

Chapter 5

INTERVALOMETER, TYPE FMK/A/3

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Introduction

1. The intervalometer, Type FMK/A/3, is a timing device designed to provide pulses for a cyclic switch or similar mechanism used in the de-icing system of an aircraft.
2. It provides a continuous series of half second pulses of 24V nominal d.c.

- separated by an interval of time which is manually adjustable in duration from 3 to 30 seconds.
3. The interpulse duration is selected by means of a knob which is pressed and rotated to turn a scale relative to a fixed mark. The scale is graduated in seconds.

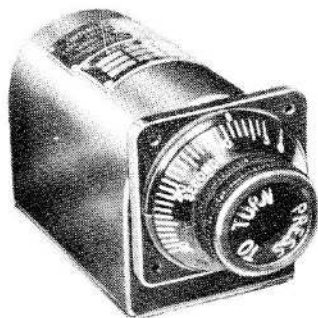


Fig. 1. Intervalometer, Type FMK/A/3, front view

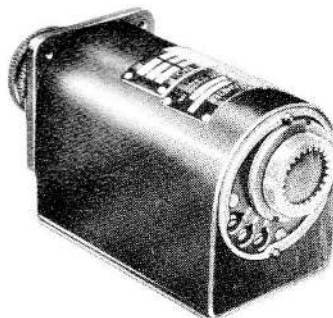


Fig. 2. Intervalometer, Type FMK/A/3, rear view

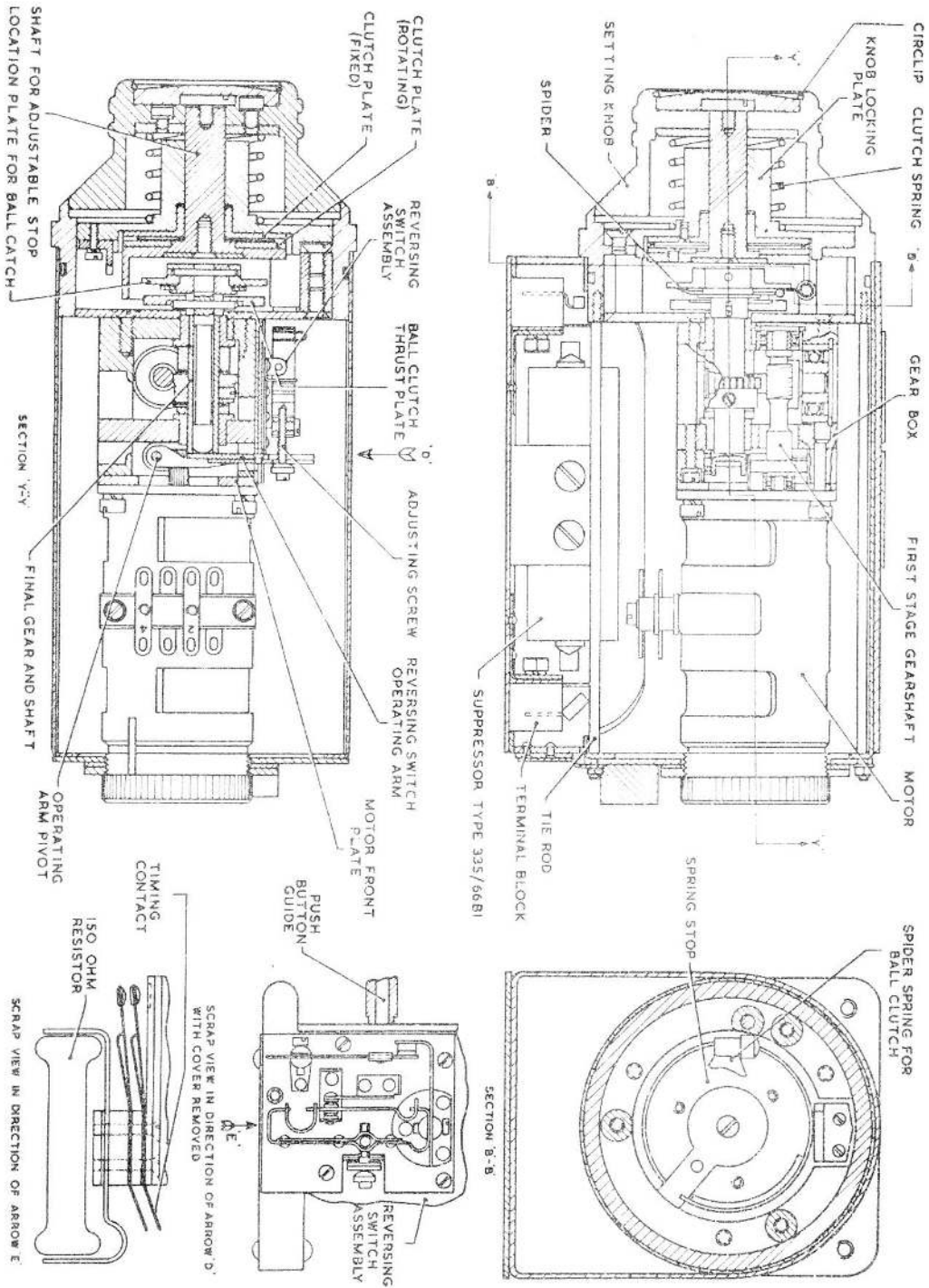


Fig. 3. Sectional views of intervalometer

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DESCRIPTION

4. The unit has an aluminium alloy mounting cylinder, having an integral radial flange for mounting the instrument, and an internal flange upon which the instrument is built up.
5. The calibrated setting knob and clutch assembly are secured to one side of the internal flange, and a circular aluminium alloy mounting plate is secured to the other side upon three distance pillars.
6. A gearbox is secured to this mounting plate, and a governed, constant speed, reversible motor is attached to the opposite face of the gearbox.
7. The intervalometer is best considered as three sub-assemblies:
 - (1) reversible, constant speed motor;
 - (2) reduction gearbox;
 - (3) reversible and switching mechanism.

Governed motor, Type FJA/A/38

8. The aluminium alloy motor housing has two centrally positioned lugs upon which are held two Bakelite terminal bars, each supporting two numbered double-ended soldering tags. The bars are varnished to insulating strips and held in position by two 2 B.A. ch/hd. screws and spring washers.
9. On each side of the terminal block installation the housing is cut away to provide easy access to the governor and commutator brush gear.
10. The motor housing is machined internally on one diameter, whilst at its open end it is reduced and threaded externally to receive a locking ring and end cap. The opposite or drive end is blanked off and flanged, to carry in each corner of this flanged plate a 6 B.A. ch/hd. screw and spring washer, the four of which join the motor to the gearbox. A crescent-shaped boss is milled centrally on the outer face of the mating flange to ensure a one-way and rigid location of the gearbox.
11. The field assembly consists of two field coils and field laminations and is a push fit in the housing. Its location in the housing is effected by two special 10 B.A. bolts entering from the blanked end of the motor housing, and passing through diametrically opposite holes in the field stack. These bolts also pass through, and hold in position, the bakelite brush gear mounting plate and its insulating packing washer, which lie immediately inside the housing.
12. Distance tubes are placed on the field stack bolts, between the brush gear plate and the field stack, and two special nuts secure the assembly from the opposite end of the field stack.
13. The drive end of the motor housing supports the armature ball bearing, and the armature shaft projects beyond the housing as a splined drive.
14. The other armature ball bearing and a felt washer are held by a recessed stainless steel clamping plate, in a recess machined in the bearing housing drum. The plate is secured by four 8 B.A. countersunk screws.
15. The bearing housing drum is a push fit in the open end of the motor housing, and carries on its inboard face, over the clamping plate and a combination of insulating Bakelite shim washers, the Bakelite governor brush gear carrier plate. These are held by two 8 B.A. ch hd. screws to the bearing housing drum.
16. The bearing housing drum is located in the motor housing by a dowel pin inserted into the drum, which locates in a slot in the wall of the housing. The degree of entry of the drum into the housing is regulated by shim rings interposed between the edge of the motor housing and the shoulder of the drum.
17. An internally threaded knurled end cap clamps the drum in position, and is locked by a tag washer which locates on the outer face of the drum, one tag being turned down into a slot in the drum and the other being bent up to engage one of the internal castallations milled in the end cap.
18. The motor shaft carries a ball race, a spacer, the commutator, the armature and governor unit and a spacer and ball race, in that order from the drive end of the motor housing, and these are locked in position by a 6 B.A. nut bearing on the ball bearing inner race.
19. The governor unit is of moulded Bakelite, having a pair of copper brush contact segments.
20. A leaf spring vibrating contact is bolted to one side of the contact bearer together with a stop plate. The contact lies over a hole in the bearer and comes to rest on a fixed contact

on the end of an adjusting screw threaded in the opposite bearer face. This face also holds a locking strip for the adjusting screw, secured by a 10 B.A. ch/hd. screw.

21. The armature assembly, consisting of the armature windings, and the commutator and governor unit, is protected by varnish, and is a dynamically balanced unit.

22. The bush carrier plates carry each a pair of brush boxes which house square section carbon brushes. Brush load on the commutator is maintained by a leaf spring.

Reduction gearbox

23. One end of the gearbox is an aluminium alloy end plate in which is a crescent-shape hole which mates with the boss on the motor base plate, ensuring positive location.

24. The motor is secured to the gearbox by four 6 B.A. ch/hd. screws and lock washers, through the corners of the motor base flange.

25. In the gearbox end plate a ball race is mounted, supporting one end of the first stage shaft. This shaft carries a steel spur wheel which engages with a pinion cut in the end of the motor shaft. A worm is machined on the shaft near its opposite end, whilst at the extreme end the shaft is shouldered and supported in a ball race mounted in the base of the gearbox housing.

26. Outboard of this ball race a circlip fits into a groove in the housing; this retains a combination of shims against the outer face of the bearing, to provide a means of taking up end float on the first stage shaft.

27. The intermediate, or second stage shaft runs normal to and to one side of the first stage shaft. A phosphor bronze spur wheel pinned on this stage shaft mates with the first stage worm, and the shaft is itself machined into a worm.

28. The driven end of the second stage shaft is shouldered and carried by a larger ball bearing supported in the gearbox housing, and retained by a circlip. The drive end is shouldered and supported by a ball race similarly retained by a circlip in the opposite side of the housing. Between this shoulder and ball race are fitted shims to take up end play.

29. The third stage shaft is tubular, and supported in plain, shouldered, bearing bushes.

One of these is supported in a sandwich plate in the gearbox housing (this plate is drilled clearance for the first stage shaft), and the other bearing is located in the base of the housing, projecting through it to locate in the mounting plate.

30. A bronze spur wheel, driven by the second stage worm, is secured to the third stage shaft by two grub screws, and a distance collar and shims on either side of this worm wheel take up end play.

31. The sandwich plate is located by dowels in the main housing, and is spigoted into the housing end block, being secured by 8 B.A. ch/hd. screws and lock washers which are located in the housing end block and screwed into the main housing, through the sandwich plate.

32. The housing end block has a rectangular aperture in one edge, matching a similar opening in the reversing switch plate, and through this aperture projects the forked end of the operating arm, to engage with the link pin of the reversing switch. The foot of the operating arm turns on, and is supported by, a bearing pin which spans the hollow housing end block.

33. The bearing pin is threaded over more than half its length to screw into the end block, whilst the leading end is turned below root diameter, and passes through the operating arm and spacing washer.

34. The operating arm is thus supported on the pin between a shoulder and the spacer, and the bearing pin can be screwed home to take up any end float. The arm is so positioned that its bearing face covers, and closely abuts, the inboard end of the third stage (or output) tubular shaft.

Switch mechanism

35. To one face of the gearbox is attached a switch mounting plate which carries on its face the safety on-off switch, and the snap action reversing switch.

36. Secured beneath the projecting edge of the switch mounting plate is the impulse switch and a spring clip supporting a fixed resistor.

37. Supported in the output shaft tube is a push rod assembly, the inboard end of the push rod bearing against the operating arm, such that movement of the push rod rotates the operating arm on its bearing pin.

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- 38.** The output shaft projects through the mounting plate, and has a circular plate mounted on its extremity and pinned thereto. This is the ball clutch locating plate, and has eighteen holes evenly spaced on a P.C.D. near its edge.
- 39.** Beneath this plate a further circular plate is mounted on the output shaft tube, freely sliding thereon and having a slot in its under face. This is the ball and clutch thrust plate.
- 40.** A pair of diametrically opposed slots in the output tube carry a cross pin, which passes through the push rod inside the tube and engage in the slot in the thrust plate.
- 41.** Between the two plates, and supported on a shoulder on the output shaft, is a spider, having six legs turned alternately up and down to bear on the opposing plates, and one leg of which is extended beyond the plates to carry an operating button.
- 42.** In the spider are three holes in which are located $3/32$ in. diameter steel balls. The balls are thus trapped between the clutch plates and can locate against three of the holes in the locating plate. Movement of the operating button and spider will carry these balls out of their locating holes, thereby forcing the thrust plate down, and with it the cross pin and push rod.
- 43.** Mounted on top of the internal flange of the mounting cylinder is a knob locating plate, secured by three 6 B.A. countersunk screws. It is drilled centrally to take the adjustable clutch and stop shaft, and carries the safety push rod supporting brush riveted in its under surface.
- 44.** The underside of the knob locating plate is counterbored and has a steel clutch plate disc with radial teeth on its face, secured to it by three countersunk 8 B.A. screws.
- 45.** The adjustable stop shaft terminates in a flange, behind which is mounted another steel clutch plate ring, similarly toothed, so that it will engage with the fixed clutch plate.
- 46.** The flange of the adjustable stop shaft has a projection from its face, at the rim, which constitutes the adjustable stop. Downward movement of the stop shaft will disengage the clutch plates and allow rotation of the stop shaft and stop. The stop is the same radial distance from the common axis as the operating button, and is rotated to a chosen position where it limits the arc of rotation of the operating button.
- 47.** Let into the face of the stop shaft is a disc having a radially projecting arm, which projects beyond the edge of the stop shaft flange. This is the spring stop arm. Upon rotation of the setting knob beyond the 30 seconds position towards the position marked OFF, the spring stop arm engages a small bracket, the top edge of which is an inclined plane.
- 48.** The stop bracket is secured to the edge of the knob location plate by two 10 B.A. ch/hd. screws and lock washers, and projects through a gap in the internal flange of the mounting cylinder.
- 49.** Engagement of the spring stop arm with the stop bracket pulls in the stop shaft, and the setting knob which is secured to it. One of the three spacing pillars between the mounting cylinder and the gearbox mounting plate acts as a fixed stop and prevents setting the instrument to operate at less than a three second interpulse interval.
- 50.** Over the outer end of the stop shaft is fitted the aluminium alloy setting knob, the calibrated flange of which fits loosely in the forward rim of the mounting cylinder.
- 51.** To the underside of the setting knob is secured a steel thrust plate, by means of 6 B.A. ch/hd. screws through the knob. A slot in the thrust plate engages a steel drive pin in the stop shaft. The knob and plate assembly is secured to the stop shaft by a special flat head 6 B.A. screw.
- 52.** Shims are placed under the flat head screw, against the end of the stop shaft, to pre-set the distance the knob can be depressed before its rim bottoms on the internal shoulder in the mounting cylinder.
- 53.** Trapped between the thrust plate and a shoulder on the knob location plate is a spiral compression spring which pushes the knob outwards, engaging the clutch plates firmly, thus holding the setting stop in the selected position.
- 54.** The end of the motor housing remote from the gearbox is threaded externally, and a Bakelite band disc, suitably pierced, fits over the threaded portion and is secured by a knurled ring nut under the motor end cap.

55. Two holes through opposite edges of the disc accommodate the cover tie rods.

56. A cylindrical anodised aluminium cover drum with an insulated lining fits over the disc and onto the mounting cylinder, enclosing the motor, gearbox and switch plate.

57. The connections are brought out to an external terminal block, and two suppressors, positioned internally, are electrically interposed in the d.c. leads to the motor.

63. The ball thrust plate moves the thrust pin, push rod, and operating arm, and movement of the operating arm operates the snap action switch, reversing the motor.

64. Now the operating button lifts from the output switch contacts and moves away on its reverse arc.

65. The steel balls are out of their holes keeping the ball clutch plates apart, thereby keeping the motor running in reverse.

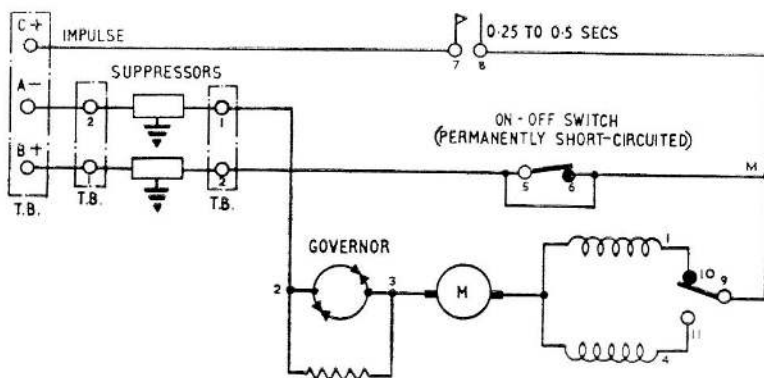


Fig. 4. Circuit diagram

OPERATION

58. Let the intervalometer be connected to a 24V supply and let the output terminal and common negative be connected to a cyclic switch or similar mechanism.

59. Press the control knob and rotate to the 30 second position. When released, the control knob moves out under the action of the spring and the clutch plates engage to hold the setting.

60. The switch contacts, being closed, allow the current to flow to the motor which rotates at constant speed under the action of its governor.

61. The output shaft turns, carrying the spider and projecting operating button, until the button closes the output contacts at which time the switch emits a pulse of d.c. current.

62. The operating button is now arrested, and with it the three steel balls trapped in the spider. Continued rotation of the ball clutch plates, however, causes the balls to lift from their holes, forcing the plates apart.

66. 15 seconds after lifting from the output switch contacts the operating button comes up against the adjustable stop which projects from the stop shaft.

67. The arresting of the spider and steel balls causes the ball clutch plates to overrun until the balls drop in their holes, when the snap switch reverts into the forward motion position.

68. After 15 seconds forward motion the operating button again closes the output switch, sending out another pulse to the external switch. The interpulse cycle is thus completed in 30 seconds.

69. Now let the setting knob be depressed and rotated to a new setting, say 10 second cycle.

70. If the operating button is near the adjustable stop at this moment, the stop will bear on the button, carrying it round complete with the spider and steel balls.

71. On releasing the knob at the 10 second mark, the balls will be either in a set of three

holes (forward motion) or out, forcing the thrust plate down (reverse motion).

72. The intervalometer will instantly commence to operate somewhere within a new 10 second cycle.

73. During this new cycle the contact button will travel forward for 5 seconds, reversing the motor alternately on the setting stop and the output switch stop.

SERVICING

74. Very little servicing can be done on this equipment other than examination for damage, security of attachment and the condition of connecting leads. Should the intervalometer be suspect the following functional tests may be made. An un-serviceable intervalometer should be returned to stores and a new one fitted.

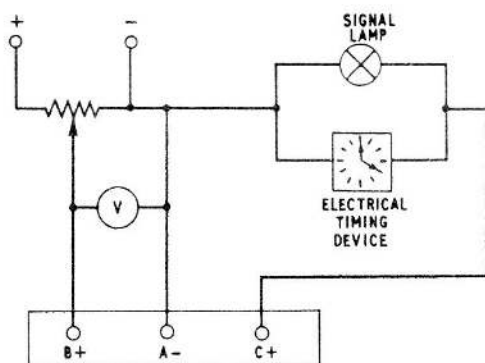


Fig. 5. Test circuit

Tests

75. Unless otherwise specified, all tests must be carried out at normal room temperature (approximately 20°C).

Caution . . .

The d.c. supply is connected to terminals A and B. Terminal B must be POSITIVE. It is important that this polarity be observed. Terminal C provides the positive pulse output.

Timing

76. Connect the intervalometer as shown in fig. 5 and adjust the d.c. voltage to 28V. The duration of the pulse can be read on the electrical timing device (Synclock) and must be between 0.25 and 0.75 seconds. ▶

77. The duration between pulses can be observed on the lamp and timed with a stop watch. The interpulse duration must be within the following limits:—

Selector setting (seconds)	Time period (seconds)
5	5 + 0.75 - 0.5 ▶
10	10 ± 1.0
20	20 ± 2.0
30	30 ± 3.0

Minimum operating voltage

78. The intervalometer must function satisfactorily with an applied voltage of 22V d.c. but not necessarily within the limits mentioned in para. 77. Check that the unit functions with the selector turned fully anti-clockwise and fully clockwise.

Selector

79. Check that the intervalometer continues to function when the selector is pressed fully inwards.

Current consumption

80. The current consumption at 28V d.c. must not exceed 0.5 amp. This does not, of course, apply at the moment of reversal.

Insulation resistance

81. Test the insulation resistance with a 250V insulation resistance tester, with the voltage applied for at least 15 seconds, between terminals A, B and the frame. The value should not be less than 0.05 megohms.

82. Test the insulation resistance between terminal C and the frame (with the switch in the "no pulse" position). The value should not be less than 0.05 megohms.

Note . . .

If the suppressor capacitors are in circuit, the insulation resistance test voltage must not exceed the maximum rated voltage of the capacitors.

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Appendix 1

INTERVALOMETER, TYPE FMK/A/5

Introduction

1. The intervalometer, Type FMK/A/5 is similar in construction to the Type FMK/A/3 except that the stop plate is slightly different in shape. The interpulse duration is variable between 5 and 22.5 seconds.

interpulse duration laid down in Para. 77 should be replaced by the following:—

Testing

2. The testing of the Type FMK/A/5 is identical to the Type FMK/A/3, as described in the chapter, except that the

<i>Selector setting</i> (seconds)	<i>Time period</i> (seconds)
5	5 + 0.75 - 0.5
10	10 ± 1.0
20	20 ± 2.0
22.5	22.5 ± 2.0

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