Chapter 41.

ACTUATORS, TEDDINGTON, FJC/A SERIES

(Three Position)

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Introduction

1. These actuators are designed for use with hot air valves installed in aircraft systems for anti-icing purposes. They regulate the flow of air by positioning the valve in the Fully Open, Fully Closed or to an Intermediate position. A typical actuator is described and illustrated in this chapter and details of individual types are given in Appendices to this chapter.

DESCRIPTION

General

2. Basically the actuator consists of a 24 volt d.c., reversible, split field series motor which drives an output quill through a seven stage, in-line reduction gear train. Cam-operated snap action switches within the unit control the motor so that the quill takes up any one of three positions. An electro-magnetic brake within the motor stops it when the d.c. supply is discontinued.

3. The unit is encased in a light-alloy housing sealed against the ingress of dust and moisture. The housing is constructed in three main parts; a cover enclosing the motor and switch mechanism, a box containing the gear train and interposed between them is an adaptor frame which mounts a 9-pole key location connector plug through which the electrical

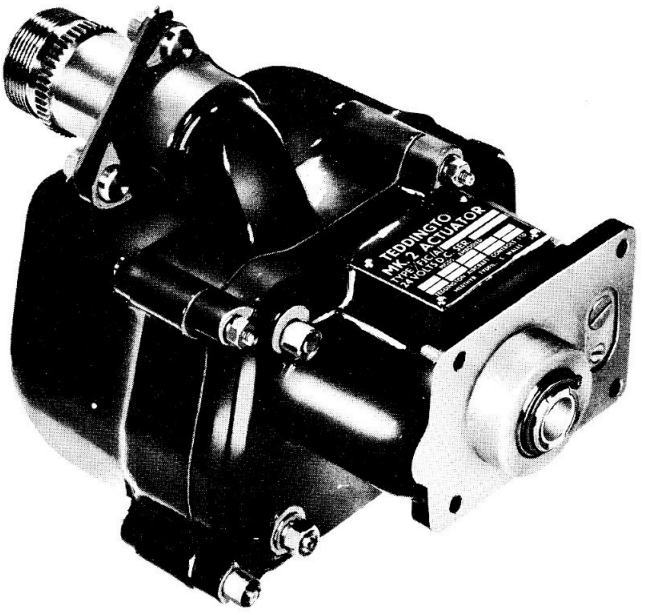

Fig. 1. General view of actuator

connections are made. The parts are bolted together with O ring seal washers at the joint faces.

Gear box

4. Generally rectangular in shape the gear box is enclosed at its output end and its other end is closed by a top plate. A circular, bored spigot is machined on the output face and into this is fitted a flanged phosphor bronze bearing secured to the inner face of the box. The output shaft rotates in this bearing and into the end of the shaft is fitted the output quill. The shaft and quill are mutually located by a dog and slot arrangement and secured together by a circlip fitted into an annular groove embracing both items. Two O ring seal washers fitted between the bearing and the spigot and another between the bearing and the shaft provides sealing.

5. Fitted inside the bore disposed on two parallel shafts are six gear stages, all pinion and gear assemblies, which drive the output shaft through a gear wheel cut on its inner end. The main shaft is supported at one end by a bush fitted into the top plate and at the other by a slot and blind hole in the end of the output shaft. The layshaft is supported at one end by a bearing secured to the top plate and at the other in a drilling through the flange of the output bearing.

6. The gear wheel section of the output shaft drives a wheel pinned to one end of a camshaft. This shaft passes out of the gearbox and through a switch mounting frame which is secured to the outside of the top plate. The shaft is supported at its inner end by a bearing formed by a drilling through the flange of the output bearing and at its outer end by a bush fitted into the end of the switch mounting frame.

Switch mechanism

7. Fitted on the camshaft are four cams separated by spacers which are splined

to engage the splined section of the shaft. The cams are a free fit to allow adjustment so that the switches can operate at precise settings. Once this has been achieved the cams are friction locked by the clamping effect of a nut screwed over the end of the shaft. The cams operate roller ended, spring loaded push rods which bear on moving contact blade assemblies mounted across the face of the frame.

8. Each moving contact blade is clamped to a mounting block at one end and has double-sided contacts at the other end. The moving contacts either make or break with the fixed contacts which are also secured to mounting blocks.

Motor

9. The motor is secured to the top plate, its gear cut spindle passing through the plate to engage the first gear of the gear train. The motor is a Plessey type and is fully described and illustrated in A.P. 4343D, Vol.1, Book.5, Sect.16, Chap.40, Para. 15. (actuators, Teddington, FJC/A series, single speed).

Electrical connections

10. Electrical connections to the switches and motor are made to the pins of the 9-pole key location plug mounted on the adapter. External supplies are made tc the same plug.

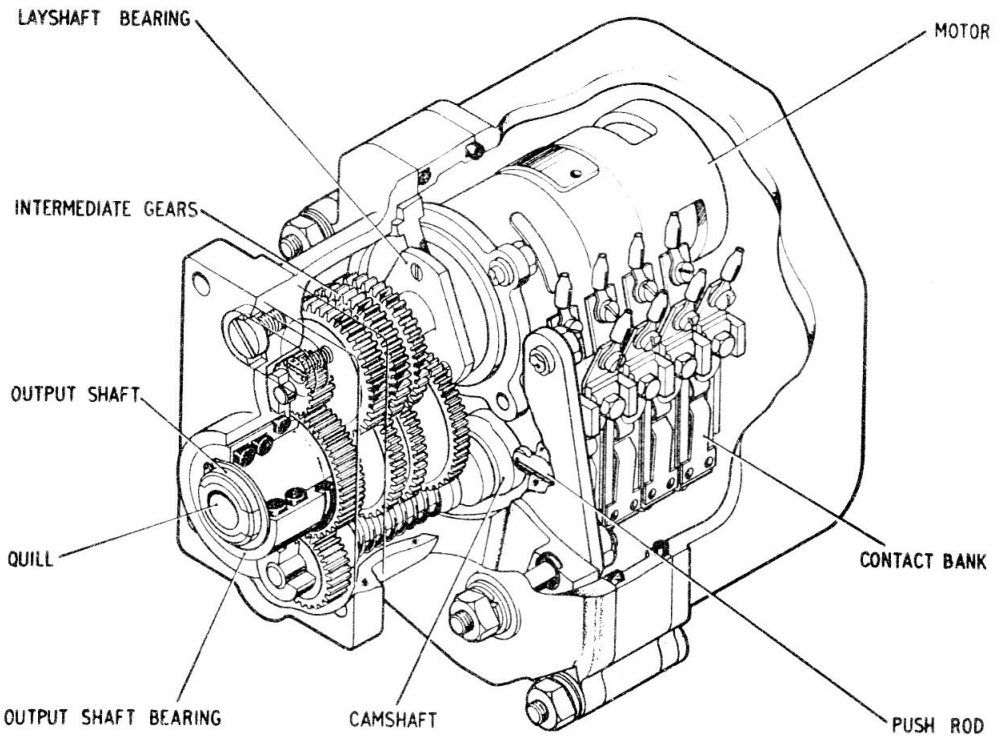

Fig. 2. Cut-away view of actuator

OPERATION

11. Reference to the circuit diagram (fig.4) and the movement arc of the master spline (fig.3) will assist in the appreciation of the operation. Selection of the control switch may be manual or automatic.

12. Assuming the actuator to be in the closed position; selection to either OPEN or INTERMEDIATE will cause the motor to be energised and rotate in the necessary direction.

13. Motor rotation is transmitted to the gear train and so to the output shaft which rotates in the correct direction and speed. At the same time the camshaft is rotated to operate the spring loaded push rods. When the output shaft reaches the selected position, the push rods cause the switches to snap over and break the supply to the motor. The switches are automatically set for a further selection.

14. On reaching the selected position an indicator lamp connected in the circuit should illuminate.

INSTALLATION

15. The actuator is mounted to the valve and secured to the valve flange by four 2 B.A. nuts, plain and spring washers. The quill engages the valve shaft and it is important to ensure that, before engaging the quill with the shaft, the two master splines are in correct alignment. The movement arc of the master spline is shown in fig. 3.

SERVICING

16. These actuators should be serviced in accordance with the general chapter in A.P.4343, Vol.1, Sect.17, Chap.1 and the instructions contained in the relevant Servicing Schedule.

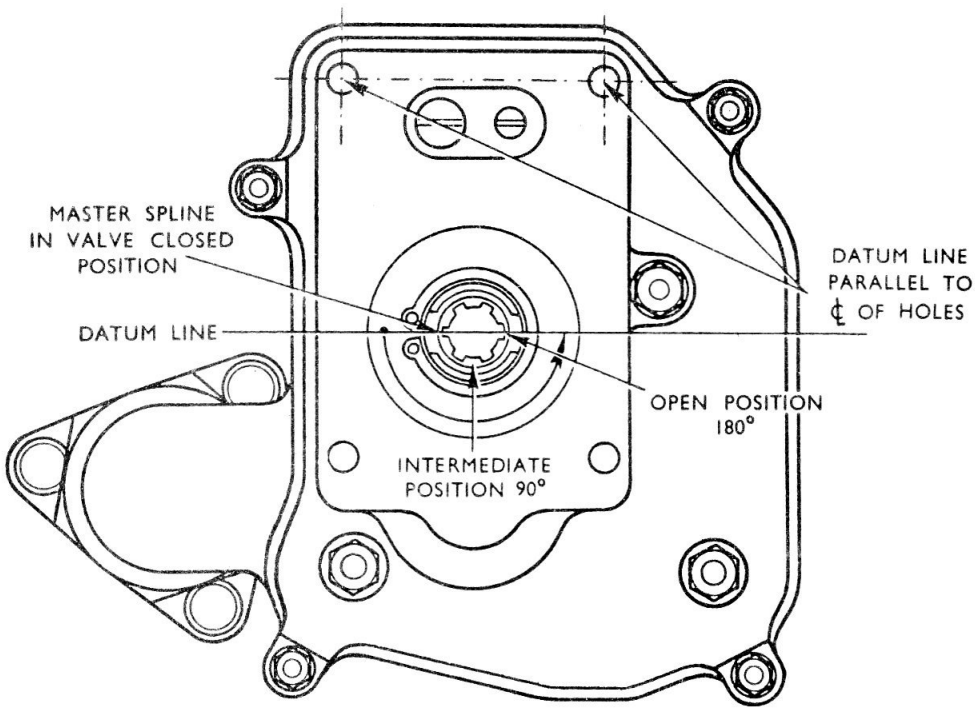

Fig. 3. Movement arc of master spline

Setting procedure

17. Should the actuator be performing outside specifications it can be re-set in accordance with the following procedure.

(1) Remove the cover enclosing the motor and switch mechanism. Slacken off the nut at the end of the crankshaft and mount the actuator to the Rotary Actuator Test Rig which is fully described in A.P.4343S, Vol.1, Book.2, Sect.8.

(2) Initially remove the link lead between the contact clamps at cam positions 3 and 4, also disconnect the plug lead from pin 3 of the connector plug to the contact clamp at position 3.

(3) During the operations the d.c. supply is to be set and maintained at 29 volts and a torque of 6 lb. in. applied to oppose the actuator travel.

(4) Cams are adjusted by turning in the required direction with a suitable rod acting in one of the holes in the cam boss. To avoid movement after setting, the cam bank should be held firmly by the end nut with just sufficient slack to allow the cam being adjusted to be turned without upsetting any of its neighbours.

(5) Commence by switching to open and close in turn. Adjust cams 1 and 2 so that the limits of travel occur when the indicator is 90 degrees on each side of the scale. Cam 1 adjusts the the close position and cam 2 the open.

(6) When cams 1 and 2 have been set satisfactorily, re-connect the lead from pin 3 of the connector plug to the contact clamp at cam position 3. Adjust cam 3 to give a travel of 92 degrees when the actuator commences at the close position and intermediate is selected.

(7) When cam 3 has been set, transfer the lead from pin 3 of the connector plug to the contact clamp at cam position 4. Adjust this cam to give a travel of 88 degrees when the actuator commences at the open position and intermediate is selected.

(8) This concludes the setting. Finally tighten the camshaft and nut with a torque loading of 100 lb.in. Transfer the lead from pin 3 of the connector plug back to the contact clamp at cam position 3 and re-fit the link lead between the clamps at cam positions 3 and 4. Re-fit the cover enclosing the motor and switch mechanism.

Functional tests

18. With the actuator still mounted to the Rotary Actuator Test Rig carry out the following tests.

(1) Against a torque load of 120 lb.in. the actuator must start with a supply voltage not exceeding 16 volts. This applies to rotation in both directions.

(2) Against a torque load of 120 lb.in. and with a supply voltage of 28 volts, the time taken for the output shaft to rotate between the extreme positions (closed to open and open to closed) must be between 13 and 18 seconds.

(3) Against a torque load of 6 lb.in. and with a supply voltage of 29 volts, the angular travel between the extreme positions must be between 170 degrees and 180 degrees.

(4) Against a torque load of 6 lb.in. and a supply voltage maintained at 29 volts the angular travel from the closed to the intermediate position must be between 87 degrees and 89 degrees and from the open to the intermediate it must be between 91 degrees and 93 degrees.

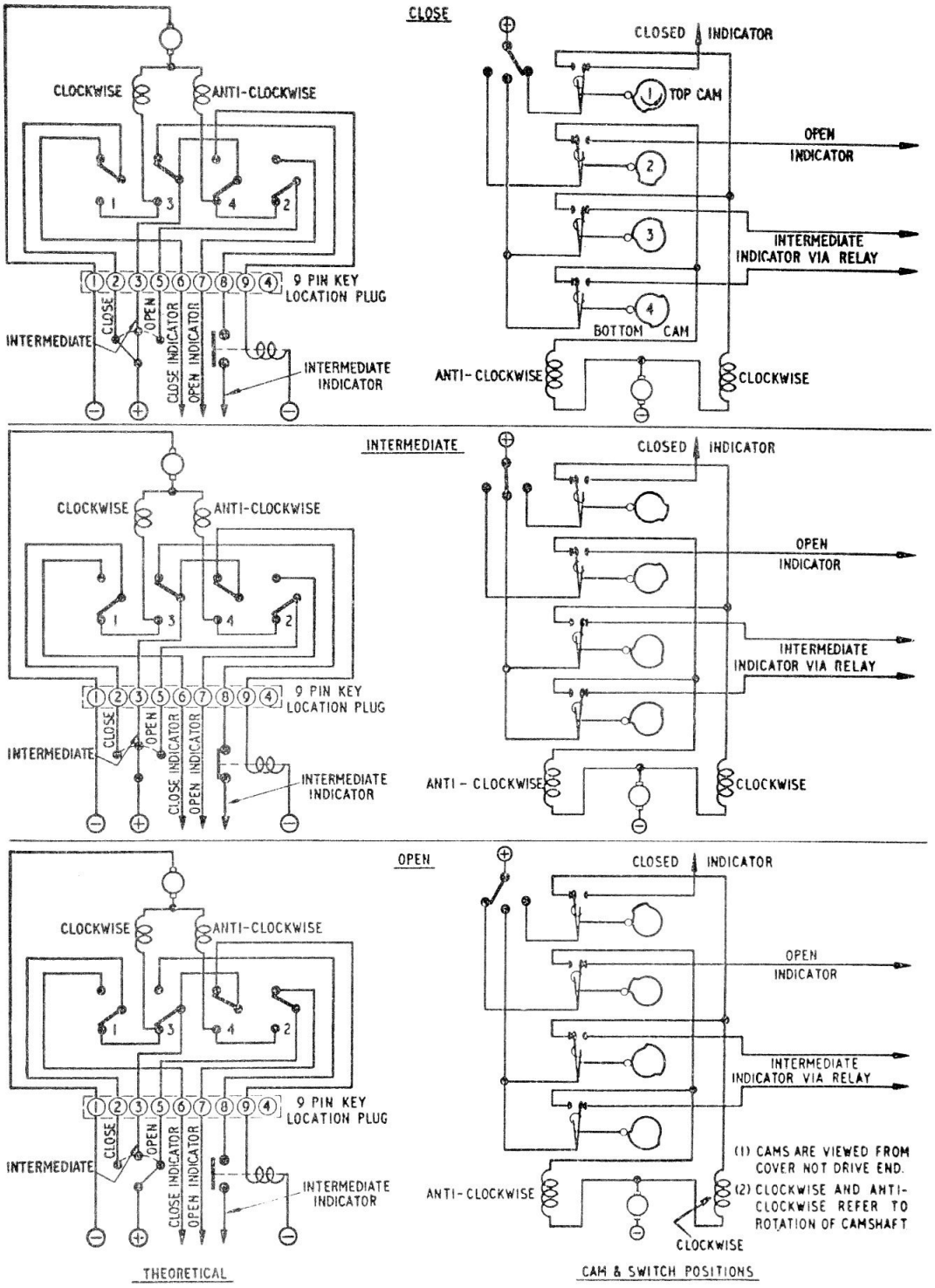

Fig. 4. Circuit diagram

(5) The backlash of free movement of the output shaft must not exceed 4 degrees when the shaft is subjected to a torque load of 12 lb.in. Check by running to the Intermediate position against the torque loading and note the scale reading. Reverse the weight to the other side and the scale must not move more than 4 degrees.

Electrical tests

19. Against a torque load of 120 lb.in. and with a supply of 29 volts, the current consumption must not exceed 1·9 amperes.

Bonding test

20. Measure the resistance between the body of the electrical plug and the gear-box with a Bonding tester, Type B (Ref. No. 5G/2126). The resistance must not exceed 0·05 ohm on actuators, Type FJC/A/84 and 922, and 0·025 ohm on actuator, Type FJC/A/965.

Appendix 1

ACTUATORS, TEDDINGTON, TYPES FJC/A/84 and 922

LEADING PARTICULARS

Actuator, Type FJC/A/84	*Ref. No. 5W/N.I.V.*
FJC/A/922	*Ref. No. 5W/4157*
Motor, Plessey Type C 1606G/44	*4CZ94690*
Normal voltage	*24V d.c.*
Operating voltage range	*16-29V d.c.*
Current at maximum load	*1·9 amp.*
Operating time at maximum load	*15 secs (nominal)*
Maximum load	*120 lb. in.*
Normal load	*6 lb. in.*
Angle of rotation	*178 - 180 deg.*
Overall dimensions	
Length	*6·0 in.*
Height	*5·3 in.*
Width	*4·5 in.*
Weight	*4 lb. 2 oz.*

1. The actuator Type FJC/A/84 is identical to that described and illustrated in the chapter.

2. The actuator Type FJC/A/922 is similar to that described and illustrated in the chapter but it has an adaptor terminating in a circular Vee flange bolted to the output face, and is fitted with a larger quill.

3. Motor details can be found in A.P. 4343D, Vol.1, Book.5. Sect.16, Chap.40, App.1. Table 3, (Actuators, Teddington, FJC/A series, single speed).

Appendix 2

ACTUATOR, TEDDINGTON, TYPE FJC/A/965

LEADING PARTICULARS

Actuator, Type FJC/A/965	*Ref. No. 5W/5115*
Motor, Plessey Type 1606G/49	*501/1/05074*
Normal Voltage	*24V d.c.*
Operating voltage range	*16 to 29V d.c.*
Current at maximum load	*1·9A*
Operating time at maximum load	*6·25 sec. (nominal)*
Maximum load	*120 lb. in.*
Normal load	*6 lb. in.*
Angle of rotation	*67 to 71 deg.*
Overall dimensions	
Length	*6·6 in.*
Height	*4·5 in.*
Width	*5·3 in.*
Weight	*2 lb. 13 oz.*

Introduction

1. The actuator, Type FJC/A/965 differs from that described in the chapter in the following respects:-

(1) The actuator contains five cams and five cam operated switches.

(2) Electrical connections are made through a 7-pole Cannon plug, Type CA 3102E-16S-1P-GB042.

(3) The master spline is in the valve closed position when it is 5±1 deg. clockwise from the datum line (fig. 1) and is in the fully open position when it is 75+0-2 deg. clockwise from the datum line. The intermediate position is 56±1 deg. from the datum line when selected from 'CLOSED' and 59±1 deg. from the datum line when selected from 'OPEN'.

(4) The CLOSE indicator is illuminated for the first 7±1 deg. of travel from the CLOSED position and the OPEN indicator is illuminated for the remainder of the arc of travel. No provision is made for an external INTERMEDIATE position indicator.

2. Motor details are given in Sect.16, Chap.40, App.1, Table 2 of this publication.

Setting procedure

3. (1) Remove the cover enclosing the motor and switch mechanism. Slacken the nut at the end of the camshaft and mount the actuator to the Rotary actuator Test Rig as detailed in A.P. 4343S, Vol.1, Book.2, Sect.8, Chap.7.

(2) Remove the connecting link between switches 3 and 4 and disconnect switch 3 from pin C of the electrical plug.

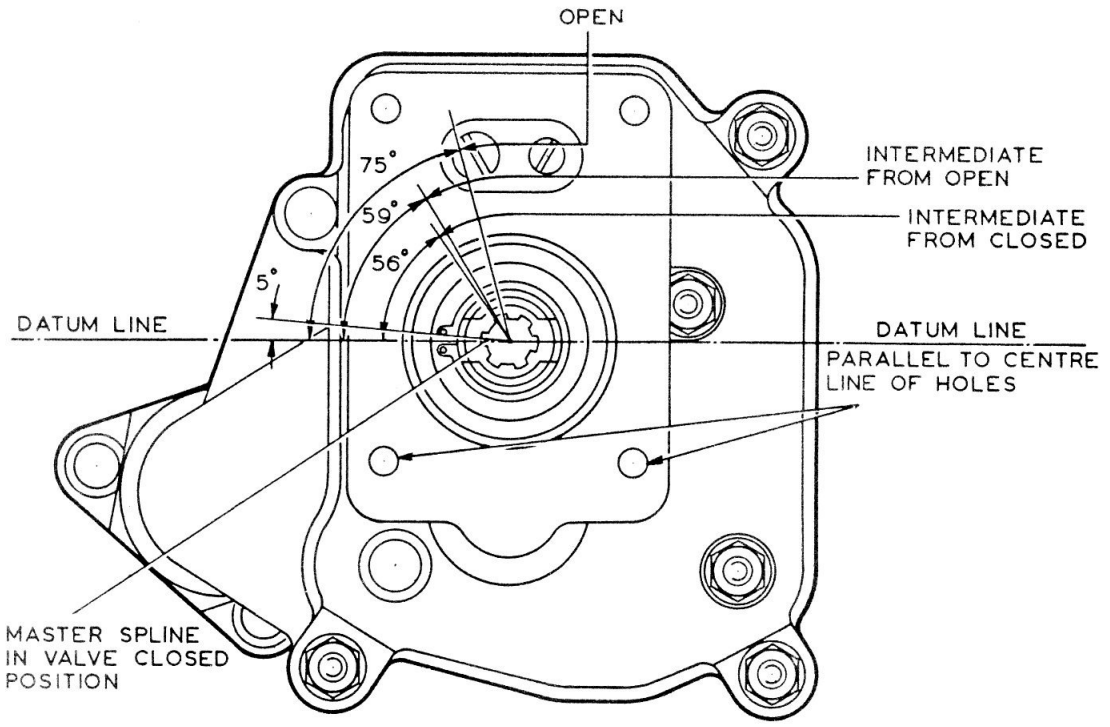

Fig. 1. Diagram showing movement arc of master spline

(3) Set the d.c. supply to 29V and apply a torque loading of 6 lb. in. to oppose the actuator travel.

(4) Adjust cam No. 2 so that when CLOSE is selected the actuator stops, when the master spline is 5±1 deg. clockwise from the datum line.

(5) Adjust cam No. 5 so that when OPEN is selected the actuator stops when the actuator is 75+0−2 deg. clockwise from the datum line.

(6) Connect the lead from pin C of the plug to the centre contact of switch 4. Adjust cam No. 4 so that when the actuator is at the CLOSE position and INTERMEDIATE is selected the actuator stops when the master spline is 56±1 deg. clockwise from the datum line.

(7) Transfer the lead from the centre contact of switch 4 to the centre contact of switch 3. Adjust cam No. 3 so that when the actuator is at the OPEN position and INTERMEDIATE is selected the actuator stops when the master spline is 59±1 deg. clockwise from the datum line.

(8) Adjust cam No. 1 so that when the actuator runs from the CLOSE position the CLOSE indicator extinguishes and the OPEN indicator illuminates when the master spline is 12±1 deg. clockwise from the datum line.

(9) Re-connect the link between the centre contacts of switches 3 and 4.

(10) Tighten the nut at the end of the camshaft with a torque spanner set to 100 lb. in. Check that the actuator meets the requirements of the tests detailed in App. A (NAVAL) or App. A (R.A.F.), para. 4 and 5.

(11) Remove the actuator from the test rig and re-fit the cover to the motor and switch mechanism.

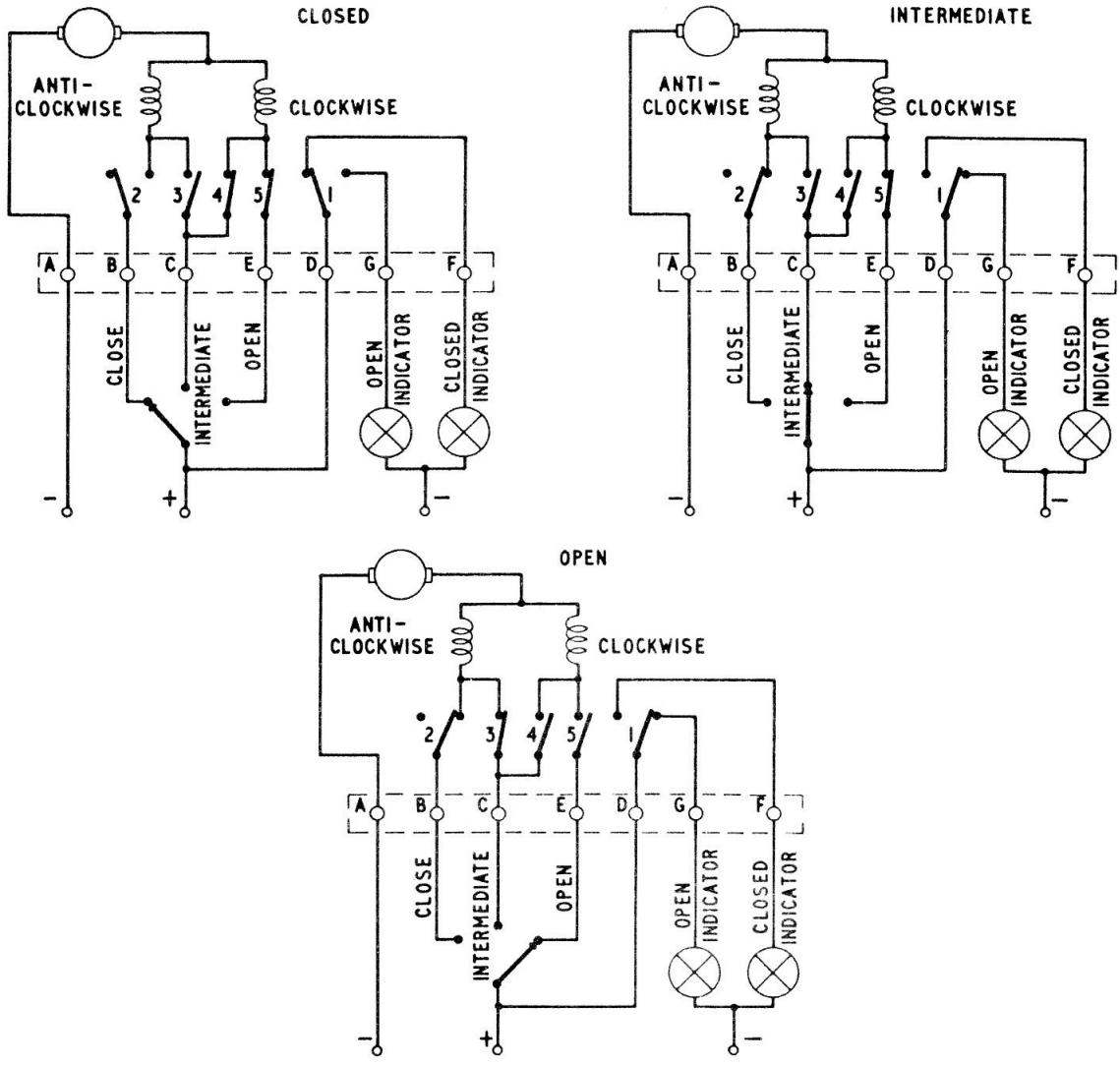

Fig. 2. Circuit diagrams

Appendix A (NAVAL)

STANDARD SERVICEABILITY TESTS
for
ACTUATORS, TEDDINGTON FJC/A SERIES (THREE POSITION)

Introduction

1. The tests detailed in this Appendix are to be applied to an actuator before its installation in an aircraft, at any time when the serviceability of the actuator is in doubt and at the appropriate re-examination periods at Second Line.

Test equipment

2. The following test equipment is required.

(1) Power Supply Unit 5G/3637 or 6130-99-101-8342.

(2) Single pole, three position switch (as available).

(3) Insulation Resistance Tester, Type C (Ref. No. 5G/152).

(4) Avometer Model 8 (Ref. No. 6625-99-943-1524).

(5) Stop Watch (6B/910-1001).

(6) Tension Gauge 1H/59.

Test conditions

3. All tests are to be carried out at normal room temperature.

Procedure

4. (1) Connect the actuator to the d.c. supply as in Fig. 1.

(2) Run the actuator to its three positions, observing that the rotary arc of travel and intermediate angles are within the limits specified below for the appropriate type of actuator.

Type FJC/A	Operating time in seconds	Rotary arc of travel in degrees	Intermediate angle in degrees
84	15^{+3}_{-2}	180^{+0}_{-2}	a 88 ±1 b 92 ±1
922	15^{+3}_{-2}	180^{+0}_{-2}	a 88 ±1 b 92 ±1
965	6·25± 1·5	70^{+1}_{-3}	a 56 ±1 b 59 ±1

Note. . .

The intermediate angles are measured relative to the closed position on actuator Type FJC/A/84 and 922 and relative to the datum line on actuator Type FJC/A/965. On actuator Type FJC/A/965 the closed position is 5 ± 1 deg. clockwise from the datum line and the fully open position is 75 - 2 deg. clockwise from the datum line The intermediate angles (a) must be obtained when the actuator is run from the closed position and the intermediate angles (b) when the actuator is run from the open position.

(3) Run the actuator from one extreme position to the other in both directions of rotation and check that the operating times are within the limits specified in the table in sub-para (2).

(4) With the Avometer set to the OHMS scale, run the actuator to each of its three positions in turn and check the operation of the indicator micro switches by a continuity test between the appropriate pins of the electrical plug referred to in the table below.

(5) Check the brush length and brush spring pressures with reference to A.P.4343D, Vol.1, Book.5, Sect.16, Chap.40, App.1, Table.3.

Minimum operating voltage

5. Reduce the d.c. supply to the 16V and observe that the actuator operates smoothly in both directions of rotation.

Insulation resistance

6. The insulation resistance between each pin of the electrical plug and the actuator body shall be not less than 500,000 ohms at 250V d.c. The test voltage shall be applied for at least 15 seconds.

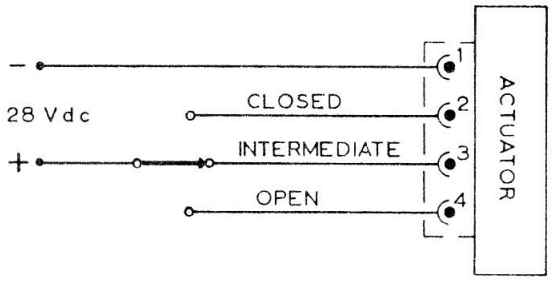

Fig. 1

Position	Shorted pins FJC/A/84 and 922	FJC/A/965	Open circuit pins FJC/A/84 and 922	FJC/A/965
	2-6	C-E	7-all other pins	B-all other pins
CLOSED	3-5	D-F	9-all other pins	G-all other pins
	3-8			
INTERMEDIATE	3-8	D-G	6-all other pins	C-all other pins
	3-9		7-all other pins	F-all other pins
OPEN	2-3	B-C	6-all other pins	E-all other pins
	3-9	D-G	8-all other pins	F-all other pins
	5-7			

Appendix A (R.A.F.)

STANDARD SERVICEABILITY TESTS

for

ACTUATORS, TEDDINGTON, FJC/A SERIES

(Three position)

Introduction

1. The tests detailed in this Appendix are to be applied to an actuator before its installation in an aircraft, at any time when the serviceability of the actuator is in doubt and at the appropriate re-examination periods at Equipment Depots.

Test equipment

2. The following test equipment is required:-

(1) Rotary actuator test rig (Ref. No. 4G/6591).

(2) Insulation resistance tester, Type C (Ref. No. 5G/152).

Test conditions

3. All tests are to be applied at normal room temperature.

Procedure

4. (1) Mount the actuator to the rotary actuator test rig as detailed in A.P. 4343S, Vol.1, Book.2, Sect.8, Chap.7.

(2) Set the actuator supply to 28V and run the actuator to the conditions specified in Table 1.

(3) The intermediate angles are measured relative to the closed position on actuators Type FJC/A/84 and 922 and relative to the datum line on actuator, Type FJC/A/965. On actuator FJC/A/965 the closed position is 5±1 deg. clockwise from the datum line and the fully open position is 75±2 deg. from the datum line. The intermediate angles in column (a) must be obtained when the actuator runs from the closed position and those in column (b) when it runs from the open position.

Minimum operating voltage

5. Set the actuator supply to the minimum operating voltage detailed in Table 1 and the applied torque to the value detailed in Table 1. Under these conditions the actuator must run when it is switched to either direction of rotation.

Insulation resistance

6. The resistance between the pins of the electrical plug and the actuator body must not be less than 0·05 megohm at 250V d.c. The test voltage must be applied for at least 15 seconds.

Note. . .

On actuator, Type FJC/A/965 the closed position is 5±1 deg, clockwise from the datum line and the fully open position is 75-2 deg, clockwise from the datum line.

Table 1

Test requirements

Actuator Type FJC/A	Operating time in seconds	Applied Torque in lb. in.	Maximum current consumption in amperes	Minimum operating voltage	Rotary arc of travel in degrees	Intermediate angle in degrees (a)	(b)
84	15^{+3}_{-2}	120	1·9	16	180^{+0}_{-2}	88±1	92±1
922	15^{+3}_{-2}	120	1·9	16	180^{+0}_{-2}	88±1	92±1
965	6·25± 1·5	180	1·9	16	70^{+1}_{-3}	56±1	59±1