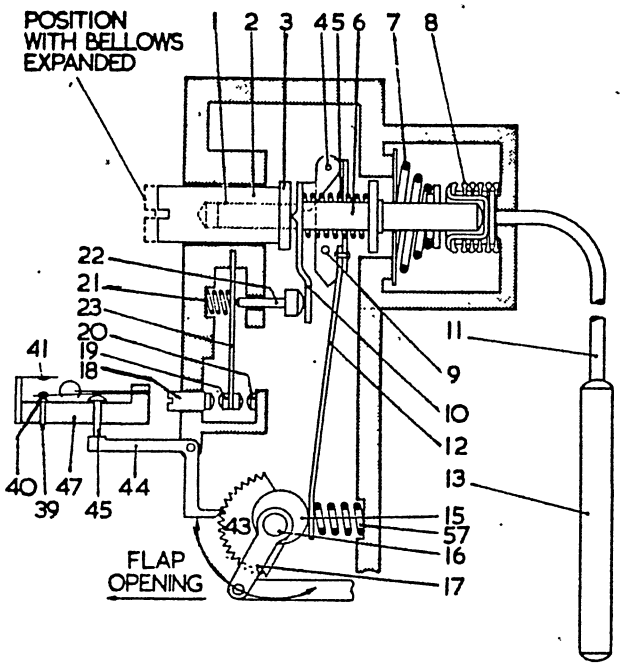


Fig.8. Simplified working diagram (step inching)

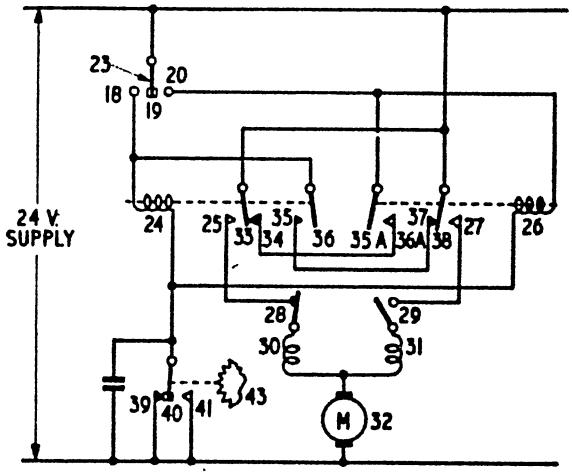


Fig.9. Circuit diagram (step inching)

1. THREADED PART OF ROD 6
2. ADJUSTING NUT
3. THRUST WASHER
4. PIVOT
5. SPRING
6. OPERATING ROD
7. SPRING
8. BELLOWS
9. PIVOT
10. SWITCH OPERATING LEVER
11. CAPILLARY TUBE
12. FOLLOWER LEVER
13. PHIAL
15. ECCENTRIC CAM
16. FOLLOWER SHAFT
17. FOLLOWER ARM
18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
21. SPRING
22. SWITCH PLUNGER
23. CONTACT ARM
39. FIXED CONTACT
40. MOVING CONTACT
41. FIXED CONTACT
43. NOTCHED CAM
44. PIVOTED ARM
45. PUSH ROD
47. SNAP-ACTION SWITCH

KEY TO FIG. 8

18. ADJUSTABLE CONTACT
19. MOVING CONTACT
20. FIXED CONTACT
23. CONTACT ARM
24. RELAY COIL
25. RELAY CONTACT
26. RELAY COIL
27. RELAY CONTACT
28. LIMIT SWITCH
29. LIMIT SWITCH
30. 'FORWARD' FIELD
31. 'REVERSE' FIELD
32. MOTOR ARMATURE
33. RELAY CONTACT
34. RELAY HOLDING CONTACT
35. RELAY HOLDING CONTACT
35A. RELAY HOLDING CONTACT
36. RELAY HOLDING CONTACT
36A. RELAY HOLDING CONTACT
37. RELAY HOLDING CONTACT
38. RELAY CONTACT
39. FIXED CONTACT
40. MOVING CONTACT
41. FIXED CONTACT
43. NOTCHED CAM

KEY TO FIG. 9

Appendix 1

STANDARD SERVICEABILITY TESTS

for

CONTROLS, THERMOSTATIC INCHING, TYPE FDF. SERIES

Introduction

1. The tests described in this appendix are to be applied to an inching control immediately prior to its installation in an aircraft, at any time when the serviceability of the control is in doubt and at the appropriate examination periods at Equipment Depots.

TEST EQUIPMENT

2. The following test equipment is required:-

(1) Insulation tester, Type C, Ref. No. 5G/152
(2) Bonding tester, Type B Ref. No. 5G/2126
(3) Calibrator, thermometer, portable, Mk.1, Ref. No. 6C/623
(4) Bath, testing thermometer, Ref. No. 6C/795
(5) Thermometer, precision, Ref. No. 6C/220
(6) Test rig, as illustrated in fig.1
(7) Testing quadrant, as illustrated in fig.2
(8) Pointer, as illustrated in fig.3
(9) Setting quadrant, as illustrated in fig.4
(10) Pointer, as illustrated in fig.5
(11) Torque testing arm
(12) Test leads and connectors, as illustrated in fig.6 and 7

TEST PROCEDURE

3. All tests should be carried out with the unit, except for the phial, at normal room temperature (approximately 20 deg.C.). For thermal tests the rate of change of temperature of the phial must not exceed 2 deg.C. per minute.

4. Before testing it is necessary to remove the locking strip and follower lever, if fitted, from the clutch extension adapter. Flexibly mounted inching controls must be removed from their anti-vibration mountings. Remove these items as directed in para.5 and 6.

Non-flexibly mounted inching controls

5. Remove the two 4BA bolts securing the locking strip and follower lever to the clutch extension adapter. Remove the locking strip and follower lever.

Flexibly mounted inching controls

6. (1) Unlock the locking strips and tab-washer at the guard plate. Remove the two 2BA hexagon head screws and the 2BA nut securing the plate. Remove the plate.

(2) Unclip the follower lever return spring from the tube to which it is anchored. Remove the tube.

(3) Remove the eccentric tube from the stud projecting from one of the movement limiting brackets.

(4) Unlock the locking strip at the follower lever and remove the two 4BA hexagon head screws securing the strip. Remove the locking strip.

(5) Remove the follower lever and the follow-up cable assembly. Coil the cable into loops of large radius.

(6) Break the locking wire at the four hexagon head screws at the base of the mounting bracket and remove these screws and the associated washers.

(7) Remove the four 2BA cheese head screws and spring washers securing the plug adapter support plate. Ease the plate away from the mounting bracket and remove the four nuts securing the support brackets to the base-plate.

(8) Manoeuvre the unit so that the support brackets can be removed.

(9) Carefully lift out the unit, complete with the plug adaptor and support plate.

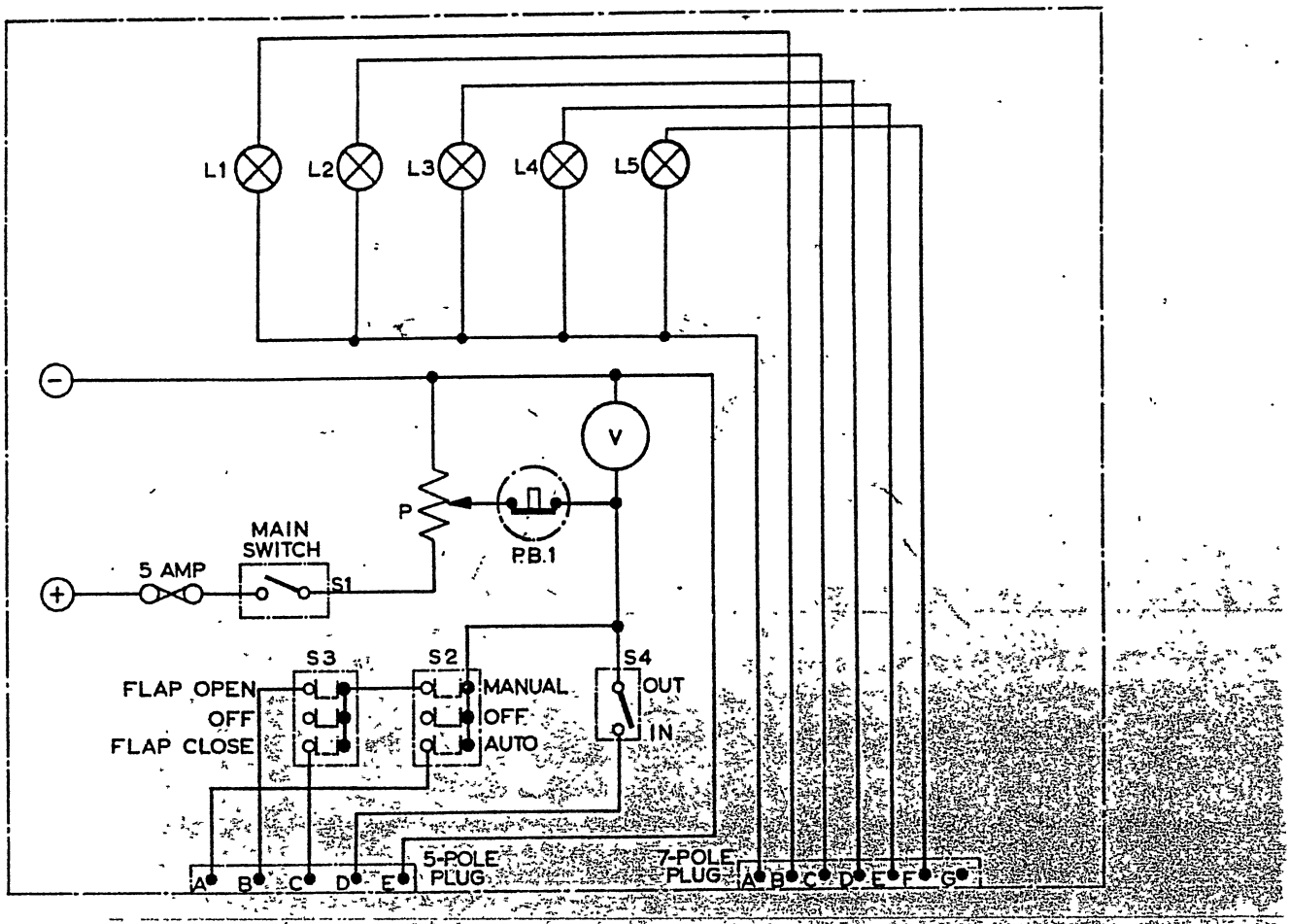


Fig.1. Circuit diagram of test rig for working controls

TESTS

Electrical tests

Insulation resistance

7. The resistance between the following points must not be less than 30 meghoms at 250 V. d.c:-

(1) Between each pin of each electrical plug and the baseplate

(2) Between the pins of the electrical plugs specified in Table 1, columns (1), (2) and (3)

Bonding test

8. The resistance between the following points must not exceed 0·025 ohms:-

(1) Between the bellows housing and the baseplate

(2) Between the main cover and the baseplate

Manual override test

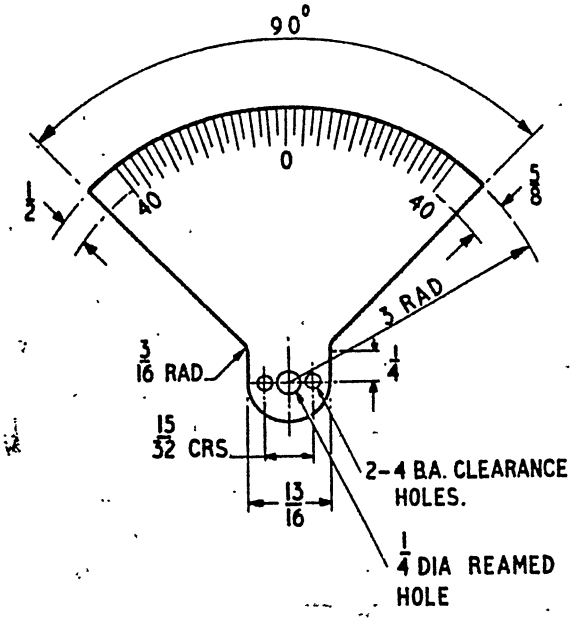
9. (1) Connect the unit to the test rig (fig.1) using the appropriate connecting leads.

(2) Switch on the d.c. supply, set switch S 2 to MANUAL and switch S 3 to OFF. The lamps specified under "relay de-energized" in Table 2, Column (2) must illuminate.

(3) Set switch S 3 to FLAP OPEN. The lamps specified under "flap opening" in Table 2, Column (2) must illuminate, indicating that the OPEN coil of the relay is energized.

(4) Adjust variable resistance P until voltmeter V indicates 29V. Depress push button PB 1 to de-energize the relay. Release push button PB 1. The relay must energize immediately

(5) Adjust variable resistance P until voltmeter V indicates 16V. Depress push button



GRADUATE SCALE WITH 2° INTERVALS.
MATERIAL 16 S.W.G. BRASS.
DIMENSIONS ARE IN INCHES.

Fig.2. Testing quadrant

PB 1 to de-energize the relay. Release push button PB 1. The relay must energize immediately.

(6) Reduce the voltage by adjusting variable resistance P until the relay de-energizes. At this point voltmeter V must not indicate less than 5V. Adjust variable resistance P until voltmeter V indicates 24 V.

(7) Set switch S 3 to FLAP CLOSED. The lamps specified under "flap closing" in Table 2, Column (2) must illuminate, indicating that the CLOSE coil of the relay is energized.

(8) Adjust varible resistance P until voltmeter V indicates 29V. Depress push button PB 1 to de-energize the relay. Release push button PB 1. The relay must energise immediately.

(9) Adjust variable resistance P until voltmeter V indicates 16V. Depress push button PB 1 to de-energize the relay. Release push button PB 1. The relay must energize immediately.

(10) Reduce the voltage by adjusting resistance P until the relay de-energizes. At this point voltmeter must not indicate less than 5V. Adjust variable resistance P until voltmeter V indicates 24V.

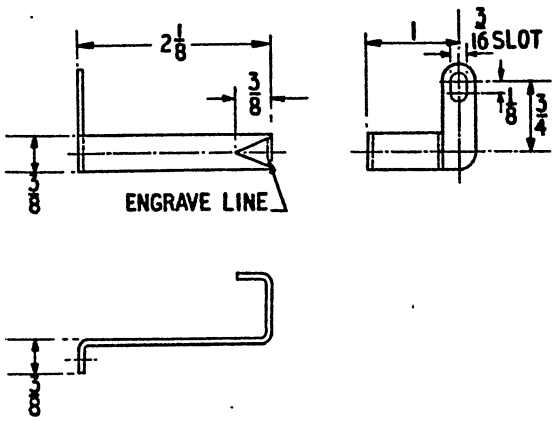
Functional test

10. Secure the testing quadrant (fig.2) to the clutch extension adapter and secure the pointer (fig.3) over the mounting stud nearest to the clutch extension adapter so that the engraved line on the pointer comes above the lines on the quadrant. Connect the unit to the test rig. (fig.1)

11. Using the appropriate connecting leads. Imerse the phial into a pocket of the testing bath and switch on the heater and stirrer of the bath.

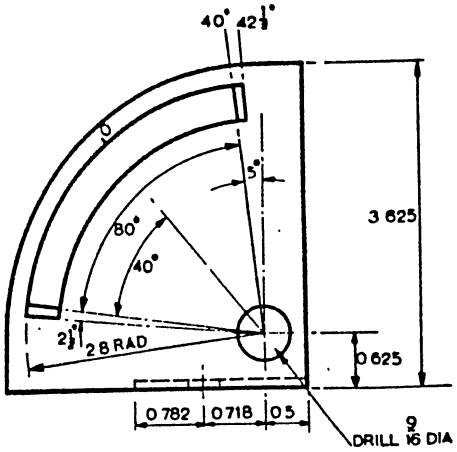
12. (1) Set switch S 1 to ON, switch S 2 to AUTO, switch S 3 OFF and switch S 4 to IN. Ensure that the inching control and the follow up mechanism are in the position corresponding to flap closed. The appropriate lamps specified under "Flap closing" in Table 2, Column (2) must illuminate, indicating that the CLOSE section of the relay is energized.

(2) Increase the temperature until the relay de-energizes and the lamps specified under "Relay de-energized" in Table 2, Column (2) illuminate. Increase the temperature further until the OPEN section of the relay energizes and the lamps specified under "Flap opening" in Table 2, Column (2) illuminate. Note the temperature at which this occurs. This is the "Commence to open" temperature and must be within the limits specified in Table 3, Column (1).



MATERIAL 16 S.W.G. BRASS
DIMENSIONS ARE IN INCHES

Fig.3. Pointer



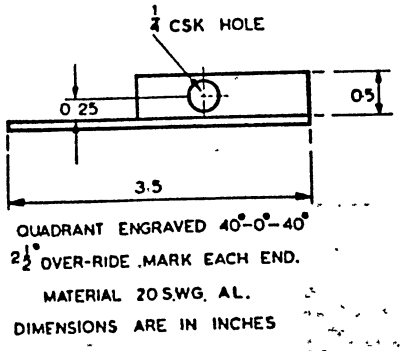


Fig.4. Setting quadrant

(3) Decrease the temperature until the relay de-energizes and the lamps specified under "Relay de-energized" illuminate. Decrease the temperature further until the CLOSE section of the relay energizes and the lamps specified under "Flap closing" illuminate. Note the temperature.

(4) Increase the temperature until the relay de-energizes and the lamps specified under "Relay de-energized" illuminate. Note the temperature. The difference between this temperature and that recorded in operation (3) is the closing contact hold-on and must not exceed the figures specified in Table 3, column (4).

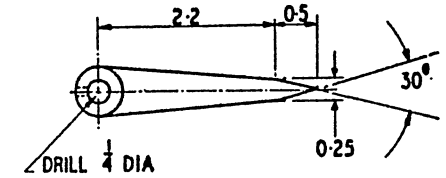
(5) Increase the temperature further until the OPEN section of the relay energizes and the lamps specified under "Flap opening" illuminate. Note the temperature. The difference between this temperature and that recorded in operation (4) is the opening differential and must be within the limits specified in Table 3, Column (5).

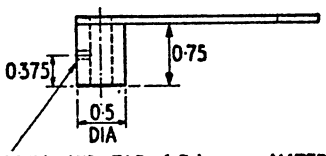
(6) If the instrument under test is a non step inching control rotate the quadrant a few degrees until the relay de-energizes and the lamps specified under "Relay de-energized" illuminate. If the instrument is a step inching type move the quadrant over 1 step of the inching control. Increase the temperature until the OPEN section of the relay energizes again and move the quadrant again until it de-energizes. Continue in this manner until the pointer is on the "Fully open" position with the relay de-energized. Increase the temperature until the OPEN section of the relay energizes and note the temperature. This is the "Fully open" temperature and must be within the limits specified in Table 3, Colum (2).

(7) Decrease the temperature until the relay de-energizes. Note the temperature. The difference between this temperature and that recorded in operation (6) is the opening contact hold on and must not exceed the figure specified in Table 3, Column (4).

(8) Decrease the temperature until the CLOSE section of the relay energizes and note the temperature. The difference between this temperature and that recorded in operation (7) is the closing differential and must be within the limits specified in Table 3, Column (5).

(9) If the instrument under test is a non step inching control rotate the quadrant a few degrees until the relay de-energizes. If the instrument is a step inching type move the quadrant over one step of the inching control. Decrease the temperature until the CLOSE section of the relay energizes again and move the quadrant again until it de-energizes. Continue in this manner until the pointer is in the "Fully closed" position with the relay





DRILL AND TAP 6 B.A. MATERIAL 16 S.W.G. BRASS
FIT SLOTTED GRUB SCREW
DIMENSIONS ARE IN INCHES

Fig.5. Pointer

de-energized. Decrease the temperature until the CLOSE section of the relay energizes and note the temperature. The difference between this temperature and that recorded in operation (6) is the closing range and must be within the limits specified in Table 3, Column (3).

Adjustments

13. If an inching control fails to meet the requirements of the functional test remove the main cover as directed in para. 14 and carry out the appropriate adjustment described in para. 15 to 17.

14. Remove the two 6BA cheese head screws and spring washers securing the clutch extension adapter and withdraw the adapter, gland ring, blanking plate and spacers. Remove the nuts at each corner of the baseplate and withdraw the bolts. Lift the main cover off the unit.

Adjustment of "Commence to open" temperature

15. (1) Fit the setting quadrant (fig.4) over the end of the follower shaft remote from the control segment and secure it to the baseplate. Secure the pointer (fig.5) to the shaft so that the pointer is equally spaced from the centre of the quadrant at both limits of travel. Rotate the quadrant until the pointer is on the mark corresponding to "Fully closed".

(2) Connect the unit to the test rig. (fig.1) and immerse the phial in a test pocket of the bath. Switch on the heater and stirrer of the bath.

(3) Set switch S 1 to ON, switch S 2 to AUTO, switch S 3 to OFF and switch S 4 to IN. Adjust variable resistance P until voltmeter V reads 24 V. The CLOSE section of the relay should be energized and the lamps specified under "Flap closing" Table 2, Column (2) should be illuminated.

(4) Increase the temperature to the "Commence to open" temperature specified in Table 3, Column (1). Loosen the screw at the plate locking the adjusting nut on the operating rod. If the OPEN section of the relay is energized adjust the nut in a clockwise direction until it de-energizes and adjust again in an anti-clockwise direction until it just energizes. If the open section of the relay is de-energized adjust the nut in an anti-clockwise direction until it just energizes. On an instrument incorporating step inching adjust the nut for "making" and "breaking" of the OPEN contact of the thermally operated switch. Reduce the temperature by about 10 deg. C then increase it again to the "Commence to open" temperature and check that the OPEN section of the relay energizes within the specified temperature limits. Lock the adjusting nut.

Adjustment of test differential

16. (1) Connect the unit to the test rig and insert the phial into a pocket of the testing bath. Switch on the heater and stirrer of the bath.

(2) Set switch S 1 to ON, switch S 2 to AUTO switch S 3 OFF and switch S 4 to IN.

(3) Rotate the follower shaft to correspond with the "Fully closed" position of the control The CLOSE section of the relay should be energized.

(4) Increase the temperature until the CLOSE section of the relay de-energizes, or, in units incorporating step inching, until the moving contact of the thermally operated switch moves to a position midway between the two fixed contacts. Note the temperature.

(5) Increase the temperature further until the OPEN section of the relay energizes. Note the temperature. If the difference between this temperature and that recorded in operation (4) is outside the limits specified in Table 3, Column (5) alter the position of the adjustable contact on the thermally operated switch to bring the differential within limits. To decrease the differential reduce the gap between the adjustable contact and the moving contact.

(6) Repeat operations (3) to (5) until the differential is satisfactory.

Adjustment of range

17. (1) Fit the setting quadrant (fig.4) over the end of the follower shaft remote from the control segment and secure it to the baseplate. Secure the pointer (fig.5) to the shaft so that the pointer is equally spaced from the centre of the quadrant at both limits of travel. Rotate the quadrant until the pointer is on the mark corresponding to "Fully closed".

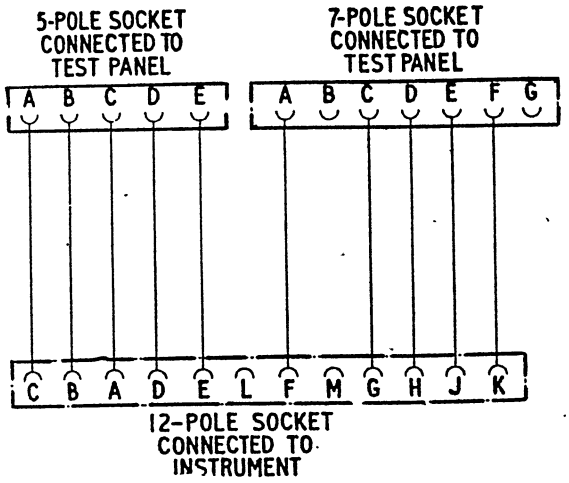


Fig.6.

Test lead for inching controls, Types FDF/A/1490, 1890, 2180, 2540, 2750 and 3020.

(2) Connect the unit to the test rig and immerse the phial into a test pocket in the bath. Switch on the heater and stirrer of the bath.

(3) Set switch S 1 to ON, switch S 2 to AUTO, switch S 3 to OFF and switch S 4 to IN. Set variable resistance P until voltmeter V reads 24 V. The CLOSE section of the relay should be energized.

(4) Ensure that the "Commence to open" temperature is correct, if necessary by carrying out the adjustments described in para. 15.

(5) When satisfied that the "Commence to open" temperature is correct move the follower shaft a few degrees until the relay de-energizes. Increase the temperature until the OPEN relay energizes. Move the shaft again until the relay de-energizes. Continue in this manner until the pointer is on the "Fully open" position with the relay de-energized. Increase the temperature until the OPEN section of the relay energizes. The temperature at which this occurs should be within the limits specified in Table 3, Column (2). If the temperature is below the specified temperature loosen the grub screw securing the eccentric cam to the follower shaft and slide the cam along the shaft towards the control segment. Tighten the grub screw, ensuring that it locates in the groove in the shaft. If the temperature is high, move the cam away from the control segment.

(6) Repeat operations (1) to (5) until the range is within the specified limits.

18. After completing adjustments to an inching control disconnect the control from the test rig and remove the quadrant and pointer. Fit the main cover and secure with four bolts and nuts. Insert into the counter bored holes in the clutch extension adapter two 6BA screws with spring washers under their heads. Locate the blanking plate over the threads of the screws. Assemble the rubber gland ring over the shoulder of the adapter. Push the adapter through the hole in the cover and secure it to the clutch sleeve with the two 6BA screws. If the adapter exerts too great a pressure on the gland ring insert spacers between the blanking plate and the clutch sleeve.

19. After replacing the cover and the clutch extension adapter repeat the functional test (para. 10, 11) then replace the items removed from the unit before testing.

Non-flexibly mounted inching controls

20. Fit the follower lever and locking strip to the clutch extension adapter and secure them with two 4BA bolts.

Flexibly mounted inching controls

21. (1) Over the cover securing bolts at the plug end of the unit locate the support bracket carrying a small plate with two tapped holes. Secure with nuts and plain washers.

(2) Guide the unit into the mounting bracket so that the shock absorbers on the support plate enter the holes in the end wall of the mounting bracket remote from the bonding strip.

(3) Manoeuvre the other support bracket over the cover securing bolts at the other end so that its shock absorbers enter the holes in

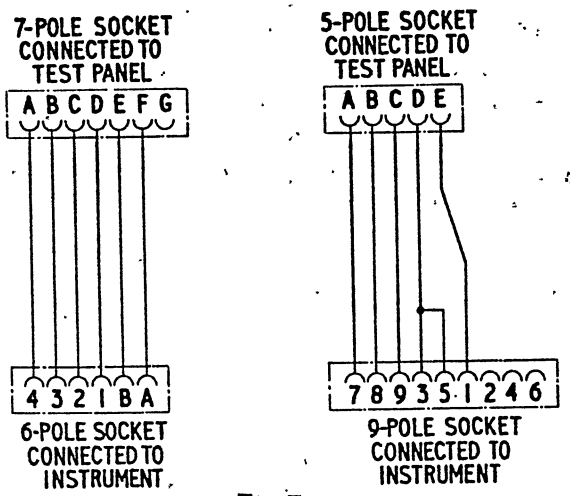


Fig.7.

Test leads for inching controls, Types FDF/A/1520, 2500, 2800, 3010, 3109, 3113.

the opposite wall of the mounting bracket. Fit the terminal tag of the bonding strip over the nearest bolt. Secure the bracket with nuts with a plain washer fitted at the bolt not carrying the bonding strip.

(4) Secure the plug support plate to the mounting bracket with four 2BA cheese head screws and spring washers.

(5) Turn the assembly over and secure the centre brackets through the holes on either side of the rectangular apertures, using hexagon head screws and plain washers. Lock the screws to each other in pairs with 22 S.W.G. stainless steel wire.

(6) Lock the screw with the drilled head at the bellows housing to the nearest securing nut on the plug support plate, using 22 S.W.G. stainless steel wire and a lead seal. If the support plate securing nut is not drilled, drill through it with a No. 56 drill.

(7) Fit the follower lever and locking strip to the clutch extension adapter and secure with two 4BA hexagon head screws.

(8) Over the stud projecting from the appropriate support plate slide the eccentric stop-tube and a washer. Above this locate the broad end of the guard plate and secure temporarily with a 2BA nut and tabwasher. Do not lock the tabwasher.

(9) Press the end of the follower lever return spring over the anchor tube and locate the tube in the slot in the follower cable ferrule clamp. Secure the narrow end of the guard plate by inserting two 2BA hexagon head screws over the locating strip through the plate and ferrule clamp and threading them into the tapped holes in the support bracket.

(10) Rotate the follower lever to the limits of its travel in both directions, overcoming the clutch to make it slip. Adjust the eccentric stop tube until these limits occur when the red line on the lever block coincides with the outer red lines etched on the guard plate. Tighten the securing nut and lock the tabwasher.

TABLE 1
Electrical tests

Insulation Resistance				
Instrument		Relay de-energized		Each relay coil de-energized in turn
Ref. No.	Type	Input (1)	Output (2)	Output (3)
5CZ/4201 5CZ/4165 5CZ/4183	FDF/A/1490 FDF/A/1890 FDF/A/2180	A and D	–	H and J
5CZ/4070 5CZ/5025 5CZ/5062 5CZ/5237 5CZ/6614 5CZ/6270	FDF/A/1520 FDF/A/2500 FDF/A/2800 FDF/A/3010 FDF/A/3109 FDF/A/3113	1 and 3 1 and 5 3 and 5	A and B A and 2 B and 2	B and 1
5CZ/5649 5CZ/6170 5CZ/5013	FDF/A/2540) FDF/A/2750 FDF/A/3020	D and E	G and H G and K H and K	H and J

TABLE 2

Operation of test rig

Instrument		The lamps specified below must illuminate for the relay position given.			Differential and 'hold-on' test. The lamps specified below must illuminate.		
(1)		(2)			(3)		
			Relay energized			Relay energized	
Ref. No.	Type	Relay de-energized	Flap opening	Flap closing	Relay de-energized	Flap opening	Flap closing
5CZ/4201	FDF/A/1490	3 and 5	3 and 5	2 and 4	–	–	–
5CZ/4070	FDF/A/1520	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4
5CZ/4165	FDF/A/1890	3 and 4	3 and 5	2 and 4			
5CZ/4183	FDF/A/2180	3 and 4	3 and 5	2 and 4			
5CZ/5025	FDF/A/2500	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4
5CZ/4649	FDF/A/2540	3 and 4	3 and 5	2 and 4	All out	3 and 5	2 and 4
5CZ/6170	FDF/A/2750	3 and 4	3 and 5	2 and 4	All out	3 and 5	2 and 4
5CZ/5062	FDF/A/2800	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4
5CZ/5237	FDF/A/3010	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4
5CZ/5013	FDF/A/3020	3 and 4	3 and 5	2 and 4	All out	3 and 5	2 and 4
5CZ/6614	FDF/A/3109	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4
5CZ/6270	FDF/A/3113	1, 3 and 4	1, 3 and 5	1, 2 and 4	All out	1, 3 and 5	1, 2 and 4

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TABLE 3

Testing tolerances

Instrument Ref. No.	Type	Operating temperatures (deg. C) Fully closed	Commence to open	Fully open	Range	Hold-on	Test differential
5CZ/4201	FDF/A/1490	94 min.	100 ± 2	126 max.	25 ± 4	3 max.	2 to 5
5CZ/4070	FDF/A/1520	62 min.	70 ± 1	90 ± 1	20 ± 2	1½ max.	4 to 5½
5CZ/4165	FDF/A/1890	92½ min.	100 ± 1	125 ± 1	25 ± 2	2 max.	3 to 4½
5CZ/4183	FDF/A/2180	47 min.	52 max.	61 max.	10 ± 1½	2 max.	1¾ to 3½
5CZ/5025	FDF/A/2500	166¼ min.	170 ± 1	180 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/4649	FDF/A/2540	156¼ min.	160 ± 1	170 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/6170	FDF/A/2750	156¼ min.	160 ± 1	170 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/5062	FDF/A/2800	146¼ min.	150 ± 1	160 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/5237	FDF/A/3010	91¼ min.	95 ± 1	105 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/5013	FDF/A/3020	59 min.	67 ± 1	82 nom.	15 ± 1	1½ max.	4 to 5½
5CZ/6614	FDF/A/3109	201¼ min.	205 ± 1	215 nom.	10 ± 1	½ max.	1¼ to 2¼
5CZ/6270	FDF/A/3113	136¼ min.	140 ± 1	150 nom.	10 ± 1	½ max.	1¼ to 2¼

Appendix 2

CONTROLS, THERMOSTATIC INCHING

TYPES FDF/A/1490, 1890 and 2180

LEADING PARTICULARS

Type FDF/A/1490

Ref. No.	*5CZ/4201*
Maximum dimensions	*9⅛ in. x 6 in. x 4⅜ in*
Temperature range	*100 to 125 deg. C*
Power supply	*24 V d.c*
Weight	*5 lb. 4 oz*

Type FDF/A/1890

Ref. No.	*5CZ/4165*
Maximum dimensions	*9⅛ in. x 6 in. x 4⅜ in*
Temperature range	*100 to 125 deg. C*
Power supply	*24 V d.c*
Weight	*5 lb. 4 oz*

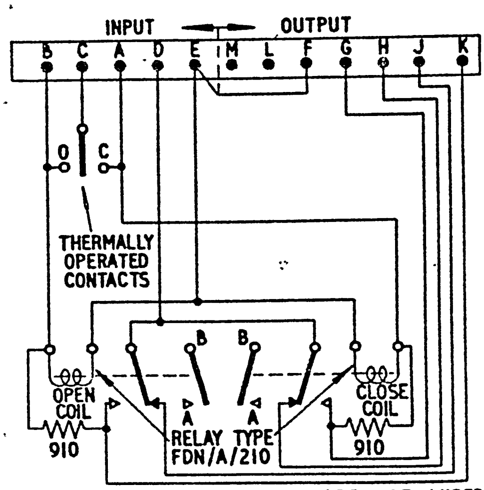
Type FDF/A/2180

Ref. No.	*5CZ/4183*
Maximum dimensions	*9⅛ in. x 6 in. x 4⅜ in*
Temperature range	*41 to 51 deg. C*
Power supply	*24 V d.c*
Weight	*5 lb. 4 oz*

DESCRIPTION

1. The construction and operation of these units are as described in the chapter. They are all flexibly mounted inching controls not incorporating step inching. The relay used is the Type FDN/A/210 but the hold-on contacts are not wired.

2. Electrical connections are made by a 12-pole fireproof and water proof plug, Ref.No. 5X/6086.



NOTE: HOLD-ON CONTACTS A & B ARE NOT WIRED IN THIS CIRCUIT. PINS E & F ARE JOINED IN THE INSTRUMENT

Fig.1. Circuit diagram

Appendix 3

CONTROL, THERMOSTATIC INCHING, TYPE FDF/A/1520

LEADING PARTICULARS

Ref. No.	*5CZ/4070*
Maximum dimensions	*5⅞in. x 3⅜in. x 4in.*
Temperature range	*70 to 90 deg. C*
Power supply	*24 V d.c*
Weight	*2 lb. 15 oz*

DESCRIPTION

1. The construction and operation of this instrument are as described in the chapter. It is a non-flexibly mounted inching control incorporating step inching. The relay used is a Type FDN/A/210.

2. Electrical connections are made by a 6-pole plug, Ref.No. 5X/6041 and a 9-pole plug, Ref. No. 5X/6036.

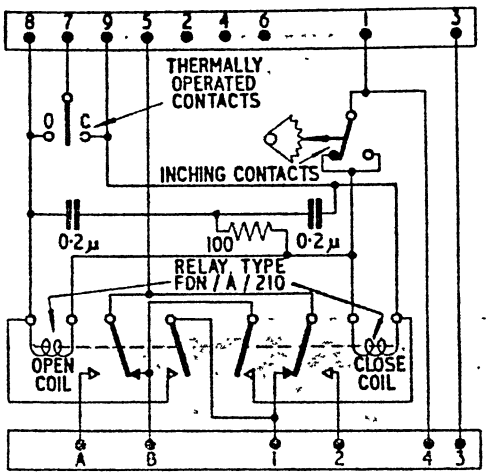


Fig.1. Circuit diagram

Appendix 4

CONTROLS, THERMOSTATIC INCHING

TYPES FDF/A/2500, 2800, 3010, 3109 and 3113

LEADING PARTICULARS

Type FDF/A/2500

Ref. No.	*5CZ/5025*
Maximum dimensions	*5⅝ in. x 3⅛ in. x 4 in*
Temperature range	*170 to 180 deg. C*
Power supply	*24 V d.c*
Weight	*2 lb. 15oz*

Type FDF/A/2800

Ref. No.	*5CZ/5062*
Maximum dimensions	*5⅞ in. x 3¾ in. x 4 in*
Temperature range	*150 to 160 deg. C*
Power supply	*24 V d.c*
Weight	*2 lb. 15 oz*

Type FDF/A/3010

Ref. No.	*5CZ/5237*
Maximum dimensions	*5⅞ in. x 3¾ in. x 4 in*
Temperature range	*95 to 105 deg. C*
Power supply	*24 V d.c*
Weight	*2 lb. 15 oz*

Type FDF/A/3109

Ref. No.	*5CZ/6614*
Maximum dimensions	*5⅞ in. x 3¾ in. x 4 in*
Temperature range	*205 to 215 deg. C*
Power supply	*24 V d.c*
Weight	*3 lb. 2 oz*

Type FDF/A/3113

Ref. No.	*5CZ/6270*
Maximum dimensions	*5⅞ in. x 3¾ in. x 4 in*
Temperature range	*140 to 150 deg. C*
Power supply	*24 V d.c*
Weight	*2 lb 15 oz*

DESCRIPTION

1. The construction and operation of these units are as described in the chapter. They are all non-flexibly mounted inching controls incorporating step inching. The relay used is the Type FDN/A/210.

2. Electrical connections are made by a 6-pole plug, Ref. No. 5X/6041 and a 9-pole plug, Ref. No. 5X/6036.

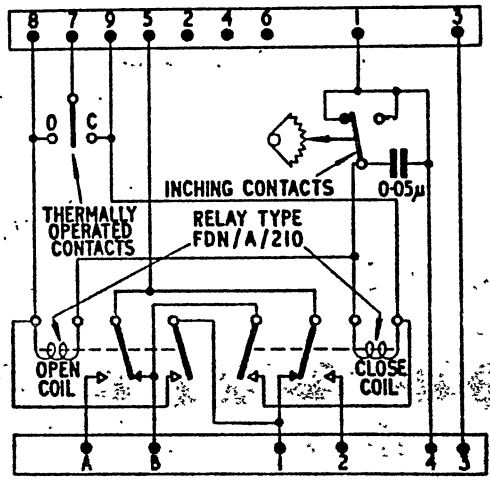


Fig. 1. Circuit diagram

Appendix 5

CONTROLS, THERMOSTATIC INCHING

TYPES FDF/A/2540, 2750 and 3020

LEADING PARTICULARS

Type FDF/A/2540

Ref. No.	*5CZ/5649*
Maximum dimensions	*8⅝ in. x 4½ in. x 5¾in*
Temperature range	*160 to 170 deg. C*
Power supply	*24 V. d.c*
Weight	*5 lb. 12oz*

Type FDF/A/2750

Ref. No.	*5CZ/6170*
Maximum dimensions	*8⅝ in. x 4½ in. x 5¾ in*
Temperature range	*160 to 170 deg. C*
Power supply	*24 V d.c*
Weight	*5 lb. 12 oz*

Type FDF/A/3020

Ref. No.	*5CZ/5013*
Maximum dimensions	*9⅝in. x 4⅛ in. x 5⅞ in*
Temperature range	*67 to 82 deg. C*
Power supply	*24 V d.c*
Weight	*5 lb. 12oz*

DESCRIPTION

1. The construction and operation of these units are as described in the chapter. They are all flexibly mounted inching controls incorporating step inching. The relay used is the Type FDN/A/210.

2. Electrical connections are made by a 12-pole fire proof and water proof plug, Ref.No. 5X/6086.

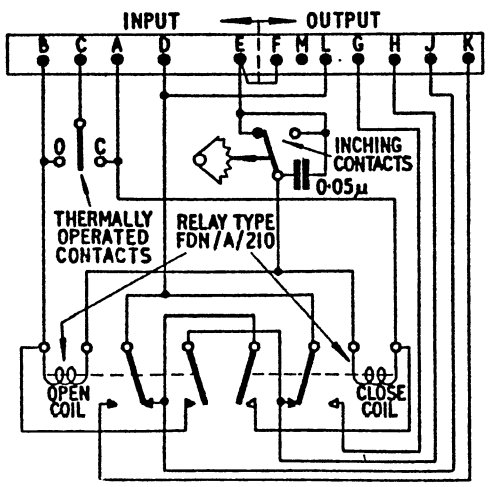


Fig.1. Circuit diagram

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4152B

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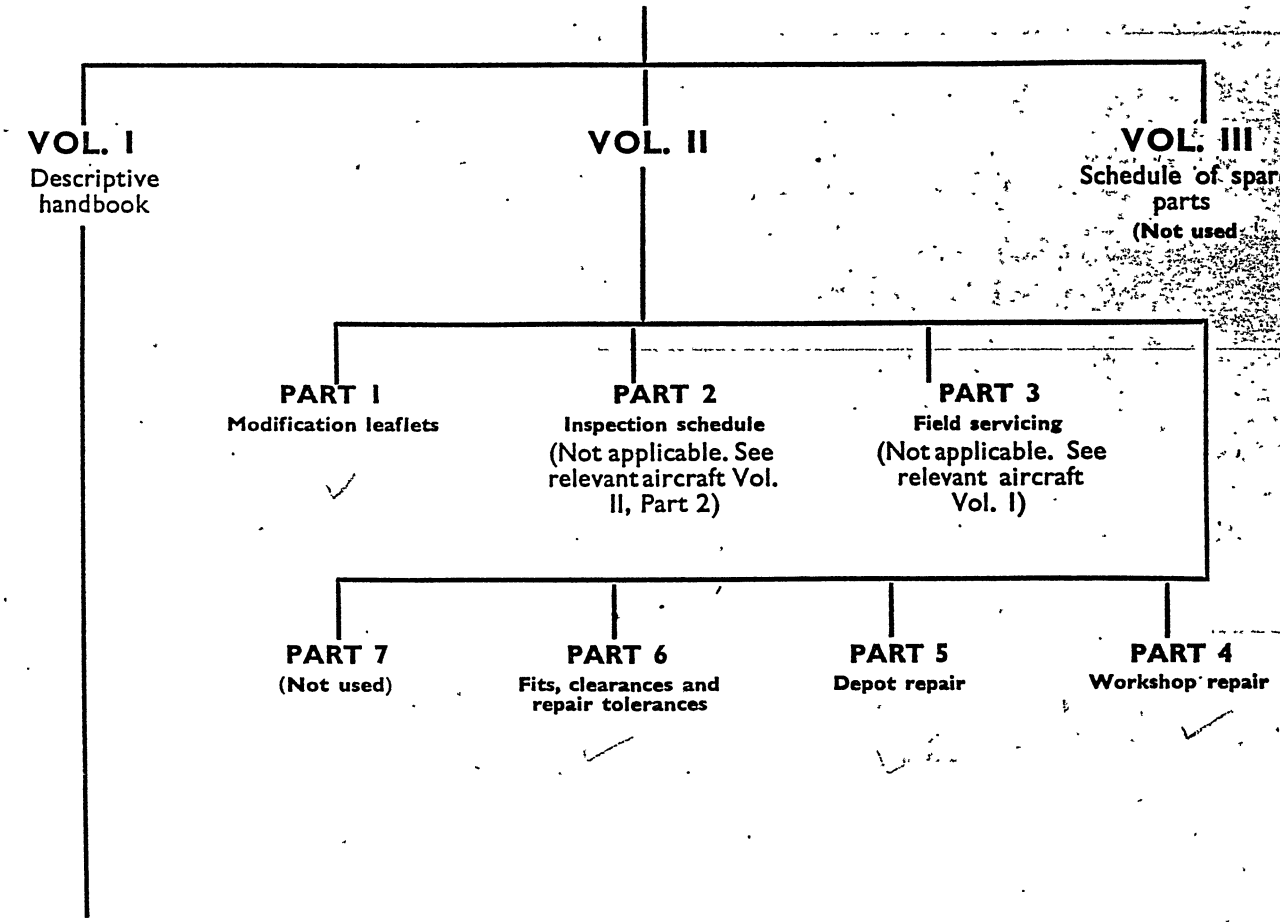
A.P.4152B—THERMOSTATIC CONTROL EQUIPMENT FOR AIRCRAFT



Chap. 1—General
Chap. 2—Thermostatic coolant by-pass valve, Type BGA
Chap. 3—Thermostatic header tank relief valve, type DS
Chap. 4 etc. *

** This layout tree shows the basic arrangement of the volumes and chapters of this publication. See the list of chapters for the complete contents.*

THERMOSTATIC CONTROL EQUIPMENT FOR AIRCRAFT

LIST OF CHAPTERS

Note.—*A list of contents appears at the beginning of each chapter*