Chapter 22

ACTUATOR, ENGLISH ELECTRIC, TYPE 270

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Actuator, Type 270	Stores Ref. 5W/56
Voltage	24
Speed of motor	11,000 r.p.m.
Input to motor	550 watts
Max. working load (tension)	14,800 lb.
Max. working load (compression)	11,200 lb.
Clutch slip load	15,000 to 16,000 lb.
Normal working stroke	4·8 in.
Stroke between stops	5·18 in.
Time taken for normal working stroke	13 sec.
Distance between centres	Refer to para. 38
Minimum brush length	0·5 in.
Brush spring pressure	15-21 oz.
Brush grade	E.G.O. (HAM)

Introduction

1. The linear actuator, Type 270, provides variation in the angle of incidence of the tail-plane on certain aircraft under all conditions of flight. It can operate normal working loads of 3,000 lb. to 5,000 lb. and is capable of dealing with loads of up to 11,200 lb. in compression and 14,800 lb. in tension.

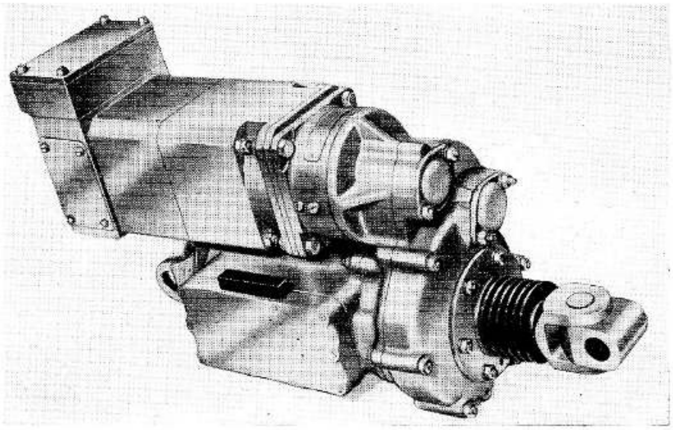

Fig. 1. General view of actuator, Type 270

DESCRIPTION

2. The actuator consists of a two-pole, split series field, 24-volt motor fitted with a magnetic clutch brake. The motor drives the ram through a gearbox consisting of two stages of epicyclic, and two stages of spur gears. The second stage of epicyclic gears has a slipping annulus clutch which slips if the load reaches a figure of between 15,000 lb. and 16,000 lb., depending upon its setting. Damage to the motor or aircraft structure is thus prevented if overloads are imposed.

3. The last pinion of the second train of spur gears is attached to the main drive shaft (*fig.* 2) which has an external ball thread and an internal acme thread. The external thread drives a ball nut while the internal thread drives an auxiliary drive shaft that is splined and has an acme thread upon it. This shaft extends rearwards so providing an increased actuation stroke, i.e., it is in addition to the travel of the main stroke provided by (the ball nut, which extends forwards.

4. No limit switching arrangement is incorporated in this actuator. The switches are fitted to the aircraft structure and form part of the aircraft electrical system. The actuator is, however, fitted with mechanical stops so that, in the event of limit switch failure, no damage is caused by excessive travel.

Housing and covers (*fig. 2*)

5. The actuator housing comprises a series of alloy castings. The motor frame houses the field windings, the pole pieces and the armature. The commutator and brush gear, however, are housed in a separate casting which has side covers and a base cover to facilitate inspection. On top of this casting the terminal box is fitted.

6. On the end of the motor opposite to the commutator fits the brake housing, to which in turn, is fitted the driving end endplate.

7. Four bolts pass through the rear casing assembly of the gearbox, the driving end endplate, and the flange of the brake housing. A further four bolts secure the motor housing to the brake housing thus forming a rigid mounting for the motor to the gearbox.

8. The gear trains are enclosed in a housing made up of the rear casing assembly and the front casing assembly and, together, these form the structure that connects the motor to the ball nut housing. The acme screw thread extends through the endplate of the front casing.

9. The ball nut (or ram) housing encloses the ball nut, the main drive shaft, and also the potentiometer assembly. A sealing ring is fitted at the end of the housing and is held in position by a washer and circlip.

10. All the working parts are thus fully enclosed though readily accessible for routine inspection, without resort to dismantling.

Motor and brake assembly (*fig. 3*)

11. The motor is a 24-volt machine, of 550 watts input, and operates at 11,000 r.p.m. The field windings are of the split-series type, four coils being wound on two pole pieces in such a way that one coil on each pole is in operation when the actuator is extending, the remaining two being used to retract the actuator.

12. To ensure good commutation under most operating conditions, the motor is

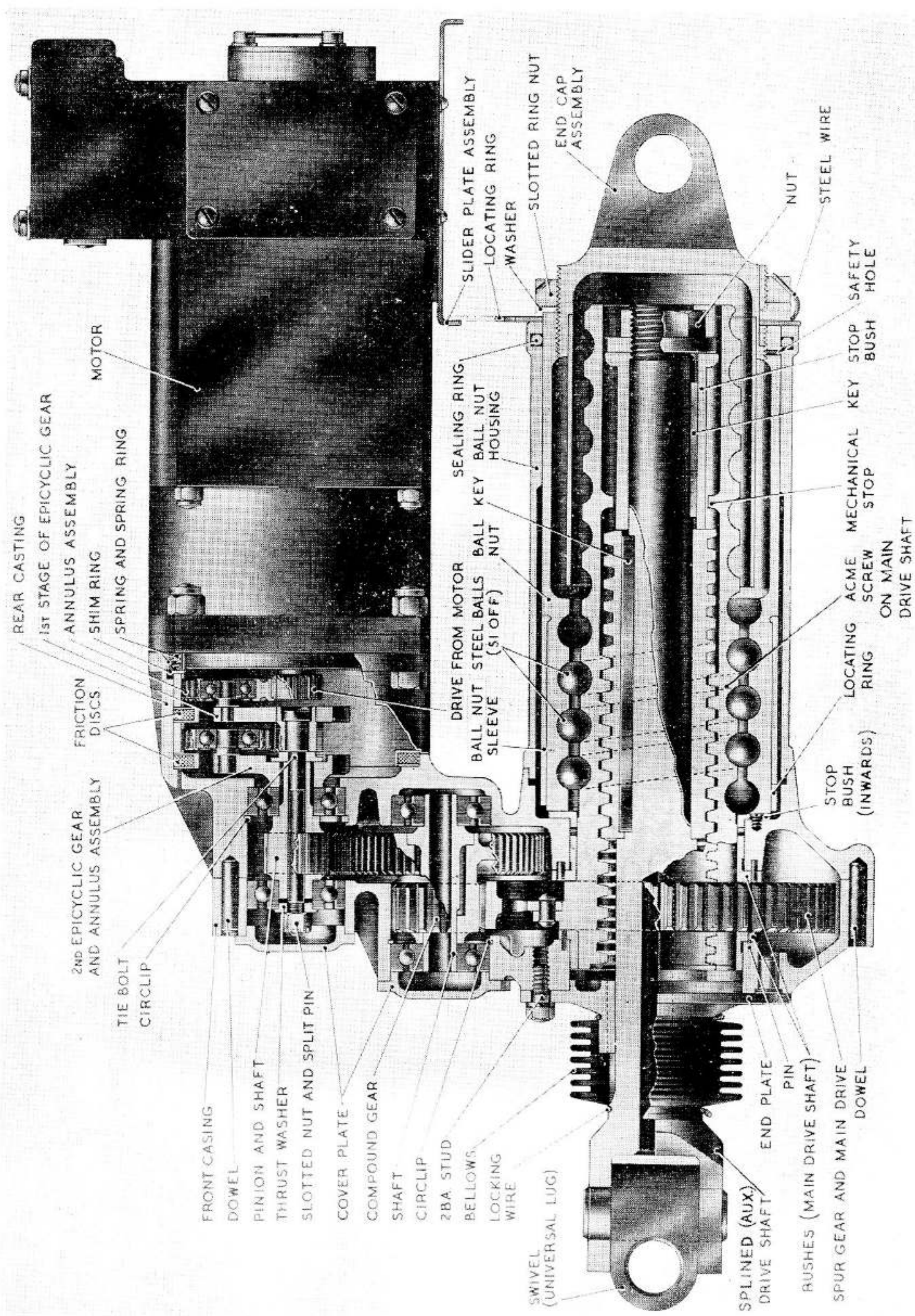

Fig. 2. Sectional view of actuator gearing and drive mechanism

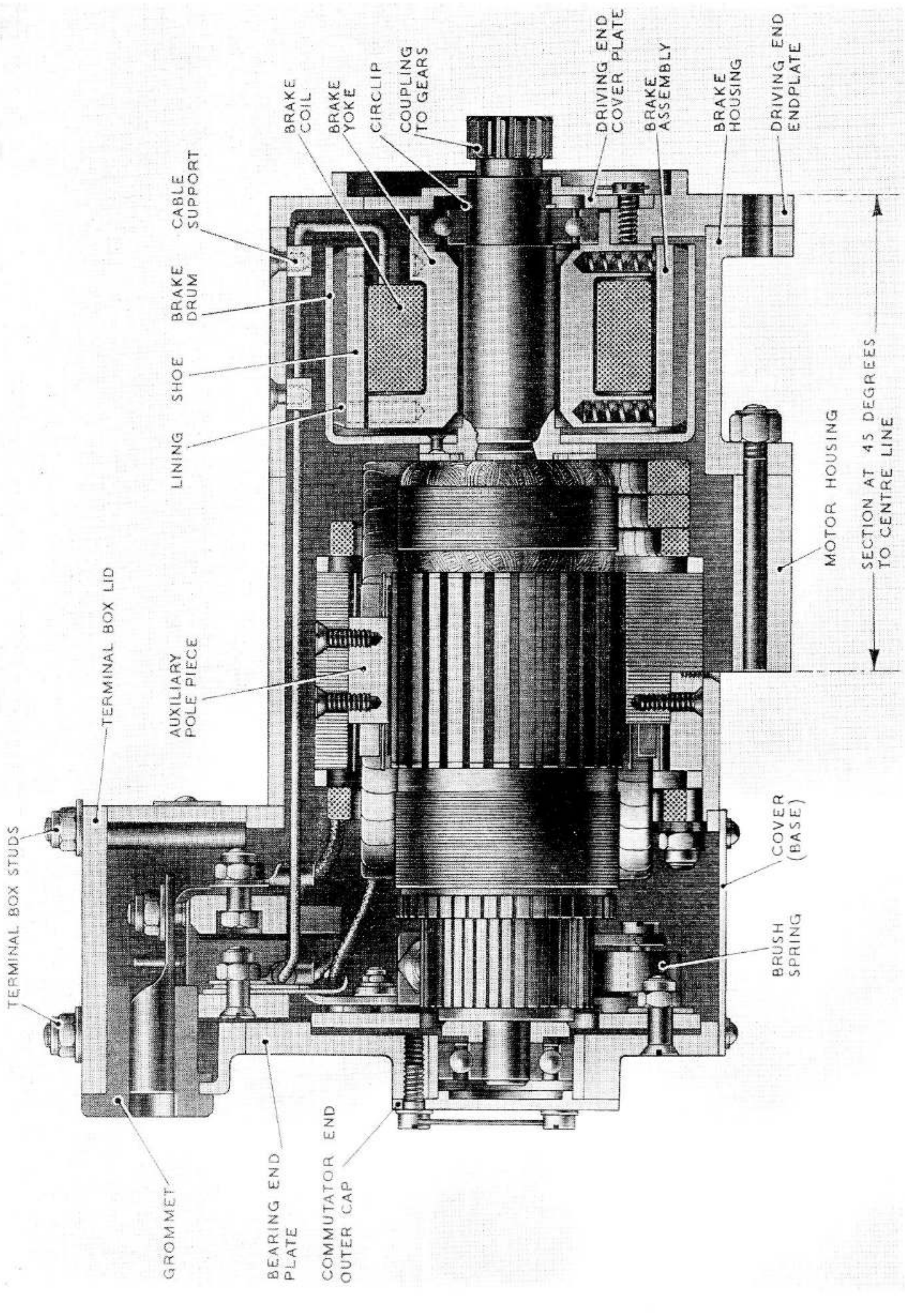

Fig. 3. Sectional view of motor and brake assemblies

fitted with auxiliary and compensating windings. The latter also serve as a safeguard in the event of sudden overloading of the motor.

13. The yoke and main pole pieces are integral, being made up of one set of laminations. The auxiliary poles, however, are of wrought iron and each is secured to the yoke by two 4 B.A. csk/hd. steel screws.

14. Two brushes are fitted; each is mounted in a light alloy brush that is pivoted at its end. The boxes are, in turn, mounted upon a moulded brush rocker. Pressure on the brushes is maintained, in each instance, by a flat coiled spring, one end of which bears on top of the brush. The grade of brush used is E.G.O. (HAM).

15. Two Bakelized fabric terminal boards are screwed to the terminal box and are separated by two spacing sleeves.

16. Each end of the armature shaft is carried in a ball bearing (*fig.* 2). This same shaft also supports the brake drum. The brake yoke assembly is secured to the driving end endplate by three 4 B.A., half-inch, csk/hd. screws.

17. The brake is of the electro-magnetic type and has four full-lit shoes, each of which is normally held against the brake drum by four helical springs. As the brake coil is connected in series with the motor field windings, the shoes and linings are held clear of the drum and against the yoke when either of the motor fields is energized. The brake linings are secured to the shoes by four rivets. The wrought iron brake shoes are each located, with respect to the yoke, by two pins which engage with two holes drilled in the shoe.

Gearbox (*fig.* 2)

18. The reduction gear assembly consists of two trains of epicyclic gearing and two of spur gears. The epicyclic trains are accommodated in the rear casing assembly.

19. The sun pinion of the first epicyclic train is integral with the motor armature shaft, while the planet gears are mounted on spindles which are brazed to the planet carrier. The sun pinion of the second epicyclic train is also brazed to this carrier.

20. The annulus gear of the second epicyclic train acts as a slipping clutch and safeguards the actuator and motor in the event of overloading. The clutch setting can be altered if the number of clutch springs is varied.

21. Passing through the sun pinion of the second epicyclic train is a tie bolt. This bolt bears against a thrust washer that seats in the planet carrier of the second epicyclic train. The bolt then passes through the shaft of the first spur gear pinion which mates with an internal gear on the planet carrier of the second epicyclic train. A nut on the end of the tie bolt secures and locates these parts.

22. The pinion and shaft of the first spur train is supported at both sides of the pinion by a ball bearing. Endplay is prevented by a clip that locates the bearing which is nearest to the epicyclic gears. The other bearing is located by the shoulder on the pinion and shaft and is held in position by a thrust washer and the nut on the end of the tie bolt.

23. The pinion of the first spur train mates with a pinion on the compound gear to form the first spur train. The other pinion of the compound gear mates with a pinion attached to the main drive shaft, this completing the second stage of the spur gearing.

24. The compound gear is supported by two ball bearings. One of these is located in the rear casing assembly and the other in the front casing assembly. The bearing in the front casting assembly is held in position by a blanking cover and a clip.

Drive shafts and ball nut mechanism (*fig.* 2)

25. The main drive shaft is of steel and is supported by bushes which fit into the front and rear casing assemblies. On the outside of the main drive shaft is cut a high-efficiency ball thread and, on the inside, an acme thread is cut.

26. The ball nut, which converts the rotary movement of the main drive shaft into linear movement, is fitted with a recirculating device. This consists of fifty-one $\frac{3}{8}$ in. dia. balls which provide an almost frictionless drive throughout the stroke.

27. The torque reaction, set up by the rotating parts and transmitted to the ball nut, and thence to the end cap assembly, is absorbed by the aircraft structure. At the opposite end of the actuator, torque reaction, transmitted through the acme thread to the splined shaft, is absorbed by the splines on the endplate which correspond to those on the shaft.

28. A locating ring is fastened to the ball nut and prevents it rotating accidentally when the unit is not held in some form of mounting.

29. The acme thread is keyed to the splined shaft and engages with the internal acme thread cut on the main drive shaft. On the inner end of the splined shaft is keyed a stop bush, held in position by a flanged nut. This bush acts as a mechanical stop in the event of limit switch failure when the actuator is extending. Further extension of the ball nut is prevented when a mechanical stop (*fig.* 2) on the inside of the main drive shaft comes into contact with the stop bush (*fig.* 2). The clutch then slips.

30. If the limit switch fails when the actuator is retracting, the end of the ball nut comes into contact with a stop bush (*fig.* 2) which fits in the rear casing assembly. Further movement of the ball nut is thus prevented and the clutch slips.

31. The splined shaft, providing extra extension through the medium of the acme screw, is protected from the ingress of dirt by a rubber, bellows-type, gaiter, held in place by spring clips. Hence, no foreign matter is allowed to enter the splines when the actuator is in the extended position.

32. Two mounting points for the actuator are provided. The first is at the ball nut drive end and consists of a mounting lug which is part of the end cap assembly. The second, a swivel lug, which forms part of the splined shaft, is at the acme screw end of the machine. It should be noted that the end cap assembly screws into the internal thread which is cut on the ball nut.

Limit switches

33. No limit switches are fitted in this type of actuator; instead they are incorporated in the variable incidence tailplane of the aircraft. Consequently, the actuator should not be operated unless it is installed either in an aircraft or in a test rig incorporating suitable limit switches.

Potentiometer and indicator

34. In certain installations the position of the ram is constantly indicated by a Desynn indicator which is connected to a potentiometer in the ram housing of the actuator.

35. Between the train coils of the potentiometer moves a sliding contact. Small springs, which hold the contact surfaces against the coils, ensure that good contact is made. The sliding contact is moved along the coils by a carrier riveted to the ball nut assembly.

36. Full stroke of the actuator is indicated by a 180 deg. movement of the indicator needle. If the actuator motor supply circuit is broken, the needle of the indicator moves immediately to its "pull-off" position, which is clear of the working part of the scale.

37. A further indication of the position of the ram, in relation to the mechanical stops, is given by a stroke plate fastened to the motor. If the ball nut has run against the stops, an indication is given by the fact that the locating ring contacts and projections on the stop plate causing them to become distorted.

INSTALLATION

38. As mentioned in para. 32, the actuator is secured to the aircraft structure by two mounting lugs, one being fitted at each end of the actuator. The lug that is a part of the end cap assembly (*fig.* 2) is adjustable. It is fitted with a locking ring nut and screws into the internal thread which is cut on the ball nut. Consequently, it is possible, by slackening off the lock-nut, to move the mounting lug in or out, as required. Such action permits the distance between the centres of the two mounting lugs to be altered. This, in turn, increases or decreases the effective extended length of the actuator.

39. The distance between the centres of the mounting lugs is normall 13·19 in. when the actuator ram is retracted. The distance is $18\frac{3}{8} \pm \frac{1}{8}$ in. when the actuator is extended. This small adjustment ($\pm\frac{1}{8}$ in.) is obtained by altering the position of the ram end mounting lug, as explained in the previous paragraph.

Note . . .
It is possible to slacken the mounting lug at the ram end to a point at which there is insufficient effective thread on the lug to carry the loads imposed upon it during normal

operation. Accordingly, the following precaution must be observed. On the ram is a safety hole (fig. 2). Always ensure that the lug is screwed on the ram sufficiently far as to cover this hole.

40. The alignment of the mounting lugs should be checked before the actuator is installed in an aircraft. During installation the actuator should be operated at a reduced voltage of 14 volts.

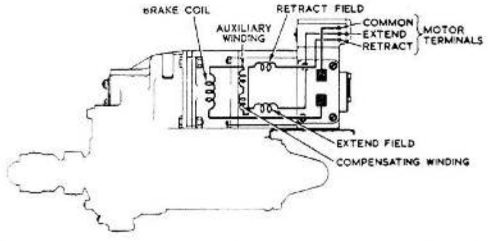

Fig. 4. Layout of wiring of motor and brake assemblies

41. A practical wiring diagram is provided in fig. 4. The motor terminals are, in fact, numbered 1, 2 and 3, corresponding to COMMON, EXTEND and RETRACT, respectively, on this illustration.

42. The connections for the indicator circuit are made by the five cores of a Quinvin 4 cable, which is connected to the potentiometer. They are as follows:—

Red	— Positive	24-volt supply to potentiometer
Blue	— Negative	
White	— No. 1 terminal on Desynn indicator	
Yellow	— No. 2 terminal on Desynn indicator	
Green	— No. 3 terminal on Desynn indicator.	

43. The potentiometer terminal block is fitted to the side of the ram housing. It should be noted that the Desynn indicator pointer should move in a clockwise direction when the actuator extends.

OPERATION

44. In the following text it is assumed that the actuator is installed in an aircraft with limit switches connected in the supply circuit. Accordingly, when the actuator is fully extended, the "extend" limit switch will be open and the "retract" limit switch closed.

45. When the supply is switched on, the brake coils will be energized so lifting the brake shoes clear of the brake drum and holding them hard against the yoke. The relevant pair of motor field coils will be energized and the armature will rotate.

46. As the sun pinion of the first epicyclic train is integral with the armature it will rotate also, thus setting the epicyclic gear trains in motion. These trains in turn rotate the spur gear trains. The last pinion of the spur trains is riveted to the main drive shaft. Hence, rotary motion is imparted to the drive shaft. As it rotates, the shaft causes a linear movement of the ball nut and of the splined shaft, both of which retract.

47. As soon as the ball nut leaves the fully extended position, the "extend" limit switch will close. When this occurs, both limit switches are closed and the actuator may be reversed simply by altering the position of the circuit selector switch so that current is fed to the "extend" field of the motor.

48. When the actuator reaches its fully retracted position, or if the supply current is switched off manually during the retraction stroke, the brake will be de-energized. Consequently, the brake shoes and linings are forced against the brake drum by action of the brake springs.

49. This stops the rotation of the armature and hence that of the other rotating parts, so bringing the ball nut to a standstill, with an overrun of less than 0·060 in., at any desired position during the stroke, or at the limits of the stroke.

SERVICING

50. The actuator is to be inspected and serviced in accordance with, and at the periods specified in, the appropriate Servicing Schedule.

Brush gear

51. The brushes may be inspected if the side covers on the motor are removed. The brush boxes and brushes should be thoroughly cleaned and any accumulation of carbon dust blown out with dry, compressed air. The brushes should slide easily in their boxes.

52. Worn brushes should be replaced with new before their maximum wear limit is reached, so ensuring that the actuator will operate satisfactorily until the next inspection. The minimum overall brush length that is allowed is $\frac{1}{2}$ in. If brush renewal is necessary, only brushes of grade E.G.O. (HAM) should be used; they must be bedded down to the contour of the commutator to give a contact surface of at least 80 per cent. of their cross-sectional area.

53. The brush spring tension should be checked and should be between 15 and 21 oz. In checking the tension a suitable spring balance should be used. The balance should be hooked beneath the brush spring at the point where it bears on the brush. The reading should be taken when the spring is lifted, in a direction parallel to the centre-line of the brush, just clear of the brush.

Lubrication

54. The actuator is lubricated during manufacture and should require no further attention except at the periods laid down in the appropriate Servicing Schedule.

Final check

55. Ensure that all nuts, screws, and locking devices are secure and that the electrical connections are tight and free from corrosion.