Chapter 5

DOUBLE ROTARY ACTUATORS, ROTAX, C8100 SERIES

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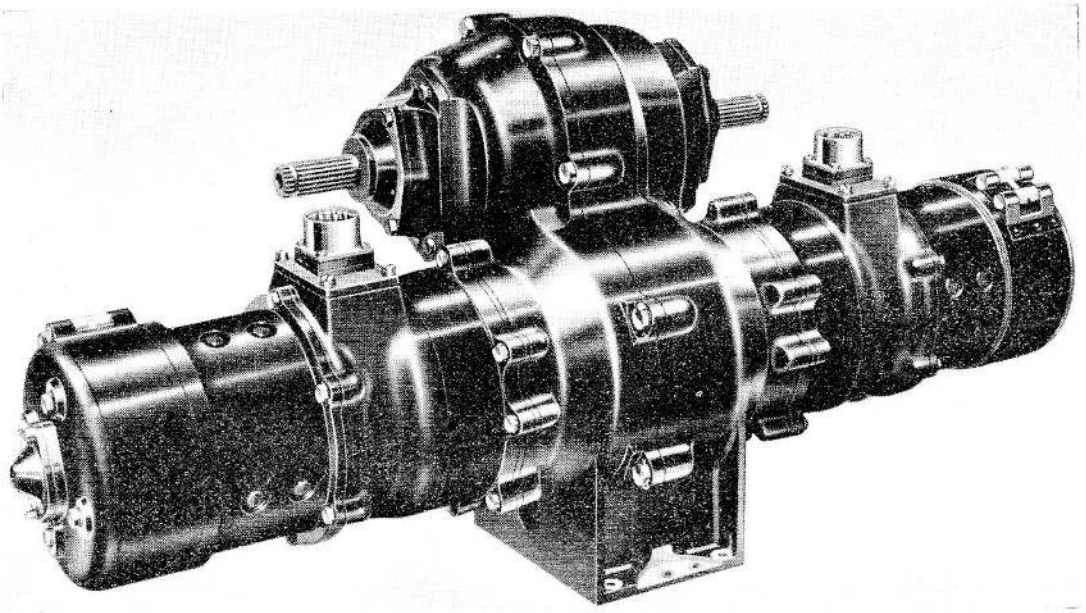

Fig. 1. Typical C8100 series actuator

Introduction

1. Actuators in the C8100 series have been designed to operate aircraft ancillary controls, e.g., landing flaps, from a 112-volt d.c. supply. They incorporate two reversible motors driving an offset parallel common shaft with two output drives; in the event of a difference of speed occurring between the two motors, differential gearing will vary the overall gear ratio. Also, if either motor becomes inoperative, the remaining motor will operate the actuator at half normal speed, the torque output remaining constant. Details of individual machines will be found in Appendices to this chapter.

DESCRIPTION

2. A typical machine of the series is illustrated in fig. 1 and 2. In construction, the actuator comprises two identical motor units mounted either side of a central casting which houses gearing, overload clutch and output shaft. The overload clutch and output shaft are offset from the axis of the motor units and gearing but they are housed within a common casting (*fig* 2).

3. A motor unit consists of motor, brake (with overrun clutch) and two stages of epicyclic gearing. The drive from each motor is transmitted via these epicyclic trains to a common differential epicyclic gear which, in turn, drives the common output shaft via a spur gear machined on the outside of the overload clutch barrel. As the motor units are identical it is only necessary to describe the components and working of one.

Motor

4. The motor is a 4-pole, 4-brush machine with a short shunt, compound wound field. Reversal of rotation is effected by changing the polarity of the armature connections. The armature is wave wound and borne by two ball bearings; one bearing is fitted in a liner pressed into the commutator end frame and the other is located in a housing machined in the motor end of the brake spider. The armature shaft is hollow and accommodates a steel push rod which is used in connection with the clutch loading adjustment of the overrun clutch.

Brake and overrun clutch

5. Between the motor and its gearing is a drum type, electromagetic brake and multi-plate clutch. The purpose of the clutch is to limit overrun and absorb part of the inertia of the armature on stopping.

6. The brake consists of a double flanged steel core on which a coil is wound, the magnetic path being completed through shoes placed around the periphery and connecting the two flanges. When the motor is switched on, the brake coil is also energized and attracts the shoes, against the influence of helical springs, on to the flanges. When the motor is switched off, the coil is de-energized and the shoes are forced against the brake drum by the springs. In this manner the brake is automatically applied. There are four springs per shoe and they are located in holes drilled around the periphery of the flanges. The brake has six shoes and locating pins protruding from the flanged core to prevent their displacement.

7. Interposed between the brake and gearing is a multi-plate clutch which dissipates the kinetic energy in the armature when the brake is applied. Relative rotation between the armature and brake drum occurs only during clutch slip. The clutch plates have alternate faces of sintered bronze and steel, the former being keyed to the clutch well inside the brake drum housing and the latter to the clutch shaft.

8. The clutch shaft is spring loaded by a single helical spring to which varied loads may be applied by means of an adjuster screw, located under the end cap of the commutator end frame assembly, and transmitted via the push rod (*para.* 4) in the armature shaft.

9. Formed integral with the brake drum is an external sun gear which engages with the planet pinions of the first epicyclic train. In this manner the motor output is transmitted to its gearing (two epicyclic trains) and, in turn, fed into the common differential epicyclic gear. The planet carriers of the first ("fast") and second ("slow") trains revolve in a fixed annulus gear which embraces both gear trains.

Gearbox

10. The sun gear of the second epicyclic gear train protrudes through an aperture in the differential planet carrier and engages with three planet gears mounted on the carrier. This arrangement, being common to both drives, produces three planet gears on each of the right-hand and left-hand differential planet carriers. These six gears are meshed to form three pairs and each pair has a gear associated with each drive. Consequently, the driving sun gears of both differential gear assemblies can only turn their respective planet gears as a locked assembly. Rotation of this locked assembly of planet gears will then cause both differential planet carriers to rotate.

11. Teeth are machined on the periphery of both differential planet carriers and they engage with a similar number of teeth machined on the inside of the revolving differential gear casing. These teeth act as splines preventing any relative movement between the planet carriers and the gear casing. Rotation of the differential planet carriers will cause the gear casing and its integral spur gear to rotate.

12. The differential external spur gear engages with a similar number of teeth machined on the outside of the overload clutch barrel causing it to rotate and, through the clutch plates incorporated, to transmit the drive to the common output shaft.

13. In the event of one motor failing to operate, its differential sun gear will become locked, due to the brake. The operative motor's differential sun gear will drive all the differential planet gears around the stationary sun gear, but in this instance, at half the normal speed.

Overload clutch and output shaft

14. The overload clutch is fitted to prevent damage to the motors and gearing. It consists of a number of steel plates of which

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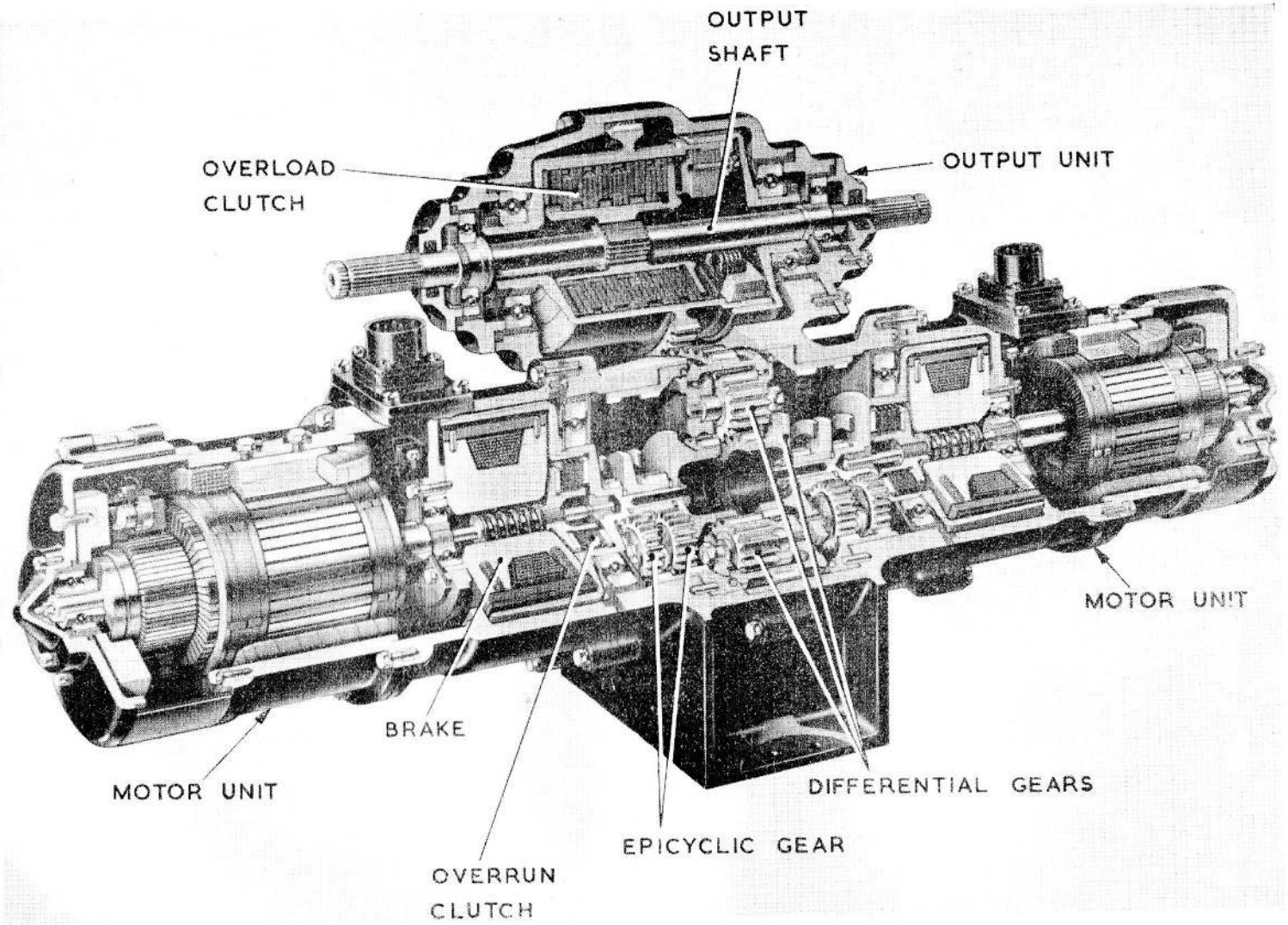

Fig. 2. Sectional view of actuator

alternate plates have a sintered bronze treatment. The sintered plates are keyed to the clutch barrel and the plain steel plates to the clutch shaft. The clutch is loaded by means of 13 equally spaced helical springs located in recess in an adjusting nut which is screwed into the clutch barrel. The open end of the clutch barrel fits into a clutch carrier or "cup" and the complete assembly rotates between ball bearings located in liners pressed into the gear housing assembly (*para.* 2).

15. The output shaft is borne between ball bearings. They are located in steel liners which are pressed into bearing houses, the latter being bolted either side of the gear housing assembly. Two end caps, each fitted with a felt oil seal through which the output shaft passes, are bolted to the bearing housings.

Note . . .

The right-hand and left-hand outputs of the shaft are integral, thus, when each output drive is viewed from its driving end the shaft will have opposite directions of rotation.

Electrical connections

16. Each motor derives its supply via a 5-pole plug (Ref. No. 5X/6061). The plug is located on a raised mounting cast integral with the intermediate housing of the motor. Connections for each motor individually (*fig.* 3) and for the two motors when assembled to the actuator, with respect to direction of output rotation, are as follows.

Connections for individual motors

17. (1) Clockwise rotation
+ ve to 2 and 5
3 to 4
—ve to 1

(2) Anti-clockwise rotation
+ ve to 3 and 5
2 to 4
—ve to 1

Connections to coupled motors

18. For the given rotation of output shaft connect as follows: —

(1) For clockwise rotation of right-hand output shaft.

+ve to { 3 and 5, 2 connected to 4 left-hand motor
2 and 5, 3 connected to 4 right-hand motor

— ve to 1 on both motors.

(2) For anti-clockwise rotation of right-hand output shaft.

+ve to { 2 and 5, 3 connected to 4 left-hand motor
3 and 5, 2 connected to 4 right-hand motor

— ve to 1 on both motors.

Note . . .

The RIGHT-HAND OUTPUT is taken as that part of the shaft appearing on the right-hand side of the output unit (*fig.* 2).

INSTALLATION

19. Information on the installation of the actuator will be found in the relevant Aircraft Handbook. Mounting arrangements differ throughout the series, and details will be found in the relevant Appendix.

SERVICING

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

Brushgear

21. The minimum length beyond which brushes should not be used is 0·562 in., the length when new being 0·750 in. Brushes should be renewed at periods prescribed in the relevant Servicing Schedule, and whenever examination reveals that they will not remain serviceable for the period that must elapse before the next servicing.

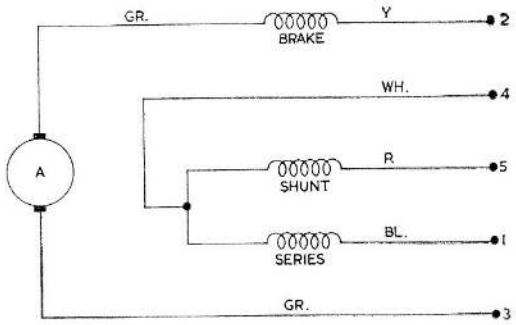

Fig. 3. Internal connection diagram

22. Brush spring pressure should be between 13 and 15 oz. (369 and 425 gm.), when measured by attaching a tension gauge (Ref. No. 1H/86) to the tip of the spring and raising it $\frac{1}{8}$ in. above the top of the brush box.

Lubrication

23. These actuators are lubricated during manufacture, and should not normally require lubrication except when dismantled for repair.

General

24. Ensure that all external screw and locking devices are secure. Examine the motor supply plugs for security and damage, also the brushgear connections.

25. At the conclusion of the servicing operations, ensure that the inspected components are in their correct positions.

Insulation resistance test

26. The insulation resistance, when measured with a 500-volt insulation resistance tester, should not be less than 0·5 megohm (for R.N.), or 0·05 megohm (for R.A.F.).

Appendix 1

ACTUATOR, ROTAX, TYPE C8101/1 (INCORPORATING MOTOR, TYPE C9701/1)

LEADING PARTICULARS

Actuator, Type C8101/1	*Ref. No. 5W/415*
Operating voltage—	
Normal	112*V d.c.*
Minimum	100*V d.c.*
Maximum	116*V d.c.*
Current at rated torque	42 *amp. (per motor)*
Starting current	120 *amp. (per motor)*
Total rated torque	105 *lb. ft.* (52·5 *lb. ft. per shaft*)
Speed at rated torque	320 *r.p.m.*
Clutch torque	380 ± 40*lb. ft.*
Rating	2 *min. at* 52·5 *lb. ft./shaft*
Rotation	*Reversible*
Operating temperature range	− 70 *deg. C to* + 50 *deg. C*
Resistance of windings—	
Shunt field	91·6 − 101·0 *ohms*
Series field	0·054 − 0·0592 *ohm*
Armature	0·0597 − 0·0657 *ohm*
Brake coil	0·0424 −0·0466 *ohm*
Brush spring pressure	13 − 15 *oz.* (369 − 425 *gm.*)
Brush grade	*E.G.O. HAM*
Brush length—	
New	0·750 *in.*
Minimum permissible	0·562 *in.*
Commutator diameter—	
New	2·062 *in.*
Minimum permissible	1·968 *in.*
Overall dimensions—	
Length	27·562 *in.*
Height	9·531 *in.*
Width	11·949 *in.*
Weight	91 *lb.*

1. The actuator, Type C8101/1, is identical to that described and illustrated in the main chapter. It is mounted by means of eight 0·203 in. dia. holes drilled through the base of the flange casting, and at right angles to the axis of the unit.

2. The motor units, Type C9701/1, are secured on each side of the central casting by eight bolts. The C9701/1 differs from the previous C9701 in having a new Hoffmann ball bearing fitted at the driving end of the motor to the brake drum assembly.

3. The C8101 and C8101/1 differ only in the manner by which the two trains of epicyclic gearing (for each motor) are secured. In the basic unit they are secured by a circlip to the shaft formed integral with the brake drum; in the /1 version the shaft is extended and carries a thread, and the gears are secured by a nut.

Appendix 2

ACTUATOR, ROTAX, TYPE C8102/2 (INCORPORATING MOTOR, TYPE C9701/1)

LEADING PARTICULARS

Actuator, Type C8102/2	
Operating voltage—	
Normal	112*V d.c.*
Minimum	100*V d.c.*
Maximum	116*V d.c.*
Current at rated torque	42 *amp. (per motor)*
Starting current	120 *amp. (per motor)*
Total rated torque	105 *lb. ft.* (52·5 *lb. ft. per shaft*)
Speed at rated torque	320 *r.p.m.*
Clutch torque	380 ± 40*lb. ft.*
Rating	2 *min. at* 52·5 *lb. ft./shaft*
Rotation	*Reversible*
Operating temperature range	− 70 *deg. C to* + 50 *deg. C*
Resistance of windings—	
Shunt field	91·6 − 101·0 *ohms*
Series field	0·054 − 0·0592 *ohm*
Armature	0·0597 − 0·0657 *ohm*
Brake coil	0·0424 −0·0466 *ohm*
Brush spring pressure	13 − 15 *oz.* (369 − 425 *gm.*)
Brush grade	*E.G.O. HAM*
Brush length—	
New	0·750 *in.*
Minimum permissible	0·562 *in.*
Commutator diameter—	
New	2·062 *in.*
Minimum permissible	1·968 *in.*
Overall dimensions—	
Length	27·562 *in.*
Height	9·531 *in.*
Width	11·949 *in.*
Weight	91 *lb.*

1. The C8102/2 double rotary actuator is similar to that described and illustrated in the main chapter; but differs in the mounting arrangement. The C8102/2 unit has ten 0·3125 in. dia. holes drilled through the flanges of the central gearbox housing (five per flange) and parallel with the axis of the machine. Each hole is steel bushed and ⅜ in. dia. bolts are used to secure the unit on installation in the aircraft.

2. The motor units, Type C9701/1, are secured on each side of the central casting by eight bolts. The C9701/1 differs from the previous C9701 in the introduction of a new Hoffman ball bearing (N3857), this being fitted at the driving end of the motor to the brake drum assembly.

Appendix 3

ACTUATOR, ROTAX, TYPE C8103/1 (INCORPORATING MOTOR, TYPE C9901/1)

LEADING PARTICULARS

Actuator, Type C8103/1	*Ref. No.* 5W/3498
Operating voltage—	
Normal	112*V d.c.*
Minimum	100*V d.c.*
Maximum	116*V d.c.*
Current at rated torque	42 *amp. (per motor)*
Starting current	120 *amp. (per motor)*
Total rated torque	105 *lb. ft.* (52·5 *lb. ft. per shaft*)
Speed at rated torque	320 *r.p.m.*
Clutch torque	490 ± 50 *lb. ft.*
Rating	2 *min. at* 52·5 *lb. ft./shaft*
Rotation	*Reversible*
Operating temperature range	− 70 *deg. C to* + 50 *deg. C*
Resistance of windings—	
Shunt field	91·6 − 101·0 *ohms*
Series field	0·054 − 0·0592 *ohm*
Armature	0·0597 − 0·0657 *ohm*
Brake coil	0·0424 − 0·0466 *ohm*
Brush spring pressure	13 − 15 *oz.* (369 − 425 *gm.*)
Brush grade	*E.G.O. HAM*
Brush length—	
New	0·750 *in.*
Minimum permissible	0·562 *in.*
Commutator diameter—	
New	2·062 *in.*
Minimum permissible	1·968 *in.*
Overall dimensions—	
Length	29·218 *in.*
Height	9·531 *in.*
Width	11·949 *in.*
Weight	100 *lb*

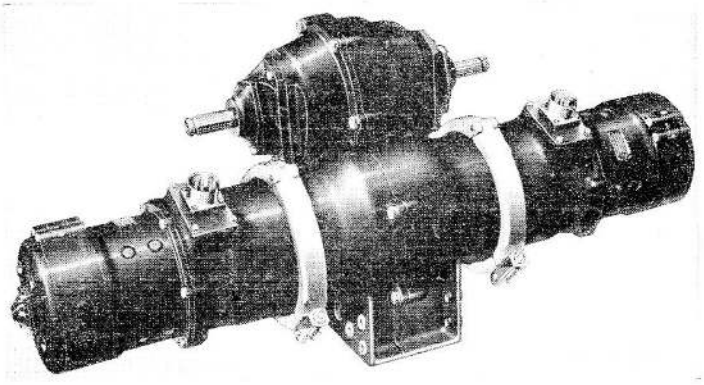

Fig. 1. Type C8103/1 actuator

1. The actuator, Type C8103/1 (fig. 1), is similar to that described and illustrated in the main chapter. It is mounted by means of ten 0·3125 in. dia. holes drilled through the flanges of the central gearbox housing (five per flange) parallel with the axis of the unit. Each hole is steel bushed and five $\frac{5}{16}$ in. dia. bolts are used to secure the unit when offered up in position.

2. The motor units, Type C9901/1, are secured to the gear housing by a manacle ring clamp which embraces two mating flanges. A dowel pin arrangement on the faces of the mating flanges serves to align the radial position of the plug connections. The C9901/1 differs from the previous C9901 in having a new Hoffman ball bearing fitted at the driving end of the motor to the brake drum assembly.

3. The clutch setting on this actuator differs from others in the series, being as quoted in Leading Particulars.

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