Chapter 2

DOUBLE ROTARY ACTUATORS, ROTAX, C7100 SERIES

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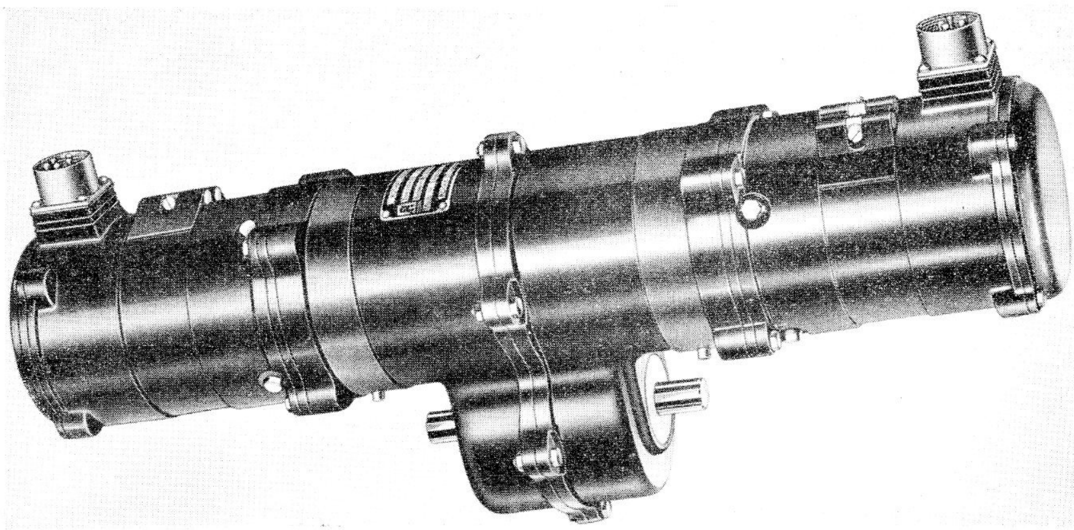

Fig. 1. General view of typical C7100 series actuator

Introduction

1. Double rotary actuators in the C7100 series have been designed for the operation of aircraft ancilliary equipment, and particularly for the raising and lowering of a bomb bay air deflector plate. Details of indivdual types will be found in Appendices to this chapter.

DESCRIPTION

2. A typical machine in the series is illustrated in fig. 1 and 2. It consists of two similar motors in tandem and an offset, but parallel, output unit, the output shaft of the latter being splined at both ends to provide two drivers. The reversible motors operate on 112 volts d.c., and a part sectional view of the machine is shown in fig. 2.

3. The output shaft receives its drive from the motors via a gearbox containing differential gearing. The differential gearing varies the overall gear ratio in the event of the two motors differing in speed. If either motor becomes inoperative, the remaining motor will operate the unit at half normal speed.

Motors

4. The motors are 4-pole, 4-brush, and are short-shunt compound wound. Reversal of rotation is effected by changing the polariy of the armature connections (*para.* 13). The armature of each motor revolves in two ball bearings, one located at each end of the armature shaft.

Brakes

5. At the commutator end of each armature shaft is a drum type electro-magnetic brake. The brake drum is keyed to the armature shaft and encloses a coil assembly, the core of which is bolted to the motor frame. Disposed around the flanged core are four spring-loaded brake shoes (locating pins protrude from the core flanges into the shoes to prevent displacement of the shoes). The four loading springs per shoe are located in holes drilled around the periphery of the flanges of the coil assembly core, the arrangement being such that the brake shoes are normally pressed against the inner periphery of the brake drum. When the motor is switched on, the brake coil, being in series with the armature (*fig.* 3), is energized and the shoes are drawn, against the pressure of the loading springs, on to the

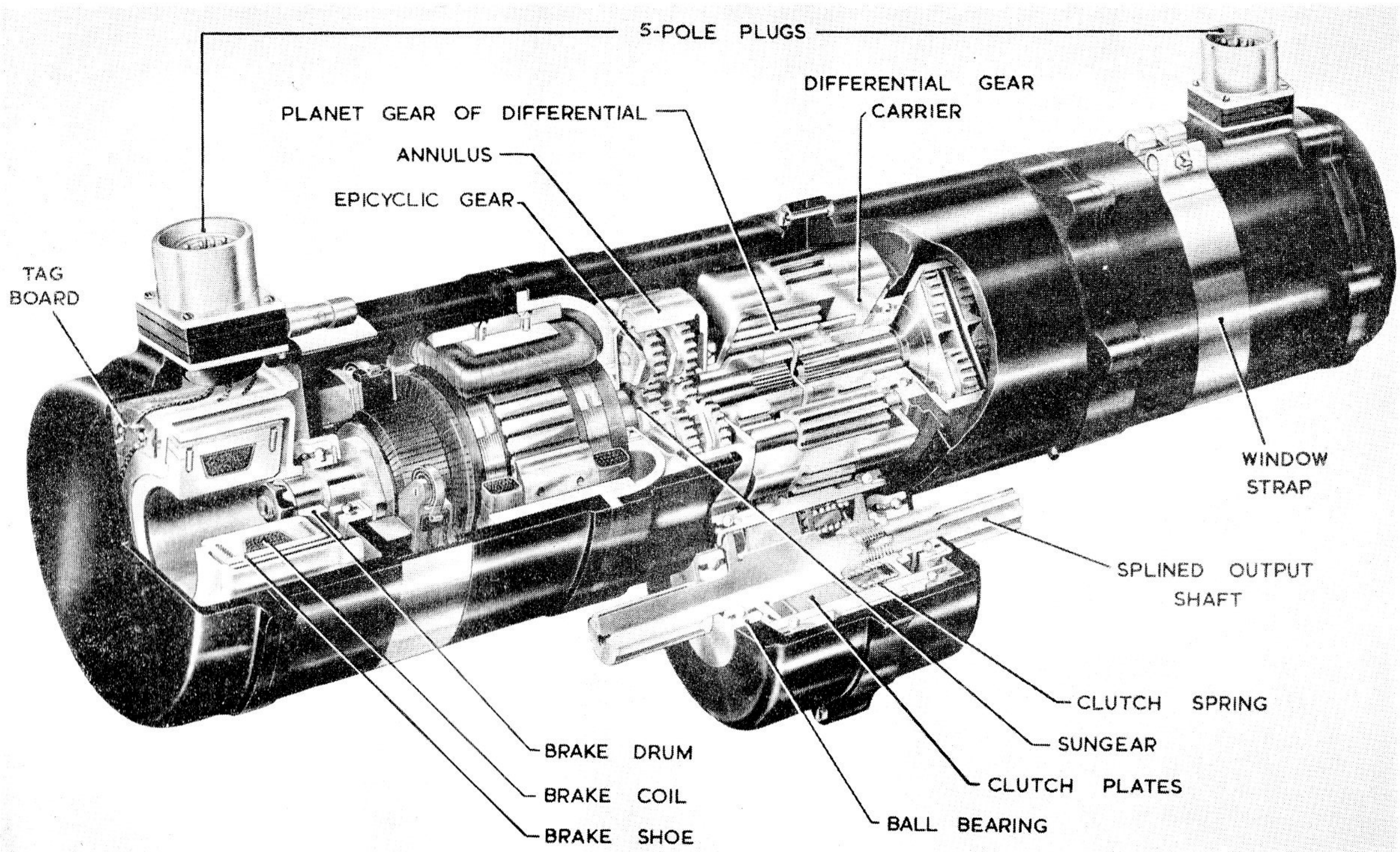

Fig. 2. Sectional view of actuator

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core flanges. When the motor is switched off, the coil is de-energized and the brake is automatically applied, due to the pressure of the loading springs.

Gearbox

6. At the output end of each armature shaft are two epicyclic trains which transmit the motor drive to a differential epicyclic gear. This, in turn, drives the output shaft via a spur gear and multi-plate clutch. The gear ratio is 49 to 1 when both motors are operated, and 98 to 1 with one motor, the actuator output shaft speeds being as quoted in the relevant Appendix.

Output unit

7. The output unit is of cylindrical form and consists mainly of a casing, a cylindrical driving drum, and overload clutch assembly and output shaft.

8. The driving drum has integral teeth round its periphery, these teeth engaging with the outer teeth on the differential gear carrier (*fig.* 2) to drive (via the overload clutch) the splined output shaft of the actuator.

9. The overload clutch consists of alternate plates of steel and sintered bronze. The clutch is loaded by a number of helical springs which are equally spaced in recesses, within an adjusting nut on the output shaft, the nut being locked in position with a steel key after correct setting.

10. The output shaft is splined at each end and revolves in two ball bearings, one housed within each end frame of the output unit casing.

Electrical connections

11. Electrical connections to the actuator are made via two 5-pole Breeze plugs (Ref. No. 5X/6061), one of which is mounted on the housing immediately above each brake assembly. The appropriate mating sockets (Ref. No. 5X/6064) are included in the aircraft installation.

12. The wiring between the motors and their respective 5-pole plugs is taken via a tab board positioned at each end of the unit and revealed by the removal of the end covers. The tag boards enable the 5-pole plugs to be renewed, if necessary, without affecting the motor wiring.

13. Pin connections for clockwise and anti-clockwise rotation, looking at drive end of motors only, are as follows:—

(1) Clockwise rotation:

(a) Connect pin 1 to NEG.—

(b) Connect pins 2 and 5 to POS+

(c) Connect pin 3 to pin 4

(2) Anti-clockwise rotation:

(a) Connect pin 1 to NEG.—

(b) Connect pins 3 and 5 to POS +

(c) Connect pin 2 to pin 4

Note . . .

(1) *The pins referred to above are the pin numbers of the 5-pole plugs; see also, diagram of connections (fig. 3).*

(2) *For CLOCKWISE rotation of ACTUATOR OUTPUT SHAFT, looking on output shaft from direction of MOTOR B (Motors engraved* A *and* B *respectively)*:—

MOTOR A to have anti-clockwise rotation.

MOTOR B to have clockwise rotation.

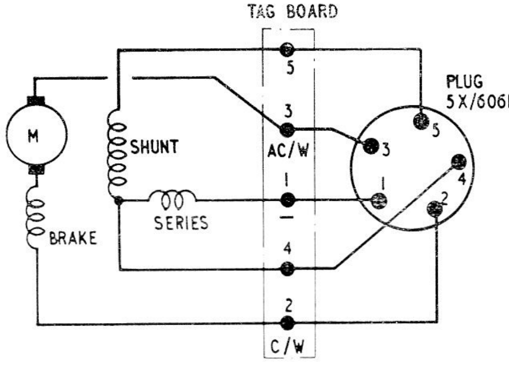

Fig. 3. Diagram of connections

OPERATION

14. As mentioned previously, direction of rotation of the motors is determined by the polarity of the armature connections, and the arrangements of the pin connections to give the change of rotation are given in para. 13.

15. The motors, associated gearing, and brake drum assemblies, being duplicated within the actuator, it will be sufficient to consider the working of one half of the unit only (the other side being identical in its performance).

16. Upon energizing the armature windings, the electro magnetic brake will be released and the armature shaft will rotate. The first sun gear is integral with the armature shaft and extends beyond the bearing housing at the drive end. The sun gear meshes with three planet gears forming the first stage of a 2-stage epicyclic train. Each train consists of a planet carrier having mounted about it, equi-spaced, three planet gears, the two epicyclic trains together revolving in a fixed annulus gear. The sun gear of the second planetary train is formed as an output shaft and carries a splined section which engages with splines of the differential epicyclic sun gear. The differential gearing forms a common assembly which receives the output drives from both motors.

17. Centrally positioned between the epicyclic trains of each motor, and carried by a ball bearing at each end, is a drum-like assembly housing the differential gearing. This is referred to as the differential gear carrier and consists of six planet gears, three being associated with one sun gear, and three with a second (the sun gears being those which are splined and engage with the output shaft of each motor). The six planet gears are formed in three pairs, each pair being in mesh; thus each meshing pair consists of a planet gear associated with each motor drive. An externally machined gear on the differential gear carrier meshes with the offset output unit giving a 1 to 1 ratio and completes the train of gearing from the motor to output shaft.

18. In the event of one motor failing, its brake will hold the reaction of the operating motor. The output torque will remain the same as for two motors operating but the output shaft will revolve at half speed.

INSTALLATION

19. Information on the installation of the actuator will be found in the relevant Aircraft Handbook.

20. Provision for mounting the actuator is made by incorporating a machined surface round each end of the central gearbox housing, the unit being clamped in a cradle mounting forming part of the aircraft installation. A dowel pin, located on each machined surface, enables the actuator to be correctly positioned relative to its associated equipment.

SERVICING

21. 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

22. The minimum length beyond which brushes should not be used is 0·406 in., the length when new being 0·687 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.

23. Brush spring pressure should be between 10 and 12 oz. (284 and 340 gm.), when measured by attaching a tension gauge (Ref. No. 1H/86) to the tip of the brush spring and raising it $\frac{1}{16}$ in. above the level of the top of the box.

Lubrication

24. These actuators are lubricated during manufacture, and should not normally require lubrication except when dismantled for repair. Any trace of oil seepage within the motors should be investigated and the point of ingress found. Oil inside the motor will seriously impair the performance of the motor, and by carrying carbon dust into the windings will lower the insulation resistance.

General

25. Check the security of all soldered leads and ensure that all external nuts, screws and locking devices are secure. Examine the electrical connections for security and damage, and the wiring for frayed or damaged insulation.

26. At the conclusion of the servicing operations, having ensured that all components are in their correct positions, refit and secure the window straps.

Insulation resistance test

27. The insulation resistance, when measured with a 500-volt insulation resistance tester between all live parts and the frame, should not be less than 0·5 megohm (for R.N.), or 0·05 megohm (for R.A.F.).

Appendix 1

ACTUATOR, ROTAX, TYPE C7101

LEADING PARTICULARS

Actuator, Type C7101	*Ref. No.* 5W/288
Voltage	112*V d.c.*
Average current (per motor)	18 *amp.*
Average motor speed	6,200 *r.p.m.*
Output speed (both motors driving)	127 *r.p.m.*
Output speed (one motor driving)	63 *r.p.m.*
Average output torque	1,050 *lb. in.*
Clutch setting	2,130 *lb. in.*
Rotation	*Reversible*
Brush length—	
New	0·687 *in.*
Minimum permissible	0·406 *in.*
Brush grade	*PM50.HAM*
Brush spring pressure	10 *to* 12 *oz.* (284-340 *gm.*)
Commutator diameter—	
New	1·750 *in.*
Minimum permissible	1·730 *in.*
Winding resistance—	
Armature	0·343 *ohm*
Shunt field	630 *ohms*
Series field	0·427 *ohm*
Brake	0·267 *ohm*
Overall dimensions—	
Length	20·375 *in.*
Height (over plug)	8·530 *in.*
Width	4·873 *in.*
Weight	31 *lb.*

1. The actuator, Type C7101, is identical to that described and illustrated in the main chapter. The clutch setting is as shown under Leading Particulars.

Appendix 2

ACTUATOR, ROTAX, TYPE C7102

LEADING PARTICULARS

Actuator, Type C7102	*Ref. No.* 5W/3342
Voltage	112*V d.c.*
Average current (per motor)	14·5 *amp.*
Clutch setting	900 *lb. in.*
Output speed (both motors driving)	174 *r.p.m.*
Output speed (one motor driving)	87 *r.p.m.*
Rotation	*Reversible*
Brush length—	
New	0·687 *in.*
Minimum permissible	0·406 *in.*
Brush grade	*PM*50.*HAM*
Brush spring pressure	10 *to* 12 *oz.* (284-340 *gm.*)
Commutator diameter—	
New	1·750 *in.*
Minimum permissible	1·730 *in.*
Winding resistance—	
Armature	0·343 *ohm*
Shunt field	630 *ohms*
Series field	0·427 *ohm*
Brake	0·267 *ohm*
Overall dimensions—	
Length	20·375 *in.*
Height (over plug)	8·530 *in.*
Width	4·873 *in.*
Weight	31 *lb.*

1. The C7102 rotary actuator is electrically and mechanically identical to that described and illustrated in the main chapter, except that the torque load of the clutch has been reduced by reducing the total number of clutch plates used; the new clutch setting is as given under Leading Particulars.