Chapter 51

ACTUATORS, PLESSEY, STOAT (TWIN MOTOR) SERIES

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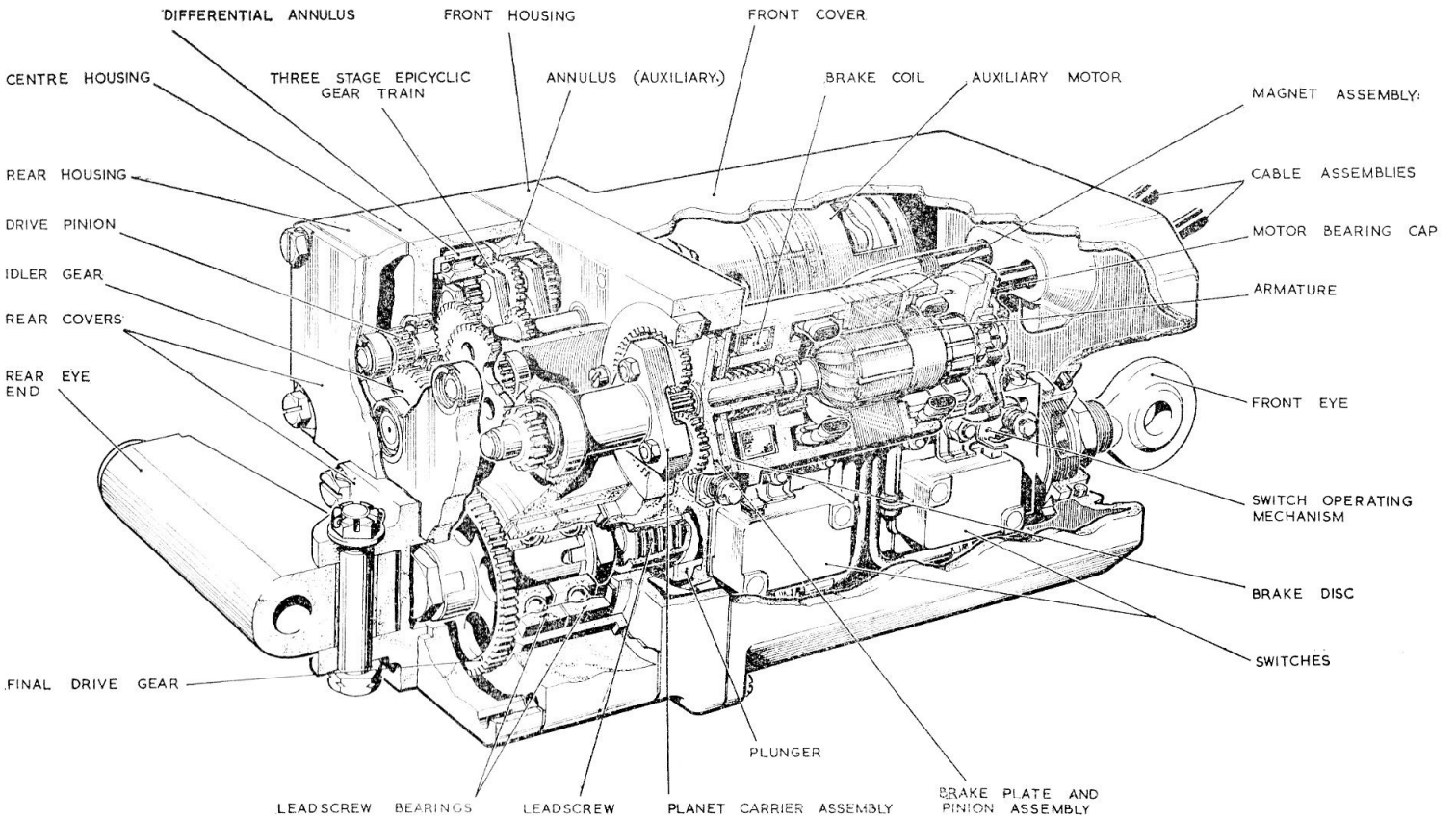


Fig. 1. Cut-away view of simplified Stoat actuator

Introduction

1. The Stoat series of actuators are linear, twin motor, actuators suitable for application where remotely-controlled thrust and pull are required. The actuators are designed to enable either motor to extend and retract a plunger through a gearbox and leadscrew.

2. The motors are of identical construction, but are electrically independent units. This feature enables free selection of motive power for operation of the plunger. The actuator assembly can, therefore, be adapted for use where instantaneous switch-over of power is desired, in the event of failure of the motor in use.

3. The nominal plunger stroke length is governed by adjustable limit switches, whilst mechanical stops limit over-run of the plunger in the event of failure of the switches, or malfunctioning of the switch controlling mechanisms.

4. End fittings are provided at the rear and the front for mounting the actuator and linking it to the associated equipment.

5. Variants in this range of actuators will be found in appendices to this chapter.

DESCRIPTION

General

6. A sectional view of a typical Stoat actuator is shown in Fig. 1.

Motors

7. The two motors used are 28V d.c. units termed "Main" and "Auxiliary". They are identical motors whose functions are established only after installation.

8. The motor is series wound and incorporates duplicate field coils to permit reversible operation. The drive end carries a brake that is engaged when the motor is at rest, and is electromagnetically released by a coil, which is in series with the field coils, when the motor is energized. Braking is thus automatically effected when the power supply is interrupted. A flange integral with the brake coil housing, is provided for mounting the motor in the actuator.

9. The motor armature is supported in two ball bearings, one located in the coil and brake housing and the other in the commutor and brushgear housing. The magnet assembly which is interposed between the two housings and encloses the armature, is spigoted at both ends to mate with recesses in the housings; a dowel pin fitted in the magnet assembly case locates in a groove in the brake and coil housing. The end housings and the magnet assembly are secured as a unit by two nuts and a bearing cap fitted on fixing studs, screwed in the brake-end housing. The studs pass through the magnet assembly, between the armature and field coils, and through slots in the brushgear housing. A nut screwed on the commutator end of the armature, before the bearing cap is fitted, pre-loads the armature bearings.

10. The brake disc which carries the brake lining is mounted on dowel pins fitted at the outer face of the brake housing in which the brake coil is installed. The brake plate and pinion assembly is mounted on the armature shaft against the brake disc; slots in the shank of the assembly align with a drive pin which is a press fit in the armature shaft. The brake disc is loaded against the brake plate by the brake spring which is mounted on the shank of the brake plate and pinion assembly. The nut, which secures the brake plate and pinion assembly to the armature, pre-tensions the brake spring. Shims are inserted between shoulders on the armature shaft and in the bore of the brake plate and pinion assembly; these shims adjust the air gap between the faces of the brake housing and brake disc.

Gearbox

11. The gearbox carries the four reduction and drive gear trains in two chambers formed between the faces of three light alloy housings viz : front, centre and rear.

Housings

12. The front housing, which carries the two motors at its upper forward face, accom-

modates two fixed annuli and a gear journal bearing; an integral extension of the lower portion of the housing forms the plunger housing. The centre housing carries five gear journal bearings, a differential annulus assembly and a liner for the leadscrew bearings. The rear housing carries three gear journal bearings. The three housings are bolted together with two rear end covers, one of which has an integral bracket for attaching the rear eye-end fitting.

Gear trains

13. Each motor uses an independent reduction gear train to the differential annulus, whence transmission of motive power to the final drive gear (mounted on the leadscrew) is through a common gear train. A typical gear train is shown diagrammatically in Fig. 2.

14. Reduction gearing of the auxiliary motor consists of a three-stage epicyclic gear train comprising two primary planet carriers, which rotate in an annulus, and an output stage planet carrier whose gears are in mesh with the inner teeth of the differential annulus. The two primary planet carriers rotate on a layshaft, pinned to the output stage planet carrier.

15. Reduction gearing of the main motor consists of a planet carrier assembly, which rotates in an annulus, and a spur gear train comprising a single spur gear, a compound spur gear and finally two spur gears mounted on a common shaft. The final spur gear meshes with the outer teeth of the differential annulus.

16. Transmission of power to the final drive gear, from the output stage planet carrier assembly, is through a pinion, mounted on an extension of the carrier lay shaft, via an idler gear.

17. The differential annulus is an internally and externally toothed ring gear enclosed in a split housing between two rows of ball bearings. Two circumferential grooves are machined at the sides of the external teeth to serve as tracks for the ball bearings. Two countersunk screws secure the two sections of the housing. The ring gear is rotatable and access to the outer teeth is provided through an aperture in the housing.

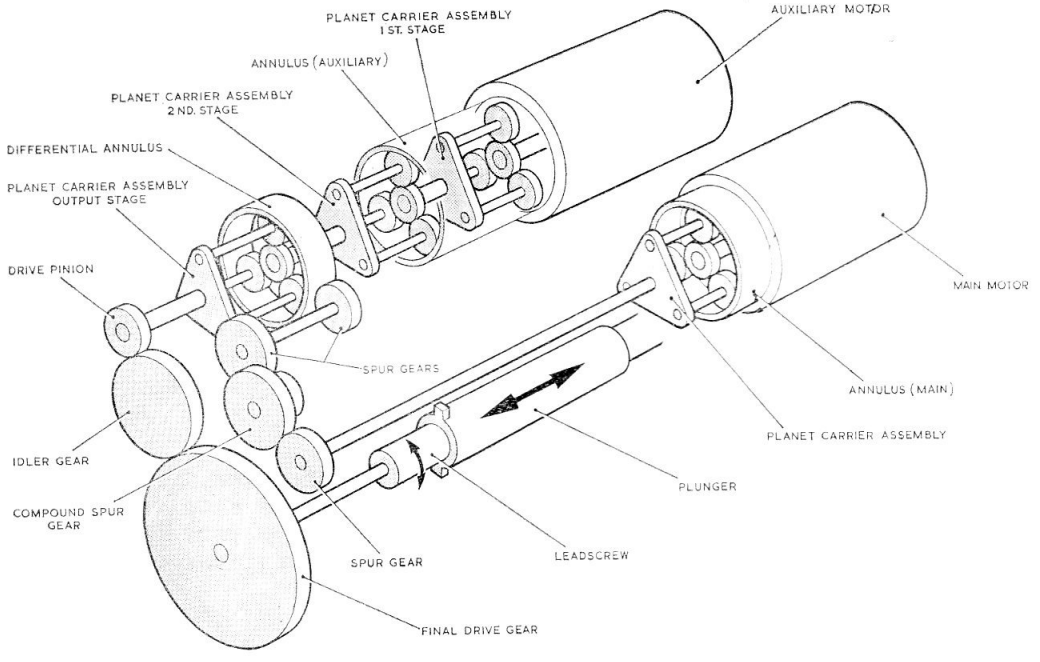


Fig. 2. Gear train diagram

Leadscrew and plunger

18. The leadscrew is externally threaded to right-hand Acme thread form for the greater part of its length, and is externally splined and internally threaded at one end to mount and secure the final drive gear. The leadscrew is supported in two ball bearings which are secured by a nut against a shoulder.

19. The plunger is internally threaded for the greater part of its length to right-hand Acme thread form; a different thread form, for mounting the front end fitting, is machined through the remainder of the bore. A collar of special form is machined at the outer surface of the plunger, to provide torque reaction ears which guide the plunger in its housing and actuate the switch operating mechanisms.

20. The leadscrew and plunger are selectively paired to give maximum backlash of 0·001 in. under a nominal loading of 10 lb.; they are then identified by code numbers.

21. Rotary action of the leadscrew is converted into linear motion of the plunger by the integral plunger torque-action ears which locate in slots in the plunger housing and prevent the plunger turning with the leadscrew.

Mechanical stops

22. The plunger is supported by two bushes which are secured by a nut to the front of the plunger housing. The bushes are so arranged that they act as mechanical stops should a condition arise in which the plunger travel is uncontrolled. In this event, the plunger ears butt against the shank of one bush in the extend position, whilst a special washer, fitted at the forward end of the plunger, butts against the shank of the other bush in the retract position. Thus uncontrolled travel is restricted.

Switch assemblies and operating mechanisms

23. The aircraft power supply is fed to the motors via switch assemblies which are located in slots at the sides of the plunger housing. The switches are normally "ON" and interrupt the power supply only when they are actuated by the operating mechanisms with which they are mounted. The operating mechanisms are tripped by the upper torque-reaction ear of the plunger. Thus the switches control the limits of plunger travel.

24. Switches and operating mechanisms are mounted on common screws but are independent units. There are four sets of switches and operating mechanisms, two sets being arranged at each side of the plunger housing. Power supply to each motor is controlled by the switches which are mounted beneath the motor. The positions of the switch assemblies and their operating mechanisms together are adjustable in the plunger housing slots, to enable variation of the plunger stroke.

25. The switches are snap-action, micro-types whose mouldings shroud the contact and micro-break mechanisms. An internal lever, which is spring loaded, is positioned to make an electrical circuit through a switch under normal conditions, but when actuated by a plunger, which protrudes through the moulding, the electrical circuit is interrupted. Two threaded lugs, which extend through the mouldings, accept the electrical connections made to each switch. Mounting plates which determine the locations of the switch assemblies are riveted to the switches.

26. Each switch operating mechanism consists basically of a spindle to which a lever is attached at one end and an arm at the other. A plate for mounting the mechanism, is fitted on the spindle between the lever and the arm.

Electrical connections

27. Electrical connections to the actuator are made by two cable assemblies which are routed through the cable clamp installed on the front cover. A typical wiring diagram is shown in Fig. 3.

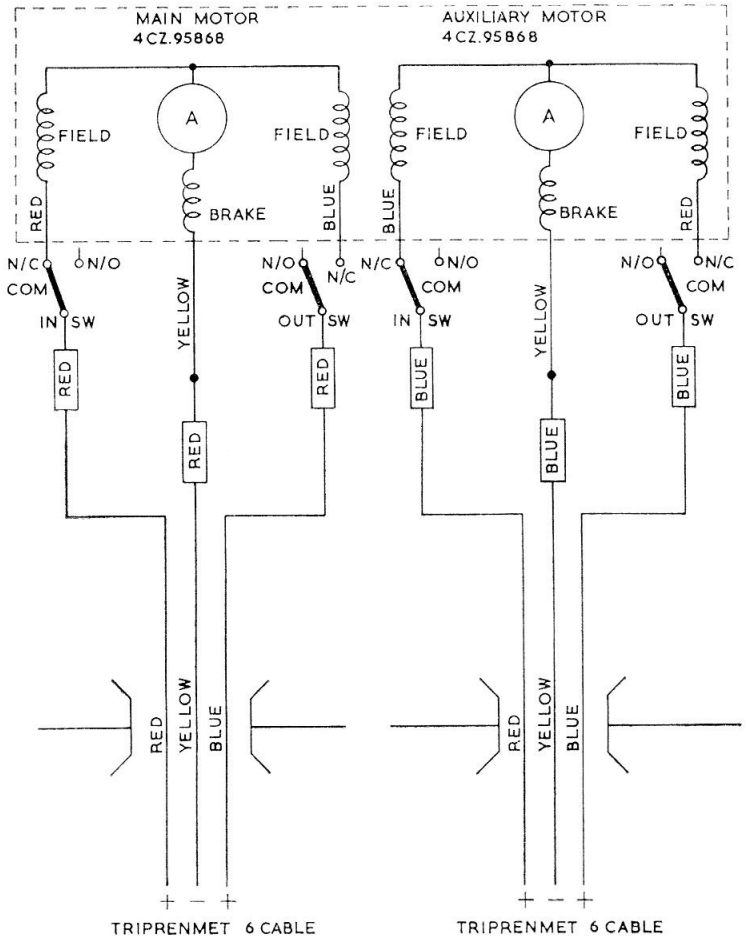
Front and rear covers

28. The front cover assembly encloses the motors and plunger housing, and is attached by screws to the forward face of the front housing. A sealing ring is installed in an annular groove machined in the cover.

29. Two rear covers are used. One is attached to the upper section of the gearbox and the other, which incorporates an integral bracket, is attached to the lower section. The covers are secured by the gearbox bolts.

End fittings

30. The actuator is anchored at the rear end by a fitting which is bolted to the integral bracket of the lower rear cover.



	MAIN MOTOR	AUX. MOTOR
SUPPLY	24-29 V DC	18-29 V DC
TO EXTEND, SUPPLY+VE TO	BLUE LEAD	BLUE LEAD
−VE TO	YELLOW LEAD	YELLOW LEAD
TO RETRACT, SUPPLY+VE TO	RED LEAD	RED LEAD
−VE TO	YELLOW LEAD	YELLOW LEAD

Fig. 3. Typical wiring diagram

31. A front end fitting which incorporates a self-aligning joint is provided for linking the actuator to the equipment which is to be operated. The fitting is threaded into the front of the plunger and locked by a nut which bears against a special washer located in slots at the forward end of the plunger.

OPERATION

Main motor

32. When "Extend" position of the plunger is selected the brake coil is energized and the brake disc is attracted away from the brake plate to unlock the motor. Simultaneously, power is delivered through the forward switch assembly to the blue field coil and the motor is rotated in a clockwise direction.

33. The drive is transmitted through the planet carrier assembly and the spur gear train to the differential annulus. The annulus is rotated and so drives the output stage planet carrier assembly, which carries with it the pinion coupled to its forward face. The pinion transmits the drive to the final drive gear mounted on the leadscrew via the idler gear.

34. The leadscrew rotates in a counter-clockwise direction driving the plunger linearly outwards until the plunger torque-reaction ear contacts the trip of the operating mechanism, which, in turn, actuates the switch assembly to interrupt the power supply.

35. When the power supply is interrupted, the brake coil is de-energized and the brake spring forces the brake disc against the brake plate, thereby bringing the motor to a rapid stop.

36. When "Retract" position of the plunger is selected, the rear switch is operative and the red field coil energized to drive the motor in a counter-clockwise direction. The leadscrew is therefore driven in clockwise direction and the plunger is withdrawn. The sequence of operation is otherwise similar to that described for the plunger "Extend" condition.

37. The main motor drive is not transmitted to the auxiliary motor, as the layshaft of the output stage planet carrier rotates freely in the auxiliary planet carrier assemblies.

Auxiliary motor

38. When the auxiliary motor is selected the electrical sequence of operation is identical to that of the main motor.

39. The mechanical drive sequence is also identical from the stage where the drive from the pinion, coupled to the output stage planet carrier, is transmitted to the final drive gear.

40. The difference in the mechanical drive sequence is that the pinion drive from the auxiliary motor is transmitted through the first two stages of the auxiliary planet carrier assemblies to the output stage planet carrier assembly. The output stage planet carrier assembly is then rotated in the differential annulus which is held stationary by the final spur gear of the main motor spur gear train.

INSTALLATION

41. For details of an actuator installation in a particular aircraft, reference should be made to the appropriate aircraft Air Publication.

42. Before fitting a new or overhauled unit, check that the actuator is of the correct type for the aircraft: no adjustment of the plunger travel is possible in service as a special test rig must be used to obtain the required accuracy. Check that the actuator has not been damaged in transit and that all external screws, nuts and bolts are fully tightened and locked.

43. When the actuator has been installed, check the security of the installation and operate the actuator to ensure that it operates the associated equipment satisfactorily.

SERVICING

44. The actuators are fully lubricated during manufacture or overhaul and require no

internal re-lubrication during their overhaul life. A thin film of grease should be maintained on the plunger, and the self-aligning joint of the front eye assembly should be kept well lubricated with a low-temperature grease.

45. During routine inspection, carried out in accordance with the appropriate aircraft servicing schedule, the actuator should be examined for signs of damage. All external nuts, screws and bolts and the mounting of the unit should be checked for security. The actuator should then be operated over its full range in both directions to ensure that it functions satisfactorily using each motor in turn.

46. An insulation resistance test can be carried out with the actuator installed in the aircraft. Using a 250V insulation resistance tester, the resistance must not be less than 500,000 ohms (R.N.) or 50,000 ohms (R.A.F.).

Appendix A

STANDARD SERVICEABILITY TEST FOR PLESSEY STOAT (TWIN-MOTOR) ACTUATOR, TYPE 500-1-01004

Introduction

1. These tests may be applied to actuators prior to installation or when their serviceability is in doubt.

TEST EQUIPMENT

2. The following equipment is required

(1) Tester, insulation resistance, 250V Type C (Ref. No. 5G/152).

(2) Test rig, Linear actuator, (Ref. No. 4G/5420).

(3) A direct current supply variable between 18 and 29 volts.

TEST PROCEDURE

Visual inspection

3. Visually inspect each actuator for external damage. Minor damaged areas can be treated using a mixture of Epihard lacquer 480/1 and Epihard accelerator 480/2 a cold curing lacquer, to D.T.D. 900P.

Insulation resistance test

4. Measure the insulation resistance between the actuator frame and each cable core. The value should not be less than 50,000 ohms (R.A.F.) or 500,000 ohms (R.N.)

Functional tests

5. Fit the actuator to the test rig in accordance with the details contained in A.P.4343S, Vol. 1, Book 2, Sect. 8, Chap. 3. Measure the length of the stroke after the actuator has run to both its extended and retracted limits against a load of 25 lb. with 28 volts applied to the main motor. The stroke length must be within the tolerance given in the table.

6. Operate the actuator on no load and check that the performance of both the main and the auxiliary motors is within the limits quoted in Table 1. During the tests check that the brakes function satisfactorily, and that there is no excessive vibration.

7. If the actuator fails any of these tests refer to the trouble shooting chart in the main chapter, determine the cause of failure, rectify the fault and retest.

TABLE 1

Stroke Setting Limits

Applied voltage	Condition of load	Main motor Time in seconds for 2·56 in. stroke (Min.)	(Max.)	Auxiliary motor Time in seconds for 2·56 in. stroke (Min.)	(Max.)	Stroke tolerance (in.) 28V, 25 lb.
29	C.L.O.	8·2	11·2			−0·020
29	T.L.O.	8·2	11·2			+0·020
24	Extend	9·8	13·4	9·0	12·0	
24	Retract	9·8	13·4	9·0	12·0	
18	Extend			12·0	16·2	
18	Retract			12·0	16·2	

Note . . .

Load abbreviations refer to compressive or tensile, opposing or assisting.

Appendix 1

ACTUATOR, PLESSEY, TYPE 500/1/00291

LEADING PARTICULARS

Actuator, Plessey, Type 500/1/00291	*Ref. No.*
Operating voltage range	18 *to* 29*V d.c.*
Normal voltage — main motor	28*V d.c.*
— auxiliary motor	24*V d.c.*
Working load — normal	25 *lb.*
— maximum	120 *lb.*
Static load — maximum	3000 *lb.*
Current consumption (normal load)	1·4 *amp. (approx.)*
Rating	*Intermittent*
Plunger — stroke (normal)	2·563 *in.*
— thread	*Single-start, R.H., Acme,* 12 *T.P.I.*
Centres — retracted	8·656 ± 0·030 *in.*
— extended	11·219 ± 0·030 *in.*
Plunger travel (mechanical stops)	0·035 *in. beyond normal positions*
End fittings — front	1*CZ* 135942
— rear	1*CZ* 136338
Ambient temperature range	—50 *to* + 100 *deg. C*
Weight (including cable assemblies)	5½ *lb.*
Motors, Type 4*CZ*95868	*C*.1305*A*/8
Weight	8 *oz.*
Rating	90 *sec. at maximum load*
Brushes, Type	*Z*73081
Length, new	0·235 *to* 0·265 *in.*
worn	0·156 *in.*
Commutator diameter — new	0·490 *to* 0·495 *in.*
— worn	0·450 *in.*
— after skimming	0·470 *in.*
Armature shaft	
Journal diameter — commutator end	0·1248 *to* 0·1253 *in.*
— drive end	0·1873 *to* 0·1878 *in.*
Brake air gap	0·006 *to* 0·009 *in.*
Brake disc and friction lining thickness — new	0·120 *to* 0·125 *in.*
worn	0·115 *in.*
Reduction gear ratio — main motor	311 : 1
— auxiliary motor	380 : 1

The 500/1/00291 is the basic type of the Stoat series of twin-motor, linear actuators. It is identical in constructional and operational details to the actuator described and illustrated in the main chapter. A detailed installation drawing is shown in Fig. 1, to supplement the data of leading particulars.

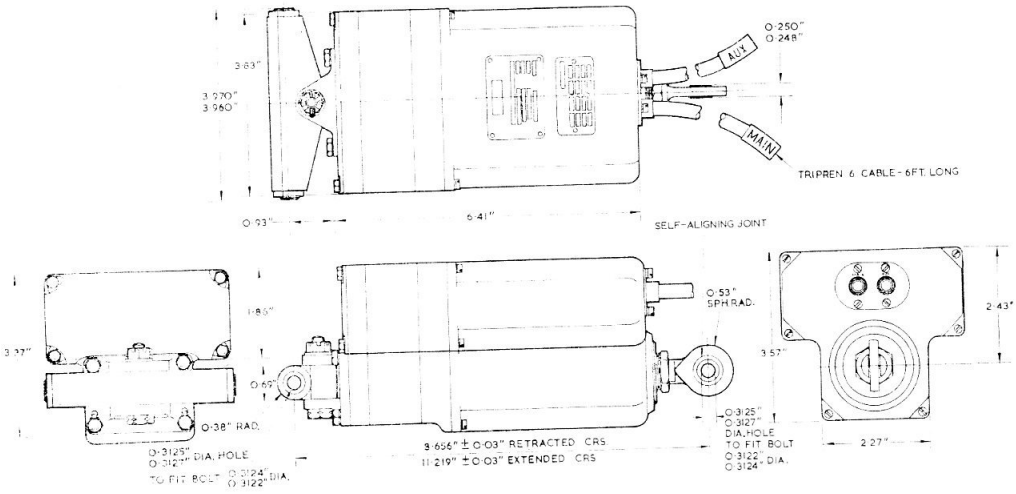


Fig. 1. Installation drawing

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Appendix 2

ACTUATOR, PLESSEY, TYPE 500-1-01004

LEADING PARTICULARS

Actuator, Plessey, Type 500-1-01004	*Ref. No.* 5W/5977
Operating voltage range — main motor	24 *to* 29*V d.c.*
auxiliary motor	18 *to* 29*V d.c.*
Normal voltage — main motor	28*V d.c.*
— auxiliary motor	24*V d.c.*
Working load — normal	25 *lb.*
maximum	120 *lb.*
Static load — maximum	3000 *lb.*
Current consumption (normal load)	1·4 *amp (approx.)*
Rating	*Intermittent*
Plunger — stroke (normal)	2·562 *in.*
— thread	*Single-start, R.H., Acme,* 12 *T.P.I.*
Centres — retracted	8·656 ± 0·020 *in.*
— extended	11·219 ± 0·020 *in.*
Plunger travel (mechanical stops)	0·035 *in. beyond normal positions*
End fittings — front	1CZ135942
— rear	1CZ136338
Ambient temperature range	−50 *to* +100 *deg. C.*
Weight (including cable assemblies)	5·5 *lb.*
Motors, Type 4CZ95868	*C.*1305*A*/8
Weight	8 *oz.*
Rating	90 *sec. at maximum load*
Bushes, Type	*Z*73081
Length, new	0·235 *to* 0·265 *in.*
worn	0·156 *in.*
Commutator diameter — new	0·490 *to* 0·495 *in.*
— worn	0·450 *in.*
— after skimming	0·470 *in.*
Armature shaft	
Journal diameter — commutator end	0·1248 *to* 0·1253 *in.*
— drive end	0·1873 *to* 0·1878 *in.*
Brake air gap	0·006 *to* 0·009 *in.*
Brake disc and friction lining thickness	
— new	0·120 *to* 0·125 *in.*
— worn	0·115 *in.*
Reduction gear ratio — main motor	179 : 1
— auxiliary motor	152 : 1

The 500-1-01004 is similar to the basic type described and illustrated in the main chapter. The difference is in a lower reduction gear ratio and stroke time.

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