Cancelled now A.P.113F-0408-1

Chapter 2

ROTARY ACTUATOR, SMITHS, Type 302/RAA/1

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LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Power supplies	26*V a.c.*
Weight	2 *lb.* 12 *oz.* (1250*g*)
Threshold volts	1*V.*
Time of travel	
Stop to stop	3 *seconds*

Introduction

1. The rotary actuator Type 302/RAA1, Ref. No. 6A/9058 (fig. 1) is a gas turbine engine top temperature control actuator. It is used in conjunction with a temperature control amplifier, and an engine speed governor, to maintain the engine temperature below required limits. The actuator trims the setting of the engine speed governor made by the pilot in response to signals from the engine control amplifier unit.

2. The actuator consists of a motor which is mechanically coupled to an output gear, and also drives an a.c. tacho-generator. The tacho-generator provides an a.c. feedback signal proportional to the speed of the output gear.

DESCRIPTION

Body and gears assembly (fig. 2)

3. The body and gears assembly comprises a body assembly, motor generator, gear train, and thermistor assembly.

4. The body assembly consists of a main body, bushed plate, motor generator housing, and coverplate. The main body is a machined aluminium alloy casting open at one end, and with a snout at the other. Two mounting lugs are provided on the casting for securing the unit in place on the engine. The bushed plate is located in position in the main body by two dowel pins, and divides the main body into two compartments, one housing the gear train, and the other housing the thermistor assembly, and motor generator. The motor generator housing is located in position in

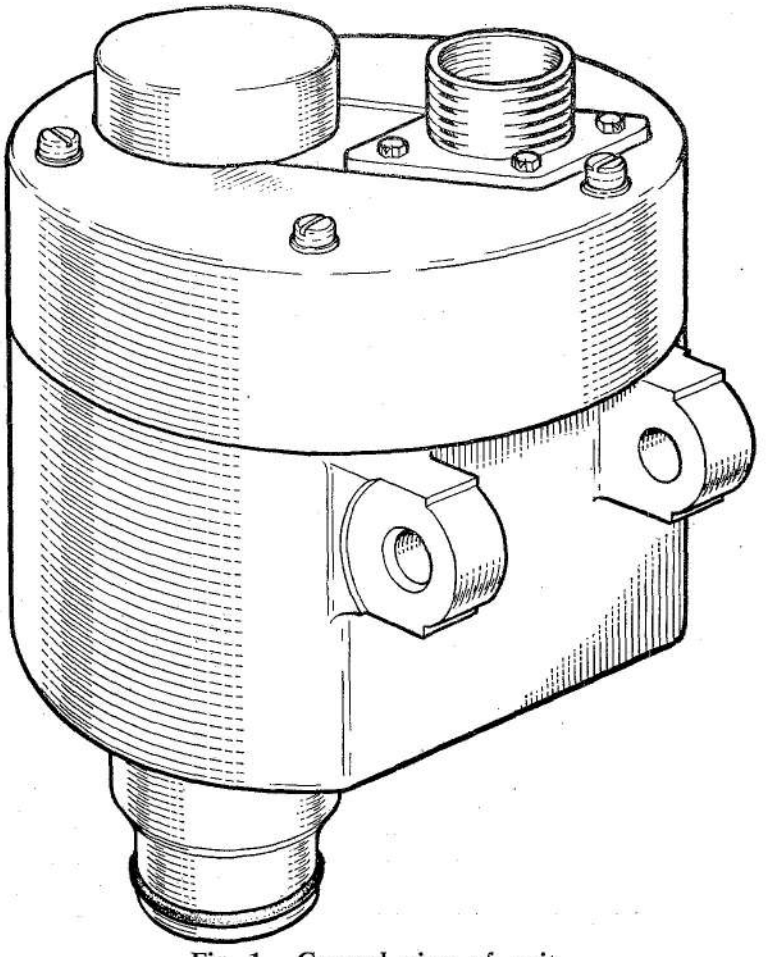

Fig. 1. General view of unit

the bushed plate by a dowel pin, and secured to the plate by a screw, and tab washer. Both the motor generator housing, and the bushed plate, are secured to the main body by four pillars which screw onto four studs on the main body casting. Three of the pillars are locked by special tags, an elongated hole in the end of which is located over the head of a dowel pin. The fourth pillar is locked by a tab washer.

5. The motor generator is held in its housing by two half rings, which fit in a special groove around the pinion end of the motor generator casing, and a special nut, which screws into the motor generator housing, and bears on the half rings to hold the motor generator in place (fig. 3).

6. The motor generator comprises a 26V, 2 phase a.c. induction motor, the output pinion of which drives the actuator gear train, and a tacho-generator, both of which are housed in one case. The tacho-generator is mechanically coupled to the motor, and supplies a feed-back signal, proportional to motor speed, to the temperature control amplifier. The feed-back signal gives stability to the system, and allows the amplifier to have sufficient gain to respond to small changes of temperature at the thermocouple system. The reference winding of the motor, and the excitation winding of the tacho-generator, are supplied with a 26V a.c. supply from the temperature control amplifier. The motor control winding is also supplied from the temperature control amplifier, the magnitude, and phase sense, of the supply being dependent on the difference between the output of the thermocouple system, and a fixed datum voltage in the amplifier.

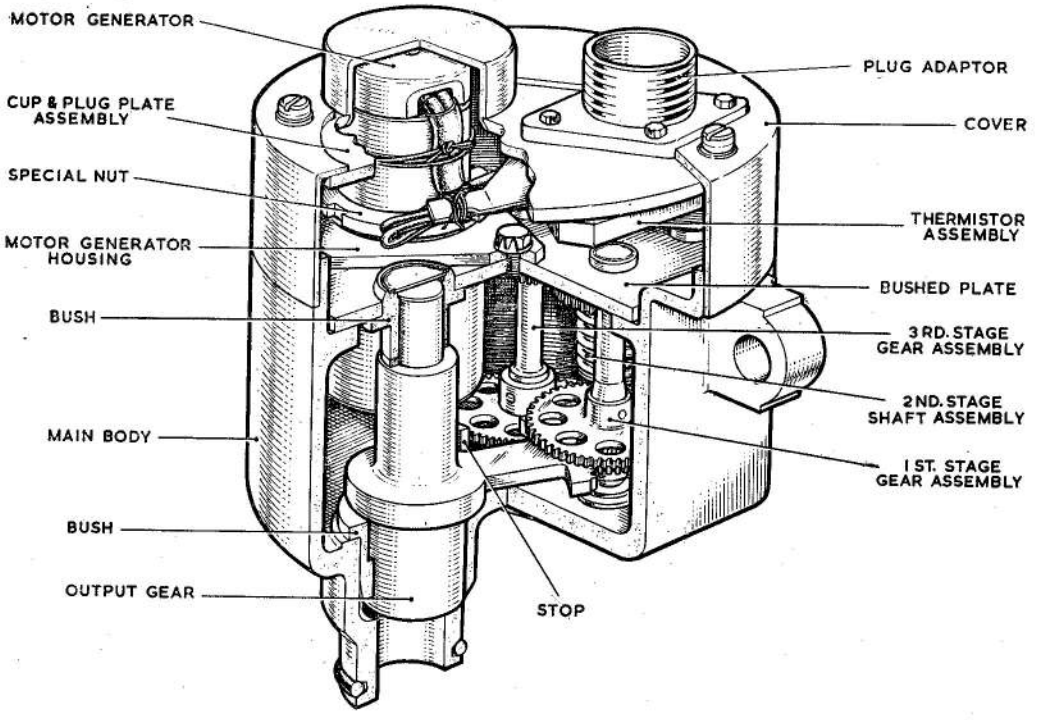

Fig. 2. Sectioned view of rotary actuator

7. The motor generator output pinion drives the actuator output gear via a 2000 : 1 reduction gear train. The output gear shaft rotates in two bushes, one in the bushed plate, and one in the snout of the main body. The output from the actuator is obtained from an internal spline drive in that part of the output gear shaft which rotates in the bush in the snout. This spline has one blind tooth which is used for setting the gears correctly relative to the engine during the installation of the actuator on the engine. Stops in the main body casting limit the rotation of the output gear to an angular movement of 36 degrees, though in normal operation when the actuator is installed on the engine this travel is further restricted by stops on the engine.

8. The intermediate stages of the gear train comprise a geared shaft rotating in ball bearings fitted in bushes in the main body, and the motor generator housing, and three intermediate stage shaft or gear assemblies rotating in bushes fitted in the bushed plate, and the main body. Shims are fitted to the bushed plate ends of the gear shafts to limit the end float of the shafts. The 1st, and 3rd, stage gear assemblies are ordinary gear, and pinion assemblies, but the 2nd stage shaft assembly includes a spring which absorbs the inertia of the motor, and gear train when the output shaft comes up against its stops (fig. 4).

9. The 2nd stage shaft assembly, consists of a shaft with integral output pinion, a special double coil helical spring, which is fitted over an aluminium bush on the shaft, a brass sleeve fitted to reduce friction between the inner, and outer coils of the spring, an input gear fitted over a phosphor bronze bearing bush, and fitted to the shaft, and a stop flange pinned to the shaft. The input gear has two curved slots through which two stops on the rim of the stop flange project. The stops are positioned inside two similarly shaped driving dogs on the input gear, and the two ends of the special spring are held under tension between the dogs. Since the loading torque of the spring is greater than the stall torque of the motor, the spring keeps

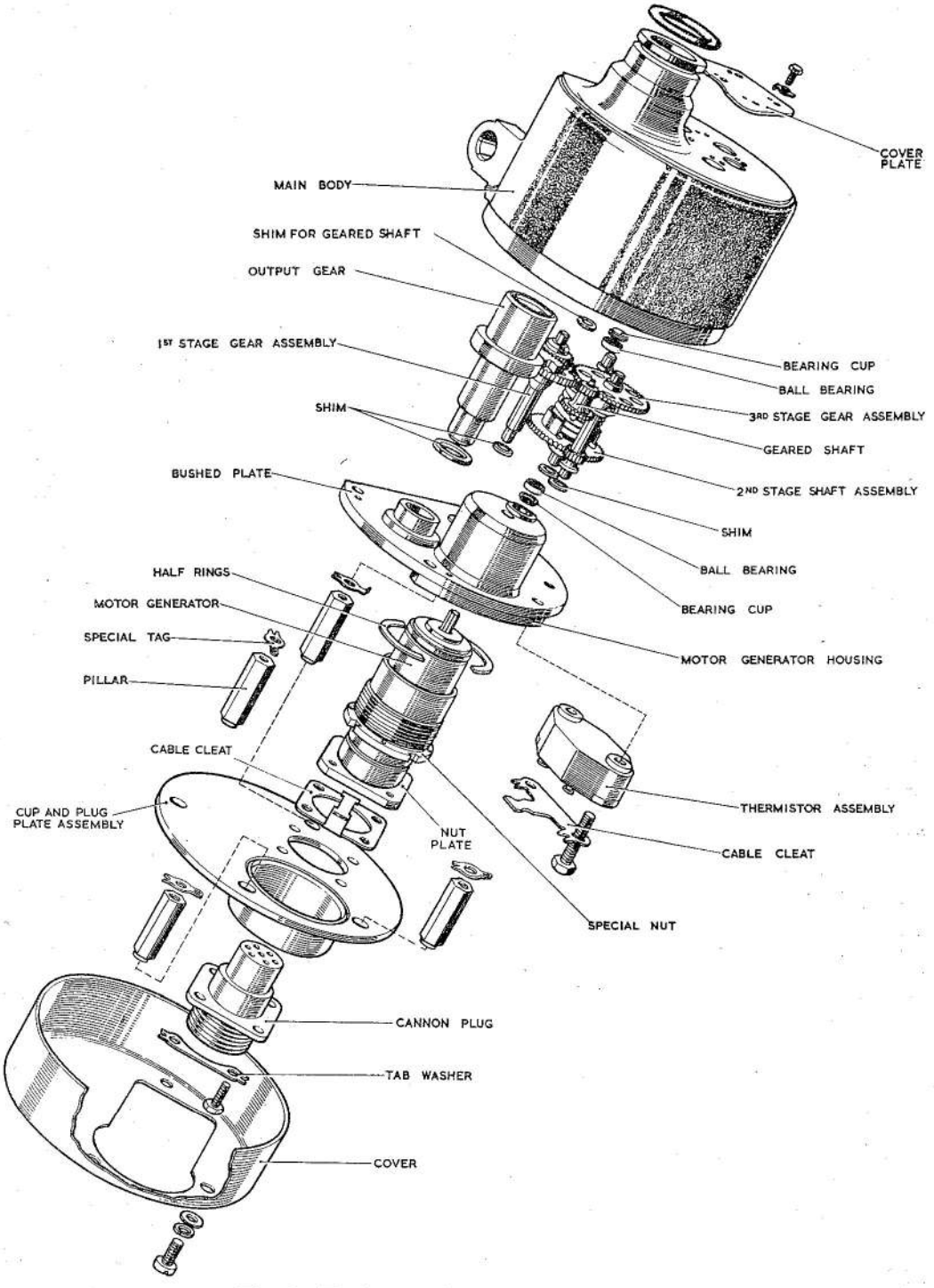

Fig. 3. Exploded view of rotary actuator

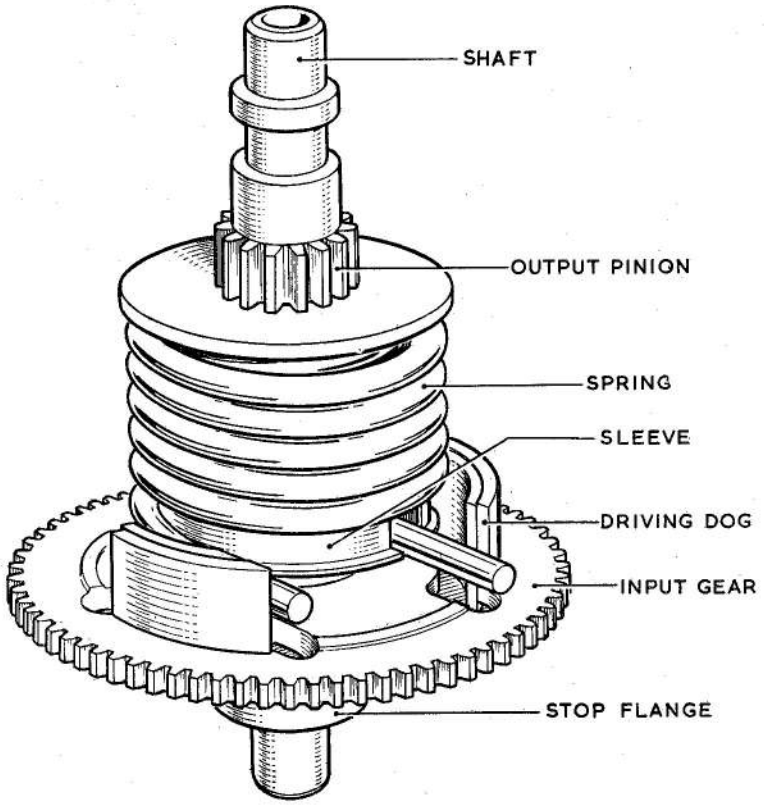

Fig. 4. 2nd stage shaft assembly

the shaft assembly perfectly stiff during normal operation but is allowed to absorb the inertia of the motor, and gear train if the actuator output gear is driven at speed against its stops.

10. The thermistor assembly consists of a thermistor, of nominal resistance 1kΩ at 20°C, mounted on a base board, and connected across a 1kΩ resistor. The whole assembly is enclosed in a moulded resin block, and secured to the top of the bushed plate, together with a cable cleat, by two hexagon head screws. The thermistor has a negative temperature coefficient of resistance, and is connected in the tacho-generator output circuit to compensate for any changes in tacho-generator output due to changes in resistance of the tacho-generator windings with changes in temperature. The nominal resistance is 500Ω at 20°C.

Rear casing (fig. 3)

11. The rear casing comprises a cup and plug plate assembly, cover, plug adaptor, and plug. The cup and plug plate assembly, and cover, are secured to the pillars by four pan-head screws, plain, and spring washers. The plug is secured to the plug adaptor by three screws, tab washers, and wire thread inserts. The plug adaptor is then secured to the cup and plug plate assembly by three screws which locate into a nut plate beneath the cup and plug plate assembly. Each screw is locked by a tab washer. A cleat is carried beneath the cup and plug plate assembly by the three screws securing the plug adaptor.

OPERATION

12. The circuit diagram of the actuator is shown in fig. 5. When a 26V a.c. supply is fed to the motor reference winding, and the tacho-generator excitation winding, and

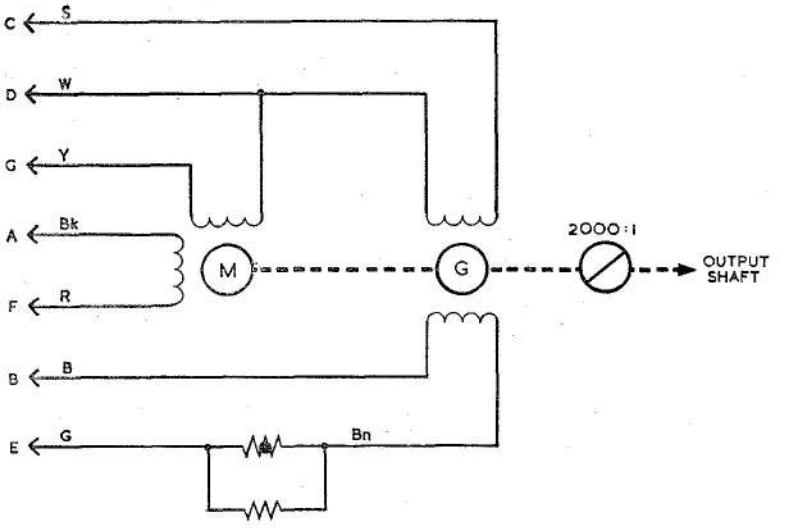

Fig. 5. Circuit diagram

a control supply fed to the motor control winding, the motor will run, and drive the actuator output shaft through the gear train. At the same time the tacho-generator will supply a rate feedback signal proportional to the motor speed, to the engine control amplifier unit.

13. In operation the actuator output gear may be frequently driven against its stops, and when this occurs the inertia of the motor, and gear train, will be absorbed by the spring of the second stage shaft assembly.

14. The 2nd stage shaft assembly is shown diagrammatically in fig. 6. When the input gear is rotated in the direction shown, dog A drives against one end of the spring and the driving torque is transmitted through the spring to the other end which acts on stop B, and rotates the stop flange. The stop flange, being pinned to the shaft, rotates the shaft and the output pinion. If rotation of the actuator output gear is arrested by the output stops, rotation of the 2nd stage output pinion, and the stop flange, will cease but the inertia of the motor and gear train will continue to rotate the input gears, and will drive dog A against the set-up tension of the spring. Any further rotation of the input gear will cease when the spring tension overcomes the inertia of the gear train. A maximum angular movement of 12 degrees is possible before the input gear butts against stop A, but in normal operation this limit will not be reached.

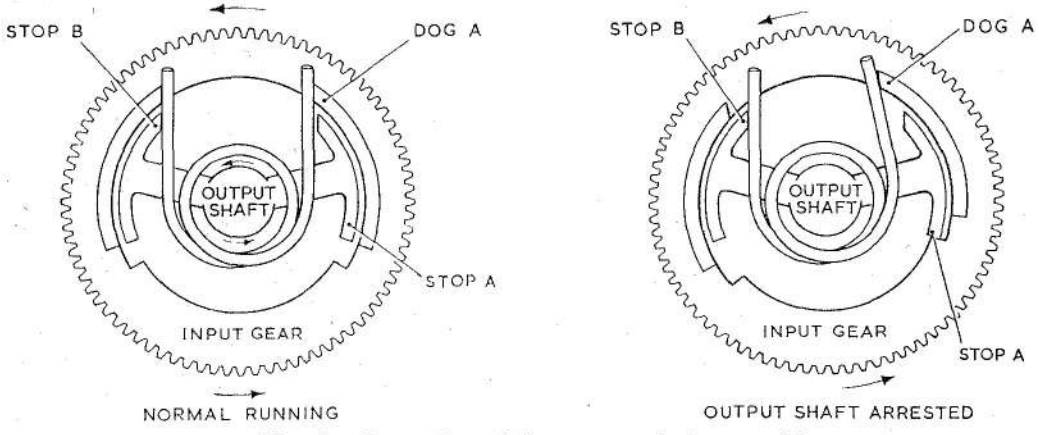

Fig. 6. Operation of 2nd stage shaft assembly

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