

Chapter 38

ACTUATOR, B.T.H., TYPE EA2

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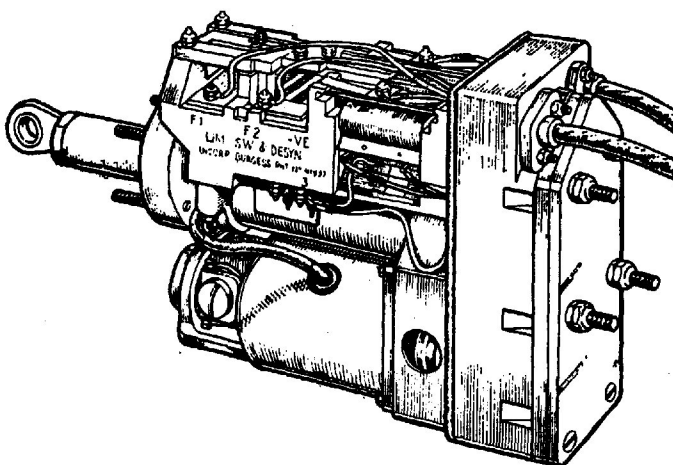


Fig. 1. Actuator, Type EA2, with cover and stop nut removed

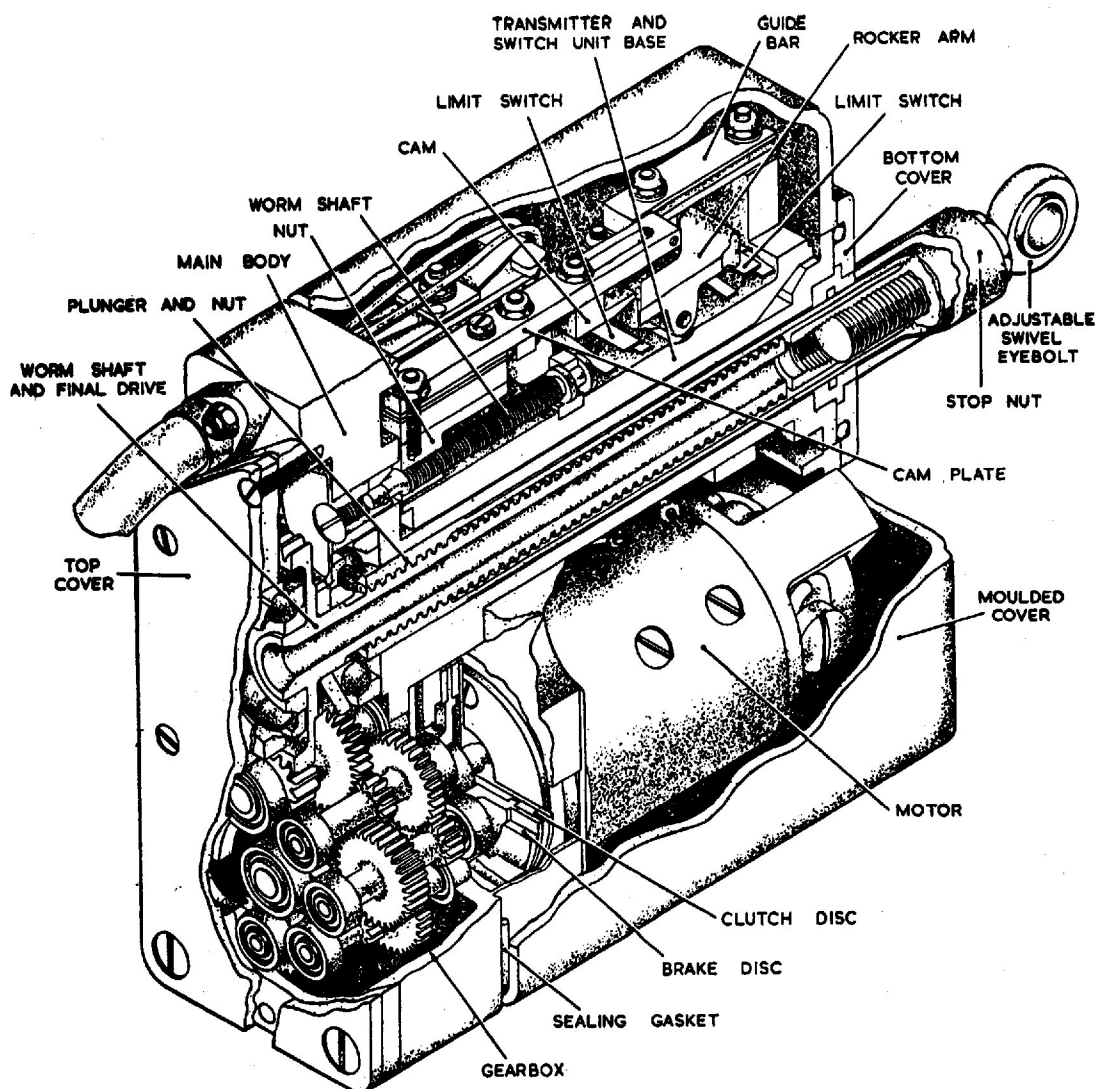


Fig. 2. Sectional view of actuator

Introduction

1. The actuator, Type EA2, incorporates a 24-volt split-series d.c. motor, Type LD0704, Form 5, which drives the operating plunger through a spur gear train. A brake and overload clutch are fitted, and a Desynn transmitter unit gives remote indication of plunger travel throughout the whole range; the extent of the plunger stroke is controlled by limit switches.

DISMANTLING

2. Unscrew the swivel eyebolt, and the stop nut on the main nut, or operating plunger. Remove the four 2 B.A. hex. nuts securing

the bottom cover. The bottom cover complete with gasket can now be withdrawn from the main nut, and the moulded cover and its sealing gasket removed.

3. Disconnect the leads at the terminals of the transmitter/limit switch unit; the motor leads are also disconnected at these terminals. Ensure that all leads are correctly marked for identification before removal. The transmitter/limit switch unit cannot be removed until the motor has been dismantled.

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4. Remove the four 6 B.A. screws securing the motor to the actuator body. Carefully withdraw the motor, complete with clutch plate, from the housing.

5. The clutch friction washer, clutch plate, brake friction washer, brake plate, three brake springs and clutch spring are now accessible, and can be withdrawn from the housing in that order. The clutch spring is located in the hollow centre of the motor extension shaft. Beneath it are a number of packing discs, used to vary clutch spring compression, which should be removed and retained.

6. The motor extension shaft can now be extracted from its bearing, as it is a push fit in the inner race. The slip clutch plate, which is keyed to the motor shaft, can also be removed.

7. Undo the two 6 B.A. nuts securing the clamping plate of the transmitter/limit switch unit to the actuator body. Remove the clamping plate and ease out the transmitter/limit switch assembly from its doweled position. It will be found that if the unit is lifted slightly in relation to the actuator body, it will slide clear. Care should be taken during removal, as the transmitter drive pin engages in a special slot drive to the gear assembly. Detach and remove the complete transmitter/limit switch unit.

8. The cable assemblies can now be withdrawn, by removing the 6 B.A. lock-nuts on each cable gland where cables pass through the actuator body, and easing out cable glands, rubber grommets and cables complete. The internal cover plate can be extracted from the actuator body by unscrewing the small brake peg, and the three 6 B.A. csk/hd. screws. The felt washer under the cover plate can now be removed.

9. To dismantle the gearbox of the actuator, unscrew the four 2 B.A. nuts securing the top fixing bracket and remove the three csk/hd. screws holding the top cover; this can now be removed. Remove the shims giving 0.002 in. to 0.004 in. clearance between the bearing plate and top cover; these shims are located over the end of the main gear outer bearing.

10. The bearing plate can be removed, giving access to the gear train, which can be carefully extracted gear by gear.

Note . . .

The bearing plate should be checked to ensure that it is marked similarly to the actuator body. These are matched components and are machined to fit; they should not be separated.

11. When removing the plate, it will be found that the bearings of the gear assemblies can be pressed inwards, leaving the gears and bearings intact. All the bearings are a good press fit into their respective recesses in the bearing plate. Extract the gears in sequence, so that their positions are identified.

Note . . .

The gear ratio differs between various forms of actuator, as listed in A.P.4343D, Vol. 1, Sect. 14, Chap. 38; the actuator illustrated in this chapter is Form 3.

12. The inner and outer ball races, balls, and outer ball race locating plate on top of the main gear can now be removed.

13. Carefully unscrew the main screw gear to its limit, and lift out the screw gear and main nut, so that the transmitter gear wheel can be removed. The main screw gear and nut can now be separated, and the inner ball race, balls and locating plate can be withdrawn.

14. Extract the gland ring in the end of the actuator body by reversing the main nut and pushing out the gland ring.

Note . . .

It is important to ensure that there are no burrs on the phosphor-bronze attachment of the main nut.

Motor, Type LD0704, Form 5

15. Undo the three 6 B.A. csk/hd. screws and remove the commutator end bearing cover. Unscrew the two brush caps, and carefully remove the small spring-loaded brushes. Holding the driving end of the armature shaft in a suitable clamp, undo the armature spindle nut in the recess at the commutator end bearing. The driving end bearing cover can be removed by undoing the three csk/hd. screws. Using a small hide-faced mallet, lightly tap off the driving end casting from the motor yoke assembly. The armature can now be extracted by using a suitable small drift at the commutator end of the armature shaft.

16. The commutator end bearing and driving end bearing can be removed from their

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respective housings by using a suitable small drift. They are a push fit in the alloy housing.

17. The yoke and field coil assemblies should not be dismantled, since special jigs are necessary for assembly.

Transmitter/limit switch assembly

18. Remove the two terminal insulation barriers by unscrewing the five 6 B.A. nuts on the base of the unit. Undo the two 6 B.A. csk/hd. screws in the base, and release the operating bearing assembly.

19. Remove the two fixed contacts by lifting out the leaf springs and extracting the silver contact plates from the moulding recesses. The operating screw, complete with leaf contact springs, adjusting screws and cams, can now be lifted out.

20. Undo the four 8 B.A. csk/hd. screws in the base of the moulding securing the two bobbin rheostats of the Desynn transmitter, and withdraw the two coil assemblies. Remove the clamp bars and insulation holding in the contact leaves by undoing the four 8 B.A. screws. The Durawire (grade S.10) can now be withdrawn.

Note . . .

It is important to check the relative positions of these wires and their associated connections.

21. The two side bars of the operating screw can now be removed by unscrewing the four 6 B.A. attachment screws. These guide bars are handed and cannot be fitted incorrectly. Remove the two 6 B.A. nuts securing the limit switch contacts. Care should be taken in their removal, since when they are released, they will be forced upwards and outwards by the pressure of the main trident springs. The small tags on each of the limit switch contacts hold in the end insulating pieces to the spindle of the moulded Bakelite rocker arm. Having removed these contacts, drive out the spindle and the two end insulating pieces of the rocker arm. Remove the rocker arm.

22. Undo the two 6 B.A. nuts and carefully remove the anchor plates and trident contact springs.

INSPECTION AND REPAIR

23. All components should be inspected for electrical and mechanical faults in accordance with the instructions given in A.P.4343,

Vol. 6, Sect. 17, Chap. 2, and any repair which is possible and practicable should be carried out. Any components beyond repair must be renewed, reference being made to A.P.1086 for a list of spare parts. In addition, the following points should be noted.

Motor, Type LD0704, Form 5

24. The minimum diameter beyond which the commutator must not be skimmed is 11.25 mm. Check the commutator end bearing housing for wear; the bore must not exceed 0.5 in dia.

25. Check that the bearing liner is secure in the casting, and also that its bore is not worn in excess of 0.7498 in. dia.

Transmitter/limit switch unit and cable assembly

26. Check that all soldered cable connections and cable insulation are undamaged and in good condition. Special attention should be paid to the insulation of the cable cores at the cable gland entry through the housing. The cable identifications should be clean and easily read.

27. Check the two rheostat bobbins for signs of discoloration or overheating, and test each resistance bobbin for continuity. The resistance should be approximately 1,000 ohms each. Should it be necessary to change a rheostat bobbin, ensure that the insulating varnish is cleaned off at the correct line of travel of the wiper contact unit.

28. Inspect the wiper arm contact assemblies, leaf springs, and fixed contacts for signs of wear or fatigue.

29. Reject and renew any contacts showing signs of pitting or burning. Check the engaging pin in the end of the transmitter drive shaft, and ensure it is not bent out of correct alignment, or damaged. If the pin is found to be distorted, it is an indication that the actuator has been overrun, and a careful check should be made of the limit switch positions when testing after assembly.

Gear assembly

30. Check the freedom of the main screw gear in the main nut; these parts must be renewed if end play between them exceeds 0.020 in.

31. Insert the main nut in the actuator body, and ensure the nut moves freely.

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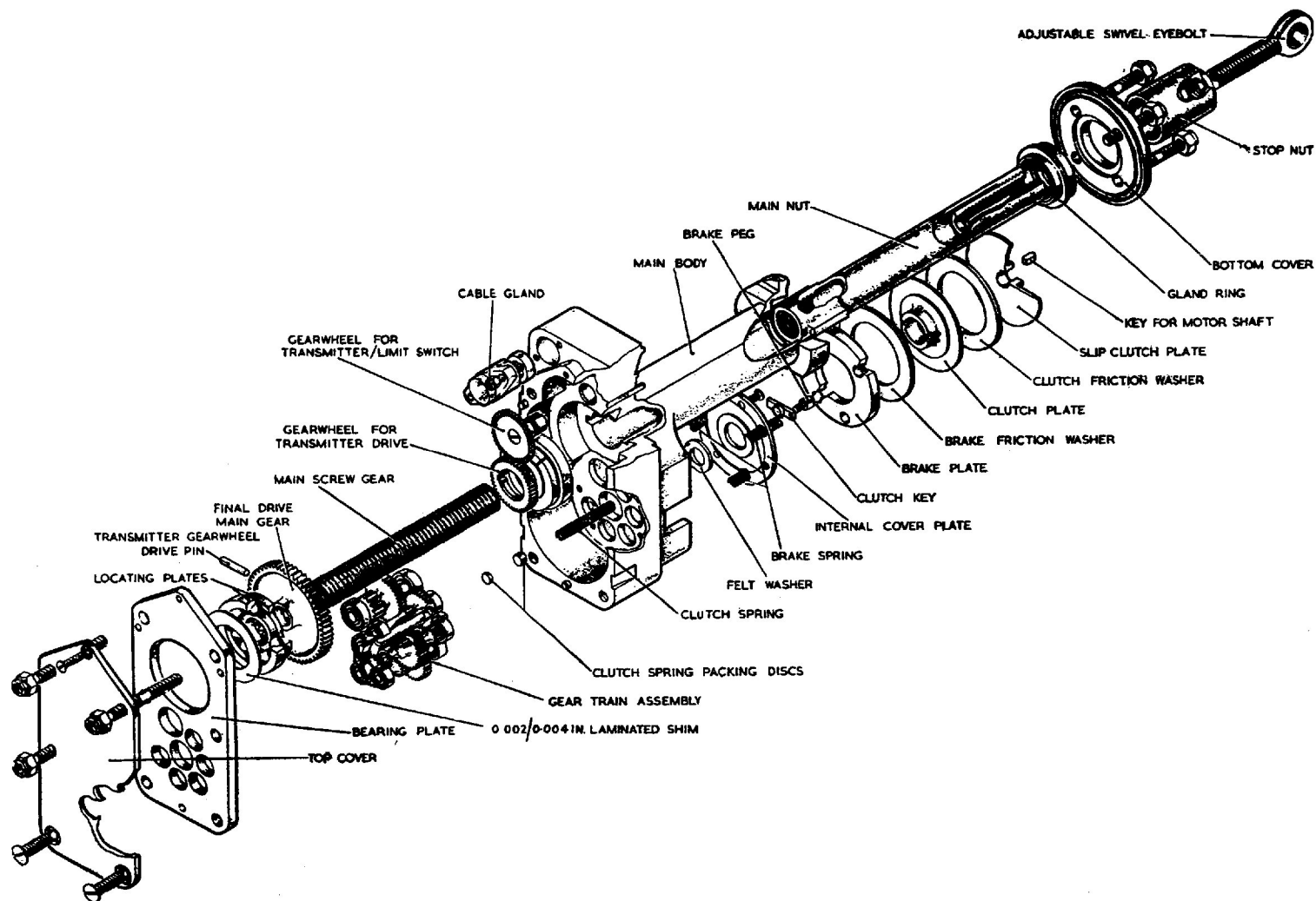


Fig. 3. Exploded view of screw shaft, gearing, brake and clutch assemblies

Check for any burrs on the phosphor-bronze attachment of the main nut, and carefully remove as necessary with a fine file. Ensure that the main nut is a tight slide fit in the actuator body. Inspect the gland ring packing, and renew the packing grommet if it is hard or worn.

32. Should there be signs of excessive wear on either inner race of the main screw gear, or to the transmitter drive gear wheel on the screw gear, it is recommended that the complete assembly be renewed. This is necessary because of the method of fitting the inner races and transmitter drive gear wheel to the screw gear shaft.

Transmitter drive

33. The transmitter/limit switch unit is driven by a gear wheel rotated by a gear attached to the shaft of the main screw gear. Examine the latter and ensure that the slotted drive attachment engaging with the shaft pin of the transmitter unit is not damaged or distorted.

34. The slotted drive has four slots, the shaft pin engaging with either pair of slots. Check that there is no backlash when the transmitter shaft pin engages with either set of slots. The shaft pin does not need to reach the base of the slots; approximately half way is adequate. The centre of the transmitter driven wheel is filled with a 4 B.A. csk/hd. screw; this need not be removed.

Clutch, brake, and motor extension shaft

35. Examine the clutch and brake friction washers for wear or signs of grease, and renew as necessary. Check the clutch and brake friction washers for wear; they should be approximately $\frac{1}{8}$ in. thick. The clutch plate locking pin across the centre bore should be a good fit on the motor extension shaft; no backlash is permissible. This fit should be checked if the motor extension shaft or slip clutch plate have to be renewed.

36. Check the three brake springs for condition, and the clutch compression spring which engages in the hollow centre of the motor extension shaft.

Notes . . .

The small spacers which are placed under the spring with the extension shaft should be carefully retained, and the correct number

replaced when assembling, to ensure that the clutch spring compression remains unaltered. The numbers may vary from one to three according to the requirements of the individual actuator.

37. Inspect the felt washer which fits over the motor extension shaft, and renew if saturated with grease.

General assembly

38. Examine the main cover gasket for condition, and renew if it is a loose fit around the actuator flange plate. The gasket will be cemented into position on the main body during the final assembly procedure, after testing.

39. Check the swivel eyebolt and stop nut for condition.

ASSEMBLY

40. All components should be thoroughly clean before they are assembled. During assembly, reference should also be made to para. 75 to 81, since much of the testing is done as the items are assembled.

Gearing and screw gear

41. Fit the locating plates to both inner races on the main screw gear; they are split for ease of assembly.

42. Place the main nut in the actuator body. Place the outer race in the actuator housing and apply a coating of grease XG-275 (Stores Ref. 34B/222) to the race. Now place the twelve $\frac{3}{8}$ in. dia. balls in the grease around the race, and carefully screw in the screw gear into the main nut, ensuring that the balls stay in position. Before reaching the fully screwed-in position, grease and insert the transmitter driven gear wheel into its position in the actuator housing. Screw in the screw gear fully into the main nut.

43. Pack one quarter of the available space in the gearing ball races with grease XG-275. Slowly rotate each bearing and replace any grease which exudes. Fit the correct ball races to each of the gear assemblies, having previously checked that each ball race is an accurate push fit into its respective recess in the actuator body. Lightly grease the gears and place them in their correct positions. Do NOT force these gears into position at this stage of assembly, or

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difficulty will be experienced when meshing the gears. With all gears in position, gently press home the complete gear train, so that the bearings enter their recesses in the housing and the gears mesh correctly.

Note . . .

No force must be used during this operation

44. Check that the gear ball races have not

been pressed too far into the housing. Fit the inner race and locating plate of the outer ball race to the main screw gear, and apply a coating of grease XG-275. Place the twelve $\frac{7}{8}$ in. dia. balls in the grease around the locating plate.

45. Pack one quarter of the ball race to the motor extension shaft with grease XG-275 and insert the ball race in the centre

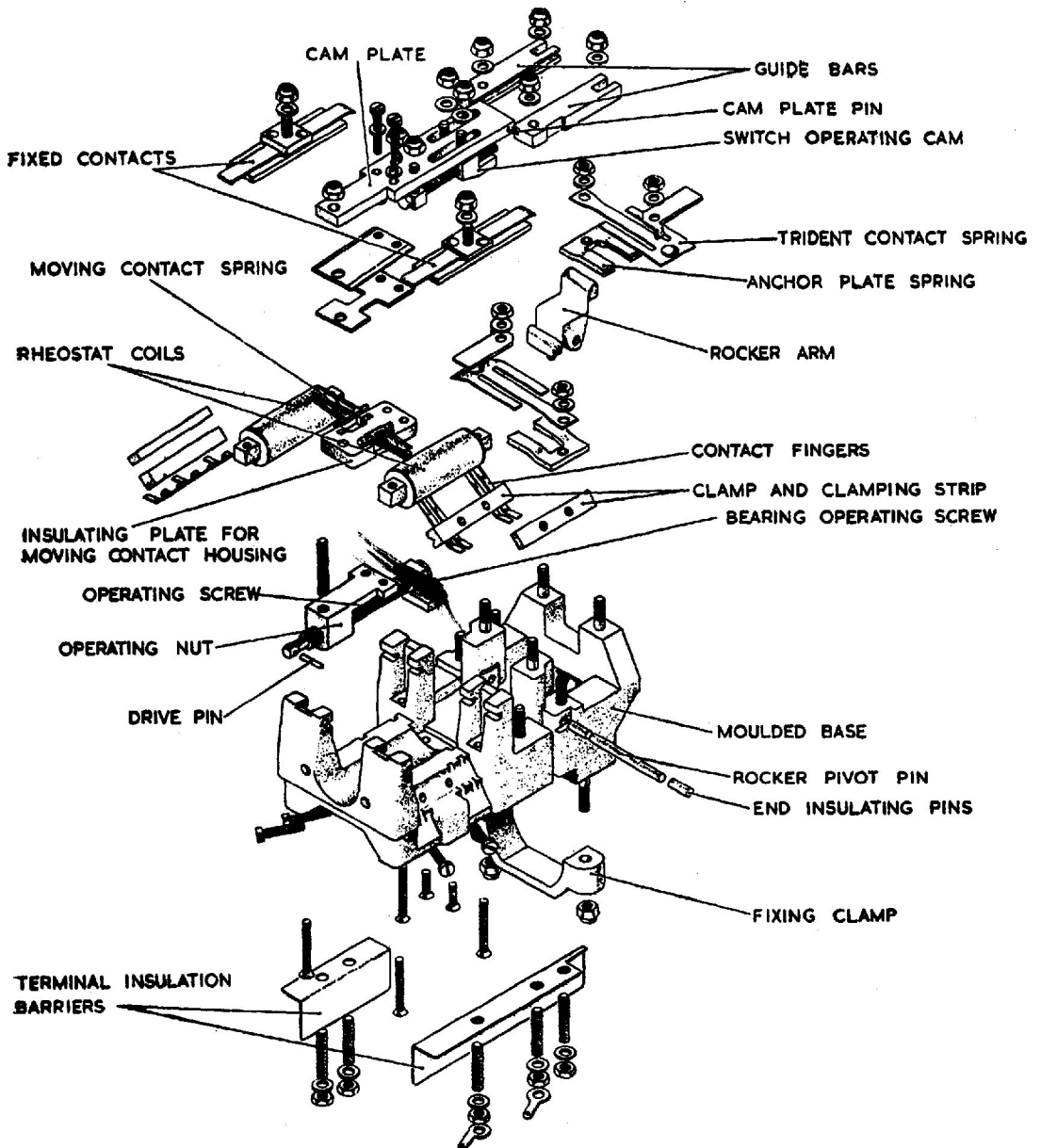


Fig. 4. Exploded view of transmitter/limit switch unit

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recess of the bearing plate. Ensure that the correct bearing plate is used; it will be identified by similar markings as are found on the actuator housing. Check the final greasing of the gear train and fit the bearing plate carefully over the gear ball races.

46. Check that there is a clearance of between 0.002 in. and 0.004 in. between the bearing plate and the top cover, adding shims if necessary. Place the top cover plate in position and secure with the two 2 B.A. csk/hd. screws and one 4 B.A. csk/hd. screw, which should be locked by punching metal into the slots.

47. Fit the gland ring over the main nut, and press it into the actuator housing (the largest diameter enters into the actuator body). Attach the bottom plate and gasket and secure with four 2 B.A. nuts. Fit the stop nut and screw down to its maximum position, and screw on the swivel eyebolt attachment.

48. The motor extension shaft and pinion can now be inserted from the motor mounting side of the housing, to engage with the bearing previously fitted in the bearing plate;

this should be an accurate press fit. Place the felt washer over the extension shaft and fit the internal cover plate. Care should be taken to ensure that this plate is placed correctly in position.

49. At this stage, it is advisable to fit temporarily the clutch plate and a slave motor, Type LD0704, Form 5, to make a preliminary check of the gearing.

50. Run the slave motor with 15 volts applied, and check smoothness of gearing in each direction. Remove the clutch plate and slave motor assemblies after this test.

51. Fit the internal cover plate and secure with the three 6 B.A. csk/hd. screws which should be locked by punching metal into the slots. Fit the brake peg in position.

52. Holding the actuator in an upright position, place the clutch compression spacers into the hollow centre of the motor extension shaft, followed by the clutch spring. Position the three brake springs in the three circular recesses of the internal cover plate and carefully insert the brake plate, brake friction washer, clutch plate,

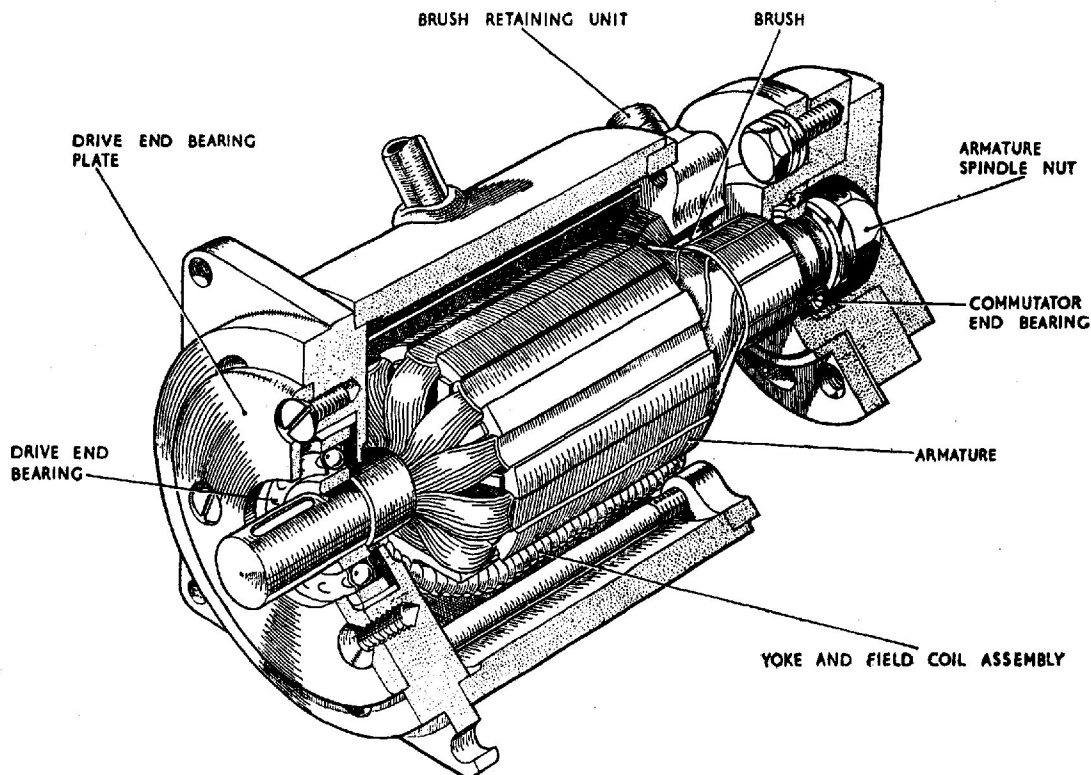


Fig. 5. Sectional view of motor

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and clutch friction washer, in that order. During this assembly ensure that all parts are clean and free from grease.

53. Take the complete motor unit, assembled as described in para. 54 to 59, including the slip clutch plate which is keyed to the motor shaft, and press into position, compressing the clutch and brake assemblies. Hold the motor in position, and secure with the four ch/hd. 6 B.A. screws and shakeproof washers.

Note . . .

When testing the actuator, it may be necessary to adjust the brake assembly in order to gain correct time travel figures. This is done by varying the length of the brake springs.

Motor, Type LD0704, Form 5

54. Pack one quarter of the available space in the driving end bearing and commutator end bearing with grease XG-275; slowly rotate the bearings and replace any grease which exudes. Press the bearings into their respective housings.

55. Assemble the commutator end housing to the motor yoke and field coil assembly, engaging with the dowel for correct positioning.

56. Place the armature in position inside the yoke and field coil assembly and engage the armature shaft with the commutator end bearing; this should be an accurate press fit. Assemble the driving end casting complete with bearing into position over the drive end of the armature shaft. Lightly tap into position on the motor yoke assembly, and secure with two 6 B.A. long csk/hd. screws, which should be locked by punching metal into the slots. Check for freedom of the armature in its bearings, and that no fouling takes place between the armature and field coil assembly.

57. Make the field coil connections to the brush boxes, and insert the brushes. The brush springs are secured to the brushes complete with contact washers. Screw in the brush screw caps.

58. Secure the armature at the drive end shaft in a suitable clamp, and fit the armature spindle nut at the commutator end. Remove the clamp. Fit the commutator end bearing cover, and secure with the

three 6 B.A. csk/hd. screws, locking in the usual manner.

59. Attach the slip clutch plate to the motor shaft, ensuring that the key fits securely in the keyway. The motor assembly is now ready for installation in the actuator.

Transmitter/limit switch unit

60. Assemble the anchor plates and trident contact springs, and secure to the studs in the moulded base with the two 6 B.A. lock-nuts.

61. Place the rocker arm in position, and using a suitable drift fit the spindle through the aperture in the moulded base; secure the rocker arm in position. The spindle pin must be a sliding fit in the rocker arm—do not use any force.

62. Fit the two insulating end distance pieces in each side of the spindle aperture. Place the limit switch contacts in position, and secure with the two 6 B.A. washers and lock-nuts. The small tags on the limit switch contacts hold the insulating spindle pieces in position in the moulding.

63. Assemble the guide bars to the studs in the moulded base, and secure with the four 6 B.A. washers and lock-nuts. These guide bars are handed, and cannot be wrongly positioned.

64. Fit the contact fingers, which should be placed in the grooves in the moulded base and held with the clamps and insulated clamping strips. Secure the assembly to the moulded base with the four 8 B.A. ch/hd. screws.

65. Fit the two rheostat bobbins. The bobbin ends should slide into slots in the moulded base, the bobbins being secured in position with four 8 B.A. csk/hd. screws. Lock these screws in position by applying a light covering of air-drying varnish to the threads before insertion.

66. The operating screw, operating screw bearing, operating nut and drive pin are a complete sub-assembly, and should be assembled in conjunction with the moving contact spring housing and moving contact springs. The moving contact spring housing should be placed over the stud in the operating nut, and the moving contact spring fixed in the housing. The insulating plates should be placed over the moving contact spring housing.

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67. Where the cam plate assembly has been dismantled, the screw bearing, switch operating cams and limit switch adjusting screws should be fixed to the cam plate with the appropriate washers and lock-nuts. Place the guide pin of the cam plate in the slots of the guide bars, and slide the cam plate along until the operating screw bearing locates in its slot in the moulded base. Fit the two 6 B.A. csk/hd. screws through the base of the moulding and secure the bearing plate.

68. The two insulation barriers can now be fixed in position on the studs on the underside of the moulding, and secured with the 6 B.A. washers and lock-nuts.

69. Place the two fixed contacts in their grooves in the moulding, easing the spring clips in the process, and taking care not to damage the moving contact spring.

70. The transmitter drive should be rotated so that full movement of the assembly can be checked for smoothness of operation. Finally set the transmitter so that the contacts Y3 are open. The transmitter/limit switch unit is now ready for installation to the actuator body.

Final procedure

71. Slide the glands over the Trivin and Quinvin cables. Where new cables have been fitted, ensure that the actuator cable core lengths are correct. Fit the cables through the cable entry ports in the actuator body and secure the cable glands with the

four 6 B.A. locknuts. Route the cables carefully in the inner housing, so that they will not be trapped when the transmitter limit switch is placed in position.

72. Assemble the transmitter/limit switch unit to the actuator body. The unit is dowelled into position. Ensure that the pin in the end of the unit engages correctly in either pair of slots in the transmitter driven gear wheel assembly. It may be necessary to rotate the drive shaft slightly to engage. The transmitter unit slips into position easily; and no force is required; ensure that all cables are clear.

73. Fit the clamping plate around the actuator body extension and over the two 6 B.A. studs, and secure the transmitter unit with the two 6 B.A. lock-nuts. Make all terminal connections at the transmitter unit, as shown in the wiring diagram (fig. 7).

74. The moulded cover is fitted at the conclusion of all tests (para. 75 to 89). The gasket should be cemented to the main body, using Bostik B cement.

TESTING

Motor, Type LD0704, Form 5

Brush gear

75. Brush spring pressure should be within the limits of 3 oz. \pm 10 per cent. Brushes should be renewed before they reach a minimum length of 4 mm.; the correct grade for renewal is E.G.12 (H.A.).

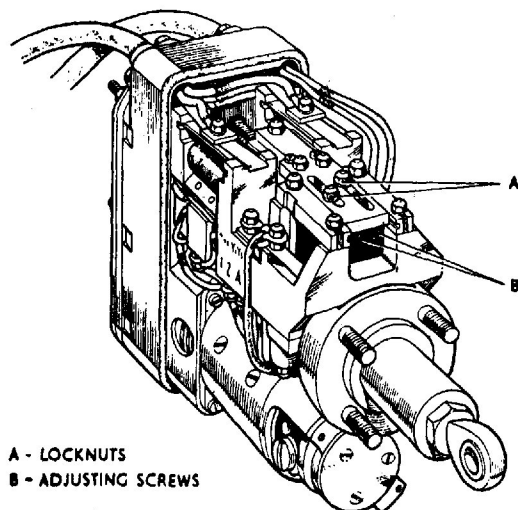
Resistance of windings

76. The resistance values of the windings at 20 deg. C should be as follows; a tolerance of \pm 10 per cent. on the readings is allowed in each instance.

| | | | |
|----------------------|------|------|----------|
| Armature | | | 3.3 ohms |
| Field (each winding) | | | 2.6 ohms |

Testing before connection to actuator assembly

77. Connect a 15-volt supply between the leads marked A and Y3, and check that the motor rotates in a clockwise direction when viewed from the driving end. Run for at least two periods each of a quarter hour's duration, with at least a quarter hour between the two runs, to bed the brushes over at least 80 per cent. of the width and the whole thickness.



A - LOCKNUTS
B - ADJUSTING SCREWS

Fig. 6. Adjustment of limit switches

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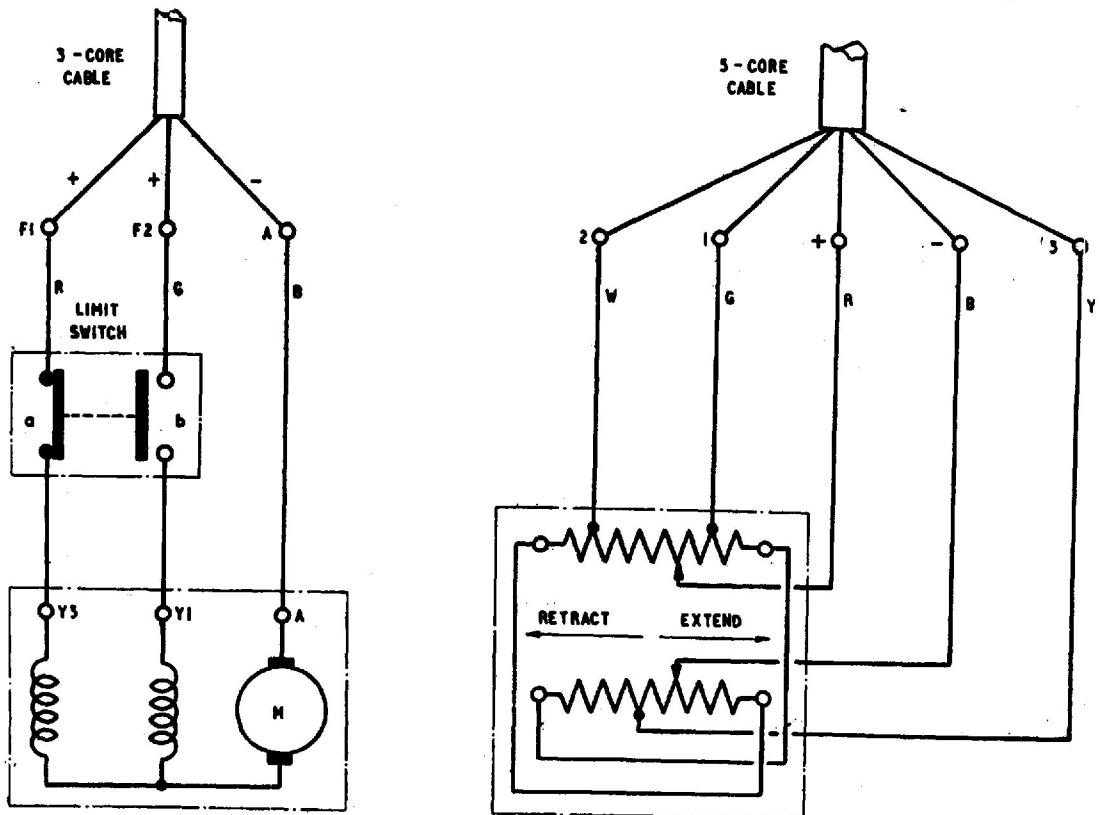


Fig. 7. Circuit diagram

78. With a supply of 24 volts connected between leads A and Y3, check the following performance figures.

| Voltage | Max. current (amp.) | Torque (oz. in.) | Min. speed r.p.m. |
|---------|---------------------|------------------|-------------------|
| 24 | 1.6 | 1.0 | 9,000 |
| 24 | 2.3 | 3.5 | 4,400 |
| 24 | 3.5 | 6.0 min. | stalled |

check that commutation is satisfactory.

79. Repeat the test in para. 78 with the supply connected between leads A and Y1, when rotation should be anti-clockwise viewed from the driving end.

80. With the machine still hot, measure the insulation resistance between the wind-

ings and frame with a 250-volt insulation resistance tester; the reading should not be less than 10 megohms.

81. For a final test after strip inspection and locking, check the current and speed as given in para. 78 for a torque load of 3.5 oz. in., and repeat the test in para. 80.

Testing of complete actuator

82. Set the limit switches to give full stroke of the actuator.

83. Run in with 29 volts applied.

Carry out 25 operations on no load

Carry out 25 operations on 50 lb. load

Carry out 25 operations on 100 lb. load

Carry out 25 operations on 350 lb. load

Each operation is to consist of one extend stroke and one retract stroke, which should be timed; a performance table is given in para. 86. If consistent times are not obtained after 95 operations, the running

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in is to be continued for a further 50 operations. Final adjustment for timing can be made on the brake spring compression, if this is considered necessary.

84. Slip the clutch for three periods of 30 seconds each, allowing the motor to cool between runs. Set the clutch so that the actuator stalls at a load between 550 lb. and 850 lb.

85. Set the limit switches to give the required stroke, and set the Desynn trans-

mitter to give centre zero on the indicator for the midpoint of the stroke, and check that the Desynn indicator operates correctly.

Note

The indicator will not necessarily indicate to the extremes of the indicator scale due to limit tolerances and stops in the actuator.

86. Check the performance of the actuator with a supply of 29 volts and loads as shown; the speed of travel and current consumption should be as tabulated below.

| Load | Form | Speed of travel (sec. per in. of travel) | | Max. current consumption (amp.) |
|-----------------------------------|---------|---------------------------------------------|------|---------------------------------------|
| | | Min. | Max. | |
| 350 lb. assisting extension | 2, 6 | 28.0 | 35.0 | 1.9 |
| | 3, 5, 7 | 14.0 | 20.0 | 1.7 |
| 350 lb. opposing retraction | 2, 6 | 35.0 | 42.0 | 2.0 |
| | 3, 5, 7 | 18.0 | 24.0 | 1.8 |

87. The following times of travel and figures for current consumption are for retraction under 350 lb. opposing load at 22 volts and 29 volts. The lengths to which the various actuators are controlled by limit

switches are also listed; there is an allowance of 0.050 in. to 0.060 in. at each end of the stroke before the mechanical stop is reached, in the event of the limit switch failing to operate.

| Form | Max. time of travel (sec.) | | Max. current (amp.) | | Extended length (in.) |
|------|-------------------------------|------|------------------------|-----|-----------------------------|
| | 22V | 29V | 22V | 29V | |
| 2 | 136.0 | 84.0 | 1.9 | 2.0 | 1.955 \pm 0.025 |
| 3 | 105.0 | 72.0 | 1.7 | 1.8 | 2.925 \pm 0.025 |
| 5 | 70.0 | 48.0 | 1.7 | 1.8 | 1.955 \pm 0.025 |
| 6 | 68.0 | 42.0 | 1.9 | 2.0 | 1.000 \pm 0.025 |
| 7 | 87.5 | 60.0 | 1.7 | 1.8 | 2.500 \pm 0.025 |

88. Check that the clutch setting remains within 550 lb. to 850 lb.

89. Test between the motor and the transmitter circuits, and both circuits to earth, using a 250-volt insulation resistance tester.

With the machine hot, the reading should be not less than 2 megohms.

Note . . .

Whenever the actuator is being bench tested, it must be suitably mounted; during testing, the bottom cover must be replaced in position after the outer Bakelite cover has been removed.

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