

Chapter 64

ACTUATOR, WESTERN TYPE EOJ 600, MK. 1

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Introduction

1. The linear actuator, Western, Type EOJ 600, Mk. 1, has a normal working load of 600 lb. with a maximum of 900 lb.

2. The actuator incorporates a split-field, series-wound, fractional horsepower motor

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(normally operating from a 28-volt d.c. supply) which drives the piston through a gear reduction train and a worm. The piston is mounted parallel with the motor axis and its linear travel is controlled by two snap action limit switches. The motor, with its pinion and electro-magnetic brake, is a complete replaceable item.

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DISMANTLING

3. Before commencing dismantling, separate the electrical socket from the plug, remove the bolt or pin which connects the actuator to the actuated component and run the actuator to the approximate centre of its stroke.

End fittings

4. The end fittings should first be removed.
- (1) Slacken back the lock nut, unscrew the front end fitting from the piston and take off the lock nut.
 - (2) Take off the nuts and washers from the four studs which connect the rear end fitting to the bearing housing and remove the end fitting and its gasket.

Cover

5. The cover should next be removed.
- (1) Take off the stiffnuts and washers which connect the cover to the securing bracket and remove the cover, taking care to retain the rubber seal which is fitted between the cover and the bearing housing.
 - (2) Take out the grub screw and slide the securing bracket off the piston housing.

Limit switches

6. The limit switches may now be removed.
- (1) Disconnect all leads from switches after marking for re-assembly.
 - (2) Take out the sq.hd. screws and washers and remove the locking tags and the switch assemblies.

Motor

7. The motor should now be removed from the actuator.
- (1) Disconnect leads from motor after marking for re-assembly.
 - (2) Take off the nuts and grover washers from the four studs which connect the motor (through the gearbox housing) to the bearing housing and withdraw the motor over these studs.
 - (3) Remove the rubbing plate and shims between the motor and the gearbox, noting the shims for re-assembly.

Note . . .

Dismantling of the motor is described in para. 10 to 14.

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Gearbox, piston and worm

8. The gearbox, piston and worm should now be dismantled.

- (1) Take off the nuts from the four studs which hold the gearbox housing to the front bearing housing and draw the complete gearbox off these studs.
- (2) The annulus may be removed, if necessary, from the gearbox housing by sliding it over the protruding grub screw.
- (3) Take off the nuts and shakeproof washers from the two studs which secure the circular cover plate to the rear bearing housing and remove the cover plate and gasket.
- (4) Draw the rear bearing housing off the six studs which project from the front bearing housing and retain the gasket which is fitted between these two housings.
- (5) The piston and worm, complete with $\frac{5}{8}$ in. nut, locking washer, two ballraces, shims and worm driving gear, may be withdrawn from the rear end by tapping lightly with a plastic or hide hammer from the front end.
- (6) Unscrew the worm from the piston and remove the nut, locking washer, ballraces, shims, and drive gear from the worm shaft, carefully observing the location and rotation of each ballrace so that they can be re-assembled exactly as before.

Note . . .

The drive gear is keyed on to the worm shaft.

- (7) Remove the idler gear from its bush in the front bearing housing.
- (8) Take off the nuts and washers from the four studs which connect the piston housing to the front bearing housing and remove the piston housing, taking care to retain the two 'O' rings at the out-board end.
- (9) Remove external circlip from rear end of gearshaft and push out the complete gear assembly from the gearbox housing.
- (10) Take out three csk.hd. screws and remove the ballrace retaining plate.
- (11) Press the gearshaft ballrace out of the front bearing housing.
- (12) Remove Anderton clip from front end of gearshaft and dismantle planets and

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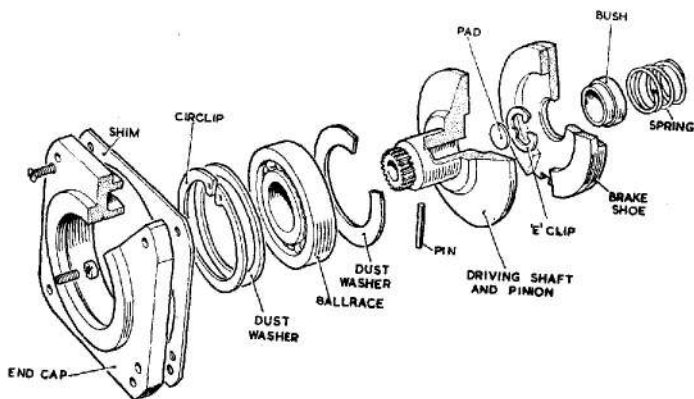


Fig. 2. Motor end cap, driving shaft and brake assembly

carriers, carefully noting their sequence and retaining the shims for re-assembly.

Electrical connection

9. The electrical plug and connections may now be removed.

(1) Take out four ch.hd. screws, lift the Breeze plug off its mounting (retaining the gasket) and ease the leads through the access slots in the bearing housing.

(2) If it is necessary to remove the plug mounting, take off the nuts and grover washers from the two studs which project from the front bearing housing and remove the mounting and its gasket.

Motor end cap, driving shaft and brake assembly

10. The end cap, driving shaft and brake assembly should first be removed when dismantling the motor.

(1) Take out two csk.hd. screws which hold the end cap to the motor casing and remove the end cap complete with ballrace, dust washers and driving shaft, retaining the shims which are fitted between the end cap and the body.

Note . . .

The driving shaft will slide off the end of the armature shaft.

(2) Draw the driving shaft out of the ballrace.

(3) Remove the internal circlip and both dust washers.

(4) Press the ballrace out of the end cap.

(5) Take off the 'E' clip from the armature shaft and remove the brake shoe, bush and spring.

Brushes and brushgear

11. The brushes and brushgear should next be removed.

(1) Remove the screws from the brush tags and disconnect the leads from the solenoid and field coils.

(2) Raise the brush springs, taking care not to strain.

(3) Mark the brushes and slip them out of their holders.

(4) Slacken the two ch.hd. screws which secure the brushgear mounting plate to the brushgear end cap, and rotate the brushgear sufficiently to obtain access to the nuts on the two studs which hold the brushgear end cap in position.

(5) Take off these two nuts and remove the brushgear end cap complete with internal circlip, ballrace, insulator brushgear assembly, dust washer and shim washers.

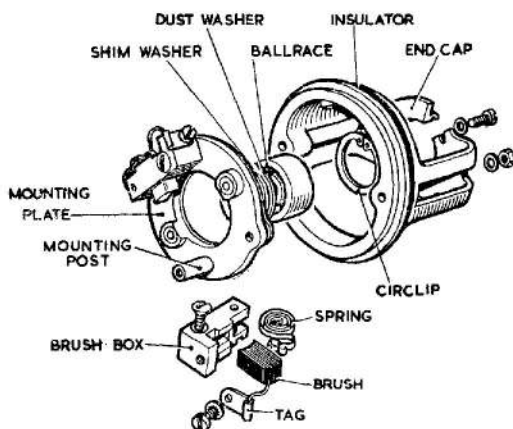


Fig. 3. Brushgear assembly

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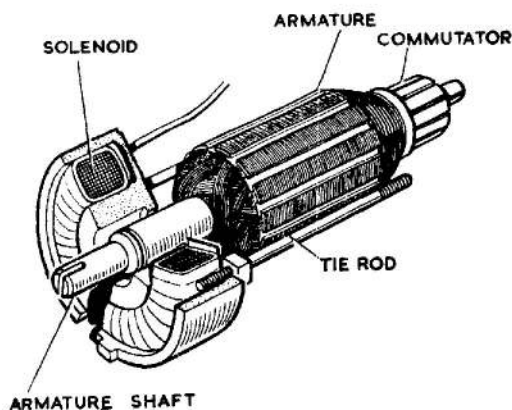


Fig. 4. Armature and brake solenoid

(6) Take off the circlip and withdraw the ballrace and dust washer from the end cap.

(7) Remove the brushgear mounting plate, if necessary, after taking out the two ch.hd. screws referred to in (4) above.

Armature and brake solenoid

12. The armature and brake solenoid may now be removed.

(1) Withdraw the armature from the front end.

(2) Unsolder the lead which connects the solenoid with the motor field tag.

(3) Tap the tie rods with a plastic or hide hammer and withdraw the solenoid from the rear end.

Field coil assembly

13. The field coil should be tested in situ. If it proves defective, remove as follows:—

(1) Remove all wires from the brushbox end of the windings.

(2) Close the tags down on to the field.

(3) Take out the csk.hd. screw which locates the field assembly in position and withdraw the field coils.

INSPECTION AND REPAIR

14. The faults, causes and remedies table which follows indicates the nature of failure causes and is a guide to the inspection and repair required.

(1) Wash all mechanical parts in lead-free gasoline or white spirit until all traces of dirt and stickiness have disappeared.

(2) Measure parts for tolerances, etc., in accordance with Schedule of fits, clearances and repair tolerances given in Appendix 1.

(3) Examine gears carefully for signs of burrs or grooving. Burrs may be removed with a fine carborundum stone but chipped or grooved gears must be renewed.

(4) Check that 'O' rings are not damaged.

(5) Information on inspection and repair of motors is contained in A.P.4343, Vol. 6, Sect. 18, Chap. 1.

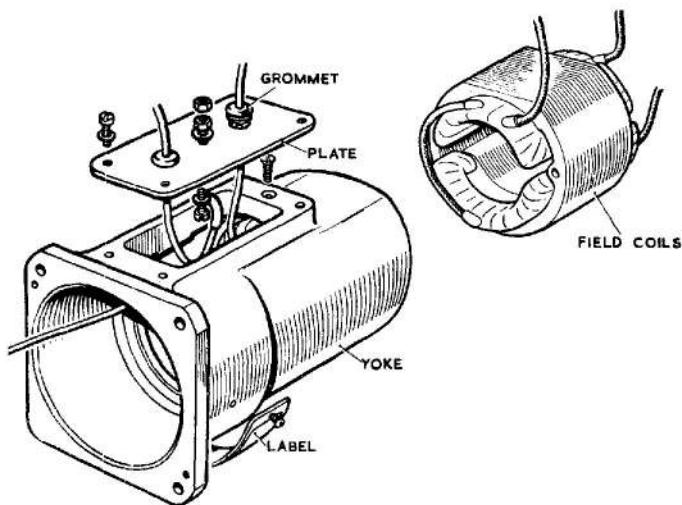


Fig. 5. Yoke and field coils

Table 1
Faults, causes and remedies

Fault	Possible cause	Remedy
Actuator fails to start	Open circuit Limit switch not making	} Clean contacts or renew limit switch
	Seizure Mechanical failure	
	Breakage	} Indicated by motor running but output not operating. Strip and examine, renew broken parts
Actuator operates slowly or lacks power	Defective motor	} Check motor, see last item in Table
	Excessive friction in actuator	
	Loose connection or faulty switch	} Trace and correct. Renew switch or clean contacts

For motor faults, causes and remedies, see A.P.4343, Vol. 1, Sect. 18, App. 1.

ASSEMBLING

Motor

15. After completing the inspection and repair of the motor, it should be re-assembled in the reverse order from that used in dismantling but the following special points should be noted.

- (1) Adjust brush pressure before assembling the brushgear to the motor. This, measured on a former of 0.74 in. dia. should be between 7.5 and 8.5 oz. and is obtained by rotating the adjustment stud in the direction required to adjust the spring tension.
- (2) Re-assemble all screws with varnish Ref. No. 33B/937.
- (3) Replace shim washer between commutator and the dust washer at brush-gear end.
- (4) Adjust grub screw in motor end cap to remove armature end float.
- (5) Replace shims between body and motor end cap to maintain brake gap of 0.012 in. to 0.018 in.
- (6) Ensure that brake solenoid and motor end cap locate on their respective spigots and keys.
- (7) Return the brushes to their holders only when the motor is fully assembled, after which the leads may be connected up.

Gearbox

16. The gearbox may be assembled as follows:—

- (1) Press the gearshaft ballrace into the front bearing housing and fit the ballrace retaining plate, securing same with three csk.hd. screws.
- (2) Insert the final carrier shaft into the ballrace. This carrier is integral with the transmission pinion and stub shaft.
- (3) Fit the external circlip to the rear end of the gearshaft.
- (4) Slide the annulus ring into the gearbox housing, fit the gearbox housing over the four upper studs which project from the front bearing housing and secure with four nuts.
- (5) Fit three planet gears to the final carrier hubs, insert the second carrier and engage its sunwheel with the three planets.
- (6) Drop in three more planet gears, insert the first stage carrier and engage its sunwheel with these three planets.
- (7) Fit the four remaining planet gears on to the hubs of the first carrier and replace shims, Anderton clip and rubbing plate.
- (8) Gears and annulus should be lightly greased before assembly with XG-275 grease.

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Bearing housing piston and worm

17. The bearing housings, piston, worm and idler gear may next be re-assembled and fitted.

(1) Pass the piston housing over the four lower studs which project from the front bearing housing and secure with nuts and grover washers.

(2) Assemble the piston and worm as follows:—

(a) Fit the forward ballrace on the wormshaft, followed by the driving pinion which is to be keyed on, and then fit the rear ballrace, ensuring that the ballraces are replaced in the same location and rotation as when they were dismantled.

(b) Screw the worm into the piston.

(c) Replace the shims, lockwasher and $\frac{5}{8}$ in. nut.

(3) Return the assembled piston and worm into the piston housing and ensure that 'O' ring is correctly fitted in the piston housing bush.

(4) Fit the idler gear shaft into the bush in the front bearing housing and ensure that its pinion meshes with the worm driving gear below it and with the final carrier transmission pinion above it.

(5) Offer the rear bearing housing to the front bearing housing, with gasket between them.

(6) Press the two housings together, engage the locating dowels, register the upper bush of the rear bearing housing with the final carrier shaft and the lower bush with the idler gear shaft.

(7) Grease the ballraces, idler gear and worm with XG-275 grease before assembly.

Note . . .

The 'Reservoir' bushes in the bearing housings must NOT be greased.

Motor to gearbox

18. The motor, after it has been tested in accordance with para. 25, should now be returned to the actuator.

(1) Pass the motor over the four studs which project from the front bearing housing and through the gearbox housing.

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(2) Engage the motor pinion with the four planets of the first stage gears.

(3) Replace the nuts and grover washers on the four studs which connect the motor to the gearbox housing.

Rear end fitting and end cover

19. The rear end fitting and the end cover should now be replaced.

(1) Replace the circular cover plate and gasket and secure to the rear bearing housing with two studs, lock nuts and shakeproof washers.

(2) Fit the rear end fitting and gasket over the four studs which project from the rear bearing housing and secure with nuts and grover washers.

Electrical connection

20. The electrical connections can now be made to the Breeze plug and the plug replaced.

(1) Attach the wire leads to their correct pins in the plug.

(2) Thread the leads through the plug mounting and through the slots in the front bearing housing.

(3) Replace the plug and its gasket on the mounting and secure with four ch.hd. screws.

Limit switches and wiring

21. The limit switches should next be replaced and the wiring completed.

(1) Fit the limit switches and locking tags to the piston housing with washers and sq.hd. screws but do not lock the screws pending final adjustment of switches (see para. 22).

(2) Wire the actuator completely, making reference to the circuit diagram in A.P.4343D, Vol. 1, Book 3, Sect. 14, Chap. 64.

(3) Ensure that the correct field lead from the motor is connected to the correct terminal by selecting the common lead (negative) and energizing each switch in turn, inching the motor as the switch is approached.

Final assembly

22. The actuator may now be finally assembled and the limit switches adjusted.

(1) Mount the actuator so that the fully

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extended and contracted centres between end fittings many be accurately measured.

(2) Operate the actuator over its full stroke of 4.093 inches, at 28 volts, with an opposing load of 600 lb.

(3) Set the limit switches to operate within the limits shown under Leading Particulars in A.P.4343D, Vol. 1, Book 3, Sect. 14, Chap. 64, after which the sq.hd. screws should be tightened and locked with the locking tags.

(4) Attach the cover securing bracket to the piston housing by means of a grub screw.

(5) Fit the rubber seal to the front bearing housing and replace the cover, ensuring that the 'O' ring is correctly fitted in the piston housing.

(6) Attach the cover to the securing bracket with two ch.hd. screws, stiffnuts and washers.

(7) Screw the front end fitting on to the piston and lock in position with $\frac{1}{2}$ in. nut.

(8) Apply a coat of varnish, Ref. No. 33B/937 to all external nuts and washers and a band of similar varnish $\frac{1}{8}$ in. wide to all external joints.

TESTING

Test rig

23. Information on the test rig for actuators is contained in A.P.4343S.

Actuator tests

24. Load tests are to be carried out on the actuator, after repair and re-assembly, as follows:—

(1) A running-in test consisting of approximately 10 runs in each direction at 25 volts and an opposing load of 600 lb.

(2) A functional test should be performed by connecting the actuator to a 28-volt d.c. supply and applying opposing loads of zero, 600 lb. and 900 lb. The maximum current consumption and the time the piston takes to complete its 4.093 in. travel, should not exceed the figures given below:—

Load (lb.)	Max. current (amp.)	Max. time (sec.)
0	6.88	8.63
600	10.38	12.25
900	12.38	13.75

Motor tests

25. Before the motor is returned to the

actuator, the following tests and checks should be made.

(1) Ensure that winding resistances are between the following limits

Armature, between

adjacent segments 0.059 to 0.072 ohms

Armature, across

segments 0.340 to 0.415 ohms

Field coil 0.11 to 0.13 ohms

Brake coil 0.25 to 0.26 ohms

(2) Check that brush pressure is between 7.5 and 8.5 oz.

(3) Ensure that brushes bed down satisfactorily over the whole circumferential width and at least 80 per cent of the area.

(4) Equalize speed in both directions of rotation to within 2.5 per cent of the mean figure by rocking the brushgear assembly.

(5) Check for correct rotation when connected to a source of supply and when viewed on the pinion.

(a) C and 2=Anticlockwise

(b) C and 3=Clockwise

(6) Check, through the inspection slots provided, that the brake air gap is between 0.012 in. and 0.018 in.

(7) Operate five or six times in each direction of rotation on no load, to ensure that brake shoe pulls off satisfactorily to allow the armature to rotate freely at a maximum terminal voltage of 18 volts.

(8) Apply a torque of 12 oz. in. at a terminal voltage of $25 \pm \frac{1}{2}$ volt, when the speed in each direction must not be less than 8,750 rev/min. and the current consumption must not exceed 11 amps.

(9) Test for armature over-run by running the motor on no load at 28 volts and measure the over-run after switching off. Repeat five times in each direction when the reading must not exceed ten revolutions of the armature.

(10) Subject the motor to a flash test of 500 volts r.m.s. at 50 c/s a.c. between live parts and the frame for a period of 15 seconds while the motor is still warm after a 15 seconds run in each direction of rotation with no load at 25 volts.

(11) Carry out a subsequent insulation resistance test of 500 volts after a further 15 seconds run in each direction, when the reading must not be less than 2 meg-ohms.

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- (12) Test the motor for endurance with 50 starts and 50 stops in each direction of rotation with a terminal voltage of 18 volts and the motor running light. This test should be spread over a period of 25 minutes, allowing a maximum running period of 5 seconds, followed by a 10 seconds rest. Upon completion of this test, re-check for armature over-run.
- (13) Check that all screws and nuts are properly locked.
- (14) The test scheduled above are to be carried out at a room temperature of 15 deg. C.

Insulation resistance after installation in aircraft

26. Using a 250 volt insulation resistance tester, measure the insulation resistance between live parts and the frame. The reading must not be less than 2 megohms.
27. Due to the humidity prevalent in aircraft at dispersal points, the minimum permissible insulation resistance shall be 50,000 ohms.



SCHEDULE OF FITS, CLEARANCES AND REPAIR TOLERANCES

APPENDIX 1

All dimensions in inches

Item No. (1)	Description (2)	Dimension New (3)	Permissible Worn Dimension (4)	Clearance New (5)	Permissible Worn Clearance (6)	Remarks (7)
1	ACTUATOR					
	Piston bush, bore	0.9375	0.9385	0.002		
				0.0012	0.002	Measured over any part of its length
2	Piston, dia.	0.9375	0.9365			
3	Front bearing housing (upper ballrace)	1.25 nominal		0.001 to 0	0.001	Bearing selected to give the fits quoted in Col. 5
4	Ballrace o/d					
5	Ballrace i/d			0.0004 clear to	0.0004	
6	Land on final carrier shaft	0.8125 nominal		0.0004 interf.		
7	Upper bush in rear housing, bore	0.3125	0.3130	0.0024	0.0025	
8	Pinion stub shaft, dia.	0.3125	0.3105	0.0006		
9	Bushes in both bearing housings	0.3125	0.3130	0.0024	0.0025	
10	Idler gear shaft, dia.	0.3125	0.3105	0.0006		

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SCHEDULE OF FITS, CLEARANCES AND REPAIR TOLERANCES

APPENDIX 1—*contd.*

All dimensions in inches

Item No. (1)	Description (2)	Dimension New (3)	Permissible Worn Dimension (4)	Clearance New (5)	Permissible Worn Clearance (6)	Remarks (7)	
11	Both bearing housings (lower ballraces)	1.5625 nominal	—	0.0008 clear to 0.0002 interf.	0.0008	Bearing selected to give the fits quoted in Col. 5	
12	Ballraces o/d						
13	Ballraces i/d	0.625 nominal	—	0.0007 to 0	0.0007		
14	Land on wormshaft						
15	Guide slots in piston housing	0.250	0.251	0.012	0.0055		
16	Piston ears, width	0.246	0.2455	0.004			
17	Trunnion forks, bore	0.3125	0.3138	0.0018	0.0033		
18	Trunnion pins, dia	0.3125	0.3105	0.0005			
19	Gear carriers						Max. end float 0.0035 to 0.0075
20	MOTOR Brushgear end cap, bore	0.8268 nominal	—	0.0005 clear to 0.0005 interf.	0.0005		Bearing selected to give the fits quoted in Col. 5
21	Ballrace o/d						

SCHEDULE OF FITS, CLEARANCES AND REPAIR TOLERANCES

APPENDIX 1—contd.

All dimensions in inches

Item No. (1)	Description (2)	Dimension New (3)	Permissible Worn Dimension (4)	Clearance New (5)	Permissible Worn Clearance (6)	Remarks (7)
22	Ballrace i/d	0.236 nominal		0.0009 clear to 0.0001 interf.	0.0009	
23	Armature shaft (com- mutator end)					
24	Motor end cap, bore	1.378 nominal		0.0004 clear to 0.0006 interf.	0.0004	Bearing selected to give the fits quoted in Col. 5
25	Ballrace o/d					
26	Ballrace i/d	0.551 nominal		0.0009 clear to 0.0001 interf.	0.0009	
27	Drive shaft, dia.					
28	Brush length	0.437	0.30	—	—	

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