Chapter 74

ACTUATOR, ROTAX, TYPE C8701/1 AND RAM UNITS ZA4601, ZA4602, ZA4502A AND B

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LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Actuator, Type C8701/1	*Ref. No. 5W/718*
Voltage	28*V d.c.*
Normal working load	21 *lb. ft. torque per shaft*
Maximum working load	50 *lb. ft. torque per shaft*
Stall load	500 *lb. ft. torque*
Current draw at normal load	114 *amp. per motor*
Stall current	1,600 *amp. per motor*
Starting current at normal load	800 *amp. per motor*
Speed of output shaft at normal load—	
Both motors driving	350 *r.p.m.*
One motor driving	175 *r.p.m.*
Rotation	*reversible*
Operational temperature range	*—75 deg. C. to +90 deg. C.*
Brush grade	*P.M.50—H.A.M.*
Brush spring pressure	1·25 *to* 1·75 *lb.*
Minimum brush length	0·625 *in.*
Overall dimensions—	
Length	29 *in.*
Height	12 *in.*
Width	8·219 *in.*
Weight	95 *lb.*
Ram unit, Type ZA4601	*Ref. No. 5W/720*
ZA4602	*Ref. No. 5W/719*
ZA4502A	*Ref. No. 5W/721*
ZA4502B	*Ref. No. 5W/2066*
Maximum working load	11,000 *lb.*
Normal working load	6,000 *lb.*
Maximum static load	19,000 *lb.*
No. of turns for full travel	58·4
Thread pitch	0·5 *in.*
Length of stroke	14·6 *in.*
Direction of rotation (viewed from driven side)—	
To extend	*anti-clockwise*
To retract	*clockwise*
Overall length (from trunnion centre)—	
Types ZA4601, ZA4602—retracted	27·375 *in.*
extended	41·975 *in.*
Types ZA4502A, ZA4502B—retracted	27·562 *in.*
extended	42·162 *in.*
Weight—	
Types ZA4601, ZA4602	25 *lb.*
Types ZA4502A, ZA4502B	26 *lb.*

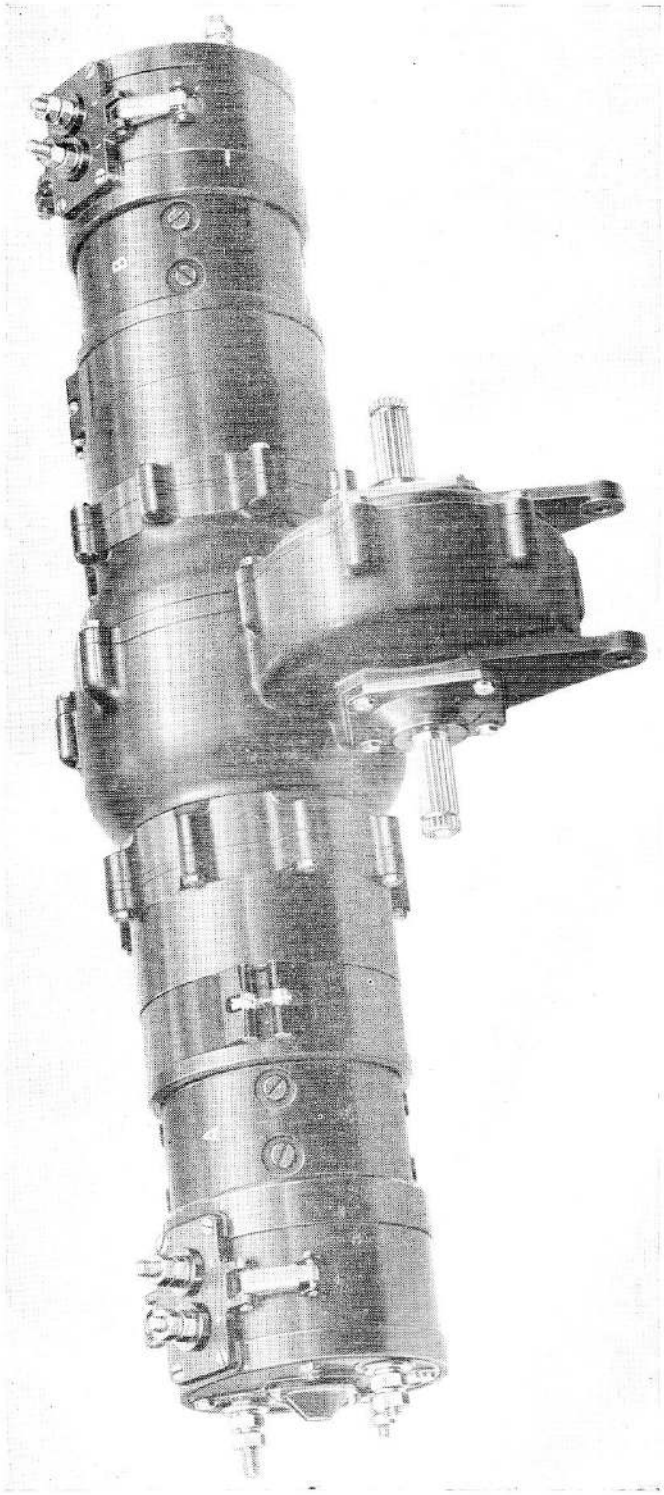

Fig. 1. Actuator, Type C8701/1

Introduction

1. The Rotax C8701/1 actuator is a rotary machine having two output shafts (off-set from the main axis) rotating together and driven by two horizontally opposed motors through differential gearing. The differential gearing transmits the sum of the output power of the two motors to the output shaft load and is arranged so that with one motor operating alone, the full rated load will be driven at half speed. The gear reduction ratio (armature shaft to output shaft) is 23·8 : 1 with two motors driving and 47·6 : 1 with one motor driving.

2. The actuator does not incorporate limit switches, but is intended to operate equipment (e.g., Rotax ram units ZA4502 and ZA4601) which has limited switches fitted. The machine is reversible and has a rating of five minutes with either one or two motors driving.

DESCRIPTION

3. The actuator (*fig.* 1) consists of two identical motors provided with electro magnetic brakes and overrun clutches, bolted one on each side of the central gearbox unit. The epicyclic, differential and spur gear trains, together with the off-set output shafts are enclosed by two castings bolted together which incorporate the mounting shackles. Each motor is housed by a yoke to which is bolted an intermediate housing which encloses the brake and clutch and a commutator end frame which encloses the brushgear. The commutator end of the motor is closed by an end plate.

Motors

4. Each motor is a four-pole compound wound machine, the field being wound on four laminated pole shoes which are bolted to the interior of the yoke. The armature runs in two ball bearings, the commutator end bearing being housed in a liner set in the commutator end plate and the drive-end bearing being housed in a liner formed by the brake spider (*para.* 5) and in turn supported by the intermediate housing. The four brushes ride in brush boxes which are secured to a moulded brush ring mounted on the commutator end plate; the brushes are maintained in contact with the commutator by coiled brush springs. Inspection windows for gaining access to the brushes are provided in the commutator end frame and are sealed by a coverband assembly (*para.* 12). Inspection windows are also provided in the intermediate housing and these are also sealed by a coverband.

Brakes

5. Each motor is provided with an electromagnetic brake which normally locks the motor armature and associated gear train but releases it for rotation whenever the motor is switched on. The brake consists of a solid core, or spider which is wound with an energizing coil connected in series with the series field of the motor. The spider is bolted to the intermediate housing (a locating spigot also forming a seating for the drive end ball bearing) by four screws which also secure a bearing retaining plate. A brake drum is located around the spider and, being carried by a ball bearing seated in a bearing housing bolted to the gear end of the intermediate housing, rotates at armature speed when the motor is operating. The drum, however, is normally held stationary by six cork lined brake shoes equispaced around the spider and forced against the interior of the drum by helical springs in compression. The brake shoes are located by guide dowels pressed into the spider, on which they slide. When the motor is switched on, the brake coil is also energized and the brake shoes are drawn in towards the spider, against the compression of their springs, leaving the drum free to rotate with the armature. When the motor is switched off, the brake shoes are reapplied to the drum by their springs.

Clutches

6. The armature drive is communicated to the brake drum via a clutch located in a recess in the gearbox end of the drum. The clutch is interposed between the armature and the drum in order to dissipate the momentum of the armature when the brake is applied to the drum at the end of a run. The slipping of the clutch greatly reduces the overrun of the output shaft.

7. Each clutch consists of five inner steel plates alternating with five outer steel plates with sintered bronze mating surfaces. The

outer plates engage a spline in the brake drum recess whilst the inner plates are splined to a sleeve. The armature is coupled to this clutch sleeve by a spindle passing through a bore in the brake spider. The spindle has a male serrated spline at each end, engaging female splines in the sleeve and the end of the armature shaft. The clutch plates together with a spacer at each end of the clutch form a pack which is compressed between a shoulder on the sleeve and the end of the recess by a helical spring about the coupling spindle. A shoulder on the spindle engages the spring and correct clutch pressure is maintained by a rod passing through the centre of the armature shaft (which is hollow) abutting the end of the coupling spindle and engaging an adjustment grub screw at the commutator end of the shaft. The adjustment screw is normally enclosed by the bearing cap secured to the commutator end plate.

Gearbox

8. The gearbox receives the drive from the two motors, one at each end, and has two identical two stage epicyclic gear trains, one for each motor. The sungears of the first stage of these gear trains are integral with the brake drums of the associated motor units. The first stage planet carriers have three planet gears running on ball bearings whilst the second stage planet carriers each have three planet gears running on roller bearings. The two planet assemblies of each gear train run within annulus gears located in the appropriate half of the gearbox housing by dowels.

9. The second stage planet carriers of the epicyclic gear trains have sungears integral with them which engage the differential gear train. This differential gear train consists of a cage containing a ring of six planet pinions, three alternative pinions engaging one sungear and the remaining three engaging the other sungear. The cage rotates, being carried by two ball journal bearings set in the gearbox housings; the cage is fitted with an external annulus gear which engages the output shaft spur gear (*para.* 10). When both motors, and therefore both sungears, are rotating at the same speed, there is no rotation of the planet pinions with respect to the cage so that the annulus rotates at the common sungear speed. When however there is a difference in sungear speeds, this is taken up by relative rotation of the pinions and the annulus rotates at the mean of the two speeds. Thus if one motor stops altogether, the annulus rotates at half the speed of the one rotating sungear.

Output shafts

10. The two output shafts, one projecting on each side of the off-set portion of the gearbox housing, and the spur gear which engages the differential annulus are a single integral unit. This unit is carried by two ball bearings, one on each side of the spur gear, which are clamped on to the shaft by shaft nuts. A felt seal is fitted into the gearbox housing where each shaft projects. Each shaft has a serrated spline for connection to its driven load.

Electrical connections

11. Each motor has an entirely separate and similar set of connections, as shown in fig. 2. Each motor has two terminals mounted on a terminal block fitted to the commutator end coverband and three terminals set in the commutator end plate.

12. The terminals are arranged as follows:-

Terminal 1
0·312 in. B.S.F. stud on coverband (long terminal)

Terminal 2
0·375 in. B.S.F. stud in commutator end plate

Terminal 3
0·312 in. B.S.F. stud on coverband (short terminal)

Terminal 4
0·375 in. B.S.F. stud in commutator end plate

Terminal 5
0·250 in. B.S.F. stud in commutator end plate

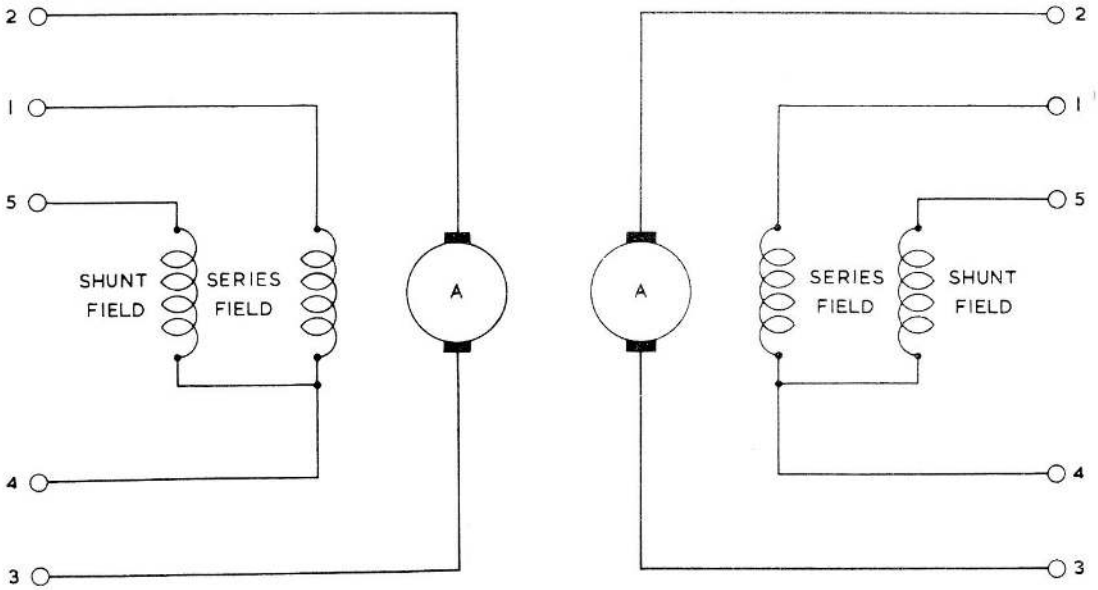

Fig. 2. Diagram of internal connections

13. The connections to obtain clockwise rotation of the adjacent output shaft are as follows :—

Connect positive to terminals 2 and 5
Connect negative to terminal 1
Interconnect terminals 3 and 4

For anti-clockwise rotation of the adjacent output shaft the connections are as follows:–

Connect positive to terminals 3 and 5
Connect negative to terminal 1
Interconnect terminals 2 and 4

Note . . .

For any given direction of rotation of the output shafts one motor is connected for clockwise rotation, the other for anti-clockwise rotation.

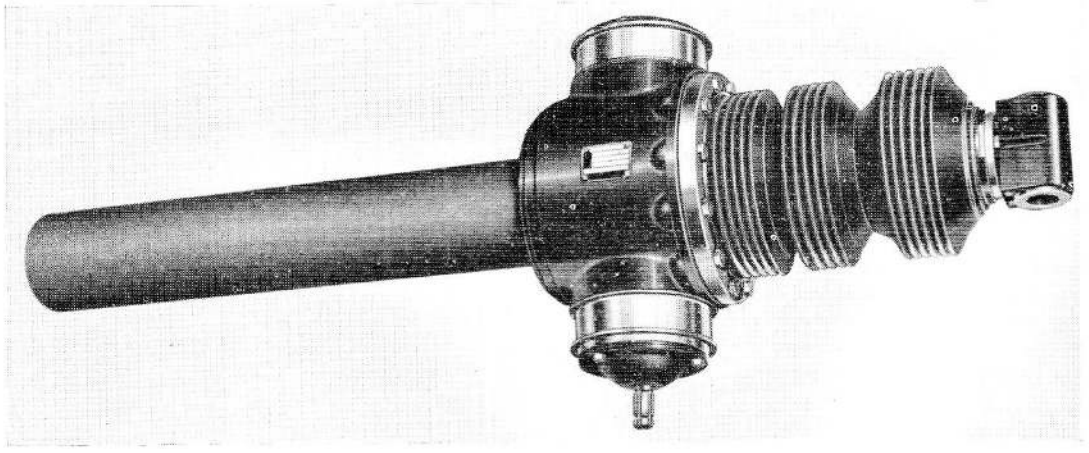

Fig. 3. Ram unit, Type ZA4601

Ram units

14. The ram units, Type ZA4601, ZA4602, ZA4502A and ZA4502B are driven by the C8701/1 actuator and are normally used for flap operation.

15. Type ZA4601 (*fig.* 3) consists essentially of a screwshaft, with nut and driving barrel. The nut incorporates two rows of recirculating balls which run in threaded grooves on the screwshaft when the nut and driving barrel rotate. The latter is geared to a bevel pinion, on the outer end of which is a serrated shaft for coupling via a torque tube and gearbox to the C8701/1 actuator. Between the main housing and the shackle end of the screwshaft is a bellows type covering made from neoprene. The screwshaft retracts into a cylindrical covering, also of neoprene.

16. Type ZA4602 is similar to ZA4601, but with an additional bevel gear for driving the transmitter which is also assembled to the unit. The transmitter controls an indicating device which is located in the pilot's cockpit. The transmitter and its driving gear are positioned directly opposite the bevel pinion.

17. Types ZA4502A and B (*fig.* 4) are also similar to ZA4601, but have a light alloy covering in place of the cylindrical neoprene covering and an additional bevel pinion including a serrated shaft. The two bevel pinions are positioned directly opposite one another. Two pairs of limit switches are mounted on the light alloy covering and are operated by screwshaft movement. The limit switches on ZA4502B are set at 180 deg. to ZA4502A for opposite handing. Electrical connection is made via two 2-pole plugs (Ref. No. 5X/6001).

INSTALLATION

18. The output shafts each have a serrated spline cut on a 0·746 in. nominal diameter. Each spline is 1·500 in in length (full depth of the serrations) and has an annular groove, 0·062 in. in radius, 0·250 in. from the end of the shaft.

Mounting

19. Four mounting shackles project from the gearbox housings, each provided with a 0·312 in. diameter hole drilled concentrically in a 0·875 in. diameter boss. The shackles are aligned in pairs giving two fixing centres spaced at 10·687 in.

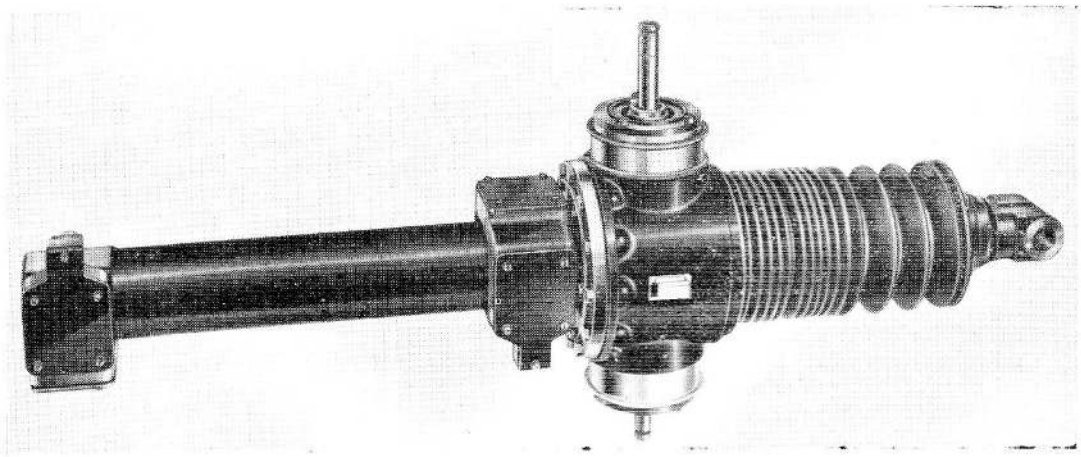

Fig. 4. Ram unit, Type ZA4502

SERVICING

20. Make a general inspection of the unit to ensure that it is in good condition and has not sustained damage. Examine the mounting and the mechanical connections for security. The electrical connections should be clean and securely made.

21. Remove the commutator end coverbands from the motors and make the following inspections of the brushgear.

(1) Examine the brushes for wear and condition. Any brush which is cracked or chipped, or of which the pigtail is insecure, should be rejected. The minimum permissible brush length is 0·625 in.; any brush which has worn so close to this minimum that it is unlikely to function satisfactorily until the next servicing, should be discarded as unserviceable.

(2) Ensure that the brushes are free but not slack in their boxes. If they are tight as a result of carbon deposits having formed in the boxes, these deposits should be removed.

(3) Inspect the commutators for scores and burns. If carbon deposits have formed, they should be removed with a soft cloth soaked in lead free white spirit.

(4) Measure the brush spring pressure with a spring balance (Ref. No. 1H/97). The pressure exerted by each spring as it leaves the top of its brush should be between 1·25 lb. and 1·75 lb.

No load tests

22. The actuator should be run on no load with each motor driving in turn and then with both motors driving together. With one motor driving the current draw should not exceed 62 amperes and the speed of the output shafts should be at least 200 r.p.m. With both motors driving the total current draw should not exceed 120 amperes and the speed of the output shafts should be at least 410 r.p.m.

Load tests

23. The actuator should be run with a total load of 40 lb. ft. torque applied. The load should be equally divided between the two shafts i.e. 20 lb. ft. per shaft. Run the actuator in each direction of rotation with each motor driving in turn and then with both motors driving together. With one motor driving, the current draw should not exceed 120 amp. and the speed of the output shafts should be at least 180 r.p.m. With both motors driving, the total current draw should not exceed 230 amp. and the speed of the output shaft should be at least 36 r.p.m.

Overload tests

24. The load on the actuator should be increased to 50 lb. ft. per shaft (100 lb. ft. total) and the machine should be run in each direction of rotation with each motor driving in turn and then with both motors driving together. With one motor driving the current draw should not exceed 190 amp. and the speed of the output shaft should be at least 140 r.p.m. With two motors driving the total current draw should be not more than 375 amp. and the speed of the output shaft should be at least 290 r.p.m.

Insulation resistance tests

25. Measure the insulation resistance between the live parts of each motor and frame using a 250V insulation resistance tester. A reading of at least 50,000 ohm should be obtained in each test.

Note . . .

The value of insulation resistance given in para. 25 applies to actuators being tested under normal workshop conditions. Due allowance should be made for the climatic conditions of the locality and those of the aircraft servicing area or dispersal point where the tests are being applied. In particularly damp climates, the readings obtained may be low enough to give apparently sufficient reason for rejection and, in these instances, discretion should be exercised.

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