Chapter 28

ACTUATORS, ROTAX, A1600 SERIES

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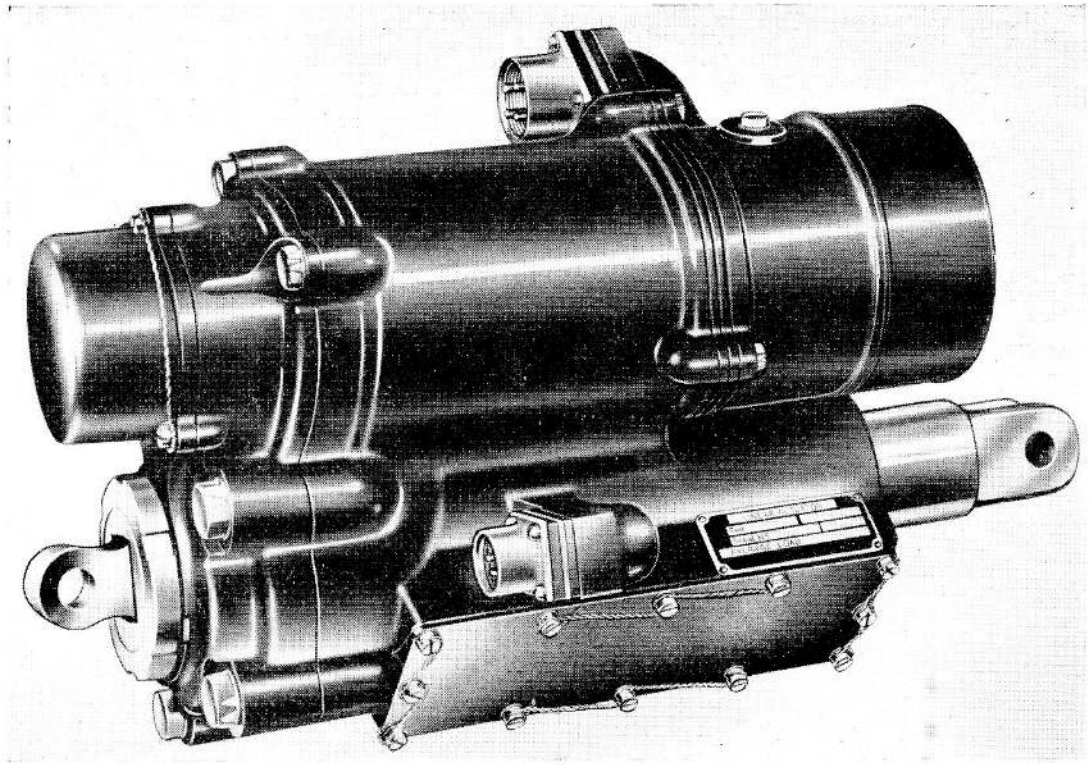

Fig. 1, A1600 series actuator

Introduction

1. Actuators in the A1600 series are 28-volt, d.c. machines having a main and emergency motor, either one of which, when selected, will drive the ram via epicyclic and spur gear trains. They have been designed primarily to control tail plane incidence.

2. Details of individual actuators within the series will be found in Appendices to this chapter. The chief points of difference are the working load, the type of screwshaft, speed and distance of travel, combined with other associated design variations.

DESCRIPTION

3. A typical actuator is illustrated in fig. 1 and 2, which shows the earlier type having an Acme screwshaft. The actuator comprises three main assemblies, viz, ram and screwshaft, main motor with brake, gearbox and overload clutch, and emergency motor with brake and gearbox. The three assemblies are disposed so as to form a triangular shape when the actuator is viewed from either of its two shackles; the motors are offset from the ram but parrallel to it.

4. A casting, common to the three assemblies, forms the ram housing and contains a revolving annulus gear, the third planetary trains of the main and emergency motors and an idler gear common to both gearboxes. To this common casting are assembled the motor, brake, fixed annulus gear and two trains of planetary gears for the main and emergency motor units.

5. An end-frame encloses the ram casting and houses a ball bearing which supports the drive to the overload clutch. The latter is on the same axis as the main motor, and is enclosed by an end cap which is bolted to the end frame.

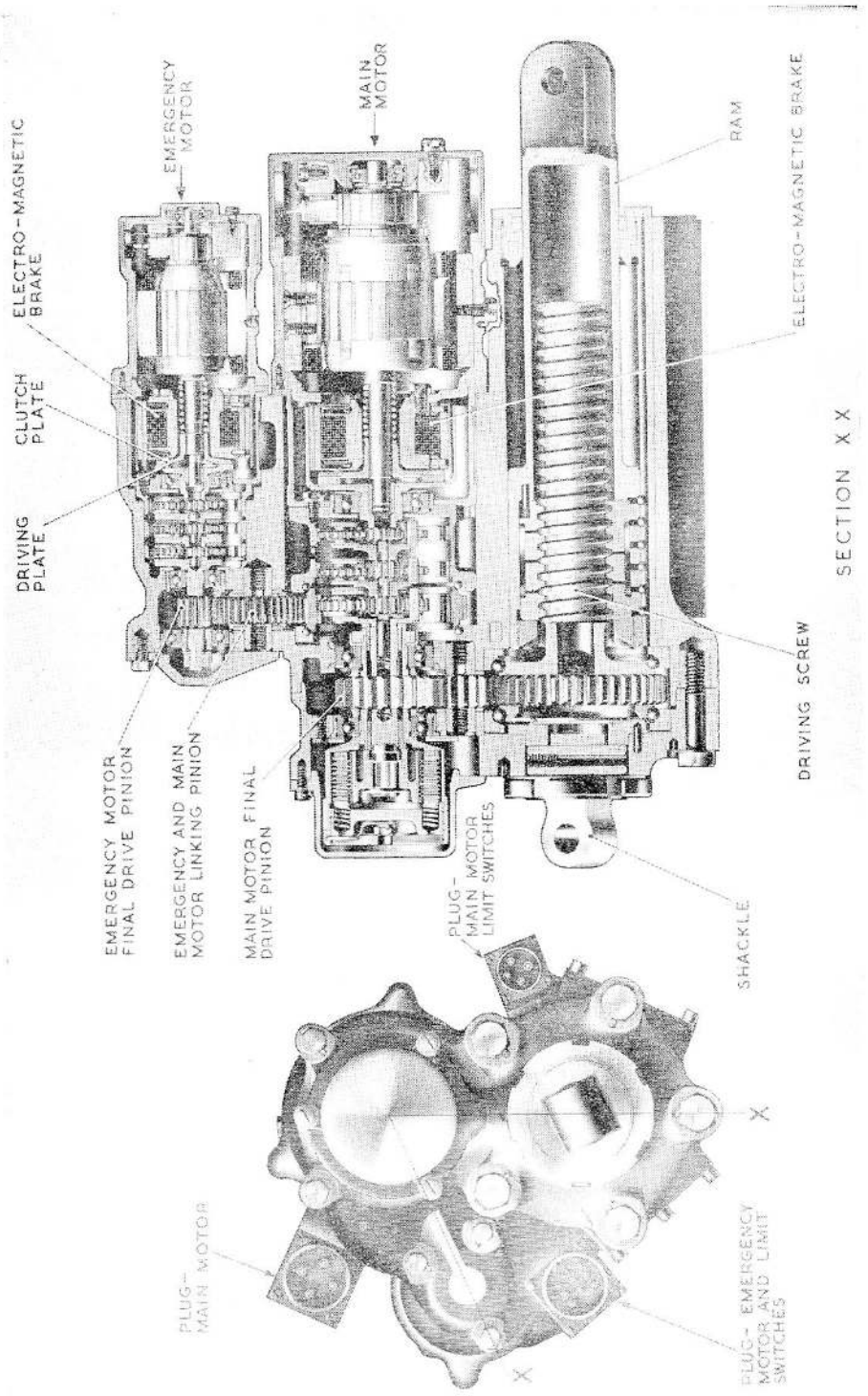

Fig. 2. Expanded sectional view of actuator

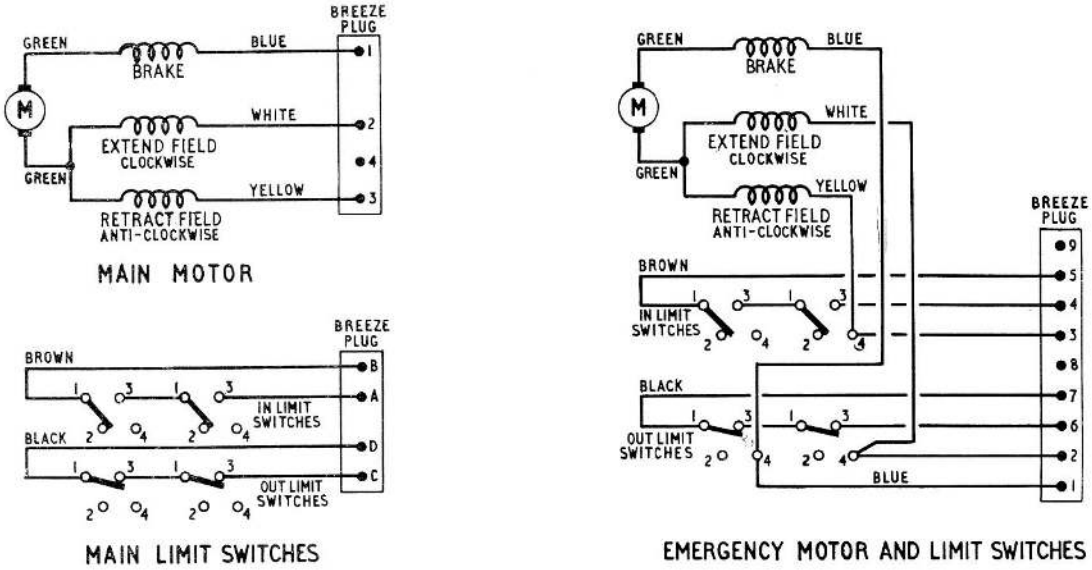

Fig. 3. Internal wiring diagram

Motors

6. The main and emergency motors are split-series wound, 4-pole, 4-brush and 4-pole, 2-brush machines respectively, except for the earlier A1601 and A1602, which were both 2-pole, 2-brush machines. Rotation for the main and emergency motors is anti-clockwise when the ram retracts, when looking on the fixed shackle end of the actuator.

7. In each motor, the armature is borne at the commutator end by a ball bearing, and at the driving end it is carried in a plain bearing in the brake drum which, in turn, can rotate in a ball bearing. The drive is normally transmitted from the armature to the brake drum by means of a single-plate clutch, relative rotation between the arma ture and brake drum occurring only during clutch slip.

Brake and clutch

8. Between each motor and its reduction gearing is a drum type, electro-magnetic brake, the brake shoes of which are stationary, and normally in contact with the inner surface of the brake drum under pressure from helical springs. A brake coil is connected in series with the motor armature so that, when the motors are operating, the brake coil is energized and the shoes with drawn from contact with the brake drum.

9. When the motor circuit is broken, the coil is de-energized and the springs cause the brake shoes to engage with the brake drum. In this manner the brake is automatically applied, and the kinetic energy stored in the rotating armature is dissipated as frictional loss between the clutch plate and brake drum.

Gearing

10. The drive from each motor is transmitted via a three-stage epicyclic reduction gear to an overload clutch, and thence to the final gear train and screwshaft. The gear ratios for the main and emergency motors are 197:1 and 1025:1 respectively, armature to screwshaft.

11. The output drive from the emergency motor is applied to the final annulus gear of the main motor's epicyclic train. Thus, when the gearing of the emergency motor is locked by means of its brake, the drive is obtained from the main motor, and vice versa.

Ram and screwshaft

12. The stainless steel ram, housing a steel

nut, is driven by a high efficiency screwshaft having two tracks of re-circulating balls.

Note . . .

In some early types, the ram houses a bronze nut, driven by a screwshaft of Acme form as illustrated in fig. 2.

13. The screwshaft is borne by a double-row ball bearing located in the ram housing and torque reaction is absorbed by three sets of six balls, located in depressions in the ram and sliding in ways in the ram housing. Positioned at the front of the ram housing is a bronze guide bearing through which the ram travels. This bearing houses a felt washer which serves to prevent foreign matter from entering the ram housing.

Shackles

14. When installed, the actuator is supported between two shackles, one at each end. One is formed integral with the ram, and the other is a fixed shackle, or trunnion, secured to the rear end of the ram housing and so formed as to permit the unit a limited arc of movement in one plane only.

Limit switches

15. The actuator is provided with eight snap-action limit switches (four duplicated as a safety measure), arranged in two banks of four and housed in recesses on either side of the ram housing. Inspection plates, secured by twelve screws each, enclose the switch housings and bear suitable inscriptions relating the switches to the motor they control.

16. The limit switches are actuated by contact with cams machined on the ram. The supplies to the main end emergency motors are controlled by relays (forming part of the aircraft installation), the operating coils of which are in series with the limit switches.

Electrical connections

17. Electrical connections to the actuator are made via three multipole plugs as follows:—

(1) Main motor
One 4-pole plug (Ref. No. 5X/6056).

(2) Main motor limit switches
One 4-pole plug (Ref. No. 5X/6006).

(3) Emergency motor and its limit switches
One 9-pole plug (Ref. No. 5X/6036).

Note . . .

The pins of the 4*-pole plug in* (1) *are numbered,* 1, 2, 3 *and* 4; *those for* (2) *are lettered A, B, C and D.*

INSTALLATION

18. The actuator may be mounted in any attitude, and is supported by the two shackles. Details of a particular installation will be found in the relevant Aircraft Handbook.

SERVICING

19. These actuators should be serviced in accordance with the general information in A.P.4343, Vol. 1, Sect. 17, Chap. 2, and the instructions contained in the relevant Servicing Schedule.

Brushgear

20. The minimum length beyond which the brushes should not be used is 0·400 in. for the main motor, and 0·250 in. for the emergency motor. 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.

21. Brush spring pressure should be measured by a tension gauge (Ref. No. 1H/86) with the spring level with the top of the holder in each instance. The correct pressure for the main motor is between $10\frac{1}{2}$ and 12 oz. (298 and 340 gm.), and for the emergency motor between 5 and 7 oz. (142 and 198 gm.).

Lubrication

22. The bearings of the actuator are grease lubricated during manufacture and repair, and should not normally require lubrication during servicing periods. For gear lubrication grease XG-276 may be used if necessary.

Testing

23. If the serviceability of the machine is suspect, it may be tested as laid down in the relevant Appendix.

Appendix E

STANDARD SERVICEABILITY TEST FOR ACTUATOR, ROTAX, TYPE A1612

Introduction

1. The following tests may be applied to the actuator before it is put into service, or at any time when its serviceability is suspect.

Test equipment

2. The following test equipment is required:—

(1) Linear actuator test rig (Ref. No. 4G/5420).

(2) Insulation resistance tester, Type C (Ref. No. 5G/152).

Testing

Performance test

3. Set the actuator on the test rig, using the correct end fittings. Ensure that it operates within the limits given in Tables 1 and 2 respectively. All load tests should be made in both directions of travel, and timed over the full stroke, i.e., 2·760 in.

TABLE 1
Main motor driving

Applied voltage	Load (lb.)	Time for 2·760 in. stroke (sec.) (max.)	Max. current (amp.)
28	0	8·49	11·0
28	1500	9·52	14·0
20	0	10·61	9·5

TABLE 2
Stand-by motor driving

Applied voltage	Load (lb.)	Time for 2·760 in. stroke (sec.) (max.)	Max. current (amp.)
28	0	8·40	5·25
28	1500	21·23	6·25
20	0	22·08	4·50

4. *Load assisting, 18 volts.*—The unit should be operated in each direction of travel through a full stroke, assisted by a load of 1500 lb. Throughout this test there must be no evidence of brake shoe "drop-on".

Insulation resistance test

5. The insulation resistance, when measured with a 250-volt insulation resistance tester between all live parts and the frame, should not be less than 0·05 megohm.

Appendix 1

ACTUATOR, ROTAX, TYPE A1601

LEADING PARTICULARS

Actuator, Type A1601	*Ref. No. 5W/315*
Voltage	28*V d.c.*
Current at maximum load: —	
Main motor	30 *amp.*
Emergency motor	10 *amp.*
Rating at normal working load	1·5 *min.*
Normal working load	4,500 *lb.*
Maximum working load	6,000 *lb.*
Ram travel	2·560 *in.*
Ram speed at maximum load: —	
Main motor	0·14 *in. per sec.*
Emergency motor	0·04 *in. per sec.*
Maximum overrun using relays: —	
Main motor	0·048 *in.*
Emergency motor	0·020 *in.*
Brush spring pressure: —	
Main motor	$10\frac{1}{2}$ *to* 12 *oz.* (298 *to* 340 *gm.*)
Emergency motor	5 *to* 7 *oz.* (142 *to* 198 *gm.*)
Overall dimensions: —	
Length (retracted)	14·094 *in.*
Length (extended)	16·654 *in.*
Height	8·625 *in.*
Width	6·686 *in.*
Weight	31 *lb.*

1. The actuator, Type A1601, has an Acme type screwshaft as illustrated in fig. 2 of the main chapter. Its operating characteristics are as given under Leading Particulars, and the stroke is 2·560 in.

Appendix 2

ACTUATOR, ROTAX, TYPE A1603

LEADING PARTICULARS

Actuator, Type A1603	*Ref. No. 5W/433*
Voltage	28*V d.c.*
Current at maximum load: —	
Main motor	23 *amp.*
Emergency motor	12 *amp.*
Normal working load	4,500 *lb.*
Maximum working load	6,000 *lb.*
Ram travel	2·560 *in.*
Ram speed at maximum load: —	
Main motor	0·12 *in./sec.*
Emergency motor	0·04 *in./sec.*
Overload clutch setting	7,000 *to* 8,000 *lb.*
Maximum overrun using relays: —	
Main motor	0·030 *in.*
Emergency motor	0·020 *in.*
Brush spring pressure: —	
Main motor	$10\frac{1}{2}$ *to* 12 *oz.* (298 *to* 340 *gm.*)
Emergency motor	5 *to* 7 *oz.* (142 *to* 198 *gm.*)
Minimum brush length: —	
Main motor	0·400 *in.*
Emergency motor	0·250 *in.*
Brush grade: —	
Main motor	*EGO.HAM*
Emergency motor	*EGO.HAL*
Operating altitude	60,000 *ft.*
Temperature range	−70 *deg. C. to* +90 *deg. C.*
Overall dimensions: —	
Length (retracted)	12·96 *in.*
Length (extended)	15·52 *in.*
Height	8·625 *in.*
Width	6·686 *in.*
Weight	31 *lb.*

1. The actuator, Type A1603, has an Acme type screwshaft as illustrated in fig 2 of the main chapter. It introduces new ram races, armature and field coils, and its operating characteristics are as given under Leading Particulars; the stroke is 2·560 in.

Appendix 3

ACTUATOR, ROTAX, TYPE A1606

LEADING PARTICULARS

Actuator, Type A1606	*Ref. No. 5W/1003*
Voltage	*28V d.c.*
Current at normal load —	
Main motor	*12·5 amp.*
Emergency motor	*6·5 amp.*
Normal working load	*1,500 lb.*
Maximum working load	*5,000 lb.*
Ram travel	*2·760 in.*
Ram speed at normal load —	
Main motor	*0·340 in./sec.*
Emergency motor	*0·125 in./sec.*
Overload clutch setting	*7,000 to 8,000 lb.*
Maximum overrun using relays —	
Main motor	*0·062 in.*
Emergency motor	*0·040 in.*
Brush spring pressure —	
Main motor	*10½ to 12 oz. (298 to 340 gm.)*
Emergency motor	*5 to 7 oz. (142 to 198 gm.)*
Minimum brush length —	
Main motor	*0·400 in.*
Emergency motor	*0·250 in.*
Brush grade —	
Main motor	*EGO.HAM*
Emergency motor	*EGO.HAL*
Operating altitude	*50,000 ft.*
Temperature range	*−45 deg. C. to +60 deg. C.*
Overall dimensions —	
Length (retracted)	*13·894 in.*
Length (extended)	*16·654 in.*
Height	*8·625 in.*
Width	*6·686 in.*
Weight	*31 lb.*

1. The actuator, Type A1606, has a high efficiency type screwshaft with two tracks of recirculating balls. Its operating characteristics are as given under Leading Particuars, and the stroke is 2·760 in.

Appendix 4

ACTUATOR, ROTAX, TYPE A1607/1

LEADING PARTICULARS

Actuator, Type A1607/1	*Ref. No. 5W/3913*
Voltage	28*V. d.c.*
Current at normal load —	
Main motor	14·0 *amp.*
Emergency motor	6·25 *amp.*
Normal working load	1,500 *lb.*
Maximum working load	5,000 *lb.*
Ram travel	2·760 *in.*
Ram speed at normal load —	
Main motor	0·29 *in./sec.*
Emergency motor	0·13 *in./sec.*
Overload clutch setting	8,500 *to* 9,500 *lb.*
Maximum overrun using relays —	
Main motor	0·062 *amp.*
Emergency motor	0·040 *amp.*
Brush spring pressure —	
Main motor	10½ *to* 12 *oz.* (298 *to* 340 *gm.*)
Emergency motor	5 *to* 7 *oz.* (142 *to* 198 *gm.*)
Minimum brush length —	
Main motor	0·400 *in.*
Emergency motor	0·250 *in.*
Brush grade —	
Main motor	*EGO.HAM*
Emergency motor	*EGO.HAL*
Operating altitude	50,000 *ft.*
Temperature range	−60 *deg. C. to* +100 *deg. C.*
Overall dimensions —	
Length (retracted)	12·760 *in.*
Length (extended)	15·520 *in.*
Height	8·625 *in.*
Width	6·686 *in.*
Weight	31 *lb.*

1. The actuator, Type A1607/1 (Ref. No. 5W/3913) supersedes Type A1607 (Ref. No. 5W/2313) and differs from it in having a locking plate for the main clutch adjustment nut. This actuator has a high efficiency type screwshaft with two tracks of re-circulating balls. The main and emergency, extend and retract field coils are reversed in direction of winding from those shown in fig. 3 of the main chapter; the extend field coils are wound for anti-clockwise rotation and the retract field coils for clockwise rotation. It introduces a modified main brake and the operating characteristics are as given under Leading Particulars. The stroke is 2·760 in.

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Appendix 5

ACTUATOR, ROTAX, TYPE A1612

LEADING PARTICULARS

Actuator, Type A1612	*Ref. No. 5W/5449*
Voltage	*28V d.c.*
Current at normal load—	
Main motor	*14 amp.*
Standby motor	*6·25 amp.*
Normal working load	*1500 lb.*
Maximum allowable working load	*10500 lb.*
Ram travel	*2·760 in.*
Ram speed at normal load—	
Main motor	*0·290 in./sec.*
Standby motor	*0·130 in./sec.*
Overload clutch setting	*11000-12000 lb.*
Maximum static load	*13000 lb.*
Maximum overrun using relays—	
Main motor	*0·062 in.*
Standby motor	*0·040 in.*
Main motor armature—	
Commutator diameter (new)	*1·385 in.*
Commutator diameter (minimum permissible)	*1·350 in.*
Standby motor armature—	
Commutator diameter (new)	*0·718 in.*
Commutator diameter (minimum permissible)	*0·688 in.*
Brush spring pressure—	
Main motor	*10½ to 12 oz. (298 to 340 gm.)*
Standby motor	*5 to 7 oz. (142 to 198 gm.)*
Minimum brush length—	
Main motor	*0·400 in.*
Standby motor	*0·250 in.*
Brush grade—	
Main motor	*E.G.O. HAM.*
Standby motor	*E.G.O. HAM.*
Operating altitude	*50000 ft*
Temperature range	*—60 deg. C to +100 deg. C*
Overall dimensions—	
Length (retracted)	*12·760 in.*
Length (extended)	*15·520 in.*
Height	*8·625 in.*
Width	*6·686 in.*
Weight	*31 lb.*

1. The actuator, Type A1612 (Ref. No. 5W/5449) now supersedes actuator, Type A1607/1 (Ref. No. 5W/3913), and differs from it in that new overload clutch springs and an overload clutch adjusting nut have been incorporated.

2. The A1607/1 code is raised to A1612 on the embodiment of conversion modification A6313, which provides an increase in the overload clutch setting; the clutch setting details are given under Leading Particulars of this appendix.

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1876 370867 12/63 1500 Gp.375/5