Chapter 20

ACTUATOR, ENGLISH ELECTRIC, TYPE 258

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LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Actuator, Type 258	Stores Ref. 5W/55
Length	8·1 in. (approx.)
Normal working travel of actuating screw	2·75 in.
Maximum length of travel of actuating screw	3·00 in
Time to complete maximum travel	10 sec.
Total weight	3·75 lb.
Brush grade	E.G.O. (HAM)
Minimum brush length	0·175 in.
Brush spring pressure	4 to 5 oz.
Voltage	24 d.c.
Motor speed	11,000 r.p.m.
Normal working load	450 lb.

Introduction

1. Linear actuator, Type 258, operates the rudder trim tab on aircraft ; it will operate the tab in both directions up to an emergency load on the actuator of 600 lb.

2. The actuator consists of a 2-pole, split series field, 24-volt d.c. motor driving an actuating nut through the medium of a dog clutch and three-stage reduction spur gear train. The third reduction gear wheel rotates a steel screw which in turn drives the actuating nut.

3. Snap-action limit switches switch off the motor supply current when the actuating nut reaches its extreme positions of travel. In the event of their failure, the actuating nut is brought to a standstill by coming into contact with a mechanical stop.

4. The purpose of the clutch is to prevent damage to the motor and gears in the event of accidental overloads and in the event of failure of the limit switches, when the actuating nut would run onto the mechanical stops.

5. Incorporated in the motor is a 4-pole electro-magnetic brake which stops the motor when the supply is switched off by the action of one of the limit switches, or at any intermediate point of travel of the actuating nut.

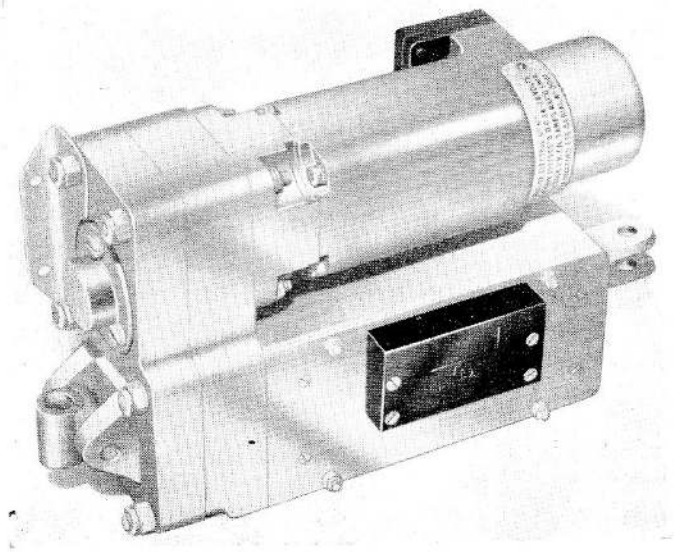


Fig. 1. General view of actuator

6. A linear potentiometer is fitted. When connected to the supply and to a Desynn indicator, the potentiometer permits the position of the actuating nut at any part of its stroke to be indicated.

7. The actuator is of off-set construction, i.e., the motor and the actuating nut are side by side and parallel to each other. 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 located on opposite sides of the actuating screw and nut.

DESCRIPTION

Housings and covers

8. The housings are in four main sections, the motor, gearbox, gearbox end cover, and potentiometer box.

Motor

9. The motor is a detachable, self-contained unit and is housed in four light alloy parts. The armature, field coils, brush gear assembly, commutator end bearing and motor supply terminal block are housed in the motor frame. The brake assembly, the armature drive end bearing, and the armature extension shaft are housed in the brake housing, the bearing for the extension shaft being located half in the brake housing and half in the drive endplate. The drive endplate serves as a location for the motor to the gearbox housing.

10. 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 to enable the brushes to be inspected. The motor frame, brake housing and drive end plate are provided with wiring ducts and, when these components are secured together, a continuous duct is formed through which the leads pass. The motor frame and brake housing are held together by four studs and nuts, whilst the drive endplate is fastened to the brake housing also by four studs and nuts which serve also to secure the whole motor unit to the gearbox housing.

Gearbox

11. The gearbox housing and

gearbox end cover are both castings of aluminium alloy; they contain the dog clutch, the three-stage reduction spur gear train, and the end of the actuating screw and its bearings. Studs for securing the cover to the housing are screwed into one side of the housing, the studs for securing the motor unit being screwed into the other side. An aluminium alloy 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. 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 for mounting the actuator. A wiring trough is cast in the gearbox housing so that the leads from the motor may be passed to the limit switches. An L-shaped bracket which acts as a cable cleat, is secured to the gearbox end cover with two of the nuts which fasten together the two castings.

Potentiometer box

12. The potentiometer box is a casting of magnesium alloy and contains the actuating screw, the actuating nut, the limit switch assemblies and the potentiometer assembly.

13. A felt seal is fitted in the box to prevent the ingress of foreign matter and the egress of oil. The box is divided into two compartments. One of these is for the limit switches, the other for the potentiometer. Each compartment is sealed with a cover and is secured in position by four studs and nuts after the switches and potentiometer have been adjusted by the manufacturers. An inspection plate for the potentiometer is held in position on the side of the box by two small screws.

Motor and brake

14. The motor is of 24-volt, 2-pole, split series field design. Two opposite fields are used to extend the actuating nut and the remaining two to retract it. Connected in series with each pair of fields is a limit switch. These switches are so adjusted that when the nut reaches the end of either its retraction or extension stroke, one of the switches operates and breaks the motor supply circuit.

15. The yoke and pole pieces are made of one set of laminations, the poles thus being integral with the yoke. Two brushes are fitted. They are mounted in brass brush boxes which are, in turn, mounted on a moulded brush rocker. Pressure on each brush is maintained by a flat, coiled spring which reacts on a brush lever which in turn bears on the top of the brush.

16. The armature is supported at the commutator end by a ball bearing; the opposite end of the armature is also supported by a ball bearing which is located halfway along the brake housing. A coil, connected in series with the armature, is wound on the brake yoke, the yoke being secured to the drive endplate by four screws. Equally spaced around the brake yoke are four brake shoes. Each shoe has a brake lining, located by two pins, which allow the shoes 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 helical springs fitted in holes in the brake yoke.

17. A flanged adapter, to which is screwed a cone clutch drum, is pinned to the end of the armature shaft. The brake drum and cone clutch disc are riveted to the armature extension shaft which is supported at one end by a ball bearing situated half in the end of the brake housing, and half in the drive endplate. The other end of the extension shaft is a sliding fit over the end of the flanged adapter. Pressure between the clutch disc and the clutch drum is maintained by a helical spring, situated between the drive end bearing and a shoulder on the extension shaft. The cone clutch is set at a higher value than that of the clutch in the gearbox and will protect the motor against damage due to accidental overloads of relatively short duration.

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

Gearbox and clutch

19. 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

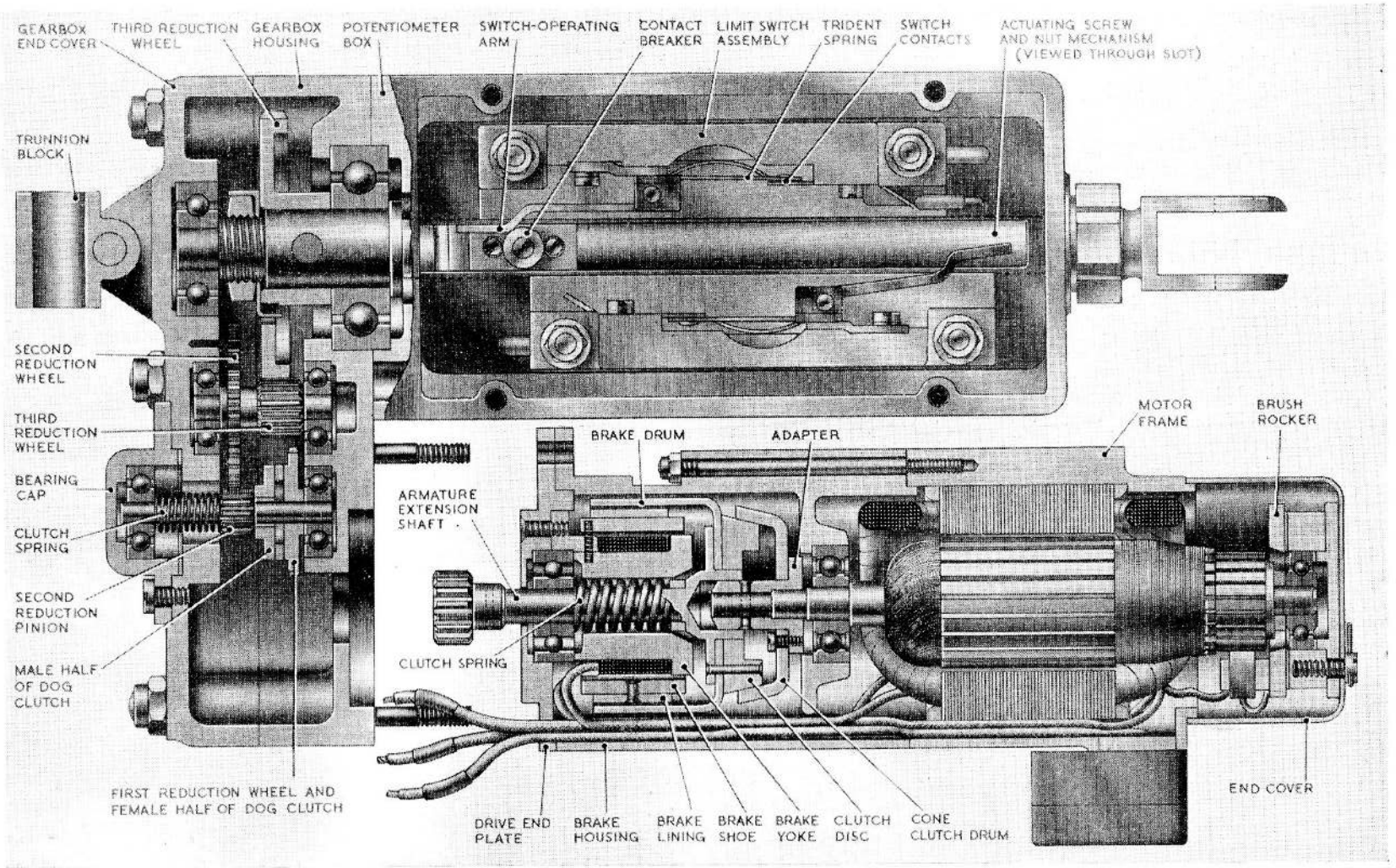


Fig. 2. Sectional view of actuator, showing motor detached

to the motor armature extension shaft. The first reduction wheel and the second reduction pinion are mounted on a shaft supported at each end by a ball bearing. One of these bearings is housed in the gearbox housing and the other in the bearing cap screwed to the end cover. 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 dog clutch is integral with the second reduction pinion and is a sliding fit on the shaft.

20. 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. The second reduction wheel is 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.

21. The actuating screw is supported by two ball bearings one of which is mounted in the gearbox housing and the other in the gearbox end cover. The bearing in the gearbox housing is located between a shoulder on the screw and the third reduction gear. The wheel is pinned in position on the screw so providing a positive drive; it is held axially against the bearing by a nut on the actuating screw.

22. By the means described a driving medium is established between the motor and the actuating nut, the clutch being designed to slip at loads in excess of those at which it is set by the spring pressure.

Actuating nut and screw

23. The screw drives the actuating nut through the medium of an Acme screw thread, the nut being threaded for approximately one-third of its length. At the end of the nut opposite to the Acme-threaded portion, a short internal thread is cut. Into this thread is screwed a fork end which serves as a mounting for the actuator. After the fork end has been adjusted, it is secured by screwing a slotted nut tight against the end of the actuating nut. The nut acts as a retraction stop against the end of the potentiometer box.

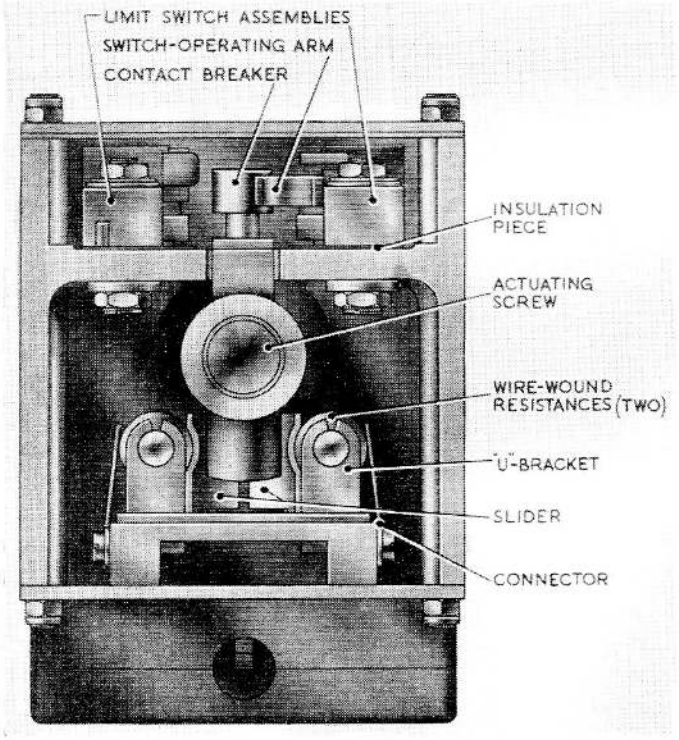


Fig. 3. Sectional view of potentiometer box

24. At the opposite end of the actuating nut, an abutment is machined integral with the nut. The abutment slides in a slot in the potentiometer box, between the limit switch and potentiometer compartments, and prevents the nut rotating during its extension or retraction. The end of the slot is carefully machined to fine limits to serve as the extension stop against the end of the abutment. Screwed to the top of the abutment is a contact breaker which strikes the switch arm of the limit switches when the actuating nut reaches the end of its travel in either direction. The motor supply circuit is thereby broken.

Limit switches

25. 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 fastened to a clamping plate by two bolts. The plate is situated on the underside of the base of the switch compartment. Each switch is secured by two nuts, the bolt holes in the compartment base being slotted to provide adjustment for the switches (*para.* 44).

26. Terminal connections are provided for the leads to the motor. One contact is integral with one end of the terminal connections, the other contact being fixed to the centre of one end of a trident spring. The opposite end of the spring is fastened to the other terminal connection and is arranged so that, when it is unrestrained, the contacts are pressed together. 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, the contacts are smartly separated and the circuit broken. If the actuating nut is now allowed to traverse in the opposite direction, the contact breaker will move away from the switch arm. Pressure of the spring will then return the arm to its normal position, the contacts once more being together.

Potentiometer

27. The potentiometer assembly, which is situated in a compartment of the potentiometer box, consists of two wire wound resistances. One of these is located on each side of the machined slot in the box. Each resistance is wound on a former and mounted in a copper, U-shaped bracket, which in turn is mounted on a bonded paper board. The board is riveted to two brackets, one at each end of the board, that are screwed to the potentiometer cover plate. Between the board and the cover plate three blocks are screwed. To these blocks are fastened the three copper connectors for the resistances.

28. 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 U-shaped brackets, and between the slider and the resistances is maintained by a spring fitted between the two halves.

29. A 5-way moulded terminal block (*para.* 31) 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 passes between the cover plate and the mounting board.

INSTALLATION

30. Cast on the outside of the end cover, and in line with the actuating screw, is a fork end, to which is pinned a trunnion block that is used in mounting the actuator in the aircraft. At the opposite end of the actuating screw assembly is a fork end-piece, screwed into the internally-threaded actuating nut; this fork end engages with the equipment operated by the actuator.

31. The internal wiring of the actuator is shown in fig. 4. Two terminal blocks are fitted. One, a 3-way unit, mounted on the motor frame, is for the motor supply leads. The second, a 5-way unit, located on the potentiometer box, is intended to be used in conjunction with a Desynn indicator. The terminal markings and appropriate connections are as follows:—

Terminal	Lead from
1	Negative
2	Positive
3	Terminal 1 on Desynn indicator
4	Terminal 2 on Desynn indicator
5	Terminal 3 on Desynn indicator

Adjustment of centres and limit switches

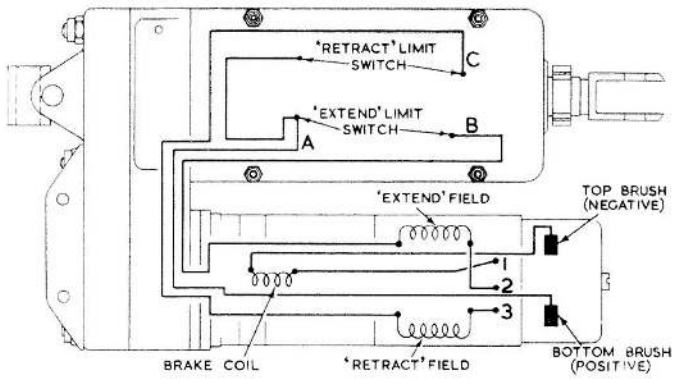
32. During installation it may be necessary to adjust the distance between the centres of the ends of the actuator. Information concerning this operation appears in para. 47. Instructions on the adjustment of limit switches is given in para. 44.

OPERATION

33. If it is assumed that the actuator has operated so as to fully retract the actuating nut, the "retract" limit switch is open and the "extend" limit switch is closed. If the current to the motor is now switched on through the "extend" limit switch, the two relevant field coils and the brake coil, which is in series with the motor armature, will be energized.

34. The brake shoes are now pulled on to the brake yoke, this releasing the pressure on the brake drum, and the armature rotates. As the first reduction pinion is integral with the armature shaft, the three-stage reduction spur gear train rotates so turning the actuating screw and extending the actuating nut.

VIEW OF ACTUATOR LOOKING ON TOP OF LIMIT SWITCHES



MOTOR LEADS EXTENDING FROM DRIVE ENDPLATE — A,B AND C
OUTGOING TERMINAL CONNECTIONS— 1, 2 AND 3.

Internal wiring diagram

35. As soon as the actuating nut moves away from the retracted position, the "retract" limit switch closes. When the current to the motor is switched off (within the setting of the limit switches) by some external means, or when the actuating nut reaches the fully extended position and operates the "extend" limit switch, the relevant field coils and brake coil are de-energized.

36. The four springs under each of the four brake shoes force the shoes against the inside periphery of the brake drum so bringing the motor, and consequently the actuating nut, to rest.

37. The actuating nut can now be reversed and thus retracted by completing the motor circuit through the "retract" limit switch. The actuator will then operate in a manner similar to that described in the foregoing paragraphs, but in the opposite direction.

SERVICING

38. The actuator is to be inspected and serviced in accordance with, and at the times laid down in, the appropriate Servicing Schedule.

Brush gear

39. Remove the locking wire and the two small screws that secure the motor end cover. Detach the cover. The brushes should now be inspected to ensure that they are a free fit in the brush boxes. Where binding brushes are encountered, the brush and brush box should be thoroughly cleaned, and any accumulation of carbon dust blown out with dry compressed air.

40. Worn brushes should be replaced with new before the maximum wear limit is reached. The minimum permissible length of each brush is 0·175 in. If brush renewal is necessary, only brushes of grade E.G.O. (HAM) must be used; they must be bedded down to the contour of the commutator to give a contact service of at least 80 per cent. of their cross sectional area.

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

Lubrication

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

Potentiometer

43. During routine inspections on no account should the potentiometer cover be removed and the potentiometer interfered with. The instrument is correctly adjusted by the manufacturers and if the settings are altered they cannot be re-obtained whilst the actuator is installed in the aircraft.

Adjustment of limit switches

44. To adjust the limit switches, the four nuts securing the switch cover should first be removed. Next, detach the cover (this cover must not be confused with the potentiometer cover, to which is attached the terminal block; this cover is not to be removed). Slacken the two nuts securing

each switch assembly. It is now possible to adjust the switches to give the required stroke.

45. A peg is fitted in the potentiometer box behind each switch to prevent the switches being adjusted beyond their maximum setting and so increasing the stroke of the actuator beyond its maximum.

46. After adjustment, the switches should be secured in their new position by tightening the nuts that hold the assemblies. A thin layer of sealing compound should be applied to the outer edges of the switch cover, which should then be re-fitted whilst the compound is till wet. Secure the cover using the four nuts previously removed.

Adjustment of centres

47. To adjust the distance between the centres of the ends of the actuator, the actuating nut should be extended until a $\frac{1}{16}$ in. dia. hole in the actuating nut is visible. The locking nut securing the fork end should then be slackened by being rotated in an anti-clockwise direction. Next, screw back the nut until the fork end can be moved freely. Adjust the distance between the centres by screwing the fork end either inwards or outwards, as required. Inwards adjustment is limited by the nature of the actuator design, it being impossible to turn the fork end beyond a certain point. Outwards adjustment, however, is not limited by any such feature. Consequently, considerable care must be taken. After making the adjustment, insert a length of $\frac{1}{16}$ in. dia. wire into the hole in the actuating nut. The wire should enter approximately $\frac{1}{16}$ in. only. If the wire can be inserted to a depth of nearly $\frac{1}{2}$ in., too much outwards adjustment has been made, and the fork end must be screwed back.

48. If this is not done, the fork end will be insufficiently strong and may fail on load. After adjustment, the fork end must be screwed back until it is firm against the end of the actuating nut.

49. The distance between the centre of the hole in the trunnion block and that in the fork end (*fig.* 2), with the actuating screw retracted against the mechanical stop, should be 7·425 in. The distance between the same centres, when the actuating screw has been stopped by limit switch action and is in the retracted position, should be 7·55 in. In this condition there is a working adjustment of $\pm \frac{1}{8}$ in. on the figure quoted.

50. Other relevant details are as follows. The normal working stroke of the actuator between its retracted and extended positions is 2·75 in. This figure is based on the normal limits witch settings ; the distance may, however, be adjusted to 2·125 in. The actual stroke distance between the mechanical stops is 3·0 in., and the time taken for this full stroke should be 10 seconds.

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