Appendix 3

TEDDINGTON, TYPE FJC/A SERIES (SINGLE SPEED)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

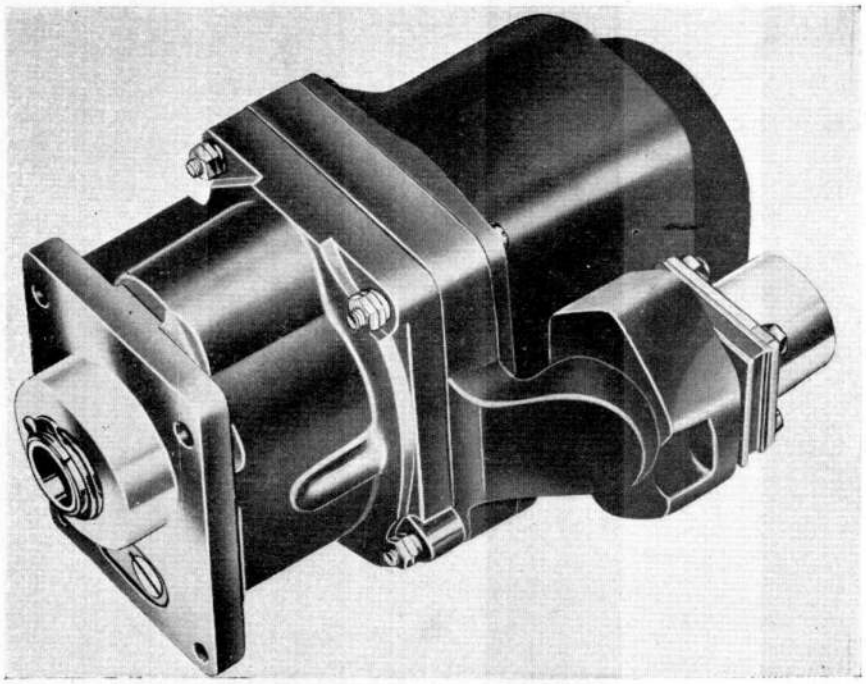

Fig. 1. General view of actuator

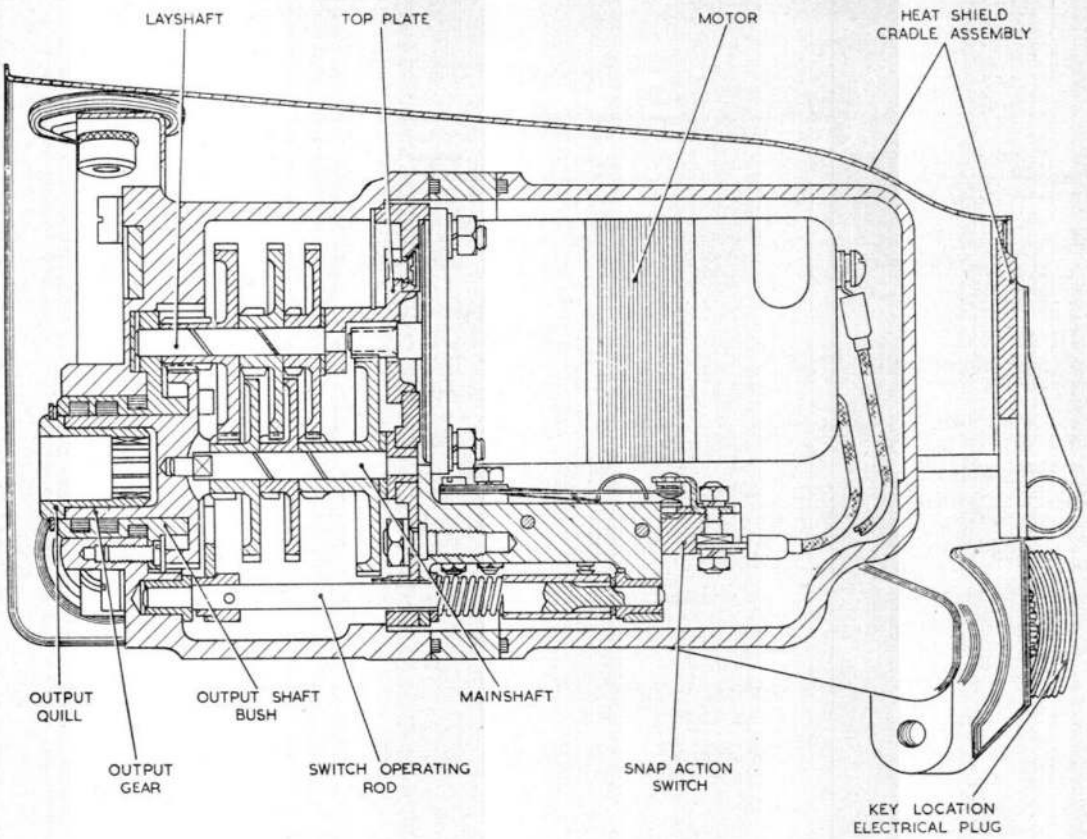

Fig. 2. Sectional view of actuator

Introduction

1. These actuators are designed primarily for use on high temperature installations, such as hot-air valves for anti-icing purposes in aircraft. Some actuators of this design are provided with a heat shield for protection when operating in extra high temperatures, thus increasing the operational ambient temperature range. Details of individual actuators will be found in A.P.4343D, Vol. 1, Book 3, Sect. 16.

2. The actuator comprises a power unit; this unit includes an electric driving motor, and over-run control electro-magnetic brake, an in-line reduction gear train, and limit switches.

DESCRIPTION

3. The motor of the actuator drives through a gear train to an output shaft, the resultant effect of which is to transmit a rotary motion to operate a hot-air valve. A splined quill provides the mechanical coupling between the output shaft and the ultimate valve movement.

4. The motor is a 24-volt, split series field, reversible, d.c., machine. An electro-magnetic brake, which is integral with the motor, eliminates over-run of the output shaft when the electrical supply is discontinued. The brake coil is always in circuit with the armature and one-half of the motor series field, irrespective of the required rotary movement when the control switch is operated. Two snap action switches limit the rotary arc of travel in either direction.

Electrical connection

5. A Breeze type plug provides the electrical connection to the motor; in some later type actuators a special Rolls type key location plug replaces the Breeze type plug. The position of the plug relative to the housing depends upon the application of the unit when installed in the aircraft.

Plug adapter

6. The plug socket adapter is a rectangular frame, having a groove on one joint face which houses a rubber "O" ring, which seals on the gear housing joint face. Four

4 B.A. clearance holes line up with those on the gear housing face. The plug socket is fitted on a hollow-shaped pedestal, through which the motor and switch leads pass, and is secured by four hex.hd. screws and tab-washers, with a gasket at the mating surfaces. The inner periphery of the plug adapter is smaller than that of the gear housing so that with the top plate in position, this latter is retained by the adapter. Bonding is achieved through a split sleeve located in a counter-bored hole in one pair of aligned holes in the plug adapter and gear housing.

Housings

7. The unit, which is completely enclosed in an aluminium alloy housing, is sealed against the ingress of moisture, and is designed to withstand a pressure differential of 20 lb. per sq. in. The housing is built in two main sections, the gear housing and motor casing, between which is interposed the adapter for mounting the Breeze type plug.

8. The motor casing is rectangular, closed at one end, with a joint face at the open end. An annular groove on this face provides a seat for a rubber "O" ring, which seals on the mating face of the plug adapter frame. At each corner of the open end a drilled boss houses a special 4 B.A. ch.hd. screw, which passes through the plug adapter frame and gear housing flange. The motor casing, plug adapter, and gear housing, are clamped together and held on to the special screws by appropriate nuts and spring washers.

Reduction gear train

9. The reduction gear train is carried on two parallel shafts on which the pinion and gear assemblies are disposed alternately. The main shaft is supported between a bush fitted to the internal face of the top plate, and in a machined recess and blind hole in the output shaft. The output shaft is carried in a flanged phosphor-bronze bush, which is housed on a mounting spigot at the gear housing closed end, and has an integral spur wheel which meshes with the stage below pinion. Two "O" rings in grooves in the bore of the bush provide a seal between bearing and shaft. The bush is secured at its flange to the inside of the gearbox by three csk.hd. screws. An "O" ring seal is also fitted between the bush and gear housing.

10. Fitted to the flange of the output shaft bush is a locking pin with a slot machined diametrically across it; this slot fits over, and traps a blade located in a recess in the gear housing. The blade also lies across a hole in the flange, and the layshaft passes through this hole, with its slotted end engaging the blade, to prevent rotation. In the design of some later type actuators, no locating blade is fitted. The other end of the layshaft fits into a bearing which is flange-fitted to the internal face of the top plate and secured by three csk.hd. screws. The centre of the bearing flange has a clearance hole through which the gear cut shaft of the motor passes.

11. Both gear shafts are shimmed at the journal ends to control axial movement of the pinion and gear assemblies. The top plate has four screws which pass through it, and are secured by special round nuts. The screws have eccentric heads which fit in similar counterbored holes in the internal face of the plate, thus holding them captive. The motor is retained on these screws by nuts, plain and spring washers, and the drive shaft protrudes through the top plate to engage with the first-stage gear.

12. The output gear shaft has a quill coupling fitted to it, which is located by a dog and slot arrangement, and retained in position by a circlip. A spacing washer and shims, to control end-play, are interposed between the circlip and the face of the mounting spigot. The gearbox top plate has an angled arm, cast integral with the face

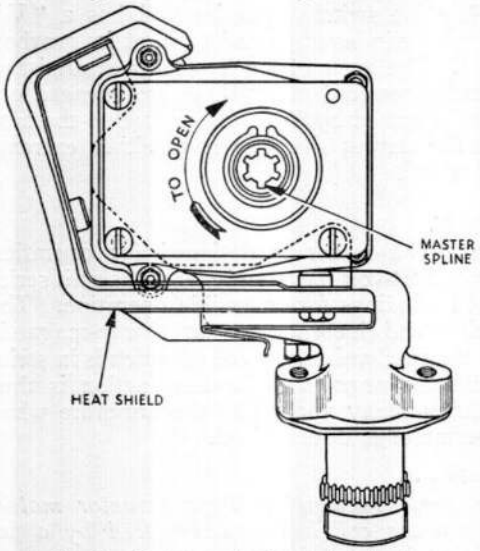

Fig. 3. Drive end view of actuator

opposite the gear assembly. In the design of some later type actuators, the angled arm is a non-integral component and is retained by a stud and nut. A switch operating rod lies parallel to this arm, and locates in a bush in the angled portion. A butterfly shaped plate, spline-fitted to that section of the operating rod, forms the limit switch trip lever. The arms of the plate are saw-cut, and a ch.hd. screw fitted to each, causes the lever to impart a grip on the operating rod, and on two grub screws which form adjusting screws for switch operation. The clamping screws are locked by spring washers. A coil spring interposed between the operating lever and the gearbox top plate, bears on a washer at the latter, and controls end-float of the operating rod.

Limit switches

13. Two snap-action limit switches are fitted to the support arm by two 6 B.A. hex.hd. bolts, nuts, and spring washers, so that their operating plungers lie immediately above the grub screws on the switch lever. One of the retaining bolts carries one cable cleat at its head, and two cable cleats at the nut end of the bolt, whilst the remaining bolt has plain washers at these positions. A fork-ended leaf spring, located in a groove on each switch plunger is secured by a single 6 B.A. bolt, nut, and spring washer. The bolt head locates in a slot in the switch support arm. The leaf springs bias the plungers in the extended position. In the design of some later type actuators, no fork-ended leaf spring is fitted, the snap-action limit switch springs have also been strengthened.

14. The switch operating rod has a "V" shaped trip lever pinned to it, at its gearbox end. The arms of the trip lever are finished hard chromium plate; these are engaged on, and operated by, two pins riveted to the face of the output shaft gear, at either extreme of travel.

Motor

15. The motor is designed for operation from a 24-volt d.c. supply, and has split series field windings for reversible operation. The drive end incorporates an electro-magnetic brake mechanism, the coil of which is in series with the armature. Braking action is thus automatically applied to the armature when the motor is de-energized.

Note . . .

In some Teddington Type actuator motors the brake coil has been replaced by a flat dished brake spring.

16. The motor comprises four main units, the brake housing with mounting flange integral and brake components, the yoke which carries the field system, the brushgear housing and brushgear, and the armature assembly. The armature is supported by ball bearings located in the brushgear and brake housings.

17. The drive-end bearing is located within the web of the brake housing and held in position by a retaining plate. A 0·005 in. shim is interposed between the outer race and the housing, and end-play is taken up by shims between the bearing and its retaining plate. The commutator-end bearing is located in the web of the brushgear housing.

Yoke

18. The pole pieces are integral with the yoke, the whole being built up from suitable stampings, and the two through bolts which are integral with the brake coil assembly pass within the yoke assembly and between the field coils; these coils encircle the pole-pieces and are held against the interior of the yoke by wedges passing through the pole-pieces.

Brushgear

19. The brushgear housing locates on the yoke assembly in like manner to the brake housing; the former encloses the brushgear carrier. The two brush holders are secured to a moulded annulus. An insulating washer lies between the carrier and the housing web; the carrier is secured to the web by two screws which thread into nut-plates. These plates are restrained within projections on the moulding so that the annulus may be rotated through an arc, in order to obtain the required commutating position. A second hole in the nut-plates, and two corresponding holes in the housing, permit the two through bolts of the brake coil assembly to protrude beyond the housing. Nuts threaded on to these secure the two housings and yoke together.

20. The carbon brushes are a loose fit in machined brass holders, and held under a pressure of $3\frac{1}{2}$ to $4\frac{1}{2}$ oz. by means of clock-type springs and levers. Bushes on the brush carrier protrude through slots in the housing and carry terminal screws.

Armature

21. The commutator is of moulded construction. The shaft journals are ground to close limits, and the bearings are selectively assembled to obtain the necessary fit. The drive pinion is integral with the armature shaft.

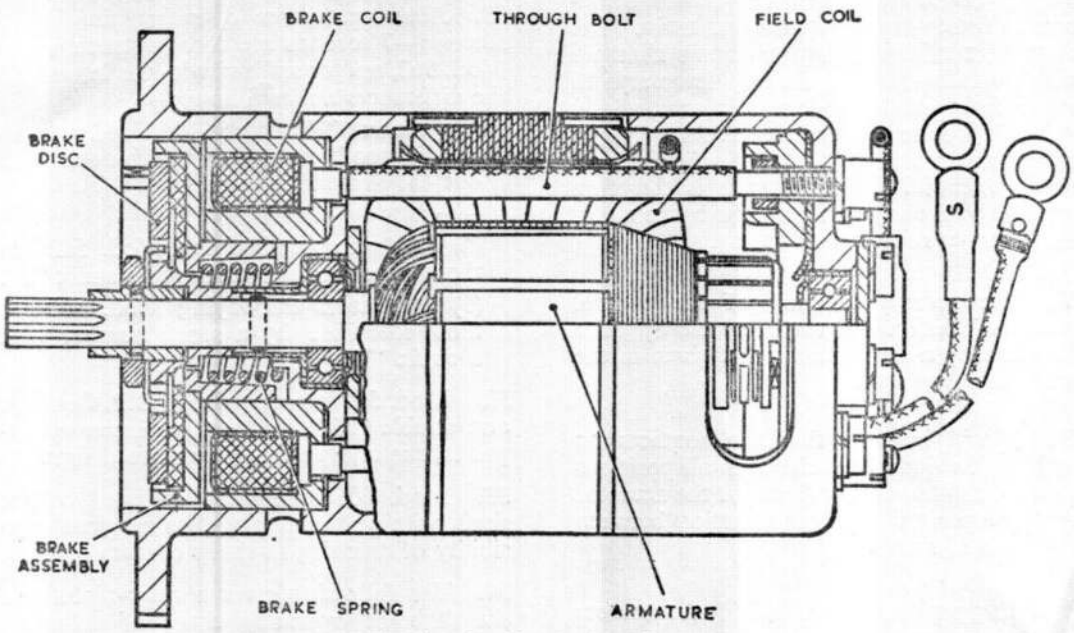

Fig. 4. Sectional view of motor

Wiring

22. The connection common to the field coils and brake coil is an internal one. The two flying leads are the connections to the field coils (*fig.* 4), the third connection being taken from the appropriate brush terminal. All windings are impregnated.

Electro-magnetic brake assembly

23. The brake disc is secured against its driving pin on the armature shaft by a special nut; this nut threads on to a short collar which is a sliding fit on the shaft, but which is prevented from moving on the shaft by a pin passing through both shaft and collar. The brake disc is counterbored to accept a portion of the collar, and is provided with holes for the outer tabs of the locking washer, held beneath the nut.

24. Behind the brake disc is a floating annulus called the attraction plate; this plate carries the friction lining, and is restrained against rotation by two projecting lugs at its periphery, which pass into corresponding slots in the brake housing. The inner diameter of the attraction plate is such that it clears the armature shaft, and it is located axially between the brake disc attached to the armature shaft and the brake coil assembly, enclosed within the brake housing.

25. A coil spring, embracing the armature shaft and co-axial with it, butts against the bearing housing at one end, and the attraction plate at the other, thus forcing the latter into contact with the brake disc. The brake is housed in an annulus of " U " section, and is held by two long diametrically opposed studs against the web of the brake housing. " U " shaped brake adjustment shims are interposed between brake coil housing and web, in order to obtain the required brake clearance. Upon energizing the motor, the annulus is attracted to the brake coil housing, and clear of the brake disc, against the action of the brake coil or flat dished spring. The armature is then free to rotate. On de-energizing the motor the loaded brake spring extends the annulus against the brake disc, and the machine stops with a minimum of over-run.

OPERATION

26. In the full travel position one limit switch is held open by the switch operating lever. This condition causes the brake solenoid and one field winding to be open circuited.

27. When the control switch, which may be manual or automatic, selects opposite travel, the brake solenoid and remaining field winding are simultaneously energized,

pulling the brake disc from the friction pad (*para.* 24) against the action of the brake spring, thereby allowing the motor armature to rotate and drive the gear train. The movement of the final gear causes that pin which was bearing on the trip lever arm to rotate the operating rod; this, in turn, allows the switch lever to depress the plunger, and break the circuit to the field winding and brake solenoid. The armature is therefore arrested by the application of the brake under the influence of its return spring.

28. The reverse selection of the control switch will effect full travel in the opposite direction by a similar action as given in the previous paragraph.

29. It will be seen that the contacts on both limit switches are closed in all positions between full travel, in order that the actuator may be operated in either direction between the limits of travel.

Operating performance of individual actuators

30. To clarify the position of operating times of pre-Mod. 562 and Mod. 606 Teddington type actuators, the following information is promulgated to avoid confusion.

31. Actuators whose operating time is 15 seconds—7 seconds are those actuators pre-Mod. 562, and/or suffixed with the letter 'T,' the differences are as follows:—

(1) Suffix 'T' and pre-Mod. 562 refer to Teddington Type actuators, sub-contracted out to Western Manufacturing (Reading) Ltd.

(2) Actuators embodying Mod. 562 are those whose serial Nos. have no suffix 'T'.

(3) Actuators embodying Mod. 606 are those identified by a serial number with a suffix 'T'.

32. Mod. 562 introduced a 48 D.P. Gearbox and double " O " ring seal, to increase output torque and generally improve design.

33. Mod. 606 introduced stiffened output shaft with radiused slots, to prevent possibility of cracking in sharp corners of slots.

34. The following gives a clear picture of the different operating times of actuators pre-Mod. 562 and suffixed 'T,' Mod. 562 and Mod. 674.

Type FJC/A/ actuators	Operating time in seconds	Applied Torque in lb/in.	Maximum current consumption in amperes	Minimum operating voltage	Rotary arc of travel in degrees
ACTUATORS TO PRE-MOD. 562 STANDARD, and/or actuators identified by suffix 'T'					
10: 11: 12: 14: 17: 19: 26: 28: 29: 32: 33: 36: 37: 43: 45: 86	15—7	120	1·3	16	180—2
13: 20: 25	3—0·5	60	1·9	16	180—2
ACTUATORS TO MOD. 562 STANDARD					
10: 11: 12: 14: 26: 28: 29: 32: 33: 36: 37: 43: 45	15^{+4}_{-2}	120	1·3	16	180—2
13: 20: 25	3—0·5	60	1·9	16	180—2
17	15^{+4}_{-2}	140	1·3	16	180—2
19	15^{+4}_{-2}	180	1·3	16	180—2

ACTUATORS TO MOD. 674 STANDARD

13: 20: 25	3—0·5	120	2·5	16	180—2
54: 62: 82: 92	15+4 —2	120	1·65	16	180—2
58: 63	15+4 —2	120	1·3	16	180—2
52	60+30	180	1·3	16	180—2
56	4 min.+1 min. —0·5 min.	180	1·5	21	180—2
67	4 min.+1 min. —0·5 min.	180	1·75	21	140—2
85: 86	15+4 —2	120	1·3	16	180—2
98	90 minimum	120	1·75	21	140—2

INSTALLATION

35. The actuator is mounted on four 2 B.A. studs which pass through clearance holes drilled in the gear housing mounting flange, and is located by the spigot machined on the mounting face. Before actual mounting to the valve to be controlled is effected, it is most important to check that the arc rotation of the actuator is identical in sense and direction to that of the unit to which it is to be coupled.

SERVICING

36. The actuator should be subjected to such functional tests as can be conveniently carried out within the aircraft maintenance cycle, to ensure positive operation and security of the Breeze plug.

37. Information on the removal of the actuator from the aircraft, and its subsequent servicing, will be found in the appropriate aircraft handbook.

Note . . .

It is recommended that actuators be removed for bay servicing in accordance with the instructions contained in the relevant Aircraft Servicing Schedule.

Insulation resistance test

38. With an insulation resistance tester measure the insulation resistance between the two field leads and earth, this test can best be effected at the Breeze plug, whilst still installed in the aircraft. The insulation resistance must not be less than 50,000 ohms.

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