Chapter 29

ACTUATORS, PLESSEY, BEAVER SERIES

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Introduction

1. The Beaver series of rotary actuators has been designed primarily to provide remote control of valves, e.g., release valves for emergency cabin pressurization. A quick-release device, in the form of an electro-magnetic clutch mechanism, is incorporated in the actuator to enable the valve to be instantly opened in an emergency. A typical actuator is described and illustrated in this chapter and details of individual types are given in appendices to this chapter.

2. The actuator is powered by a small reversible low-power split-field motor which has a disc type electro-magnetic brake to reduce overrun to a minimum. Limit switches actuated by cams on the output shaft determine the limit of angular travel of the actuator drive shaft by cutting the electrical supply to the motor. A similar switch and cam trip mechanism controls the re-engagement of the clutch under emergency conditions.

3. Two independent gear trains provide the reduction gearing for the actuator output drive shaft. The secondary gear train is driven by the motor and is coupled to the primary gear train, driving the output shaft, through the electro-magnetic clutch.

4. For the emergency operation of the valve, the clutch connecting the primary and secondary gear trains is disengaged, permitting an emergency return spring (external to the actuator and forming part of the valve linkage) to open the valve instantaneously. At a pre-determined point, just before reaching the fully-open emergency position, the cam on the output shaft operates the limit switch to break the circuit of the electro-magnetic clutch, thereby re-engaging the clutch. This counteracts the valve spring tension and the output shaft is decelerated to rest.

DESCRIPTION

Motor

5. The motor is of the series-wound, split-field, reversible type having an integral electro-magnetic brake which rapidly stops the motor when the electric current is switched off, and effectively reduces the overrun of the armature shaft. The motor

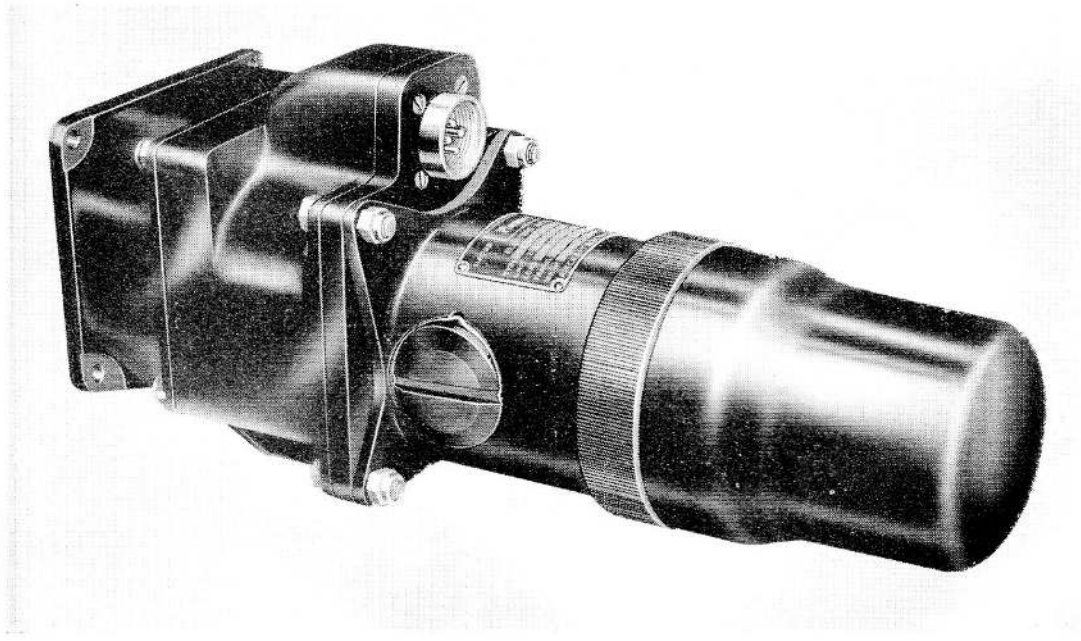
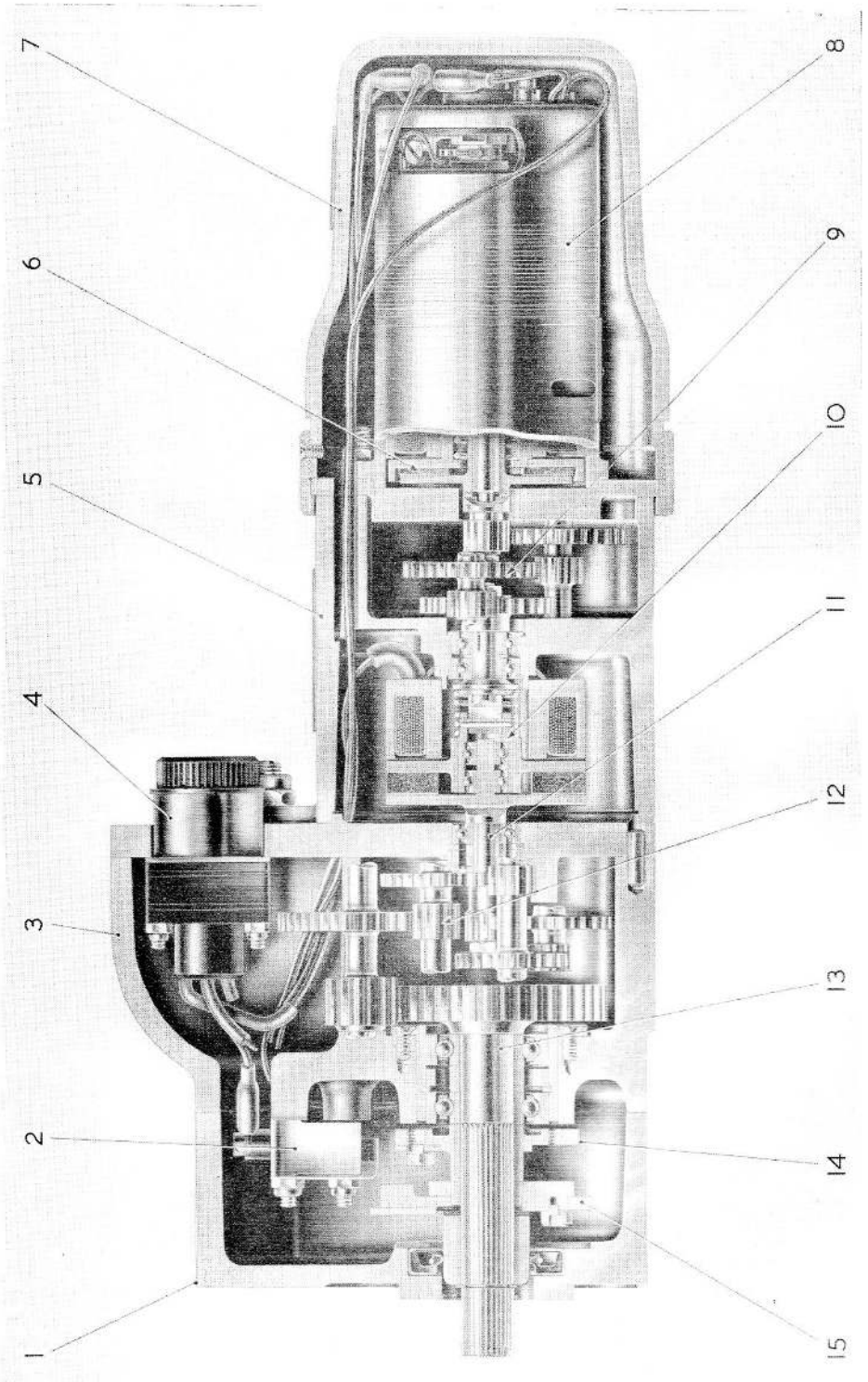


Fig. 1. General view of typical Beaver actuator



1 FRONT COVER
2 LIMIT SWITCH
3 SWITCH AND GEARBOX HOUSING
4 ELECTRICAL PLUG
5 CLUTCH HOUSING
6 MOTOR BRAKE
7 END COVER
8 MOTOR
9 CLUTCH GEARS
10 CLUTCH
11 CLUTCH DRIVE SHAFT
12 REDUCTION GEAR TRAIN
13 OUTPUT SHAFT
14 MOTOR TRIP CAM
15 CLUTCH TRIP CAM

Fig. 2. Sectional view of actuator

unit is enclosed in a cover secured to the clutch housing by a knurled retaining nut, and is kept in position by the motor spigot plate to which the motor body is bolted. The armature shaft passes through this plate and has fixed to it the motor drive pinion.

Clutch gear

5. Interposed between the motor spigot plate and the electro-magnetic clutch is the clutch gear train. Between the gear train and the clutch is a separating wall in which is located a double ball bearing supporting the clutch drive shaft.

Clutch

7. The clutch assembly comprises a series-wound coil and an electro-magnet surrounding a coiled spring through which passes the clutch drive shaft. This shaft is made up of two separate sections. The section which passes through the spring is driven by the motor pinion and clutch drive gears and is slotted at its end to receive the drive pin of the attraction plate. This enables the attraction plate to slide axially along the shaft against the spring loading of the coiled spring.

8. The other section of the shaft rides in a double ball bearing mounted in the centre plate of the actuator, and has fitted to the output shaft end the drive pinion to the main reduction gear train. The clutch end is machined to provide a spindle which rotates in ball bearings located in the hub of the attraction plate. Also at this end is an integrally formed disc to which is riveted the clutch lining making contact with the surface of the attraction plate.

9. The clutch is normally always engaged. When in this position the electro-magnet is de-energized and the attraction plate is pressed against the friction disc by the spring, allowing the two sections of the shaft to rotate together. By energizing the clutch coil the attraction plate is withdrawn from contact with the friction disc, and the main gear train and output shaft are allowed to freewheel while the motor remains stationary.

Gearbox

10. The gearbox, housing the reduction gear train, is formed by the centre bearing plate which is dowelled to the switch and gearbox housing. From the clutch drive pinion the motor drive is transmitted through a series of spur gears to the drive gear on the actuator output shaft. This shaft is supported in a double-race ball-bearing located in a bearing housing integrally machined with the switch and gear box housing. The output end of the shaft protrudes through an aperture in the actuator front cover. A slot is cut in the end to register with the drive connection on the component operated.

Limit switches

11. Three positive snap-action type micro-switches are mounted on the switch housing casting. Two switches control the OPEN and SHUT positions at the extreme limits of travel of the output shaft and are connected to the motor coils. The third controls the engaging of the clutch unit through a lead to the clutch coil. A spring lever arm fixed to the switch body actuates the switch button through a cam mounted on the output shaft.

Cam tripping mechanism

12. The cam tripping mechanism comprises the motor cam and the clutch cam, each mounted on separate carriers which are internally splined to register with splines on the output shaft. The clutch coil cam trip is bolted to the outer carrier, and is set to come into operation 25½ deg. before the OPEN position of the output shaft. The inner carrier, to which is bolted the motor cam trip, consists of a plate which is drilled circumferentially with a series of equally spaced holes to enable adjustment to be made to the position of the trip cam, and thus allow a variation in the angular travel of the output shaft to be obtained.

Electrical connections

13. The plug and socket for the electrical current supply is fitted in the top of the switch housing. The leads for the motor are encased in a sleeving passing through the clutch housing. Pin A is a neutral connection.

INSTALLATION

14. First, check that the actuator has the necessary fittings and is set to the appropriate angle of travel for the particular installation with which it is to be used. It

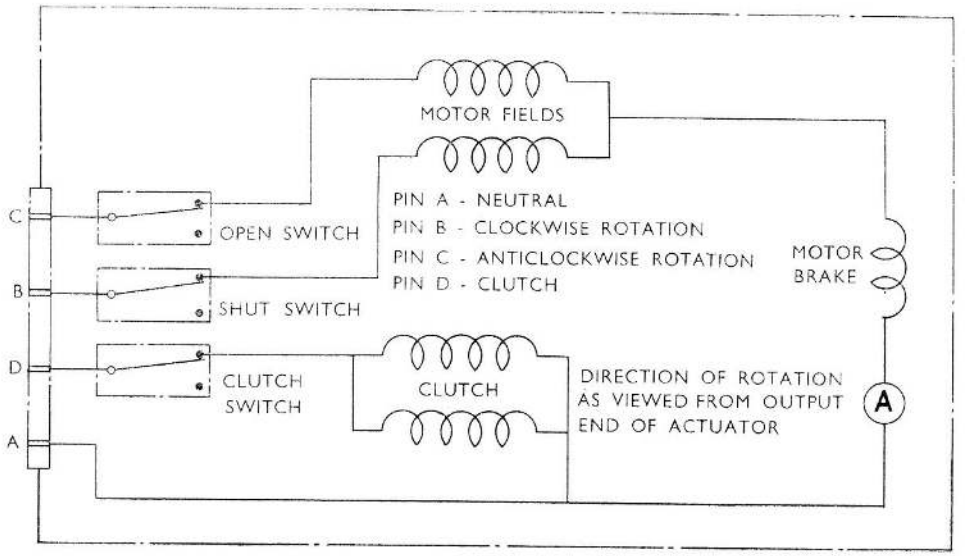


Fig. 3. Wiring diagram

is important to note that the actuator and its associated component are both at the end of their travel before coupling them together.

15. Remove the protective cap from the electrical plug on the actuator and join the plug and socket. Check that the mounting studs in the actuator and the holes in the mounting plate on the driven component are in alignment. If they are not, it is possible that the actuator will stall.

16. No lubrication of the actuator is necessary during installation, as thorough lubrication is effected during manufacture.

17. As mentioned, the actuator is fitted with limit switches. If their operation is prevented by the restrictive action of some mechanical brake or stop on the mechanism which is being operated, the actuator will remain energized in a stalled condition. This ultimately will cause the fuse to blow or, in the event of incorrect fusing, the motor windings to burn out.

18. After installation, the actuator should be given a test to ensure that it functions correctly.

SERVICING

19. These actuators should be serviced in accordance with the general chapter in A.P.4343, Vol. 1, Sect. 17, Chap. 1, and the instructions contained in the relevant Servicing Schedule.

Lubrication

20. As the actuators are lubricated during manufacture they should not normally require attention during service.

Brush gear

21. The brush gear of the motor is accessible when the cast end cover of the motor housing is removed. The condition of the brushes can be inspected and renewed if necessary: brush dust can be removed by using dry compressed air.

Insulation resistance test

22. The insulation resistance between all live parts and the frame, when measured with a 250-volt insulation resistance tester, should not be less than 500,000 ohms (R.N.) or 50,000 ohms (R.A.F.).

Final check

23. Check all external screws, and the lock-nuts for tightness and security. Ensure that the electrical plug and socket connections are tight and free from corrosion.

Appendix 1

ACTUATOR, PLESSEY, TYPE CZ 69442

LEADING PARTICULARS

Actuator, Type CZ 69442	*Ref. No. 5W/324*
Voltage range	22 *to* 29*V d.c.* 28*V d.c. (normal)*
Working load	
Normal	140 *lb. in.*
Maximum	175 *lb. in.*
Angular travel	314·5 *degrees*
Time taken for travel	
To 314·5 *deg. maximum*	26 *sec.*
To 314·5 *deg. emergency*	1 *sec.*
Motor	
Output	0·02 *h.p. at* 9000 *r.p.m.*
Rating	1 *minute*
Weight	4·5 *lb.*

The typical actuator described and illustrated in the main chapter is the Type CZ 69442.

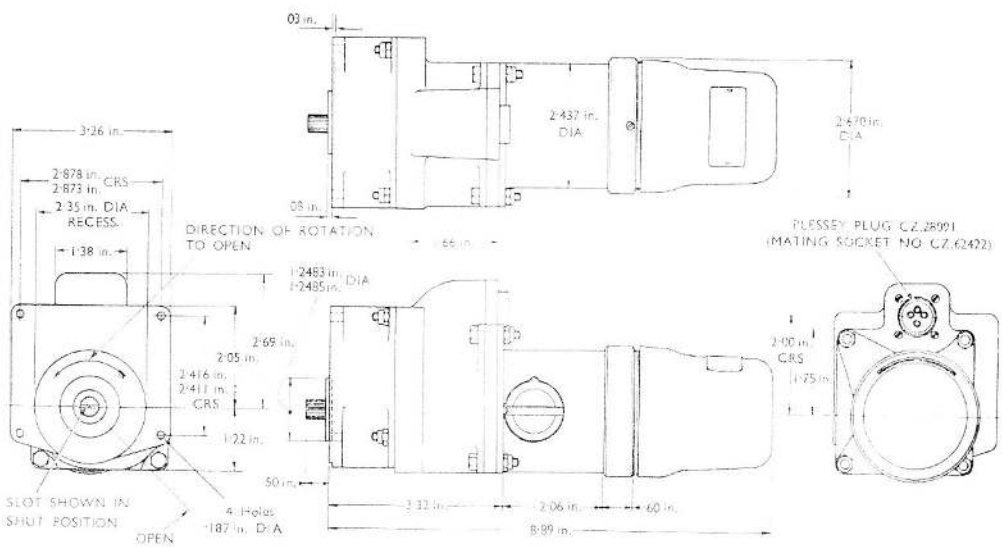


Fig. 1. Installation drawing

Appendix 2

ACTUATOR, PLESSEY, TYPE 1CZ 135442

LEADING PARTICULARS

Actuator, Type 1CZ 135442	*Ref. No. 5W/2569*
Operating voltage range	18 to 29*V d.c.*
Normal voltage	25*V d.c.*
Working load	
Normal	140 *lb. in.*
Maximum	175 *lb. in.*
Angular travel (total)	314·5 *degrees*
Time taken for full angular travel	26 *sec.*
Ambient temperature range	−50 *to* +150 *deg. C.*
Current consumption (at 25V d.c.)	1·2*A*
Weight	4·5 *lb.*
Motor, Type C1606B/9	*Ref. No. 5W/3505*
Rating	1·5 *minutes*
Weight	12·5 *oz.*
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.*
Brushes, Type CZ 62177/1	*Ref. No. 5W/1041*
Length—new	0·355 *to* 0·385 *in.*
worn	0·25 *in.*
Brake air gap	0·008 *to* 0·011 *in.*
Brake disc and friction lining	
Thickness (proud face of lining to back of disc)—new	0·120 *to* 0·125 *in.*
worn	0·115 *in.*

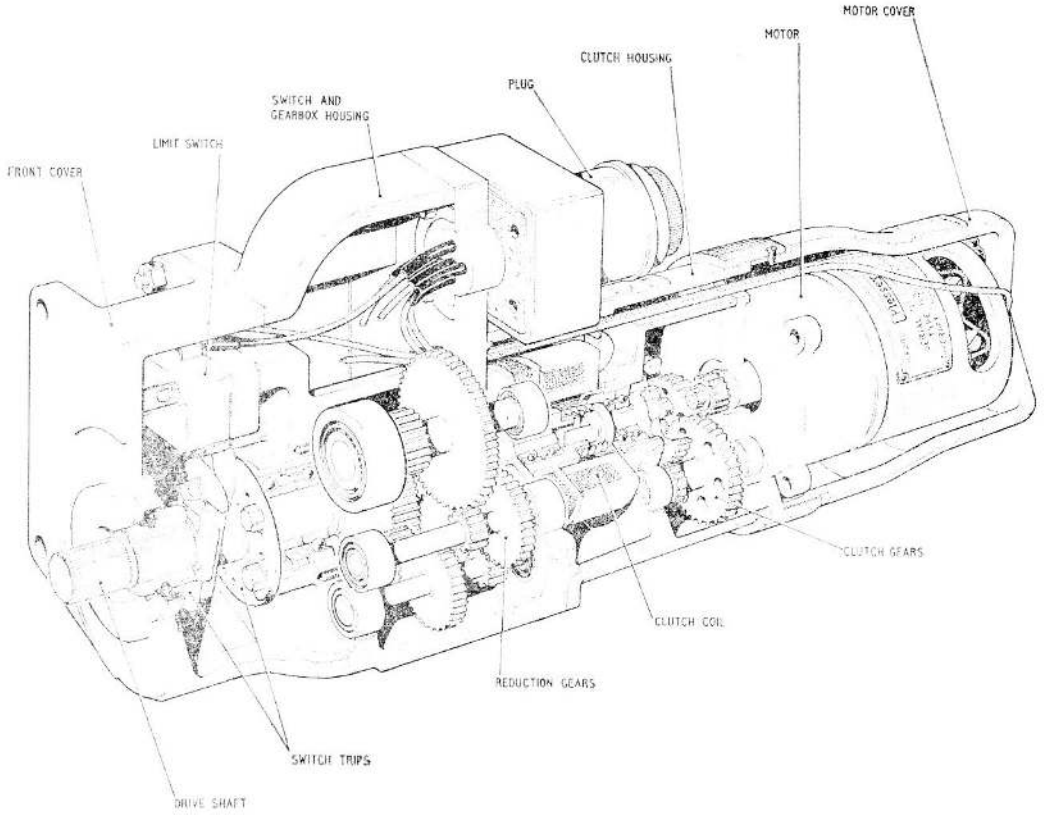


Fig. 1. Sectional view of actuator, Type ICZ 135442

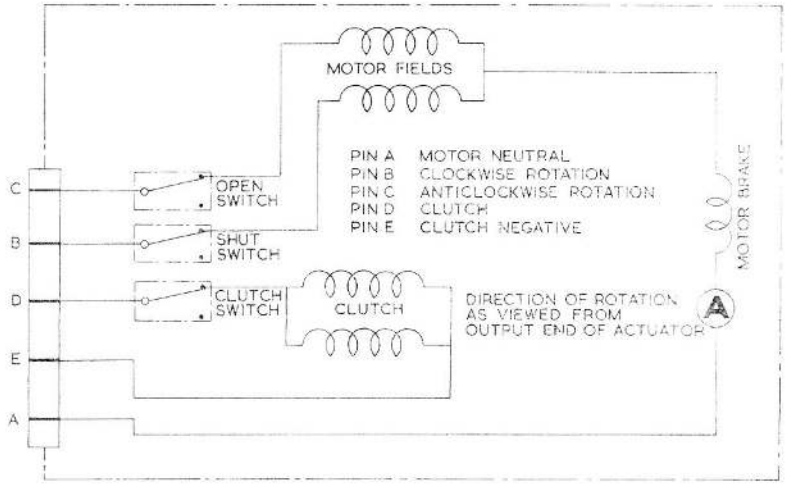


Fig. 2. Circuit diagram

1. Plessey Type 1CZ 135442 is a modified version of the typical Beaver actuator described in the main chapter. The following text outlines the salient features of this actuator and establishes the variations in design from that described in the main chapter. A sectional view of this actuator is shown in fig. 1.

2. The actuator is designed to provide remote operation of rotary equipment at a pre-set controlled rate. A clutch that is electro-magnetically released is built into the actuator to enable instantaneous disengagement of the internal driving and driven mechanism when externally selected. This enables an emergency operating procedure, external to the actuator, to prevail over the controlled opening of the associated equipment regulated by the actuator. The clutch is automatically re-engaged 25 degrees before the full "OPEN" position.

3. The essential constructional difference between this actuator and that described in the main chapter is in the clutch. Whilst the same components are used, the friction lining has been transposed. The lining is now carried by the attraction plate whilst the disc, integral with the clutch drive shaft, has a plain face. The method of attachment of the lining has also been modified; the lining is now bonded to the face of the attraction plate instead of being riveted.

4. The electrical system of this actuator differs from that of the type described in the main chapter in that the clutch coil has been provided with its own negative line return. This is effected by the introduction of a five pole plug, the pin 'E' providing the additional service. A schematic diagram of the modified circuit is shown in fig. 2. The plug itself has been re-positioned and is mounted at the outer face of the gearbox; no part of the plug extends into the actuator housing. A plate and a shroud have been introduced to adapt the plug to its new mounting position.

5. The information given in the main chapter regarding installation and servicing is applicable to this actuator. For details of installation in a particular aircraft, reference must be made to the relevant Air Publication. An installation diagram is shown in fig. 3 (overleaf).

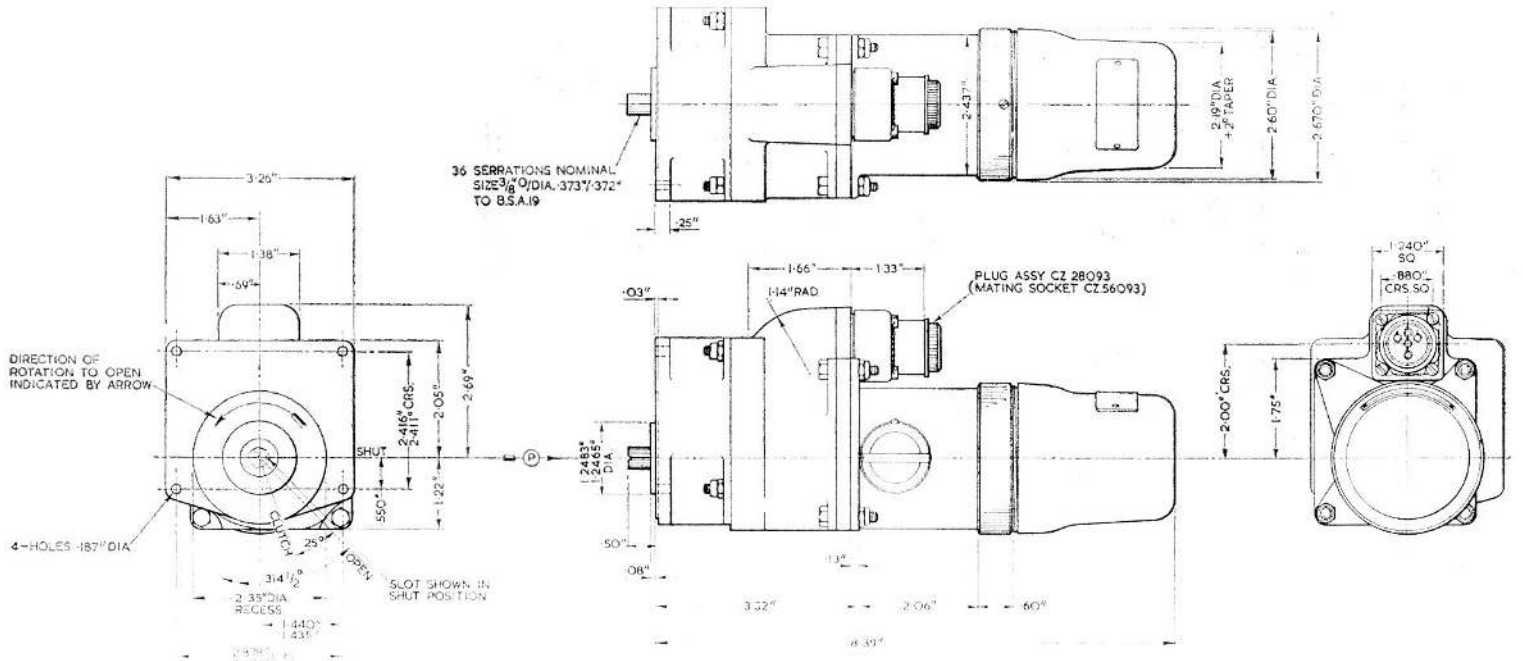


Fig. 3. Installation drawing