Chapter 7

STARTER MOTOR, ROTAX, TYPE C5109

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LEADING PARTICULARS

Starter motor, Type C5109	*Ref. No. 37F/4507*
Operating voltage	*28 volts d.c.*
Voltage characteristic	*1 volt per 73 amp. from 28V d.c.*
Current at rated output	*550 amp.*
Rated output	*11 H.P.*
Output torque	*16·5 lb. ft.*
Speed at rated output	*3,800 r.p.m.*
Time rating (intermittent)	*90 seconds*
Direction of rotation (viewed from drive end)	*clockwise*
Lubrication—	
Drive end bearings	*engine oil system*
Commutator end bearings	*grease XG-271*
Temperature range	*—26 deg. C. to +90 deg. C.*
Electrical connections	*0·375 in. Whit. studs*
Commutator diameter (new)	*2·650 $^{+0}_{-0·010}$ ins.*
Commutator diameter (minimum permissible)	*2·500 in.*

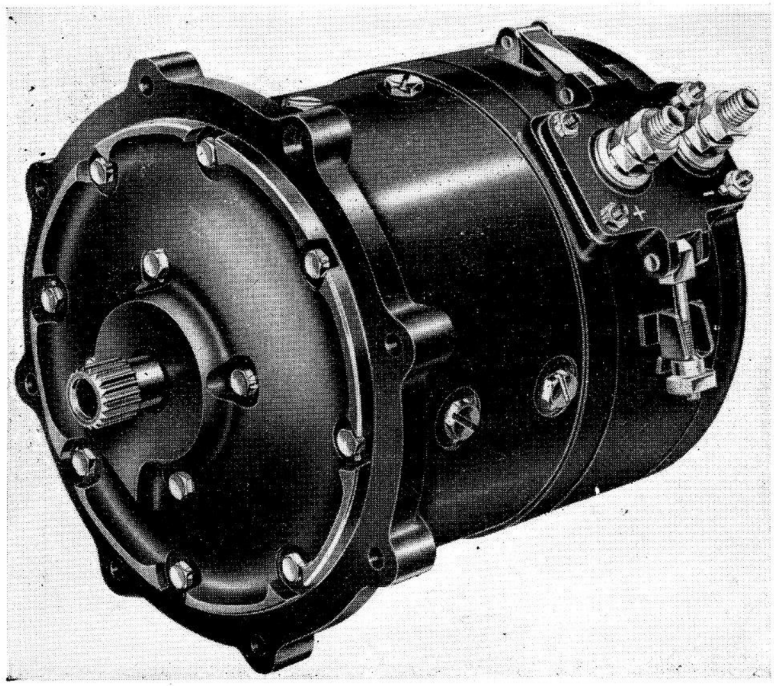

Fig. 1. General view of C5109 starter motor

Brush spring pressure	4 *to* 4·5 *lb.*
Brush spring (*working length*)	0·590 *in.*
Brush spring (*free length*)	1·130 *in.*
Brush length (*new*)	.... 0·843 *in.*
Brush length (*minimum permissible*)	.... 0·687 *in.*
Weight	28 *lb.*
Overall dimensions	*see installation drawing* (*fig.* 2)

Introduction

1. The Type C5109 starter motor is designed as a direct cranking starter for gas turbine engines; it is a 28-volt, compound wound, short shunt machine, with shunt windings included to limit the armature speed under no-load conditions at the operating voltage of 28 volts.

2. The armature is lap wound and thus every precaution should be taken to ensure that the current in the four sections of the armature are equal; any brush which has not the same resistance as the others, i.e., high resistance connections in the brush connecting links or pigtail tags, will cause excessive sparking at the respective brush and impair the motor operation.

DESCRIPTION

3. The motor is a four-pole compound wound type, the four series field coils being connected in series parallel and the shunt coils in series. The yoke assembly forms the central cylinder of the motor, the pole shoes being mounted inside the yoke and secured by $\frac{1}{4}$ B.S.F. bolts. At one end of the yoke is the commutator end frame. This alloy casting carries the terminal block assembly and provides windows for access to the brushes; it also carries the end plate assembly on which is mounted the brush gear, and a liner where the commutator end ballrace is housed.

4. At the opposite end of the yoke, attached by eight screws, is the drive end frame. This

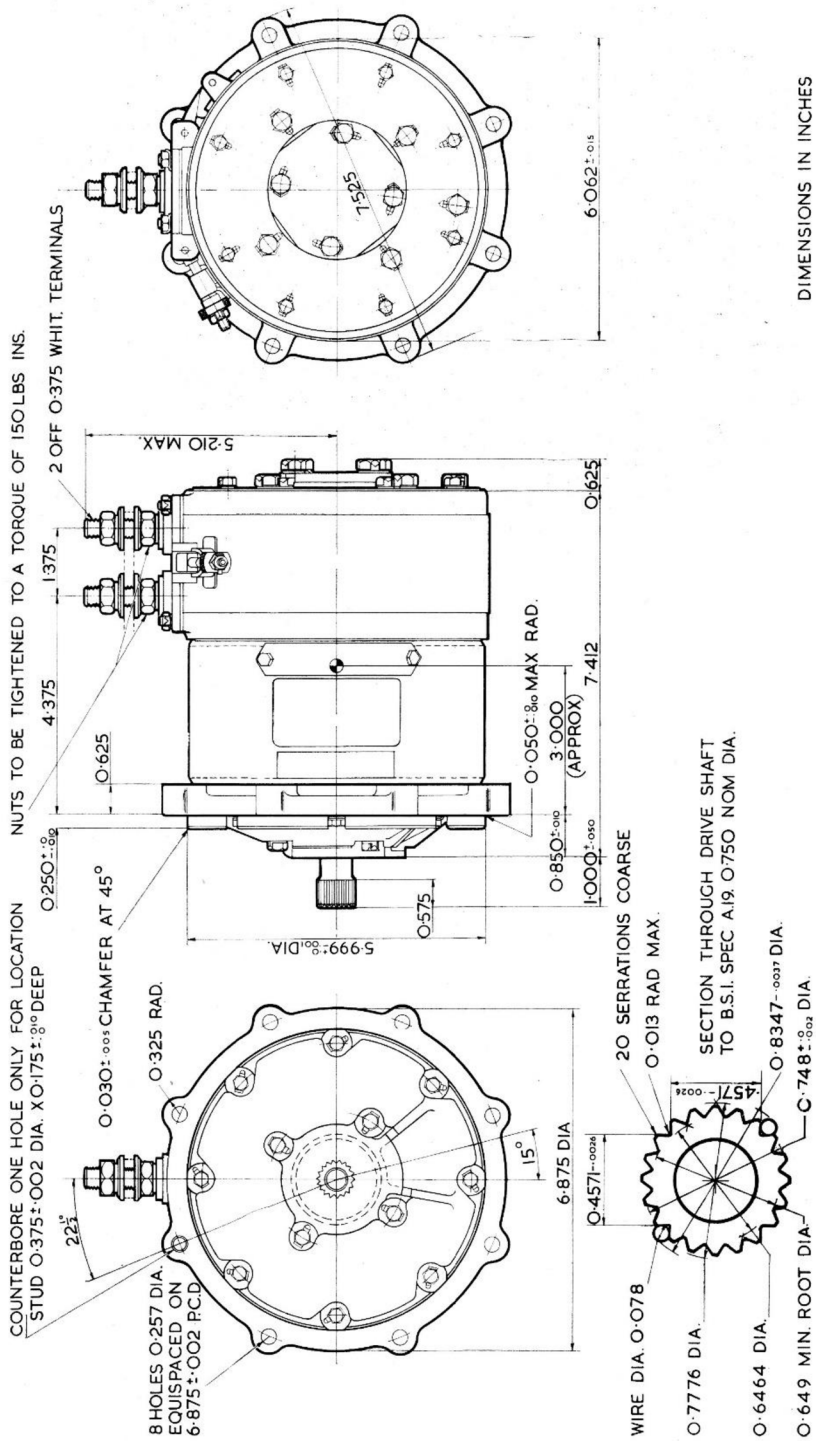

Fig. 2. Installation diagram

provides the starter mounting flange and carries an oil seal and the drive end roller bearing, which is clamped in position in a special steel bearing housing.

Armature

5. The armature revolves in and is supported by the bearings in the end frames; it is a lap wound winding with the copper conductors located in 44 semi-enclosed slots in the laminated core.

6. The conductors are silfos brazed to the commutator segments, and secured in position by a steel ring at either end of the armature core; in addition two intermediate bands of H & T spring steel strip also assist to secure the windings in the laminated core assembly. The armature is finally dynamically balanced with the bar to bar variation held to within 0·0001 inch. Concentricity between ballrace journals and commutator is held within 0·001 in. total indicator reading.

Bearings

7. A roller bearing is fitted at the drive end of the armature, and a ballrace at the commutator end; the bearings are selected to give a specific interference fit in their respective bearing housings. The commutator end and drive end bearings are both pressure filled $\frac{1}{3}$ full with grease XG-271 (Ref. No. 34 B/9100510) during manufacture.

Yoke and field coils

8. Interposed between the commutator end housing and the drive end frame is the yoke and field coil assembly. The yoke is manufactured from low carbon mild steel and the main poles from permendur laminations. The shunt coils connected in series have 133 turns per pole and the four series field coils connected in series parallel have 8 turns per pole. Field connectors and associated lugs are silfos brazed to coil leads brought out externally.

Brushgear

9. The brushgear consists of four brush boxes secured to the brush gear moulding by eight special screws and locked in position with cup washers that are crimped to the head of the screws. Each brush box has a platform for connections, the small ends of the conical brush springs fit on the projecting pegs that are an integral part of the brush, the opposite end of the springs locating in special holders fitted in a recess machined in the commutator end housing.

Note . . .
Spring holders fit in the slots one way only, i.e., the wide end facing towards the commutator end plate.

Terminals

10. The terminal posts are mounted and secured in a terminal block top casing by locknuts and associated locking washers. The complete assembly is secured to a machined platform integral with the commutator end housing assembly. The positive terminal post is connected internally to the series field coils, and the negative terminal post connected internally direct to the brush box and to one side only of the shunt field coils.

End frames

11. Eight hexagon head bolts secure the commutator end plate and brush gear assembly to the commutator end housing. The window strap assembly encloses the four brush inspection apertures in the commutator end housing; it is secured by a knurled nut and associated locknut fitted to the movable lever which is secured to the catch piece of the terminal block top casting.

12. Eight hexagon head bolts secure the drive end frame to one end of the yoke; the external spigot of the end frame serves as the main location to the mating register of the associated equipment when the unit is mounted (*fig.* 2).

Operation

13. In service a starter is operated in conjunction with a starter control panel; the following paragraphs detail the operation in a typical starting system. Depression of a hold-on push switch connects positive to one contact of an overspeed relay, and also, through the first pair of contacts of a time switch, to the energizing coil of an engaging relay. When the engaging relay pulls in, it connects the heavy current supply through the engaging resistor and series coil of the overspeed relay to the selected starter relay and starter motor.

14. Immediately the starter circuit is completed the overspeed relay contacts close. This completes the circuit through the hold-on coil of the push-switch and applies a positive to the winding relay of the time

switch. A nominal three seconds is allowed for this stage during which the starter engages with the turbine, taking up any slack in the starter drive and turning the turbine slowly.

15. At the end of the first stage the second pair of time switch contacts close and energize the main relay, thereby connecting full positive to the starter. The engaging relay is then de-energised by the first pair of contacts opening two seconds later. The starter will continue to drive and accelerate the turbine until the turbine attains self supporting speed, when the starter's armature current will fall sufficiently to trip the overspeed relay and thereby the whole circuit; or the time switch will complete its run after approximately thirty seconds and break the supply to the main relay. If the former occurs the time switch will continue to unwind until the contacts are reset ready for the next start.

16. Should an engine fail to start after three such cranking periods, the cause of the trouble should be investigated rather than make continued efforts to start with consequent possible overheat of the starter.

INSTALLATION

17. For installation purposes the starter is provided with a mounting flange having eight 0·257 in. diameter fixing holes equispaced on a 6·875 + 0·002 in. P.C.D.; integral with the flange is a locating spigot 5·999 in. diameter. For further details see installation drawing (*fig.* 2). In addition to normal procedure it should be noted that the starter is transported with a protective cover over the drive end. This is to be removed and the mounting faces thoroughly cleaned before fitting.

Lubrication of oil seal

18. The oil seal is to be primed with engine oil before fitting to the engine, as after installation it will be constantly lubricated with the engine oil of the associated equipment when the starter is in use.

SERVICING

19. To service the starter first remove the window strap from the commutator end housing to gain access to the brush springs and brushes. Remove the brushspring and holder from the commutator end housing and check the brush spring pressure; this should be 4 to 4·5 lb. when compressed to 0·590 in. dimension.

20. Check the length of the brushes to ensure that they will be satisfactory till the next servicing period; the minimum permissible length is 0·687 in. Ensure that brushes are replaced in their respective boxes the correct way for rotation after checking. If it is found necessary to remove any carbon deposit from the brush boxes, a cloth moistened with lead free white spirit should be used for cleaning purposes.

21. Check the security of the starter on its mounting and examine the mounting flange and mounting bolts, ensuring that housings and lockings are secure and free from damage. Replace all brushes in their respective boxes and secure in position with the brush springs and holders, replace the window strap and secure with the locking nut.

Insulation resistance test

22. The insulation resistance when checked with a 250 volt insulation resistance tester between the live parts and the frame should not be less than 50,000 ohms.

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