Chapter 21

ACTUATOR, ENGLISH ELECTRIC, TYPE 259

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LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Actuator, Type 259, Mk. 1	*Stores Ref. 5W/176*
Voltage	*24 d.c.*
Speed of motor	*11,000 r.p.m.*
Input to motor	*20 watts*
Max. (emergency) working load	*200 lb.*
Normal working stroke	*2·75 in.*
Stroke between mechanical stops	*3·0 in.*
Distance between centres	*Refer to para. 36*
Minimum brush length	*0·175 in.*
Brush spring pressure	*4 to 5 oz.*
Brush grade	*E.G.O. (HAM)*
Weight	*3 lb. 7 oz.*
Length of actuator	*8·3 in. approx.*

Introduction

1. The linear actuator, Type 259, operates the aileron bias mechanism on certain aircraft ; it will operate in both directions of rotation up to an emergency load on the actuator of 200 lb.

DESCRIPTION

General construction

2. The actuator consists of a miniature, two-pole, split series field, d.c. motor rated at 24 volts which drives an actuating nut through the medium of a dog clutch and a three-stage reduction spur gear train.

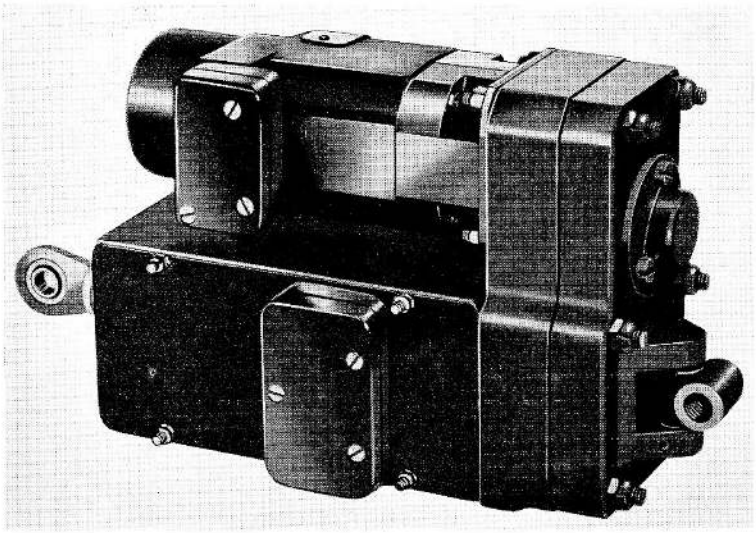

Fig. !. General view of actuator

3. Limit switches are fitted in the actuator, their purpose being to break the motor supply circuit when the actuating nut reaches the end of its travel during the extension or retraction stroke. Mechanical stops are also fitted to stop the actuating nut at the end of its stravel in the event of limit switch failure.

4. The dog clutch prevents damage to the motor and gears in the event of an accidental overload being applied to the actuator, or if the actuating nut runs on to the mechanical stops owing to failure of the limit switches.

5. A four-shoe, electro-magnetic brake is incorporated in the motor, the brake being automatically applied when the motor supply circuit is broken. Excessive over-run of the actuating nut is thereby prevented.

6. A linear potentiometer is fitted which, in conjunction with a remote Desynn indicator, enables the position of the actuating nut to be seen at any time during its stroke.

7. The actuator is of an off-set construction, that is, the motor and the actuating nut are side-by-side and parallel to one another. The spur gear train and clutch are situated across the ends of the actuating screw and the motor pinion. The limit switches and potentiometer are on opposite sides of the actuating screw and nut.

Housing and covers

8. The actuator housing is in four main sections : the motor, gearbox, gearbox end cover and potentiometer box. Firstly, the motor : this is a detachable self-contained unit and is housed in four light-alloy parts.

9. The armature, field coils, brush gear assembly, and the commutator end bearing are housed in the motor frame. The brake assembly, the driving end bearing, and the armature extension shaft are, however, fitted in the brake housing. The bearing for the extension shaft is housed half in the brake housing and half in the drive end-plate.

10. The drive endplate serves as a location for the motor to the gearbox housing. The end cover, concealing the brush gear and commutator end bearing, is fixed to the motor frame by two small screws ; the cover can be withdrawn completely for inspection of the brush gear.

11. The motor frame, brake housing and drive endplate are fitted with wiring ducts and, when these components are fitted together, a continuous duct is formed through which pass the motor supply leads. The motor frame and brake housing are held together by four studs and nuts, whilst the drive endplate is fastened to the brake housing by those studs and nuts which secure the whole motor unit to the gearbox housing.

12. The second and third items, the gearbox housing and the gearbox end cover, are both light alloy castings. The gearbox contains the dog clutch, the three-stage reduction spur gear train, and the end of the actuating screw and its bearings. The studs for securing the cover are screwed into the side of the housing, the studs for securing the motor unit being screwed into the opposite side of the same housing. A bearing cap, housing the bearing for the first reduction shaft and the spring for the dog clutch, is secured to the end cover by three screws.

13. Cast on the front of the end cover, and in line with the actuating screw, is a fork end, to which is pinned a trunnion block used in mounting the actuator. A wiring trough is cast in the gearbox housing to enable the leads from the motor to be passed through to the limit switches.

14. The last component in the actuator housing is the potentiometer box, which is a magnesium alloy casting and contains the actuating screw, the actuating nut, the limit switch assemblies, and the potentiometer assembly. A felt seal is fitted in the box to prevent the ingress of foreign matter and the egress of oil.

15. The box is divided into two compartments, one for the limit switches and one for the potentiometer, each compartment beaing sealed with a cover. The cover is secured in position with four studs and nuts after final adjustments have been made to the switches and potentiometer. An inspection plate for the potentiometer is held in position on the side of the box by two small screws.

Motor and brake (*fig. 2*)

16. The motor is of two-pole construction, fitted with split series type windings, and rated at 24 volts. There are four field windings, two on each pole piece : one pair is used in retracting the actuating nut, the other pair to extend it. Connected in series with each pair of field coils is a limit switch, adjusted so that, when the actuating nut reaches the end of its stroke, the switch cuts off the supply to the motor. One switch breaks the supply circuit at the end of the retraction stroke, the other at the end of the extension stroke.

17. The yoke and pole pieces, being made up from one set of laminations, are integral with one another. Two brushes are fitted ; they are mounted in brass brush boxes which are in turn mounted on a moulded brush

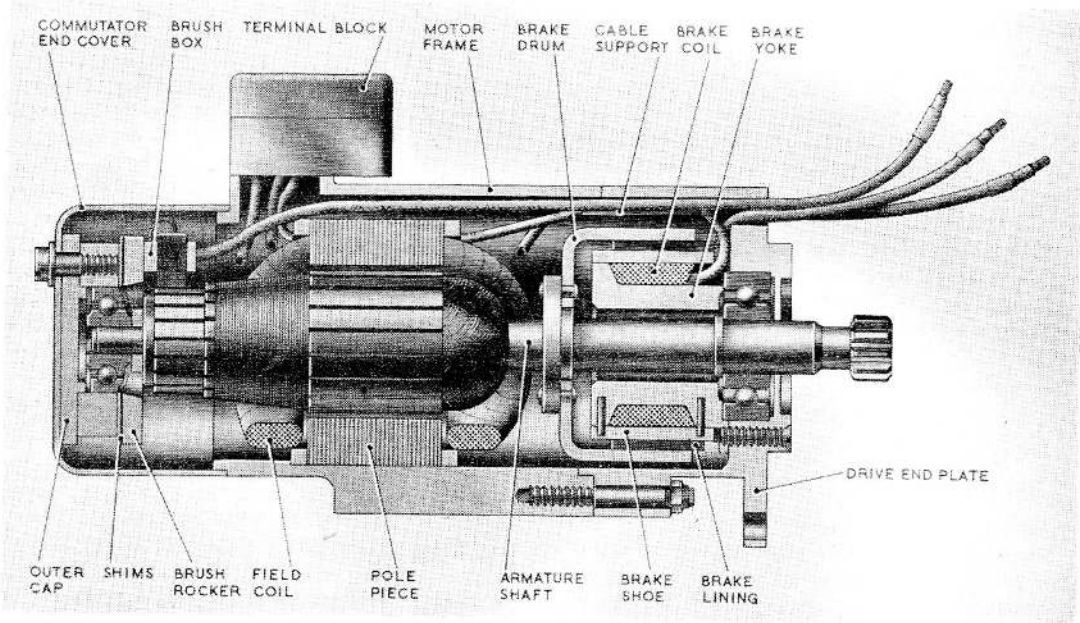

Fig. 2. Sectional drawing of motor

rocker. Pressure between each brush and the commutator is maintained by a flat coiled spring reacting on a brush lever which in turn bears on top of the brush.

18. The armature shaft, to which is fastened the brake drum, is supported at the commutator end by a ball bearing, the other end being also supported by a ball bearing situated in the end of the brake housing.

19. A single coil, connected in series with the armature, is wound round the brake yoke, the yoke being secured to the end of the housing by four screws. Equally spaced around the brake yoke are four brake shoes. Each shoe is fitted with a brake lining and is located by two pins. The pins allow the shoe to ride up and down freely on the yoke. Pressure between each shoe and the inside periphery of the brake drum is maintained by four small helical springs fitted into holes in the brake yoke.

20. A 3-way terminal block is screwed onto a machined facing at the end of the motor frame. The motor leads are run along the wiring duct in the motor frame and the brake housing, emerging through the drive endplate. The leads are prevented from sagging onto the rotating brake drum by a small support which is secured to the inside of the motor housing by two screws.

Gearbox and clutch (*fig. 3*)

21. The gearbox consists of a three-stage reduction spur gear train and is situated across the axes of the motor and the actuating screw. The first reduction pinion is pinned to the motor armature extension shaft. The first reduction wheel and the second reduction pinion are mounted on a shaft which is supported at each end by a ball bearing. One of these bearings is fitted in the gearbox housing, the other being housed in a bearing cap screwed to the end cover.

22. Integral with the first reduction wheel is the female half of the dog clutch, the wheel being a press fit on the shaft. The male half of the clutch is integral with the second reduction pinion and is a sliding fit on the shaft. The pressure required to hold the two halves of the clutch in engagement is provided by a spring situated between the bearing in the bearing cap and the end face of the pinion.

23. The second reduction wheel is made integral with the third reduction pinion, the combined gear being supported at each end by a ball bearing. One bearing is mounted in the gearbox housing and the other in the gearbox end cover. Similarly supported, that is by one ball bearing mounted in the gearbox housing and a second in the end cover, is the actuating screw. The bearing in the gearbox housing is located on the screw between a shoulder, machined on the screw, and the third reduction wheel. The wheel is pinned in position so providing the means of driving the screw ; it is also held axially against the bearing by a nut fitted on the screw. Any tendency to end float in the actuating screw is prevented by the fact that the bearing mounted in the gearbox housing is fixed between a shoulder in that housing and a shoulder in the potentiometer box.

24. By the means described in the foregoing paragraphs, a positive driving medium is established between the motor and the actuating nut. Incorporation of the dog clutch, the setting of which may be altered by adjustment of the clutch spring pressure, ensure that no damage will be done to the actuator in the event of an overload being accidentally applied to the machine.

Actuating nut and screw (*fig. 4*)

25. The actuating nut is driven by the screw through the medium of an acme thread, the nut being threaded internally for approximately one third of its length. At the end of the nut opposite to that which bears the acme thread, a short internal thread is cut, into which is screwed an eye-bolt for use in mounting the actuator. After the eye-bolt has been set, in the course of adjustment of the centres (*para.* 36), it is secured in position by screwing a slotted nut tight against the end of the actuating nut. The slotted nut serves as the retraction stop when it comes into contact with the end of the potentiometer box.

26. At the opposite end of the actuating nut, an abutment is machined integral with the nut. The abutment slides in a slot machined in the potentiometer box, between the limit switch and potentiometer compartments, and prevents the actuating nut from rotating during its extension or retraction. The end of the slot is carefully machined to serve as a mechanical stop against the end of the abutment.

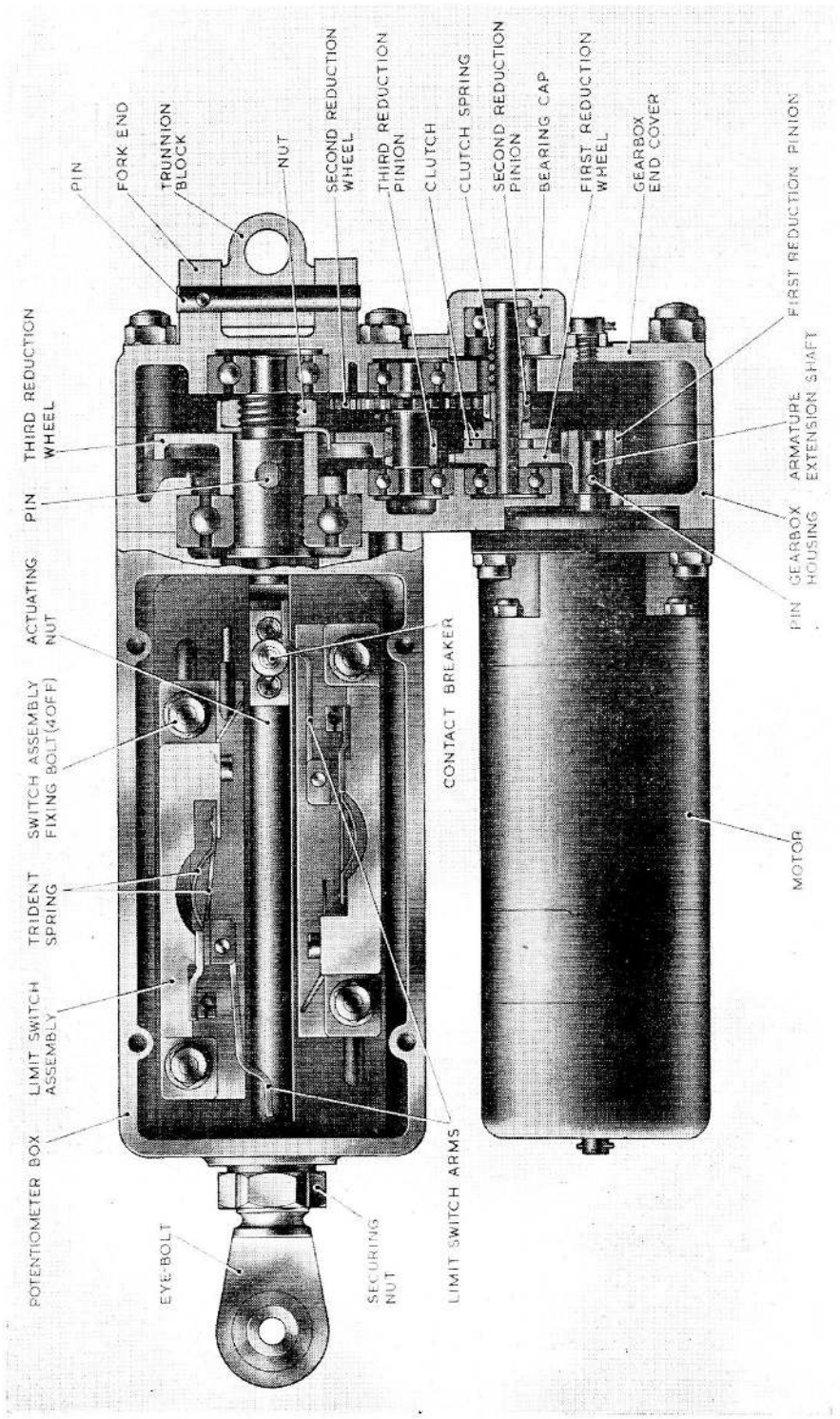

Fig. 3. Sectional drawing of gearbox, showing limit switch arrangement

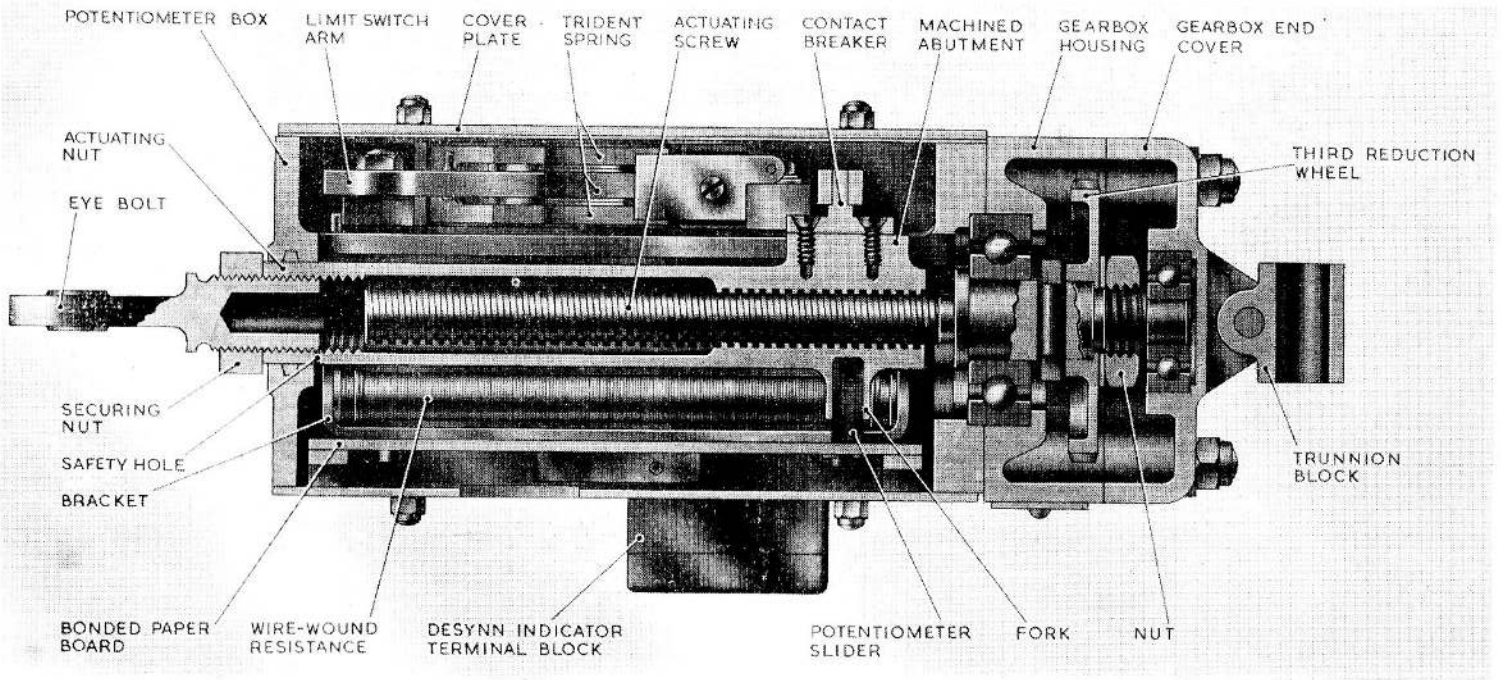

Fig. 4. Sectional drawing of actuating nut and screw mechanism

27. Screwed to the top of the abutment is a contact braker which strikes the switch arm of the limit switches when the actuating nut reaches the end of either its retraction or extension stroke, thus breaking the supply circuit to the motor. Diametrically opposed to the abutment a fork is machined on the nut to carry the potentiometer slider.

Limit switches (*fig. 3 and 4*)

28. The moulded limit switch assemblies are situated in the limit switch compartment of the potentiometer box, one on each side of the machined slot. Each switch assembly is located by two bolts fastened to a clamping plate which is situated on the underside of the base of the switch compartment. Each switch is secured in position by two nuts, the bolt holes in the compartment base being slotted to permit adjustment of the switches. Terminal connections are provided for the leads from the motor.

29. One contact of each switch is manufactured integrally with one of the terminal connections, the other contact being fitted to the centre of one end of a beryllium copper trident spring. The opposite end of the spring is fastened to the other terminal connection and is so arranged that, when unrestrained, the contacts are pressed together.

30. When the switch arm is operated by the contact breaker on the actuating nut, pressure is applied to the central part of the trident spring, causing snap action separation of the contacts and breaking the motor supply circuit. If the actuating nut is allowed to traverse in the opposite direction, the contact breaker moves away from the switch arm and the pressure of the spring returns the arm to the normal position, thereby closing the contacts.

Potentiometer (*fig. 4 and 5*)

31. The potentiometer assembly is mounted in one of the two compartments in the potentiometer box, the other being occupied by the limit switch assemblies. The potentiometer consists of two wire-wound resistances, one on each side of the machined slot in the box.

32. Each resistance is wound on an aluminium former and mounted in a copper U-shaped bracket which is, in turn, mounted on a bonded paper board. The board is riveted to two bonded paper brackets, one at each end of the board, the brackets being screwed to the potentiometer cover plate.

33. Between the board and the cover plate three blocks are screwed; to each block, is secured one of the three connectors for the resistances. The potentiometer slider is made in two halves from a moulded material and is fitted with inserts, contact between the slider and the sides of the two U-shaped brackets, and between the slider and the resistances, being maintained by a spring which fits between the two halves.

34. A 5-way moulded terminal block is screwed to the outside of the cover, the wiring from the underside of the block to the U-shaped brackets and to the three resistance connectors being arranged between the cover plate and the mounting board.

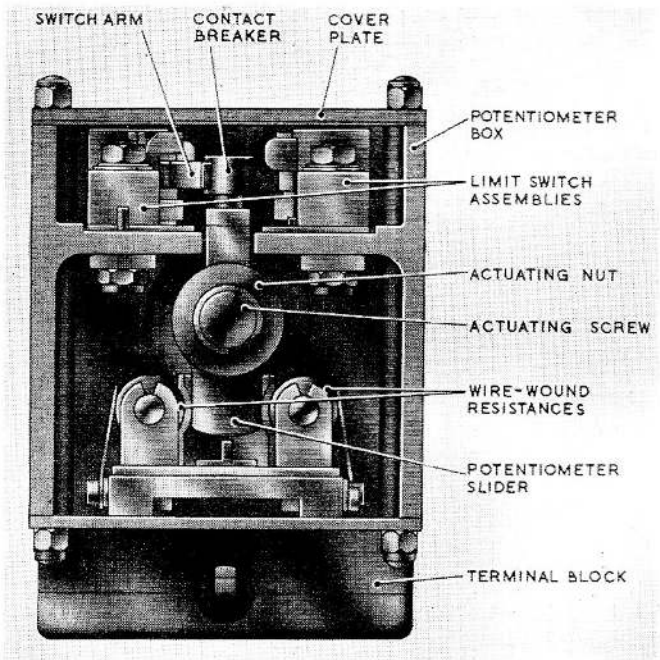

Fig. 5. End view of potentiometer box

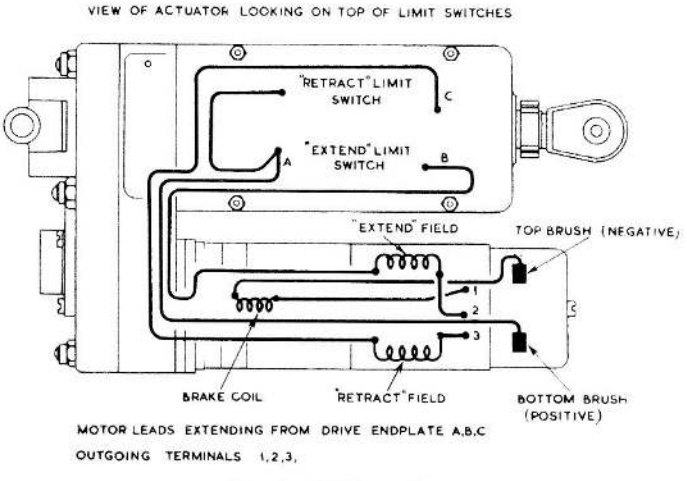

Fig. 6. Wiring diagram

INSTALLATION

35. For details of the installation of this actuator in any particular aircraft, reference should be made to the aircraft handbook dealing with that aircraft. The actuator has two mounting points at which it is secured to the aircraft structure. One is the eye-bolt at the outer end of the actuating nut, the other, at the opposite end of the actuator, is a trunnion block pinned to a fork end which is a part of the gearbox end cover.

Adjustment of centres

36. It is possible, by slackening off the securing nut, to move the eye-bolt, fitted in the actuating nut, in or out as required. Such action permits the distance between the centres of the eye-bolt and the trunnion block to be altered. This in turn increases or decreases the effective length of the actuator.

37. The distance between the centres is normally 7·63 in. when the actuating nut is retracted. The distance is 10·38 in. $\pm \frac{1}{8}$ in. when the actuator is extended. The small adjustment ($\pm \frac{1}{8}$ in.) is obtained by altering the position of the eye-bolt.

38. In adjusting the centres, the actuating nut must be extended until a $\frac{1}{16}$th dia. hole (the safety hole, *fig.* 4) in the actuating nut is visible. Slacken the securing nut on the eye-bolt by rotating it anti-clockwise; screw the nut back to allow free movement of the eye-bolt. The adjustment should now be made by screwing the eye-bolt inwards or outwards as required.

39. Inwards adjustment can be continued until movement of the eye-bolt is no longer possible, by reason of the design. Care must, however, be exercised in making outwards adjustment. It is possible to slacken the eye-bolt to a point at which there is insufficient thread in contact with the actuating nut to carry the loads imposed upon it during normal operation. Accordingly, the following precaution must be observed.

40. After making an adjustment, insert a length of $\frac{1}{16}$th in. dia. wire in the safety hole in the actuating nut. The wire should enter approximately $\frac{1}{16}$ in. only. If the wire can be pushed in to a depth of approximately $\frac{1}{2}$ in., too much outwards adjustment has been made. The eye-bolt must therefore be screwed back. After adjustment is complete, the securing nut must be screwed tight against the end of the actuating nut.

Actuator wiring

41. A practical wiring diagram, showing the wiring and terminal arrangement, appears in fig. 6. The motor terminals, numbered 1, 2 and 3, correspond to COMMON, EXTEND, and RETRACT, respectively, on this illustration.

42. The connections for the Desynn indicator circuit are made by the five cores of a Quinvin 4 cable. The cable is connected to the potentiometer box terminal block as follows :—

T.B. terminal No.	*Cable goes to*
1	Negative
2	Positive
3	Terminal 1 on indicator
4	Terminal 2 on indicator
5	Terminal 3 on indicator

It should be noted that the Desynn indicator pointer should move in an anti-clockwise direction when the actuator is extended.

Adjustment of limit switches

43. To gain access to the switches, remove the four nuts securing the potentiometer box cover plate, and lift off the plate. The potentiometer cover, upon which the terminal block is mounted, must not be

removed. Slacken the two nuts securing each switch assembly. The switches may now be adjusted to give the required stroke, a peg being fitted in the potentiometer box, behind each switch, to prevent adjustment of the switch beyond its maximum setting. It is in turn impossible to increase the stroke of the actuator beyond its safe maximum.

44. After adjustment, the switches should be secured in their new position by tightening the fixing nuts. A thin layer of sealing compound should be applied to the outer edges of the cover, which should be replaced with the compound still wet. Finally, refit the four securing nuts.

OPERATION

45. In the following text, it is assumed that the actuator is fully retracted. In consequence, the "retract" limit switch is open and the "extend" limit switch is closed.

46. When the supply is switched on, through the "extend" limit switch, the relevant pair of motor field coils and the brake coil, which is in series with the armature, will be energized. The brake shoes will be pulled on to the brake yoke, so releasing the pressure on the brake drum and allowing the armature to rotate.

47. As the first reduction pinion is integral with the armature shaft, the three-stage reduction spur gear train will rotate and turn the actuating screw. The screw will in turn extend the actuating nut.

48. As soon as the actuating nut moves away from the "retracted" position, the "retract" limit switch will close. When the supply to the motor is switched off by some external means within the setting of the limit switches, or by the actuating nut reaching the fully extended position and operating the "extend" limit switch, the field coils and the brake coil will be de-energized. Consequently the brake shoes and linings will be forced outwards against the brake drum by the action of the brake springs. The motor and the actuating nut will therefore be brought to rest.

49. As already explained (*para.* 26), in the event of limit switch failure, the actuator will be brought to rest automatically by the action of mechanical stops.

SERVICING

Brush gear

50. Access to the brushes is gained by removing the locking wire and two small screws which secure the motor end cover and by detaching the cover. The brushes should be a free fit in the brush boxes. If binding is encountered, the brush and brush box should be wiped clean, any accumulation of carbon dust being carefully removed.

51. Worn brushes should be renewed before their maximum wear limit is reached, so ensuring that the actuator will operate satisfactorily until the next inspection. The minimum permissible length of each brush is 0·175 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.

52. The brush spring tension should be checked with a suitable spring balance and should be between 4 and 5 oz. The balance should be hooked beneath the brush lever at the point where it bears on the brush. The reading should be taken when the balance is lifted, in a direction parallel to the centre-line of the brush, just clear of the brush.