Chapter 6

STARTER MOTORS, ROTAX, C.13500 SERIES

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Introduction

1. Starter motors in the C.13500 series are totally enclosed, four pole, compound wound machines designed for use with the Gnome engine of various helicopters.

DESCRIPTION

2. The starter motor comprises a commutator end frame, or front housing, yoke and field coils, drive end frame and jaw engaging mechanism located in a clutch assembly actuated by a solenoid assembly fitted to the front housing.

3. The field windings of the starter motor are four pole compound wound. The series field system is connected as a two circuit parallel winding, with a solenoid coil connected in series at the centre junction of the series winding.

4. The shunt winding is connected normally, all four field coils being in series and the whole winding short shunt (fig. 4). The armature is connected as a normal wave winding, and is supported at each end on bearings which are a clearance fit in the housings and interference fit on the shaft.

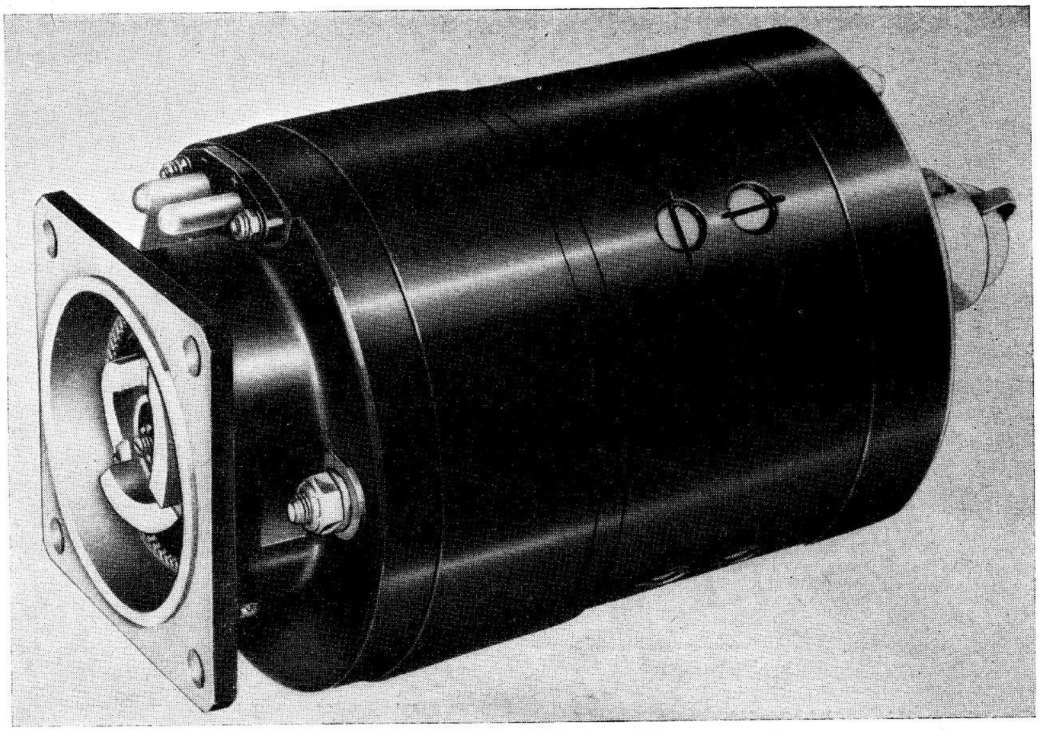

Fig. 1. General view of C.13500 series—starter motor

5. The solenoid is mounted on the commutator front housing of the starter motor. Positioned at the drive end of the solenoid plunger is a push-rod, connected through a hollow armature shaft onto the starter jaw. The starter direction of rotation is clockwise when viewed from the drive end.

OPERATION

6. Whenever possible, power for operating the starter motor should be taken from a heavy duty starter battery or from a ground diesel truck.

7. When the starter button is pressed the d.c. current energizes the motor unit. The current flow through the field coils also energizes the solenoid coil. The solenoid plunger then moves inwards towards the attracting anvil face, actuating the push rod in an axial direction thus extending the starter jaw to make the necessary engine engagement. A spring fitted at the rear of the flange face reduces, slightly, the axial jaw impact.

8. The starter jaw is disengaged when the solenoid is de-energized. The mechanical action of the spring returns the jaw to its normal retracted position.

9. This type of starter is rated at one minute only. If three unsuccessful attempts are made to start the engine, no further attempts should be made until the trouble has been investigated as serious damage to the starter may result. A period of 30 minutes should elapse before a further attempt to start is made.

Electrical connections

10. Elctrical connections are made via two 0·260 in. diameter pins which engage mating sockets when the starter motor is fitted to the engine.

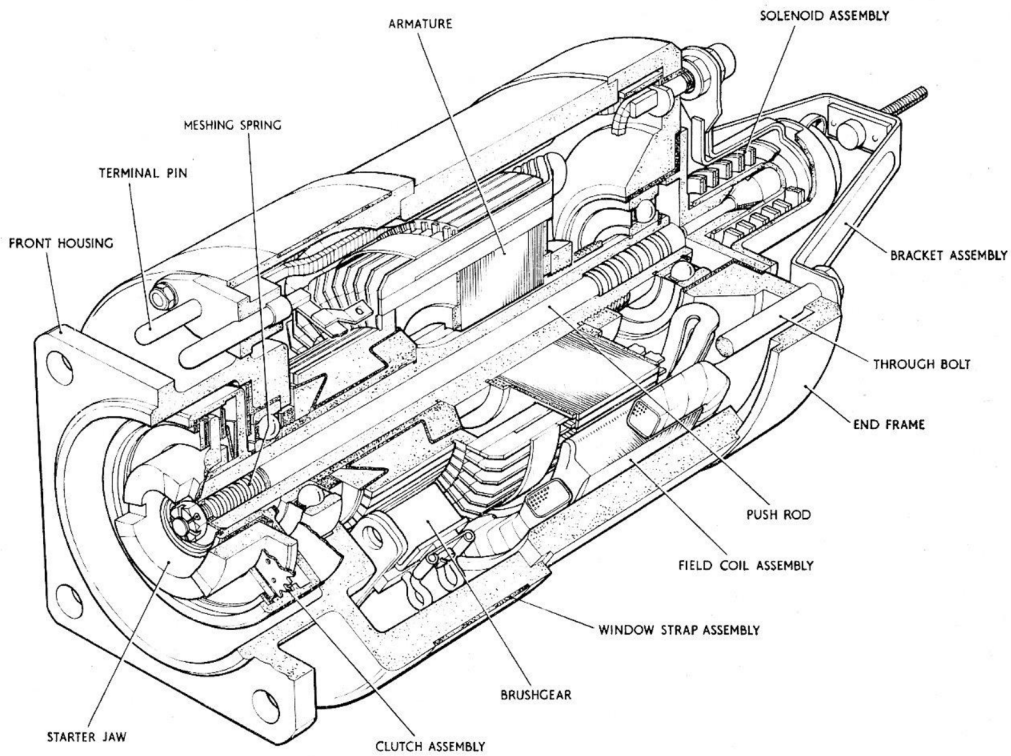

Fig. 2. Section view of starter motor

INSTALLATION

11. For installation purposes the starter is provided with a mounting flange having four 0·346 in. diameter fixing holes equi-spaced on a 4·00 in. P.C.D. Integral with the flange is a locating spigot

$$3{\cdot}000 \pm \begin{matrix} 0{\cdot}003 \text{ in.} \\ 0{\cdot}0 \text{ in.} \end{matrix}$$

SERVICING

12. Servicing on the aircraft will normally be confined to examination for freedom from mechanical damage and corrosion. Electrical connections and the starter mounting should be checked for security. If the serviceability of the starter is suspect it should be removed and tested using the procedure given in the Standard Serviceability Test, Appendix 'A' to this chapter. If the starter does not meet the equirements of the Appendix 'A' it should be dismantled and the components examined as given in the following procedure in conjunction with the relevant Servicing Schedule.

Dismantling

Brushes and clutch assembly

13. Release the turn catch and remove the cover band. Identify the brushes with their respective brush boxes. Unscrew the four brush pig-tail securing screws. Collect the four spring washers and remove the brushes.

14. Remove the split pin which locks the nut positioned in the centre of the starter jaw. Unscrew the nut and remove the clutch assembly complete with the starter jaw. Remove the meshing spring and collect the spacer and the shims from the push rod. Measure the thickness of the shims as an aid to re-assembly.

15. Remove the two stiffnuts securing the terminal moulding to the front housing and withdraw the moulding from the connection pins and the front housing.

Removal of the armature

16. Unscrew the two stiffnuts and remove the two through bolts securing the yoke and field coil assembly and the end frame together taking care not to foul the field coils. Collect the four plain washers and the bracket assembly.

Solenoid

17. Remove the two stiffnuts securing the solenoid connections to the two end frame terminals and collect the two plain washers. Unscrew the four stiffnuts securing the solenoid case together with the anvil to the end frame. Collect the four plain washers and remove the solenoid case. Release the spring clip and remove the cap.

18. Remove the plunger assembly, lift off the solenoid coil and remove the anvil. Withdraw the push rod and collect the return spring. Remove the two nuts from the end frame terminals and collect the two plain washers and the two insulating washers.

19. Separate the end frame from the yoke and field coil assembly and collect the two insulators fitted to the terminals. Remove the circlip adjacent to the commutator end ball bearing and remove the armature from the yoke and field coil assembly. Remove the circlip adjacent to the ball bearing on the armature shaft and withdraw the bearing.

Front housing

20. Separate the front housing from the yoke and field coil assembly. Unscrew the four countersunk screws securing the clamp plate to the front housing, remove the clamp plate and withdraw the ball bearing.

Examination

21. All components of the dismantled starer motor must be examined for mechanical and electrical defects in conjunction with A.P.4343, Vol. 1, Sect. 15, Chap. 1. The procedures for skimming the commutator, bedding the brushes and fitting the bearings may also be found in A.P.4343 and the relevant Air Diagrams. The brushes should be examined and renewed if pitted, chipped or burnt or the brush length measured on the long face is less than the minimum length given in the Leading Particulars or may be likely to reach this length before the next scheduled servicing.

22. Check the brush spring tension by attaching a spring balance (Ref. No. 1H/97) to the tips of the springs and raise them level with the top of the brush boxes. The reading should be between 24 and 28 oz. Check the tension of the meshing spring (positioned at the engaging jaw end of the push rod assembly), and ensure that when the spring is compressed to 1·000 in. a reading of between 5 to 5·25 lb is obtained. Brush springs and meshing spring which do not meet these requirements should be renewed.

Cleaning

23. Prior to reassembly all components, other than the sealed bearings, should be cleaned in lead-free petrol. Care should be taken to ensure that the petrol does not enter the sealed bearings.

Insulation resistance test

24. The insulation resistance of the armature, each pair of field coils, and the solenoid to the frame should be measured using a 250V insulation resistance tester. The reading obtained for each sub-assembly should be not less than 2 megohms in order to obtain an overall insulation resistance value of 5000 ohms.

ASSEMBLY

Front housing

25. Fit the ball bearing into the front housing, position the clamp plate and secure with four countersunk screws and caulk metal into slots to lock.

Re-fitting the armature

26. Fit the ball bearing onto the tail end of the armature shaft and secure with the circlip. Fit the front housing to the yoke and field coil assembly, fit the terminal moulding over the field coil leads and secure to the front housing with two stiffnuts.

27. Fit the armature into the yoke and field coil assembly, locating the commutator end shaft in the ball bearing, and secure with the circlip. Fit the two insulators onto the field lead terminals, locating the insulators in the end frame. Fit the insulating washer and plain washer onto each of the two terminals.

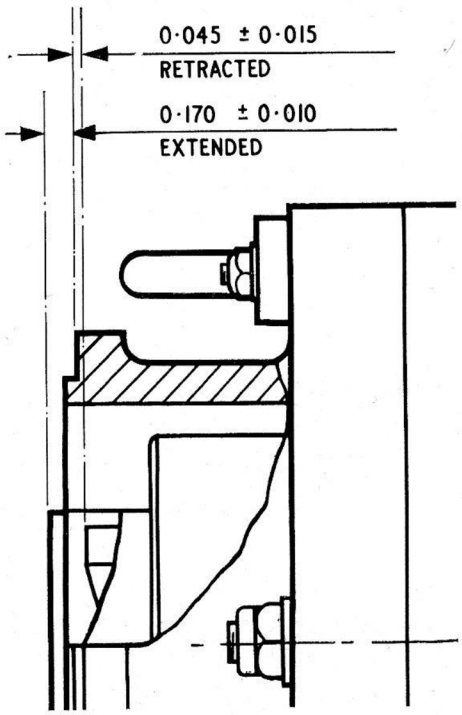

Fig. 3. ◀Part sectional view showing jaw travel limits▶

28. Fit the return spring onto the push rod and slide the push rod into the armature shaft. Fit the anvil to the end frame, locating it onto the studs. Replace the solenoid coil and plunger assembly.

29. Fit the cap to the solenoid case and secure with the spring clip. Place the solenoid case over the solenoid coil and secure the end frame with four stiffnuts. Using a plain washer and a stiffnut secure the solenoid connections to the two terminals.

30. Fit the bracket assembly in position on the end frame and pass the two through bolts through the machine to secure the whole assembly. Secure the two bolts with plain washers and stiffnuts. Ensure that the armature rotates freely when turned by hand.

Brushes and clutch assembly

31. Fit the shims and spacer into the commutator end of the armature shaft, ensuring that they locate over the push rod and seat correctly onto the shoulder. Fit the meshing spring onto the spacer.

32. Lubricate the splines of the armature shaft with grease XG-276 (Ref. No. 34B/9425139) and fit the clutch assembly to the armature shaft with the nut. Adjust the meshing spring tension by the nut to give the following conditions :—

(1) When the starter jaw is fully retracted the distance from the jaw face to the face of the mounting flange, shown in fig. 3, should be 0·045 ± 0·015 in.

(2) When the starter jaw is fully extended the distance from the jaw face to the face of the mounting flange, shown in fig. 3, should be 0·170 ± 0·010 in.

33. (1) Remove the solenoid clip and cap, and with the starter restrained check that the movement of the solenoid plunger before the coils of the spring close is $0{\cdot}060 \pm \frac{0{\cdot}0}{0{\cdot}020}$ in.

(2) Having ensured that the requirements of para. 33 (1) have been satisfied replace the cap and clip and secure the nut with the split pin.

34. Fit the brushes into their correct boxes and secure the leads to the brushgear with the screws and spring washers.

Brush bedding

35. The brushes must be pre-bedded prior to assembly as given in A.P.4343, Vol. 1, Sect. 1, Chap. 2, and finally bedded at this stage on no load at a reduced voltage of 10 to 15V until the brushes are bedded over their full arc and 75 per cent of their area. During the final bedding period the motor should be cooled using blast air. It is recommended that the solenoid plunger be removed during this operation.

Testing

General

36. The jaw position and meshing spring movement must be set prior to testing as instructed in para. 32. Following all servicing the tests given in the Standard Ser-

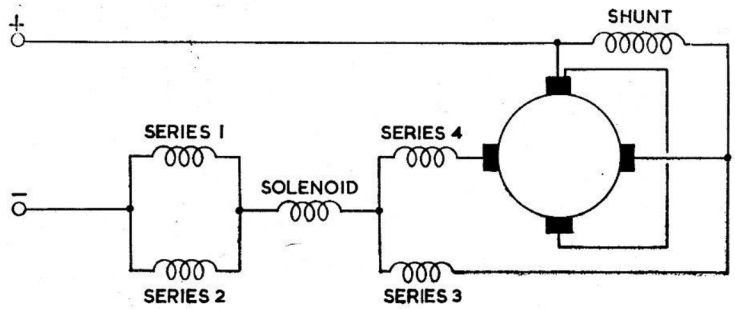

Fig. 4. Circuit diagram

viceability Test Appendix A and the following tests are to be made.

Solenoid and jaw operation

37. The starter is to be mounted on a test rig NTS.7711, the moment of inertia of which should be 0·8 to 2·4 lb/ft^2.

38. The starter clutch must be blast air cooled and care must be taken to ensure that the clutch does not overheat.

(1) The position of the starter is to be set to give a gap of 0·093 in between the rig jaw, NTS.8463, and the starter jaw when the latter is in the normal retracted position.

(2) The supply open circuit voltage is to be set at 28V.

(3) The starter is then to be switched on to line (i.e. no external series resistance), and the unit must engage the rig/jaw satisfactorily.

(4) Repeat the test ten times for different angular positions of the starter jaw relative to the rig jaw.

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Appendix A

STANDARD SERVICEABILITY TEST FOR STARTER MOTORS, ROTAX C13500 SERIES

Introduction

1. The following tests may be applied to the starter motor 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) Bridge megger tester, Type B (Ref. No. 5G/1708).

(2) Tension gauge (Ref. No. 1H/97).

(3) Suitable torque test set.

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

TEST PROCEDURE

3. Before running the motor, check for freedom of rotating parts by turning the armature by hand. There should be no excessive end play in the bearings; a slight radial play, which can just be felt by hand is permissible.

No load test

4. The starter is to be run on no load for a period of two minutes at a terminal voltage of 23·5V. At the end of this period the current should not be more than 40 amp, and the speed should be between 13,000 and 16,000 rev/min.

Load tests

5. The starter is to be mounted on a suitable dynamometer. The starter and rig jaws should be fully engaged when the starter jaw is in its normal retracted position.

50 per cent load test

6. Adjust the starter terminal voltage to 21V and the torque to 2·5 lb/ft. The starter speed should not be less than 6800 rev/min and the current not more than 190 amps.

100 per cent load test

7. Set the terminal voltage to 19V and the torque to 5 lb/ft. The starter speed should not be less than 4900 rev/min and the current not more than 320 amp. The unit should be blast cooled during test. The commutation should not be worse than slight intermittent sparking.

Insulation resistance test

8. Using a 250 volt insulation resistance tester, test the insulation resistance between live parts and the frame. A reading of at least 50,000 ohm must be obtained.

Appendix 1

STARTER MOTOR, ROTAX, TYPE C13502/1

LEADING PARTICULARS

Starter motor, Type C13502	*Ref. No. 37F/2013*
Starter motor, Type C13502/1	*Ref. No. 37F/2015*
Operating voltage	24 *volts d.c.*
Speed	5,000 *r.p.m.*
B.H.P.	5·75
Current	300 *amp.*
Torque	6 *lb. ft.*
Clutch setting	12·5 *lb. ft.*
Rating	1 *minute*
Rotation	*Clockwise, looking on drive end*
Ambient temperature range	−40 *deg. C to* +70 *deg. C*
Supply characteristic	1 *volt*/60 *amp. from* 24 *volts open circuit*
Brush length (new)	0·750 $^{+0·010}_{-0}$ *in.*
Brush length (minimum)	0·337 *in.*
Brush spring pressure	24 $^{+4}_{-4}$ *oz.*
Brush grade	*DM4A*
Commutator diameter (new)	1·750 *in.*
Commutator diameter (minimum)	1·704 *in.*
Weight	16 *lb.*

1. The starter motor, Type C13502, is identical to that described and illustrated in the main chapter. The drive end frame is made from magnesium alloy.

2. In the C13502/1, introduced by Mod. Elec. D/662 (Rotax S6266), the bracket to which the starter bullet is secured is changed from aluminium alloy to stainless steel. There is also a change in the manner of securing the bullet.

Appendix 2

STARTER MOTOR, ROTAX, TYPE C13503/1

LEADING PARTICULARS

Starter motor, Type C13503	*Ref. No. 37F/2014*
Starter motor, Type C13503/1	*Ref. No. 37F/2016*
Operating voltage	24 *volts d.c.*
Speed	5,000 *r.p.m.*
B.H.P.	5·75
Current	300 *amp.*
Torque	6 *lb. ft.*
Clutch setting	12·5 *lb. ft.*
Rating	1 *minute*
Rotation	*Clockwise, looking on drive end*
Ambient temperature range	-40 *deg. C to* $+70$ *deg. C*
Supply characteristic	1 *volt/60 amp. from 24 volts open circuit*
Brush length (new)	$0{\cdot}750\ ^{+0{\cdot}010}_{-0}$ *in.*
Brush length (minimum)	0·337 *in.*
Brush spring pressure	$24\ ^{+4}_{-0}$ *oz.*
Brush grade	*DM4A*
Commutator diameter (new)	1·750 *in.*
Commutator diameter (minimum)	1·704 *in.*
Weight	16 *lb.*

1. The starter motor, Type C13503, is generally similar to that described and illustrated in the main chapter. It differs from earlier types in the series in having a drive end frame of aluminium alloy instead of magnesium alloy.

2. In the C13503/1, introduced by Mod. D/662 (Rotax S6266), the bracket to which the starter bullet is secured is changed from aluminium alloy to stainless steel. There is also a change in the manner of securing the bullet.

Appendix 3

STARTER MOTOR, ROTAX, TYPE C13504

LEADING PARTICULARS

Starter motor, Rotax, Type C.13504	*Ref. No. 37F/2017*
Operating voltage	24 *volts d.c.*
Speed	5,000 *r.p.m.*
B.H.P.	5·75
Current	300 *amp.*
Torque	6 *lb. ft.*
Clutch setting	12·5 *lb. ft.*
Rating	1 *minute*
Rotation	*Clockwise, looking on drive end*
Ambient temperature range	−40 *deg. C to* +70 *deg. C*
Supply characteristic	1 *volt*/60 *amp. from* 24 *volts open circuit*
Brush length (new)	$0{\cdot}750\ ^{+0{\cdot}010}_{-0}$ *in.*
Brush length (minimum)	0·337 *in.*
Brush spring pressure	$24\ ^{+4}_{-4}$ *oz.*
Brush grade	*DM4A*
Commutator diameter (new)	1·750 *in.*
Commutator diameter (minimum)	1·704 *in.*
Weight	16 *lb.*

1. The starter motor Type C13504 is similar with that described and illustrated in the main chapter other than the nose cone (bullet) mounting bracket. This has been redesigned to accommodate a new nose cone, introduced by modification of the Gnome engine (Gnome Mod. 1508 and 1463) to provide anti-icing features. Starter motor Type C13504 is not interchangeable with Types C13502/1 and C13503/1.

2. The Type C13504 starter may be serviced using the procedures given in the main chapter.

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