

## Chapter 91

## ACTUATOR, ENGLISH ELECTRIC, TYPE AE4024, Mk. 1

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## LEADING PARTICULARS

<b>Actuator, Type AE 4024, Mk. 1</b> .....	<b>Ref. No. 5W/2712</b>
<i>Rated voltage</i> .....	28V d.c.
<i>Speed of motors</i> .....	1000 rev/min
<i>Output of each motor</i> .....	356 watts
<i>Maximum working load</i> .....	13000 lb
<i>Normal working load</i> .....	3000 lb
<i>Static load (as an aircraft strut)</i> .....	27000 lb
<i>Clutch slip load</i>	
<i>At overhaul</i> .....	10500 to 12500 lb
<i>During service</i> .....	10500 to 18500 lb
<i>Normal working stroke</i> .....	1.613 in
<i>Stroke between stops</i> .....	1.76 in
<i>Time of stroke</i> .....	15.7 seconds
<i>Distances between centres (closed on stop)</i> .....	14.685 in
<i>Brushes</i>	
<i>Grade</i> .....	E.G.O. (H.A.M.)
<i>Spring pressure</i> .....	11 to 15 oz
<i>Minimum length</i> .....	$\frac{7}{16}$ in
<i>Weight</i> .....	33 lb

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## Introduction

1. The linear actuator, Type AE4024 (fig. 1), has been designed to provide variation in the angle of incidence of the tailplane under all conditions of flight. It is a single speed actuator, capable of operating under a normal load of 3000 lb. Acting as a strut in the airframe, it can withstand loads of up to 27000 lb both in tension and compression.

## DESCRIPTION

2. The actuator includes two identical 28V d.c. compound wound motors, mounted side by side, and parallel to the ram. Each motor is fitted with an electro-magnetic brake to ensure accurate positioning at any point during the stroke. The main motor only is used for normal operation. The other serves as a standby in the event of failure of the main motor. The drive from the motors to the ram is provided by a differential arrangement of spur and epicyclic gear trains. The final spur gear is splined to an acme screw, which, through its mating thread on the ram, provides linear movement.

3. Although mechanical stops are provided the unit must always be used with external limit switches, so preventing running up against the mechanical stops unnecessarily.

4. The gearbox incorporates an overload friction clutch. Thus, in the event of limit switch failure, or any other cause of overloading, the airframe or actuator is not damaged.

5. A position indicator potentiometer is mounted in the unit, and is intended for use with a ratiometer type of instrument.

## Housing and covers

6. Each motor housing consists of two alloy castings, and a brushgear and commutator inspection cover. One casting forms the motor field system and brushgear mounting. The other forms the brake housing and driving end endplate. Both castings are held together by four steel bolts. Positioned on the motor frame casting is a cable gland and mounted on this is a Breeze plug.

7. The emergency motor is located through an auxiliary gearbox on to an adaptor plate. The main motor is located directly on the adaptor plate, through which studs pass to the gear case.

8. The gear case comprises two alloy castings which form the front and rear halves. They are held together by 10 steel studs.

9. The ram housing is an alloy casting enclosing the acme screw and nut assembly and potentiometer indicator transmitter. It is held on the gear case by four studs and fitted bolt. The ram shackle is a fork end on the end of the acme nut, and positioned in line with it. At the opposite end of the actuator is another steel fork end and a universal lug. This is secured to the gear case by eight bolts.

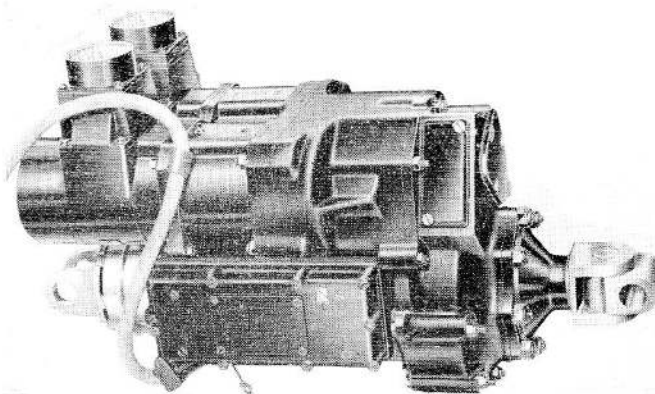


Fig. 1. General view of actuator, Type AE4024, Mk. 1

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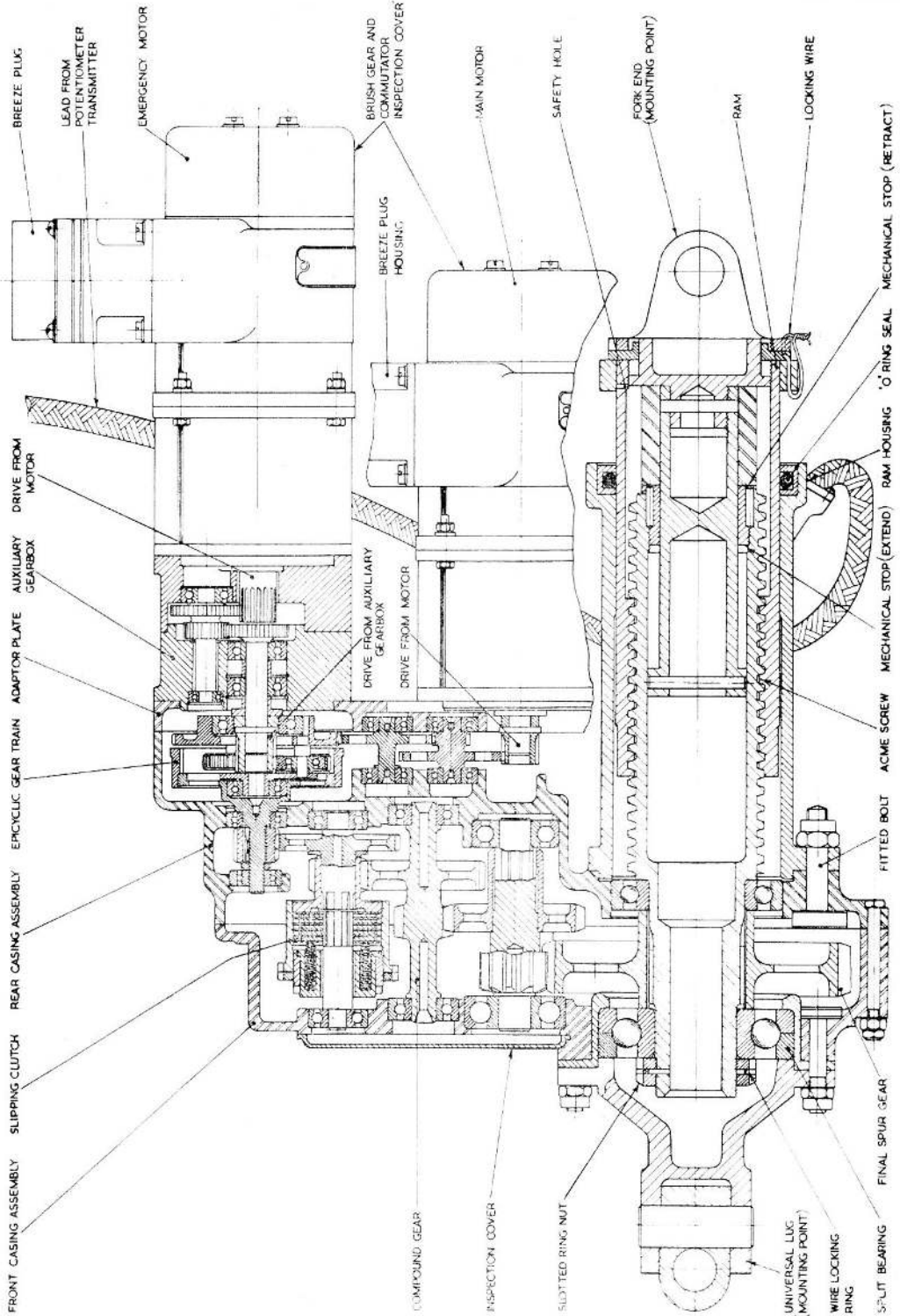


Fig. 2. Sectional view of actuator

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10. An alloy side cover on the ram housing serves to mount the potentiometer, and also seal it into the housing. On the ram housing opposite to the potentiometer is a steel lipped cover over the slot containing the torque reaction arrangement.

#### Note . . .

*The actuator should never be operated without this cover in position.*

#### Gearbox

11. The main motor has a pinion mounted on the armature shaft. This pinion drives a spur gear train which engages with an epicyclic gear train and then through spur gearing to the acme thread.

12. The emergency motor also has a pinion on the armature shaft which drives spur gearing in the auxiliary gearbox and then through the same epicyclic gear system as the main motor.

13. The clutch is of the multi-plate type. Its main shaft carries an input spur gear, and if the clutch is not slipping (due to overload) the drive is transmitted to an output spur gear. Both of these spur gears form part of the spur gear system mentioned in para. 11.

#### Acme screw and nut assembly

14. This assembly consists of an aluminium bronze acme nut, a hollow steel screw and a hollow sleeve which travels inside the screw. The hollow sleeve is screwed and pinned to the ram shackle, the shackle being screwed into and keyed to the end of the acme nut, the inner face of this shackle forming the retracted mechanical stop face. The minimum length of the thread engagement between the acme nut and ram shackle is indicated by the safety hole. When the shackle is in safety it is not possible to insert a piece of wire of 0.60 in dia. to a depth greater than 0.130 in. The acme nut is prevented from turning by a torque reaction lug.

#### Potentiometer

15. The potentiometer is of the usual type associated with ratiometer type instruments. An adjusting screw is provided in the cover for adjusting the potentiometer setting. The cable enters by way of a gland and clamping plate.

#### Motor and brake assembly

16. Essentially both motors are the same, but the plug connections are purposely made non-interchangeable (fig. 3 and 4). The motors are the same as the one on the Type AE4023, Mk. 1, actuator (Chap. 90).

17. The designed output of each motor is 356 watts at 11000 rev/min 28V d.c. supply. The windings are compound, and reversal of rotation is effected by external switch gear (i.e., the d.c. supply is reversed through leads 1 and 2).

18. The two gun-metal brush boxes are mounted on a moulded rocker. This is adjustable for setting the neutral position. The brushes are E.G.O. (H.A.M.) type, and are held in contact with the commutator by coiled wire springs. Brush spring pressure must be 11—15 oz.

19. A brake drum is fixed to a flange on the armature shaft, and the brake yoke is fixed in the end plate. With the current off, the four brake shoes are held against the brake drum thus preventing any rotation of the armature.

#### INSTALLATION

20. The distance between centres at the ram shackle and the universal lug (para. 9) with the actuator fully closed up on the stops, should be  $14.685 \pm .017$  in. The stroke between stops should be  $1.76 \pm .017$  in.

21. before the actuator is brought to the mounting, the alignment of the mounting lugs should be checked. The neutral position on the Desynn indicator should be obtained when the actuator is in its neutral position by suitably setting the potentiometer adjusting screw.

#### OPERATION

##### Normal operation

22. For normal operation the emergency motor is inoperative, and is locked under the action of its brake. The drive therefore is from the main motor through the first spur gear train, on to the epicyclic gear train, and through the second set of spur gears via the clutch to the acme screw.

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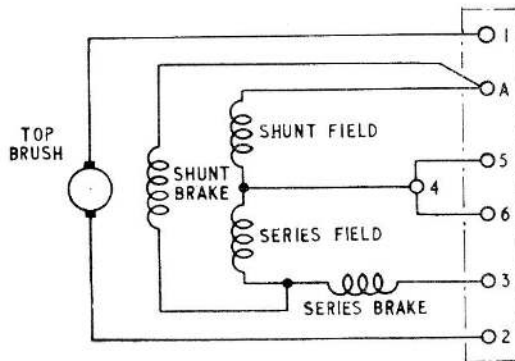


Fig. 3. Wiring diagram (main motor)

**Emergency operation**

23. For emergency operation, the main motor is locked, and the drive is from the emergency motor, through the auxiliary gearbox, onto the epicyclic gear train, and through the spur gears to the acme screws.

**Note . . .**

*The actuator must only be operated in a test rig, or on an aircraft where external limit switches are incorporated in the circuit.*

**SERVICING**

**General**

24. The actuators should be serviced in accordance with the relevant Servicing Schedule; no servicing other than that detailed should be attempted.

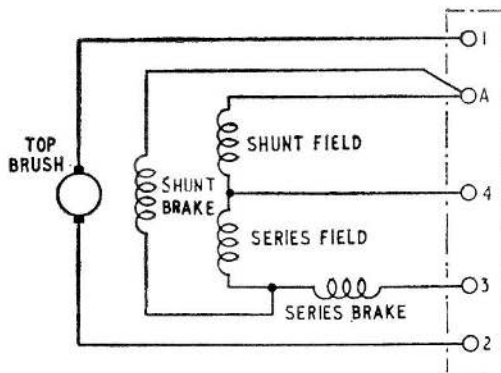


Fig. 4. Wiring diagram (emergency motor)

25. Examine the actuators for any signs of external damage. Ensure that all nuts, screws, and locking devices are secure. Examine the electrical connections for tightness and freedom from corrosion. Ensure that the wiring is not frayed or loose. Care should be taken to ensure adequate application of sealing compound to joint faces when covers are refitted.

**Note . . .**

*It should be noted that this actuator contains mated assemblies before replacing any component.*

**Brushes**

26. The brushgear should be examined at the periods stated in the relevant Servicing Schedule. On removal of the two commutator-end covers the brushes are readily accessible. Each brush should be a free fit in its box, and any accumulation of carbon should be carefully blown away with dry compressed air. The minimum brush length (measured from the top of the brush to the toe of the contact surface arc) is  $\frac{7}{16}$  in. If the brush length is below this or if the rate of wear indicates that the minimum length will be reached before the next servicing period or examination the actuator should be returned to a Repair Depot in accordance with current authorized instructions. The brush spring tension measured on a spring balance (Ref. No. 1H/97) should be between 11 and 15 oz.

**Lubrication**

27. The cover plate on the opposite side to the potentiometer should be removed and the acme screw lubricated with grease XG-278. No lubrication is necessary to either gearbox or motor between overhaul periods.

**Functional test**

28. Mount the actuator on a suitable travel setting rig with the limit switches arranged so that they operate  $\frac{1}{4}$  in. from the fully extended and retracted positions, and connect to the test circuit as shown in fig. 5.



29. With the low-speed motor connected, run the actuator to the extended limit and then to the retracted limit. The current consumption should not exceed 9 amperes and the potentiometer operation, as indicated by M1, should show a smooth reading over the full range of travel.

30. With the high-speed motor connected repeat the test given in para. 29 and check that the current consumption is not in excess of 10 amperes.

**Clutch slip current check**

31. At overhaul periods a check should be made on the current at clutch slip as follows.

(1) Remove the brushgear and commutator cover, and remove the small rectangular cover from the gear case to reveal the clutch.

(2) Using a 14V d.c. supply, inch the actuator ram on to its extended mechanical stop.

(3) Connect the actuator to a 28V d.c. supply and ensure that the clutch slips. The current taken by the motor under this condition should not be less than 25A or more than 35A.

If the current consumption is outside the limits quoted in sub. para. (3) the clutch should be adjusted by following the instruction given in para. 32.

**Note . . .**

*When the clutch is slipping the clutch housing will be stationary and the commutator will still be turning. The clutch slipping condition should not be maintained for more than 15 seconds.*

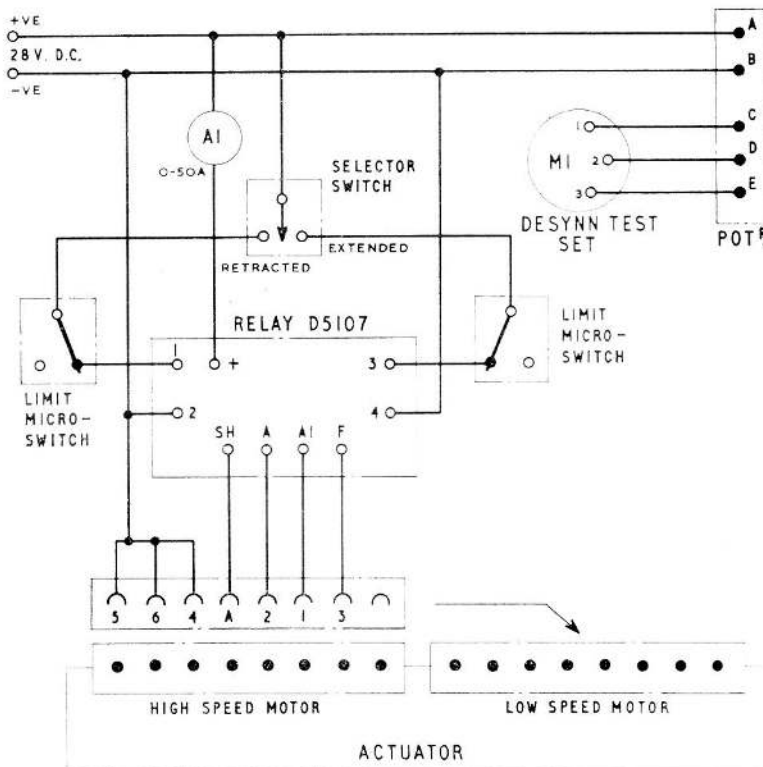


Fig. 6. Test circuit diagram

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## Clutch adjustment

32. The clutch should be adjusted so that the current consumption is within the limits of 25A and 35A. Reference should be made to fig 6 for dimensions of the C spanners which are required to fit the clutch body and the clutch adjusting locknut. The procedure for clutch adjustment is as follows.

(1) using the two C spanners unlock the locknut by holding the clutch body with one spanner and turning the nut with the other.

### Note . . .

To increase or decrease the clutch slip, turn the adjusting nut clock-

wise or counter-clockwise respectively. One slot of the adjusting nut gives a change of approximately 3A.

(2) After adjustment tighten and lock the locknut and check the current at clutch slip as detailed in para. 31, sub para. (2) and (3).

### Note . . .

During normal service life changes in clutch slip may occur, therefore for any periodic check between overhauls and for acceptance tests the current values of 25 to 45 amperes are acceptable.

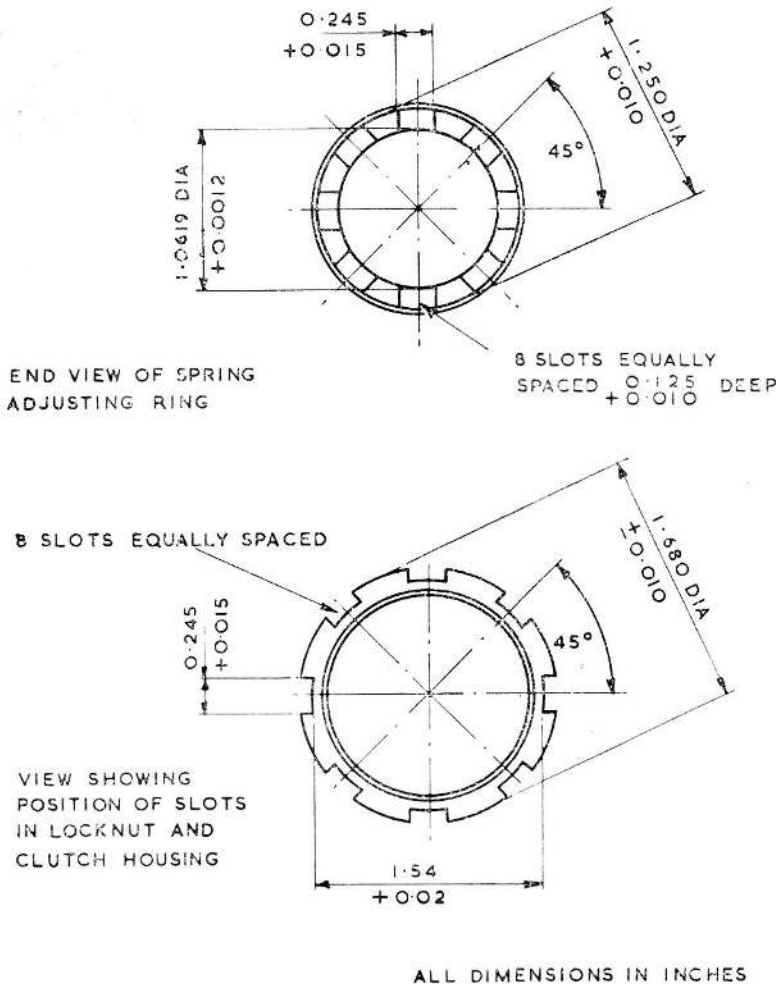


Fig. 7. Dimensions of C spanners

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LIGHTNING MK. 1  
COVER PITOT HEAD  
EB2-88-511

A close-up photograph of a red aircraft fuselage. A grey fabric cover is draped over a section, with the text "LIGHTNING MK. 1", "COVER PITOT HEAD", and "EB2-88-511" printed on it. To the right, a rectangular metal plate is mounted on the red surface. The background shows the curved structure of the aircraft with several rivets.