Chapter 7

DOUBLE ROTARY ACTUATORS, ROTAX, CA1100 SERIES

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Introduction

1. Actuators in the CA1100 series are designed to operate aircraft ancillary controls from a 200V, 400 c/s a.c. supply. Two reversible motors drive an offset parallel common shaft providing an output drive at both ends. Limit switches are not fitted. Operation is satisfactory over a temperature range of —70 deg. C. to +50 deg. C.

2. In some actuators in the CA1100 series the brake coil is connected for a.c. operation, and in others for d.c. operation; in the latter instance d.c. is obtained from a transformer rectifier unit, Type U5201, used in conjunction with the actuator.

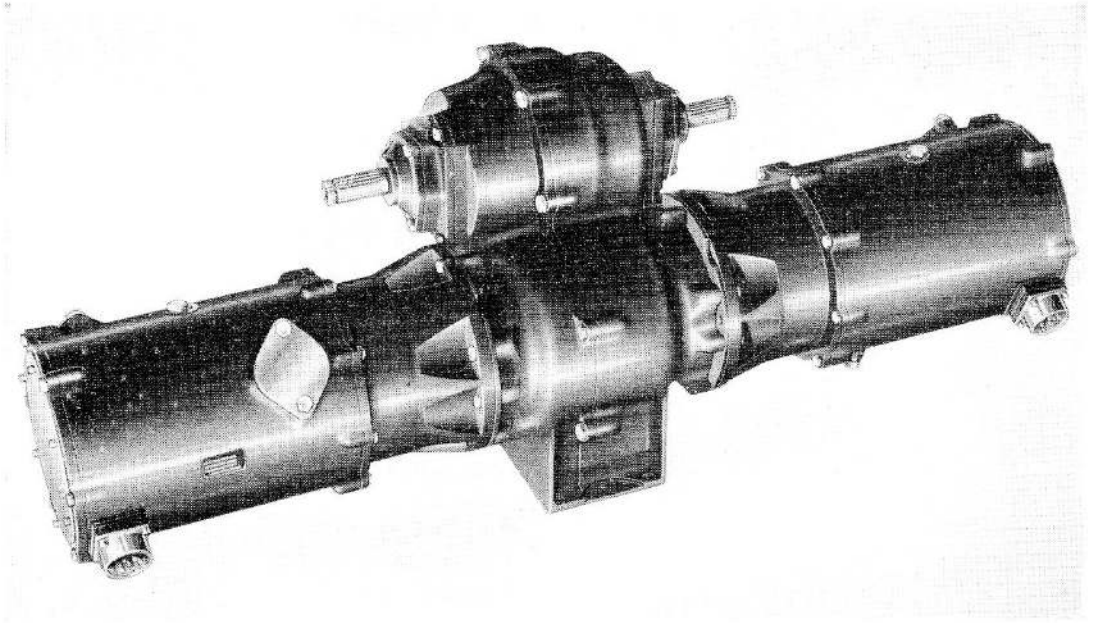

Fig. 1. Typical CA1100 series actuator

DESCRIPTION

3. A typical actuator is illustrated in fig 1. The unit comprises two 3-phase six-pole squirrel cage induction motors driving a double ended splined output shaft through two trains of epicyclic gears and a differential gear. An overload clutch is fitted to the final drive and a brake and overrun clutch are fitted to each motor.

4. The motors are mounted separately each side of the central housing and can be taken off complete with the planet gear carriers for each motor. The central housing contains the gearbox, overload clutch and output shaft. The overload clutch and output shaft are offset from the gearbox and axis of the motor units.

5. The mounting flange is part of the central housing. Electrical connection is made by a six-pole plug on each motor housing. The motors are not interchangeable but the principle of operation and components are the same so that it is only necessary to describe one.

Motor

6. The complete motor assembly comprises three castings. The clutch and brake housing, the motor housing and the end plate. The motor is contained within the motor housing with the rotor supported by two ball bearings, one in the end plate and the other in the clutch and brake housing. The three housings are secured together with bolts. Two orifices in the motor housing provide access for the cooling blast air.

7. A splined extension of the rotor shaft passes through the brake solenoid and engages in the serrated clutch plate carrier. Overrun clutch pressure is provided by a helical spring about the extension shaft and contained between a flange on the shaft and the clutch plate carrier. Adjustment of the the clutch spring pressure is made by a rod adjusting screw with locknut which passes through the hollow rotor shaft and presses on the end of the extension shaft.

Brake and overrun clutch

8. Between the motor and its gearing is a drum type, electro-magnetic brake and a

multi-plate clutch. The brake limits overrun and the clutch absorbs inertia of the rotor on stopping.

9. The brake consists of a steel core on which the coil is wound, the six brake shoes being located around the periphery of this assembly by pins protruding from the flanged core and each shoe has four helical springs located in holes in the flanged core. The brake coil is energized with the motor and withdraws the shoes from the brake drum. When the motor is switched off, the coil is de-energized and the shoes are forced against the drum under the action of the springs.

10. The multi-plate clutch is positioned between the brake and the gearing. The clutch plate housing is integral with the brake drum and first epicyclic train sun gear. Relative rotation occurs between the rotor shaft and the brake drum 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.

11. The clutch shaft is spring-loaded by an adjustable helical spring. The sun gear, integral with the clutch housing, engages with the first epicyclic train. The two planet gear carriers are mounted on an extension to the first sun gear. The two planet gear carriers revolve in a fixed annulus gear in the central housing.

Gearbox

12. The two epicyclic trains project into the central housing and the sun gear of the second 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. 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 planet gears will then cause both differential planet carriers to rotate.

13. Teeth on the periphery of both differential planet carriers engage with a similar number of teeth 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.

14. 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.

15. If one motor fails, its differential sun gear will be locked, due to the brake. The operating motor will drive all the differential planet gears around the sun gear of the stationary motor, but at half the normal speed.

Overload clutch and output shaft

16. The overload clutch is fitted to prevent damage to the motors and gearing. It consists of steel plates of which 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 recesses 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.

17. The output shaft is supported in two ball bearings. The centre of the output shaft is splined and passes through and engages with the clutch shaft. The bearings at each end are located in bearing housings bolted to the gear casing. Two end caps, each fitted with a felt oil seal through which the output shaft passes, are bolted to the bearing housings. The two outputs are provided by one shaft so when each output drive is viewed

from its driving end the shaft will have opposite directions of rotation.

Electrical connections

18. Each motor is supplied by a 6-pole plug (Ref. No. 5X/6761) mounted on a raised mounting cast integral with the motor housing.

Operation

19. When the supply is connected to the motors, the brake solenoids are energized. The brake shoes are withdrawn and the motor transmits its drive via the overrun clutch, two stage epicyclic gearing, differential gear, overload clutch and final drive shaft.

20. The overload clutch slips, when the rated load is exceeded, to dissipate excess energy. When one motor ceases to function, the remaining motor drives the final shaft and gives the same output but at only half the speed. When the motors are disconnected, the brake coil is de-energized and the brake shoes return to the brake drum under the influence of their helical springs. Each motor output shaft is thus arrested whilst the overrun clutch slips to allow the rotor to rotate and dissipate inertia.

INSTALLATION

21. The actuator may be mounted in any attitude. It is secured in position by eight 0·203 in. dia. holes drilled through the base of the flange casting and at right angles to the axis of the actuator.

SERVICING

22. Make a general inspection of the actuator for damage and ensure that it is secure on its mounting and that the electrical connections are clean and sound. Ensure that the motor securing bolts and all external screws and locking devices are secure.

Note . . .

Each motor assembly is a replacement unit identfied by a separate code number for the left and right motors respectively (looking on the actuator with the mounting base facing away and the plugs uppermost)

Lubrication

23. The bearings of the actuator are grease lubricated during manufacture and repair and should not require lubrication during servicing periods.

Insulation resistance test

24. The insulation resistance between the stator windings and the frame, and all live parts and the frame, must be measured with a 500 volt insulation resistance tester and should not be less than 50,000 ohms.

Appendix 1

DOUBLE ROTARY ACTUATOR, ROTAX, TYPE CA1101 (INCORPORATING MOTORS CA1001 AND CA1002)

LEADING PARTICULARS

Actuator, Type CA1101	*Ref. No. 5W/*
Motor supply	200*V*, 400 *c/s*, 3-*phase a.c.*
Current at rated torque per motor	33 *amp.*
Current at maximum working torque per motor	43 *amp.*
Starting current per motor	118 *amp.*
Total rated torque	150 *lb. ft.*
Speed at rated torque	324 *r.p.m.*
Total maximum working torque	250 *lb. ft.*
Speed at maximum working torque	310 *r.p.m.*
Time rating	2 *sec. operation every* 10 *sec. for* 15 *minutes*
Rotation	*Reversible*
Cooling	*Blast air*
Operational temperature range	—70 *deg. C. to* +50 *deg. C.*
Overall dimensions—	
Length	27·562 *in.*
Width	11·949 *in.*
Height (including plugs)	10·356 *in.*
Weight	100 *lb. (approx.)*

1. The CA1101 double rotary actuator is identical with that described and illustrated in the main chapter. Both motor and brake are designed for operation from a 3-phase a.c. supply.

2. Each motor is supplied by a 6-pole plug (Ref. No. 5X/6761), and is connected for clockwise rotation (viewed from the drive end). For clockwise rotation, phase connections red, white and blue must be made to poles 1, 5 and 6 respectively (*fig.* 1). Anti-clockwise rotation is obtained by reversing the connections to poles 5 and 6.

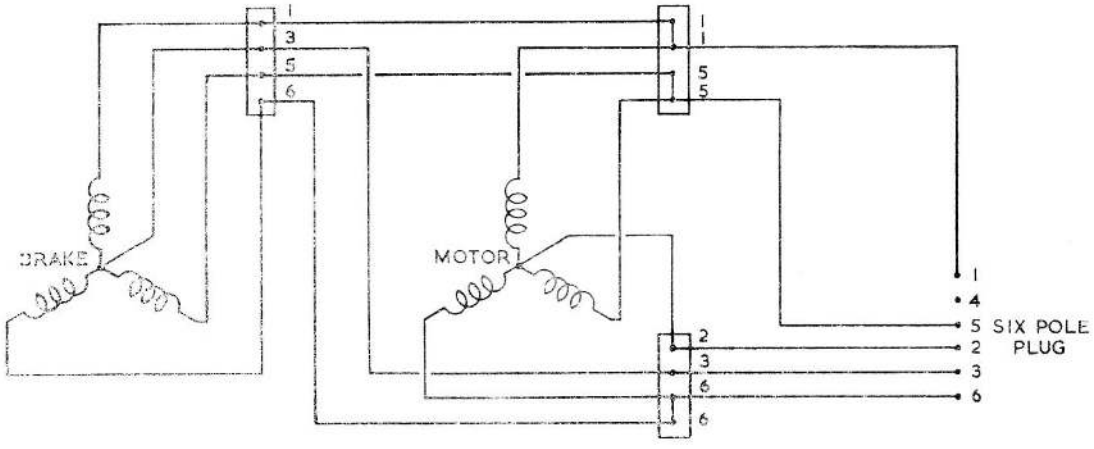

Fig. 1. Diagram of internal connections (CA1101)

Appendix 2

DOUBLE ROTARY ACTUATOR, ROTAX, TYPE CA1102 (INCORPORATING MOTORS CA1003 AND CA1004)

LEADING PARTICULARS

Actuator, Type CA1102	*Ref. No. 5W/3770*
Motor supply	*200V, 400 c/s, 3 phase a.c.*
Current at rated torque per motor	33 *amp.*
Current at maximum working torque per motor	43 *amp.*
Starting current per motor	118 *amp.*
Total rated torque	150 *lb. ft.*
Speed at rated torque	324 *r.p.m.*
Total maximum working torque	250 *lb. ft.*
Speed at maximum working torque	310 *r.p.m.*
Time rating	*One 3 sec. operation, every 10 sec. for 15 minutes*
Rotation	*Reversible*
Cooling	*Blast air*
Operational temperature range	*—70 deg. C. to +50 deg. C.*
Altitude	60,000 *ft. (max.)*
Overall dimensions—	
Length of unit	32·218 *in.*
Length over splined output shaft	13·250 *in.*
Width	11·949 *in.*
Height (including plugs)	7·674 *in.*
Weight	100 *lb. (approx.)*

1. The CA1102 double rotary actuator is identical with that described and illustrated in the main chapter, except that the brake coils in each motor are energized by the 24 volt, 18 amp. d.c. output from a U5201 transformer rectifier unit, that is connected in series with the a.c. supply to each motor, specially designed to meet this requirement.

2. Each motor is supplied by a 6-pole plug (Ref. No. 5X/6761), and is connected for clockwise rotation (viewed from the drive end). Reversal of rotation is effected by reversing the white and blue internal leads, to connections 5 and 6 respectively, as shown in fig. 1.

3. The star connected 3-phase brake winding has been disconnected from the a.c. supply terminations, and reconnected for d.c. operation, with one phase in series, and two in parallel, for the motor brake circuit as shown in fig. 1 of this appendix.

4. The terminations of the above arrangement are connected to pins 3 and 4 of the motor plug, to which the d.c. output from the U5201 transformer rectifier unit is fed.

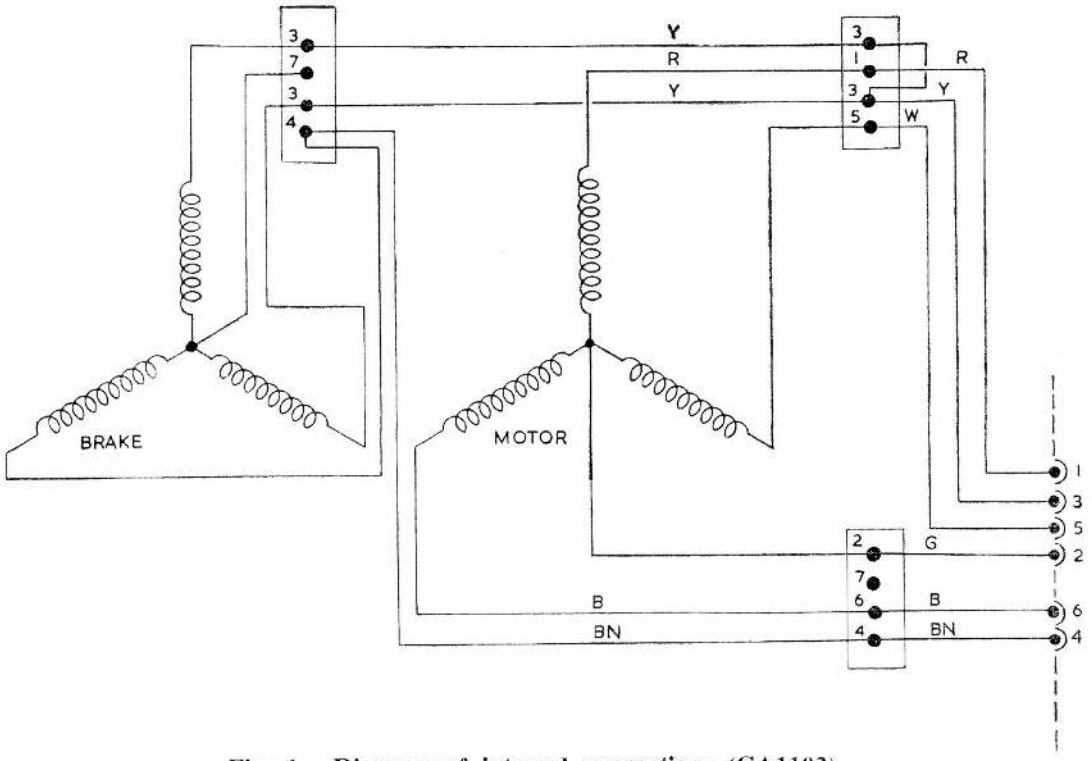

Fig. 1. Diagram of internal connections (CA1102)