Appendix 12

PLESSEY, COUGAR SERIES

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Normal working load of actuator ...	275 *lb. compression or tension*
Maximum working load of actuator ...	400 *lb. compression or tension*
Maximum static load of actuator	1000 *lb.*
Operating temperature range ...	—55 *deg. C to* +90 *deg. C (Ambient)*
Operating time for normal load	$1\frac{1}{2}$ *in. in* 8 *sec.*
Stroke in either direction	$1\frac{1}{2}$ *in.*
Working voltage	18 *to* 29 *volt d.c.*
Weight of complete unit	2 *lb.* 12 *oz.*
Fixing centres retracted	8·812 *in.* ± ·010 *in.*
Fixing centres extended	10·812 *in.* ± ·010 *in.*
Gearbox	*Three stage, epicyclic*
Performance of motor	
Voltage range	18 *to* 29 *volt d.c.*
Output	0·03 *h.p. at* 15000 *r.p.m.*
Rating	$1\frac{1}{2}$ *minute at normal working load*

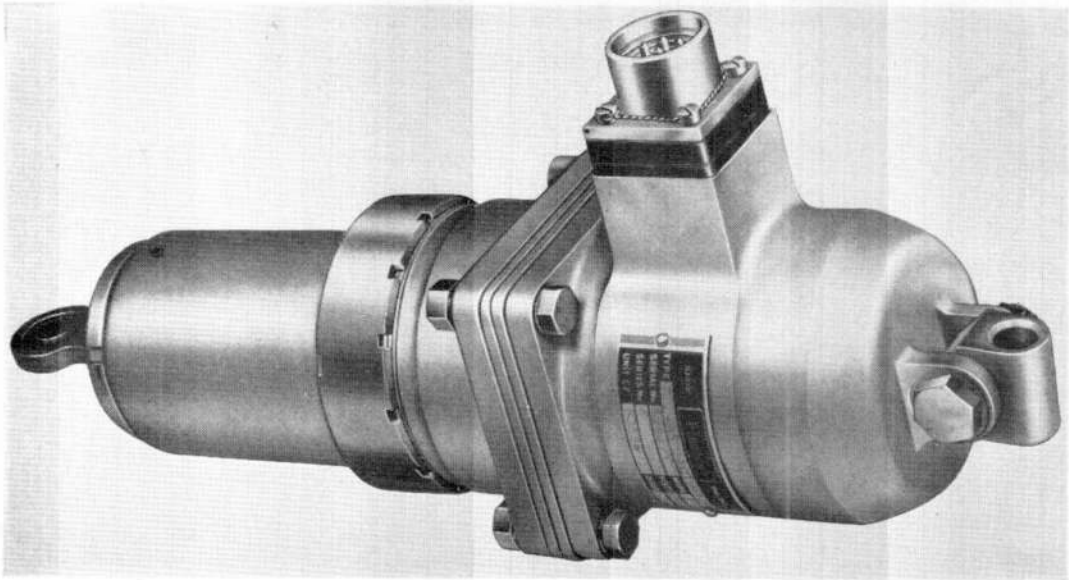

Fig. 1. General view of actuator

Introduction

1. Plessey linear actuators of the Cougar series follow the general design described in this Appendix; the actuator illustrated is typical of the series and specific details of individual actuators is contained in A.P.-4343D, Vol. 1, Book 3, Sect. 14.

2. This series of actuators has alternative types of electrical connector plugs to suit particular aircraft installations. The three alternative types of plugs used are Bendix, Cannon and Plesseys.

3. Later type actuators of this series only

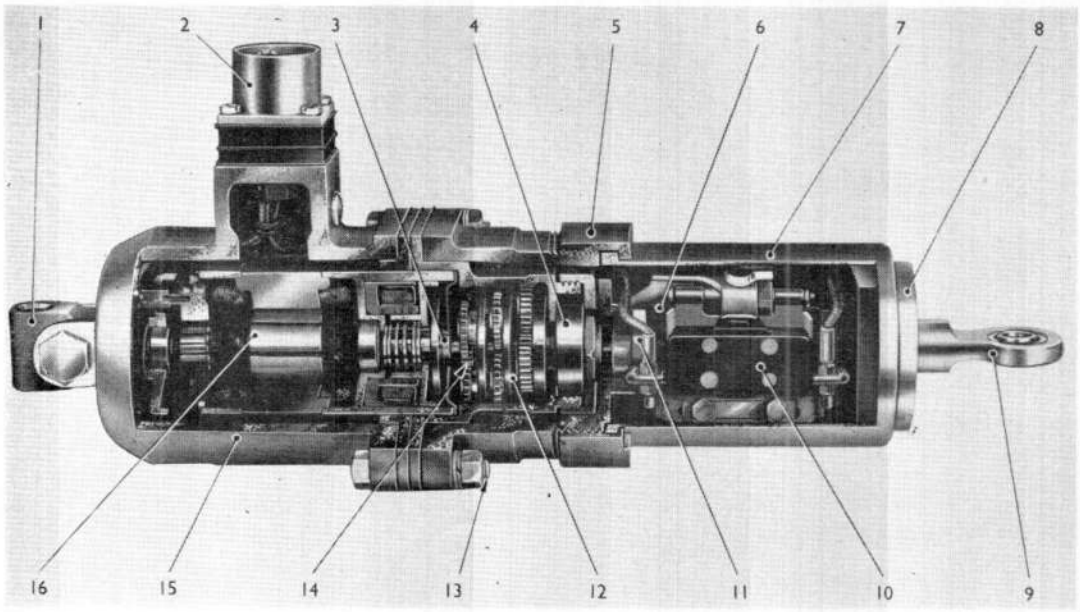

Fig. 2. Sectional view of actuator

differ from their predecessors in that certain components such as insulation sleeving for the internal wiring, all gaskets and an oil seal, have been changed to render these actuators resistant to ester base lubricants.

4. The performance of this series of actuators are identical, see Leading Particulars.

DESCRIPTION

General

5. The actuator is driven through epicyclic gears by a split-field series motor, with a built in electro-magnetic brake to prevent overrun of the armature, and is capable of withstanding a static load of 1000 lb. a maximum working load of 400 lb. or a normal working load of 275 lbs. The length of stroke is $1\frac{1}{2}$ in., controlled by snap-action limit switches. This actuator is available with alternative types of electrical connector to suit particular aircraft installations.

6. The actuator is a built up unit, the main components comprising a motor, annulus housing which also forms part of the gearbox, plunger housing, lead screw, plunger, limit switches and rear end fitting, enclosed within a metal cover in two sections, with front eye-end fitting and plug exposed.

Key to Figure 2

1 LINK, UNIVERSAL
2 PLUG, ELECTRICAL
3 PINION AND BRAKE PLATE
4 BALL RACE
5 RING, RETAINING, COVER
6 PLUNGER, HOUSING
7 COVER ASSEMBLY
8 NUT, GLAND HOUSING
9 PLUNGER, EYE END
10 SWITCH ASSEMBLY
11 KEY, PLUNGER
12 2ND STAGE GEAR ASSEMBLY
13 BOLT, MAIN ASSEMBLY
14 1ST STAGE GEAR ASSEMBLY
15 MOTOR HOUSING
16 MOTOR ARMATURE

Annulus, gearbox and plunger housing

7. The annulus housing is integral with the gearbox housing and the three-stage epicyclic gear train is attached to the lead screw, which has an extension on its shaft to locate correctly the various gear stages. The lead screw is supported in a ball race recessed at the rear of the annulus. The gearbox is fitted in the end section of the plunger housing.

8. A large retaining nut screws on the external flange of the annulus housing, and a small hexagon nut (screwed on the extension of the lead screw which protrudes through the housing) retains the lead screw in position in the ball race. The lead screw retaining nut is locked with a multi-tab washer, one tab of which is knocked into one of the two slots on the nut, while another tab locates in a slot on the housing flange. On the hexagon nut, a portion of the washer, recessed in its surface, is stagged into a flat (or recess) on the lead screw shank.

9. When assembled, the plunger housing encloses the lead screw and plunger, and is bolted to the gearbox by its end flange plate, which mates with a similar flange plate on the gearbox housing. The other end of the plunger housing contains a bush, which is a sliding fit over the plunger, an annulus groove in the bush serves as a reservoir for grease. The bush serves as a guide for the plunger, and takes any deflecting side thrust.

10. Along each side of the plunger housing is a slot, in which travel the torque reaction ears of the plunger. The limit switch operating mechanism (trip arms), fitted over these slots, is actuated by the plunger ears.

11. An oil seal, enclosed within a gland housing, is fitted at the extremity of the plunger housing, where the plunger emerges, and is retained in position (and prevented from rotating when the gland nut is being fitted or removed) by an indentation in its inner surface, which locates with a screw head on the end surface of the plunger housing. The screw, recessed into a cut-away section on the flange of the bush in the plunger housing, also serves to locate the bush in the latter.

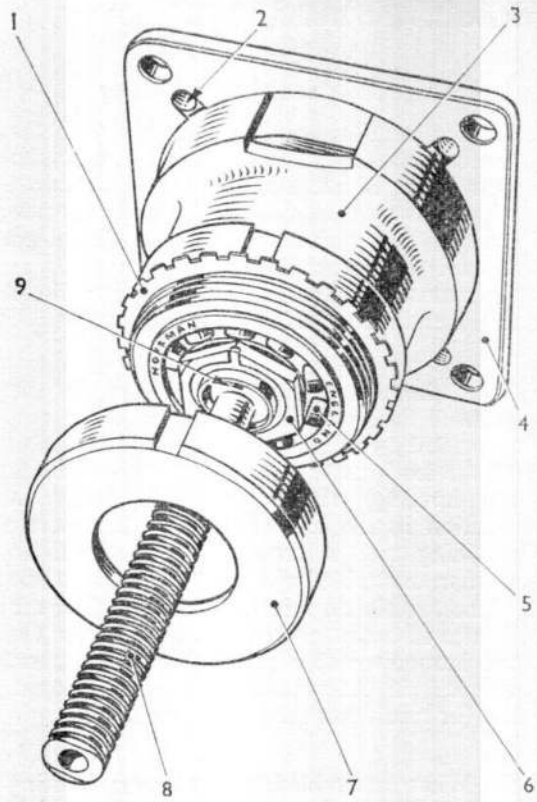

Fig. 3. Lead screw and bearing housing

Key to Figure 3

1 WASHER, TAB, SPECIAL
2 TAPPED EXTRACTOR HOLES
3 ANNULUS
4 GASKET
5 BALL RACE
6 CLAMPING NUT, HEXAGON
7 NUT, RETAINING, BALL RACE
8 LEAD SCREW
9 LOCKING RECESS

12. The plunger housing is marked " IN " and " OUT " respectively on either side; this facilitates the fitting of the correct limit switches, the operating mechanism of which, in each case is similarly marked. The limit switches are also identified by coloured spots on their moulding. In the case of the " IN " switch there is a red spot, while on the " OUT " switch is a blue spot.

Lead screw

13. The lead screw is threaded along its main length with a two-start, $\frac{5}{16}$ in. diameter Acme-form thread, ground to special limits and is a close mating fit with the plunger. The shank portion of the lead screw is referred to as the lead screw extension and becomes part of the gearbox.

14. Between the Acme-threaded portion and this extension, the lead screw is threaded to accommodate the hexagon lock nut.

Plunger

15. The plunger comprises a chromium-plated tube and eye-end, screwed and pinned together. The eye-end contains a " Hoffman " self-aligning joint and this allows for a maximum of 6 degrees inclusive misalignment with the linkage. At the gearbox end, on the square of the plunger, the detachable torque reaction and switch key (plunger ears), lock washer and ring nut, are fitted.

16. The plunger is internally threaded at the gearbox (square end) for a length of $\frac{1}{2}$ in. to mate with the lead screw.

Epicyclic reduction gear

17. The three-stage epicyclic reduction gear train comprises three sun wheels, and three carrier plates with planet gears. The first stage sun wheel drives three planet gears, pinned and riveted to a carrier plate, the remaining two sun wheels each drive four similar gears similarly pinned and riveted to carrier plates, all three stages revolving within the annulus and supported on the lead screw extension.

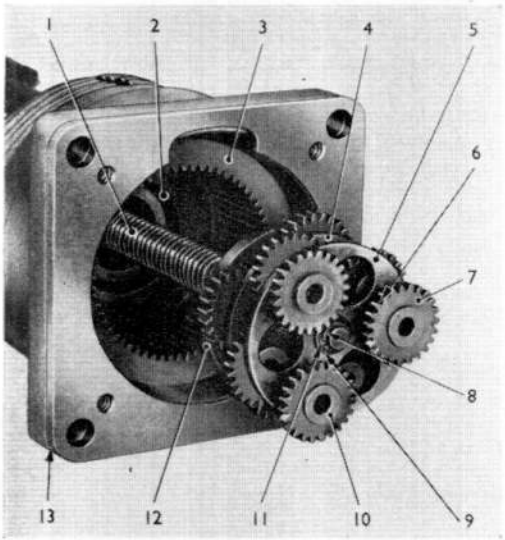

Fig. 4. Gear components

Key to Figure 4

1	LEAD SCREW ASSEMBLY
2	BALL BEARING
3	ANNULUS
4	2ND STAGE GEAR ASSEMBLY
5	1ST STAGE GEAR ASSEMBLY
6	OIL HOLE
7	PLANET GEAR
8	CIRCLIP
9	SHIM
10	SUPPORT PIN
11	WASHER
12	3RD STAGE GEAR ASSEMBLY
13	GASKET

18. The motor pinion serves as the first stage sun wheel, the carrier plates being mounted one above the other, each stage sun wheel engaging with the planet wheels of the carrier below it. The carrier plate remote from the motor has no sun wheel, being machined integrally with the lead screw. A circlip retains the gear carriers on the lead screw extension.

19. The planet gears each have two small holes through their teeth section to ensure lubrication of the gear support pins. From the motor end, each gear stage has increased tooth face width.

Limit switches

20. The limit switches are of the snap action type, on which the moulding of the switch housing completely shrouds the contacts and the micro-brake mechanism. Two electrical connections are made to each switch; these are screwed to the contacts located on each side of the mouldings. Each switch is riveted to a mounting plate, retained against the plunger housing by a clamping plate and two hex. hd. screws; these screws pass through a slot in each mounting plate and screw into holes in a threaded fixing plate fitted behind the screw locating holes in the housing. The same screws also serve to locate the guide plates (two at each switch) for the electrical connections. The guide plates are designed to eliminate any possibility of the leads fouling moving parts. The slots in the mounting plates provide the means for final stroke adjustment.

21. Integral with each mounting plate are two small hinges and centrally pivoted between each pair (by means of a pin, miniature washer and split pins) is the switch operating lever, one arm of which depresses the switch button, as the other arm is actuated by the plunger ear (or key), as the plunger moves through its stroke.

22. Reference to the circuit diagram (*fig.* 5) and schematic wiring diagram (*fig.* 6) will indicate how the limit switches are connected in the circuit.

Motor

23. The motor is of the split-field, series wound type with an integral electro-magnetic brake, and has been designed to function on 18 to 29 volt d.c. When assembled, the motor is located by a spigot into the gear

housing, the motor pinion forming the sun wheel for the first gear stage.

24. The motor pinion forms part of the brake plate and is pin-driven by the armature shaft. The friction disc is pressed against this plate by the loaded brake spring when the motor is de-energized.

25. The armature is supported in ball races enclosed in brass cases to retain lubricant.

26. The motor brushes are of " H.A. Morganite " carbon and have flexible pigtails for the electrical connections.

27. The brush boxes are mounted on an insulated brush rocker which may be set in relation to the split series field to give equal armature speeds in both directions of rotation. Performance curves are shown (*fig.* 7).

29. When the motor is de-energized, the magnetic field around the brake coil collapses and the loaded brake coil spring forces the brake disc assembly against the brake plate, rapidly retarding armature rotation, with a minimum of overrun.

30. The torque reaction of the brake disc assembly is overcome by two diametrically opposed lugs (or ears) protruding from the periphery of the disc; these locate in slots in the periphery of the front housing.

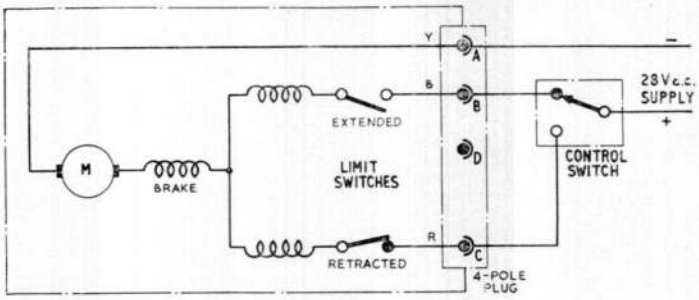

Fig. 5. Circuit diagram

Electro-magnetic brake

28. The brake is located at the pinion end of the motor and may be viewed by removing the pinion. When the motor is energized from a 18 to 29 volt d.c. supply the brake coil which is connected in series with the field coils, attracts the brake disc assembly, against the action of the brake coil spring. This action clears the brake plate (and pinion), thus allowing the armature to accelerate.

Wiring

31. The earlier type of actuator of the Cougar series are wired with 14/0076 Lewcos T.D.F. 360 glass covered cable. In addition to the normal insulation, each cable is sleeved with Vidaflex " 555 " glass braid sleeving (colour coded).

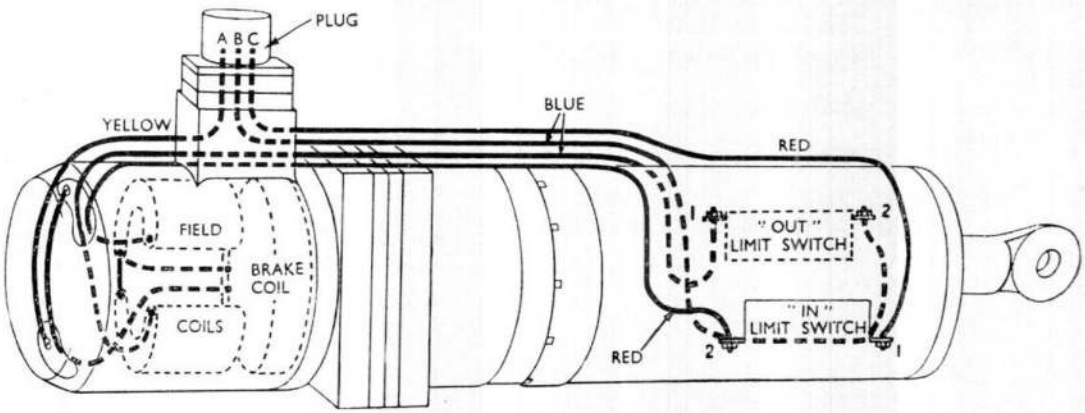

Fig. 6. Schematic wiring diagram

32. The later type of actuator of the Cougar series is wired with 14/0076 Lewcos 364 Siliconed cable which is resistant to ester

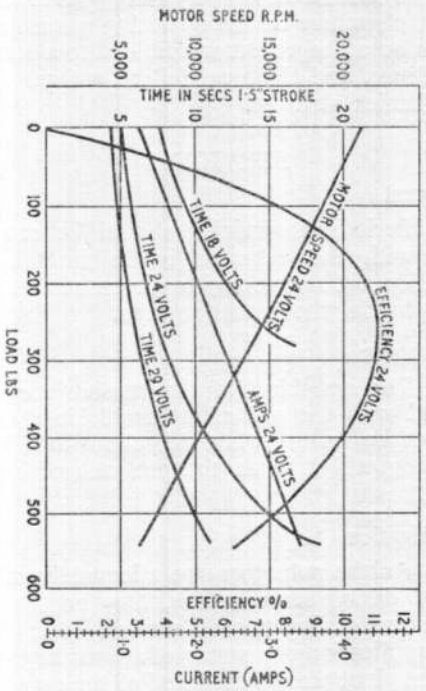

Fig. 7. Performance curves

base lubricants. The wiring conforms with the following plug designations "A" pin Common (Yellow), " B " pin Extend (blue), " C " pin Retract (red).

Electrical connection

33. With the electrical plug, pin D is spare, the plug being positioned relative to the actuator, so that the largest plug pin lies on the actuator centre line and is nearest the plunger.

OPERATION

34. The reversible, fractional horse power motor drives through a three-stage, epicyclic gearbox, the last stage being connected directly to the lead screw. Moving over this lead screw is the plunger which is prevented from rotating by two torque reaction ears (or lugs) attached to the plunger, which move in locating slots in the enclosing plunger housing.

35. Dependent on the direction of rotation of the motor therefore, the plunger extends or retracts in a linear motion within fixed limits, the extent of movement being controlled by the adjustable snap-action limit switches which are connected in each series field of the motor. The limit switches are mounted on the plunger housing and are operated by the torque reaction ears.

36. An electro-magnetic brake incorporated in the motor ensures that the selected rest positions of the plunger are controlled to within plus or minus 0·010 in. under all conditions of operation.

37. The actuator is totally enclosed by the two covers which fit over the motor and plunger housing respectively. The electrical connector plug is mounted on the motor cover, which also has integral lugs to accommodate the rear end fittings.

End fittings

38. The type of end fitting to be used on both the fixed end of the actuator and the end of the plunger (moving end), very dependent on the function to be performed by the actuator.

INSTALLATION

General

39. For details of actuator installations in particular aircraft, reference should be made to the relevant Aircraft Handbook.

Preparation

40. The mechanical coupling of the actuator to the linkage of the component requiring operation depends mainly on the installation itself. The rear end fitting of the unit is coupled to a fixed position and the front (plunger) end fitting is coupled to the linkage. Design and positioning of fork ends and levers should be such, as will allow the actuator to function freely and efficiently; the fixed and movable links of the operated components must, therefore, be in line, otherwise considerable strain on both actuator and linkage will result.

41. The fork ends, or fittings, which accommodate the actuator front and rear ends should be machined to allow a small amount of side play, and the fixing bolts should be shouldered so that when tightened the fork ends do not tend to close in and reduce this side play, with resultant binding.

42. The front end fitting contains a " Hoffman " self-aligning ball joint which, allows for any small misalignment (up to 6 degrees inclusive) in the positioning of the linkage.

43. It should be remembered that during the full throw of its stroke the actuator rises and falls an amount, depending on the radius of operation of the lever on the linkage. This movement will tend to strain the supply cable unless sufficient free play is allowed at this point.

44. Before coupling the actuator to the installation, ensure that all links, joints and bearing pivots, etc., of the components being actuated, are free to move. The installation centres must be checked with the actuator installation drawing. The fixing bolts should be passed through the location holes to ensure a good fit.

45. A functional test to ensure that the wiring connections are correct before the actuator is mechanically coupled, is desirable.

Installing actuator

46. To install the actuator, couple the rear end fitting to the fixed fork end of the installation. Slightly rock the unit to check the fitting of the fixing bolt, both before and after the attachment of the washer and nut, etc. Swing the actuator into position for coupling to the moving link, and ensure that the front (plunger) end fitting enters the fork end of the linkage freely, i.e. without touching the sides of the fork arm.

47. The fixing bolts should be well lubricated with grease, and the actuator plunger should carry a light film of grease.

Part No.	Description (New)
1CZ 81946	Cable Assembly comprises:
Z 49428	Sleeve, 4-amp.
CZ 28091	Receptacle (Plessey)
1CZ 80617/A/31	Cable Assembly } Can be
1CZ 80617/B/31	Cable Assembly } assembled
1CZ 80616/E/21	Cable Assembly } from these
	Cable 14/0076 Lewcos 364 Siliconed
1Z 80615/E	Sleeve (Yellow)
1Z 80615/A	Sleeve (Red)
1Z 81227	Sleeve (Red)
1Z 80615/B	Sleeve (Blue)
1Z 81227/B	Sleeve (Blue)
1Z 80980	Crimp Terminal
Z 54079	Tag
1Z 80412	Thimble

48. The function of the limit switches in determining the stroke of the actuator must not be interfered with by fitting mechanical stops elsewhere on the operating mechanism. Such an arrangement would lead to a stalled condition and electrical failure and possibly mechanical damage.

SERVICING

General

49. Periodical servicing should be carried out with the actuator in its installation position, the socket may be disconnected from the plug for the insulation tests.

Brushgear

50. The condition of the brushes may be tested with the use of a suitable insulation resistance tester, when an abnormal (low) reading will indicate the presence of brush dust.

Lubrication

51. As the actuators are adequately lubricated during manufacture, they require no attention during normal service, other than the application of a smear of approved grease to the pivot pins at each end of the actuator.

52. The later type of " Cougar " actuator is identical in design with the earlier types, except that the materials used for certain components (which are liable to deteriorate on contact with oil, or, grease) have been changed, to render the actuator as a complete unit, resistance to ester base lubricants.

The parts affected are listed as follows:—

Quantity	Replaces (Old)
1	1CZ 80473 (Receptacle Assembly)
3	
1	
1	1CZ 80476 (Red)
1	1CZ 80630 (Blue)
1	CZ 71381/4 (Yellow)
18 in.	14/0076 Flex TDF 360
2	Vidaflex (Yellow) 555
1	Vidaflex (Red) 555
1	Vidaflex (Red) 555
1	Vidaflex (Blue) 555
1	Vidaflex (Blue) 555
2	Z 72793
1	Unchanged
1	Z 54066

Table—*continued*

Part No.	Description (New)	Quantity	Replaces (Old)
1CZ 82558	Gland housing assembly as G	1	CZ 63286
1Z 42341	except Oil Seal R20 P70/EP	1	Z 29183
1Z 81938	Gasket	1	Z 60725
1Z 81848	Gasket	2	Z 60726
1Z 81847	Gasket	1	Z 61928
1Z 81945	Gasket	1	Z 63253
1Z 81849	Gasket	1	Z 63352
1Z 81939	Gasket	1	Z 59608
	Miscellaneous		
99/0222	Hermatite jointing compound 1326	As Req'd	99/0215 " Wellseal " compound
99/0955	Epihard clear lacquer 480/1		99/0980 Lacquer and
99/0023	Epihard Accelerator 480/2		99/1569 Kearsley's VX438

Note . . .

During the normal operational life of the actuator, no adjustment should be necessary to the brush spring pressure. It should not be necessary to renew the brushes. Should such action be necessary, it must only be carried out by qualified personnel, acting on competent authority and when adequate servicing equipment is available.

Final inspection

53. Examine all external screws, and the locknuts on the plunger end fitting, for tightness and security. Ensure that all pivot pins are secure and that the electrical plug and socket connection is tight.

Insulation resistance test

54. Using a 250 volt insulation resistance tester, measure the insulation resistance between the electrical circuit and earth; this test can best be effected at the Breeze plug whilst still installed in the aircraft. The insulation resistance must not be less than 2 megohms when first installed in the aircraft.

55. Due to the humidity prevalent in aircraft and at dispersal points, the minimum permissible insulation resistance is 50,000 ohms.

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