Chapter 4

STARTER MOTORS, PLESSEY, C3616A/3

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LEADING PARTICULARS

Motor, type C3616A/3 (Plessey, 4CZ/93552)	**Ref. No. 37F/27000**
Input voltage (nominal)	*25V d.c.*
Input voltage range	*16-29V d.c.*
Input current (nominal)	*175A*
Rated output (nominal)	*4 h.p. for 20 sec.* at *10500 rev/min*
Temperature range	*−40 to +70 deg. C*
Rotation	*Anti-clockwise viewed from drive end*
Bearings, lubrication	
Commutator end	*Grease (XG-271)*
Drive end	*Oil (OM-13)*
Weight	*10 lb.*
Length (body)	*7·55 in.*
(to end of shaft)	*8·93 in.*
Width (max.)	*3·902 in.*
Commutator dia., new	*1·495 to 1·500 in.*
after skimming (min.) ...	*1·445 in.*
worn (min.)	*1·425 in.*
Undercut mica intersegments, depth ...	*0·022 to 0·025 in.*
width ...	*0·022 to 0·025 in.*
Maximum eccentricity of commutator to shaft journal	*0·0005 in. T.I.R.*
Bearing, drive end	*Plessey Part No. Z29220/1*
commutator end	*Plessey Part No. Z29175*
Brush and tag assembly	*Plessey Part No. 4CZ92254*
Brush length, new	*0·500 in.*
worn	*0·375 in.*
spring tension	*22 to 26 oz.*

Introduction

1. The Plessey Type C3616A/3 starter motor is used to drive the fuel and air pumps of the (I.P.N.) liquid fuel starting system. Further details of its use in this application are contained in A.P.1181B, Vol. 1 and Vol. 6, Part 1, Sect. 3, Chap. 1.

DESCRIPTION

General

2. The motor is a four-pole, four brush, totally enclosed, series wound machine designed to operate from a d.c. supply of between 16 and 29 volts. The nominal output is 4 horse power for 20 seconds at 10,500 rev/min.

Yoke and armature

3. The laminated poles are bolted to a high permeability yoke and the strip-wound field and armature windings have Class " B " insulation. The armature, which rotates with the magnetic field of the magnet poles is supported in ball bearings in the end housings and has a splined driving shaft; the shaft is drilled axially and tapped No. 10 UN.F to a depth of 0·375 in. (fig. 1).

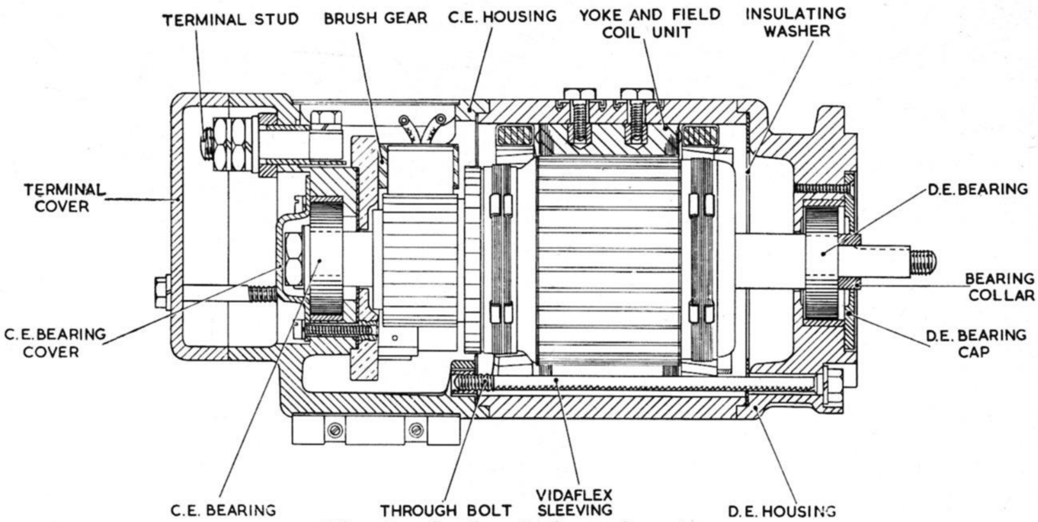

Fig. 1. Sectional view of motor

End housings

4. The end housings are spigoted to the yoke, and are secured by four insulated through bolts, which pass through the yoke and secure the end housings to it, as shown in fig. 1. The drive end housing incorporates an " O " sealing ring, a further oil seal is fitted on the shaft behind the drive end bearing to prevent oil seepage to the armature.

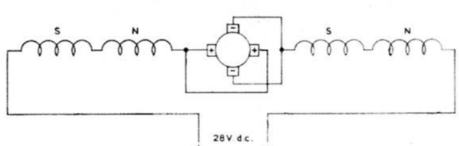

Fig. 2. Circuit diagram

Bearings

5. The ball bearings are located in stainless steel liners, and the commutator end bearing is lubricated with grease, whereas the drive end bearing is oil lubricated. Access to the commutator end bearing is obtained by removing the four 4 B.A. screws which secure the cover to the end housing. Access to the drive end bearing is (OM–13) obtained by removing the circlip which holds the cover against the end housing.

Brushgear

6. The brushgear is mounted on a moulded plate which is bolted to the commutator end housing. Slots in the housing permit adjustment of the brushgear. The carbon brushes have double flexible pigtail connections and are located by adjustable clock springs and triggers.

External connections

7. External electrical connections are made at the terminal studs which project from the commutator end housing. The terminals are protected by an aluminium cover, which is secured to the end housing by three 2 B.A. bolts.

INSTALLATION

8. The shaft is splined as shown in Fig. 1 and is drilled axially and tapped No. 10 UNF to a depth of 0·375 in. The drive end housing incorporates an " O " ring seal and a further oil seal is fitted behind the drive end bearings. The flange mounting is drilled four holes, 0·228 to 0·216 in. diameter, equally spaced on 2·85 in. P.C.D. It is important to ensure that all fixings and terminal connections are secure, before the machine is put into operation.

SERVICING

General

9. Routine servicing of the installed motor consists of examinations for security of mounting, serviceability of electrical connections and signs of damage or deterioration. At the intervals prescribed in the relevant Aircraft Servicing Schedule the motor is removed for bay servicing.

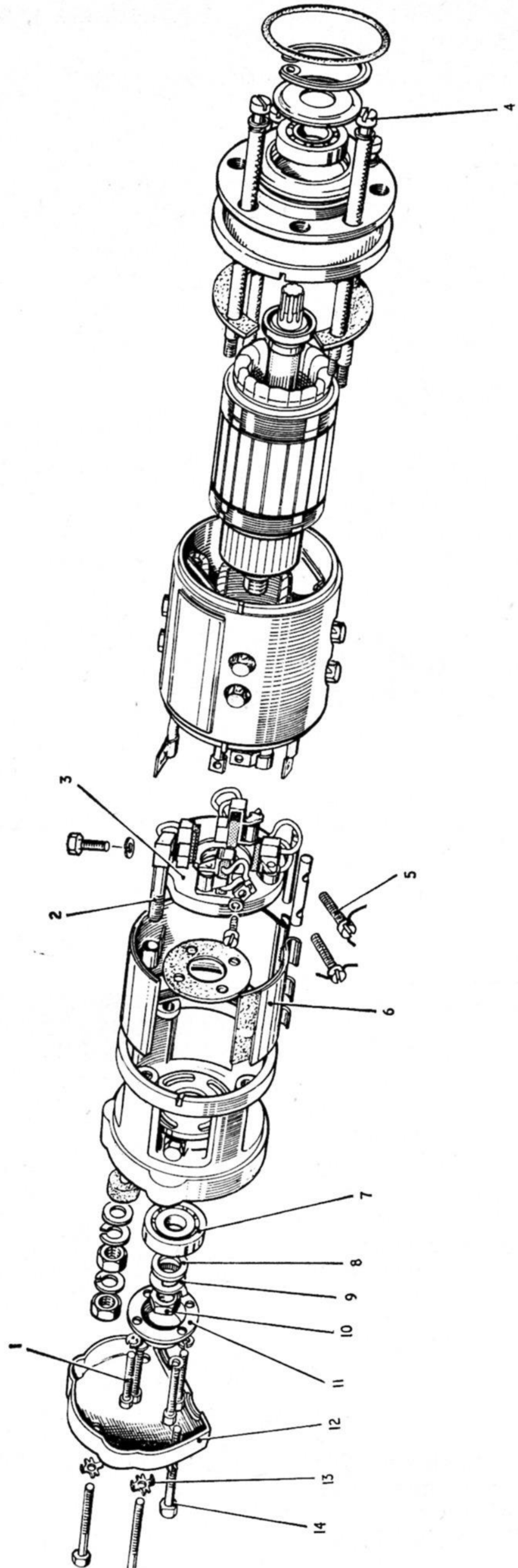

Fig. 3. Exploded view of motor

Bay servicing

10. On removal from an aircraft the motor should be cleaned externally and examined for signs of damage or corrosion, it should then be dismantled to the extent necessary to enable bearings to be cleaned, examined and lubricated, and for the brushgear and commutator to be cleaned and examined also new brushes to be fitted and bedded.

Brushgear

11. Access to the brushgear is obtained by cutting the locking wire and removing the two 4 B.A. screws holding the cover strap to the commutator end cover.

12. All traces of carbon dust should be removed from the commutator and brushgear, using dry compressed air. New brushes should be fitted at the intervals prescribed in the bay Servicing Schedule and whenever examination reveals that they may reach the minimum length before the next servicing. The new brushes should slide freely in their holders without excessive clearance and the spring pressure should be within 22 to 26 oz, measured with a tension gauge, with the tip of the spring level with the top of the brush holder.

13. Information on brush bedding is contained in A.P.4343, Vol. 1, Sect. 1, Chap. 2. The final bedding is accomplished by running the motor at 12V on no-load for half-hour periods in each direction of rotation with the brake mechanism removed. The input voltage should be adjusted as necessary to ensure that the motor speed does not exceed 10,000 rev/min. The bedding should be continued until each brush is bedded over its full thickness and at least 80 per cent of its contact surface. Care should be exercised to avoid overheating of the motor during this running. All traces of carbon dust must again be removed when the bedding is satisfactorily completed.

DISMANTLING

General

14. To perform a routine bay servicing, it will be necessary to dismantle the motor, sufficiently to gain access to the bearings.

Drive end bearing

15. The drive end bearing is oil lubricated and will not require re-greasing. In addition to the information given in the main chapter, the following procedure may be adopted when it is necessary to re-grease the commutator end bearing.

Commutator end bearing

16. To remove the commutator end bearing for periodical bay servicing the following dismantling procedure is necessary (fig. 2):—

(1) Release the tab washers (13) (fig. 3), unscrew the three 2 B.A. bolts (14) and remove terminal cover (12).

(2) Cut the commutator cover strap locking wire, slacken the two 4 B.A. screws (5) and remove the cover strap (6). Lift the brush springs, mark the brushes and holders appropriately, and remove the brushes.

(3) Mark the edge of the brush mounting plate (3) against a suitable reference to preserve optimum commutation when re-assembling.

(4) Remove the four B.A. screws (1), securing the commutator end bearing cover (11) and remove the cover; this releases the brush mounting plate and the brushgear assembly.

(5) Replace two of the screws to hold the brushgear assembly temporarily in place.

(6) Unlock the shaft locking washer (9) and remove the nut (10) locking washer and plain washer (8) from the shaft.

(7) Remove the four insulated through bolts (4) and press out the armature complete with drive end housing from the bearing (7), taking care not to damage the shaft thread.

(8) Warm the commutator end housing and, using a suitable extractor, remove the bearing.

All tab and lock washers, also oil seals must be renewed before re-assembly.

Bearings

17. Bearings should be cleaned with lead-free gasoline or white spirit, to remove old grease, or oil and foreign matter. Moisture-free compressed air should be used to dry out the bearings, care being taken to avoid spinning the races by the air jet. After a thorough examination, serviceable bearings should be regreased, or, in the case of oil lubricated bearings, the oil replenished immediately.

18. Grease lubricated bearings are regreased with XG-271, the grease should be pressed between the inner and outer races for a distance of one third of their circumference and the bearings rotated by hand to distribute the grease evenly over the tracks.

19. With oil lubricated bearings, after cleaning, the motor oil seals should be renewed on re-assembly. The machine should be examined for oil seepage along the shaft to the armature. If oil seepage is apparent, the motor is to be deemed unserviceable and must be subjected to full overhaul procedure, as described in Appendix A to this chapter.

RE-ASSEMBLY

20. Re-assembly generally follows the reverse order of dismantling. Ensure that the brushgear is reset to the reference marks made during the dismantling procedure, to obtain optimum commutation. End housings should be warmed before replacing bearings.

21. After re-assembly, coat the heads of the through bolts with Epihard 480 varnish (parts /1 and /2 mixture).

TESTING

22. The re-assembled motor should be subjected to the Standard Serviceability Test described in Appendix A to this chapter.

Appendix A

STANDARD SERVICEABILITY TEST FOR STARTER MOTORS, PLESSEY, C3616A SERIES

Introduction

1. The following tests may be applied to these motors immediately prior to installation or when their serviceability is suspect.

Test equipment

2. The following test equipment is required :—

(1) Bridge megger tester, Type B, (Ref. No. 5G/1708)
(2) Balance, spring, 0 to 4 lb. (Ref. No. 1H/97)
(3) Test rig, Plessey Part No. TD 3329
(4) 250V d.c. insulation resistance tester, Type C (Ref. No. 5G/152)
(5) Oil bath, Plessey Part No. TJ 91/1

TEST PROCEDURE

General

3. Before running the motor, check for freedom of the rotating parts by turning the shaft by hand. Check that there is no excessive play in the bearings; a slight radial play which can just be detected by hand is permissible.

Brushgear

4. The brushgear of the motor is accessible when the cover trap is removed. The brushes must be a smooth sliding fit in their holders and of a length not less than 0.375 in. The brush spring tension should be between 22 and 26 oz., inclusive, as measured with the spring balance.

5. If the length of a brush approaches, or is less than 0·375 in., the brushes must be replaced with new ones and bedded in. Dismantle the machine as set out in para. 16 (1) of the main chapter in order to gain access to the commutator, then bed in the brushes in accordance with the procedure published in A.P.4343, Vol. 1, Sect. 1, Chap. 2.

6. For the final bedding run, fit the oil bath Plessey Part No. TJ/91/1 to the torque test rig and mount the motor. Supply the oil bath with oil (OM-13) and run the motor on reduced voltage and no-load at a speed of 5000-7000 rev/min for one hour. The motor must be cooled by directing a blast of dry clean compressed air into the interior. During this run there must be no burning of the commutator or excessive sparking.

Resistance of windings

7. The resistance of the windings at 20 deg. C should be within the limits given in Table 1.

TABLE 1

Winding	*Resistance (ohms)*
Armature (measured between each pair of commutator segments 1-8, 2-9, etc.)	0·0046 to 0·0056
Field (measured between supply leads with brushes short-circuited)	0·0051 to 0·0056

Functioning test

Caution . . .

The motor must be fixed securely in position on the bench for this test.

8. Lubricate the drive end bearing with oil (OM-13) and, starting with the motor at room temperature, run it off load at the over-speed ceiling of 20,000 rev/min for 10 seconds. The terminal voltage will be approximately 14V d.c. While the motor is running, check that commutation is satisfactory by noting the absence of sparking. Also check that there is no excessive vibration or noise.

9. Fit the oil bath, Plessey Part No. TJ 91/1, to the torque test rig and mount the motor. Remove the strap assembly to expose the brushgear. During the following tests, the oil bath must be kept supplied with oil (OM-13) and the motor must be cooled by directing a blast of dry clean compressed air into the interior.

10. Perform the tests detailed in Table 2 and check that the tabulated limits are not exceeded. Check that the only discernible sparking at the brushes is blue and pin-point; no yellow sparking should occur.

Caution . . .

To avoid overheating, run the motor just long enough to perform each test. After each test, the motor must be allowed to cool if necessary so that, at the commencement of the next test, the motor is no more than " hand-warm."

Insulation resistance test

11. While the motor is still hot, measure the resistance between all live parts and the frame, using a 250V d.c. insulation resistance tester. The resistance should not be less than 50,000 ohms.

TABLE 2

Terminal Voltage (Volts d.c.)	*Torque (oz. in.)*	*Speed rev/min*		*Current max (amp.)*
		max	*min*	
16	200	—	8,000	130
16	400	—	5,600	200
18	600	—	5,500	250
25	400	—	10,000	195
25	600	—	8,000	260
29	400	13,500	—	195
29	600	11,500	—	260

Appendix 1

STARTER MOTOR, PLESSEY, C3616A/1

LEADING PARTICULARS

Motor, Plessey, C3616A/1	**Ref. No. 37F/20649**
Input voltage (nominal)	*25V d.c.*
Voltage range	*16 to 29V d.c.*
Input current (nominal)	*175A*
Rated output	*4 h.p. for 20 sec. at 10,500 rev/min*
Temperature range	*−40 to +70 deg. C.*
Direction of rotation	*Clockwise viewed on drive end*
Bearings, lubrication	
Commutator end	*Grease* } (*XG*-271)
Drive end	*Grease* } (*XG*-271)
Weight	*9½ lb.*
Length (body)	*7·55 in.*
(to end of shaft)	*8·93 in.*
Width (max.)	*3·902 in.*
Commutator dia., new	*1·495 to 1·500 in.*
after skimming (min.) ...	*1·445 in.*
worn (min.)	*1·425 in.*
Undercut mica intersegments, depth ...	0·022 to 0·025 *in.*
width ...	0·022 to 0·025 *in.*
Maximum eccentricity of commutator to shaft journal	0·005 *in.T.I.R.*
Brush and tag assembly	*Plessey 4CZ92254*
Brush spring tension	*22 to 26 oz.*
Brush length, new	0·500
worn	0·375
Bearing, drive end	*Plessey Z29175*
commutator end	*Plessey, Z29175*

LIST OF ILLUSTRATIONS

1. The motor C3616A/1 is a variant of the series described in the main chapter and is used to drive the fuel and air pumps of the Plessey liquid fuel starting system. Details of the associated equipment are contained in A.P.1181B, Vol. 1 and Vol. 6, Part 1, Sect. 3, Chap. 1.

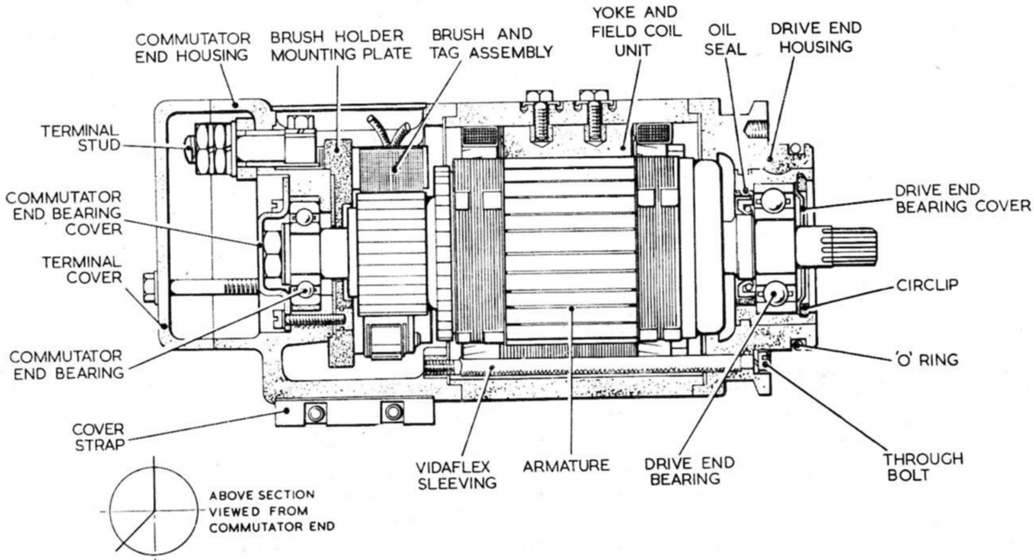

Fig. 1. Sectional view of motor

2. This motor differs from the machine described in the main chapter, in that the drive end has a keyed shaft with bearing cap and collar, also the drive end bearing is grease lubricated (fig. 1).

INSTALLATION

3. The C3616A/1 motor is designed for cradle and flange mounting, the flange being provided with three 0·281 in. dia. holes equi-spaced on 3·625 in. P.C.D. When installing the motor, ensure that the collar is in position against the drive end bearing.

SERVICING

4. Access to the drive end bearing is obtained by removing the 4 B.A. screws that hold the bearing cap and collar in position.

5. Access to the commutator end bearing is as described in the main chapter.

Testing

6. The re-assembled motor should be subjected to the Standard Serviceability Test described in Appendix A to this chapter.

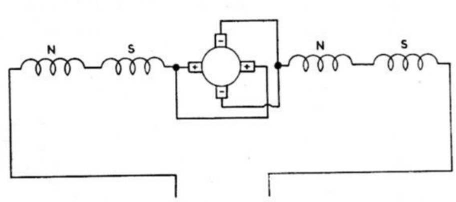

Fig. 2. Circuit diagram

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