# Chapter 24

# STARTER-GENERATOR, ROTAX, Type BC 0107

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## LEADING PARTICULARS

| | |
|---|---|
| *Starter-Generator, Type Rotax BC.0107* | *Ref. No. 5UA/8203* |
| *Starter:—* | |
| *Input* (1) | 28*V constant at* 800*A* |
| *Input* (2) | *From* 48*V batteries* |
| *Torque* | 68 *lb/ft at* 950 *rev/min* |
| *Generator:—* | |
| *Output* | 30*V d.c. nominal* |
| *Rating* | 3,150 *to* 3,500 *rev/min*—200 *A continuous* |
| | 3,500 *to* 8,400 *rev/min*—300 *A continuous* |
| *Direction of rotation* | *Anti-clockwise when viewed from the drive end* |
| *Weight (approx.)* | 54 *lb* |
| *Overall dimensions:—* | |
| *Width* | 9·031 *in* |
| *Length* | 15·302 *in* |
| *Height* | 11·250 *in* |
| *Brush grade* | *PDM 4A* |
| *Minimum brush length* | 0·850 *in* |
| *Brush spring tension* | 48 ± 3 *oz* |
| *Mounting* | *Spigot and manacle ring at drive end* |
| *Cooling* | *Blast air and fan* |

### Introduction

**1.** The starter-generator combines the functions of both starter and generator and is designed for use with jet engines on aircraft which have a 28 volt d.c. supply system and batteries that can be connected to give an output of 48 Volts. The starter generator is compound wound, with shunt field and compensating windings, and has four interpoles in addition to the four main poles.

## DESCRIPTION

### General

**2.** The components are contained within the commutator end frame and the main housing. This housing forms the yoke assembly and to one end is bolted the aluminium alloy air spout. The yoke assembly supports the field coils and compensating windings. Two ball bearings, one mounted at the drive end of the yoke and the other at the commutator end of the machine, support the armature shaft.

### Armature assembly

**3.** The armature is lap wound around a hollow shaft through which passes the steel drive shaft. A splined support, which is an integral part of the armature shaft, and a steel plate hold the armature shaft in position and provide a drive coupling. A fan assembly, which is fitted to the drive end of the armature, embodies a damper lining which bears upon a plate fitted to the drive shaft. The effect of this arrangement is to absorb initial torque when the drive shaft is rotated. A spring, positioned at the opposite end of the drive shaft, provides adequate tension for the damper.

### Brushgear

**4.** Four stainless steel brush holder assemblies are bolted to the commutator end frame equispaced at ninety degree intervals around the commutator, with a mechanical lag of fifteen degrees. Pressure is maintained on the brushes by springs located in support rods attached to rotating spring adjusters, which are used for setting the brush spring tension (Ref. para. 21). Access to the brushgear is provided by four windows. The windows are covered by an easily removeable window strap.

### Suppression

**5.** Suppression is provided for by a choke, two 3·5$\mu$F capacitors, one 2$\mu$F capacitor and one 0·5$\mu$F capacitor. These components are mounted, with external connection terminals, on a tray and shielded by a steel cover. The complete assembly is bolted to the main housing.

### Cooling

**6.** The starter-generator is cooled by blast air which enters via the air spout and flows across the commutator, armature and field

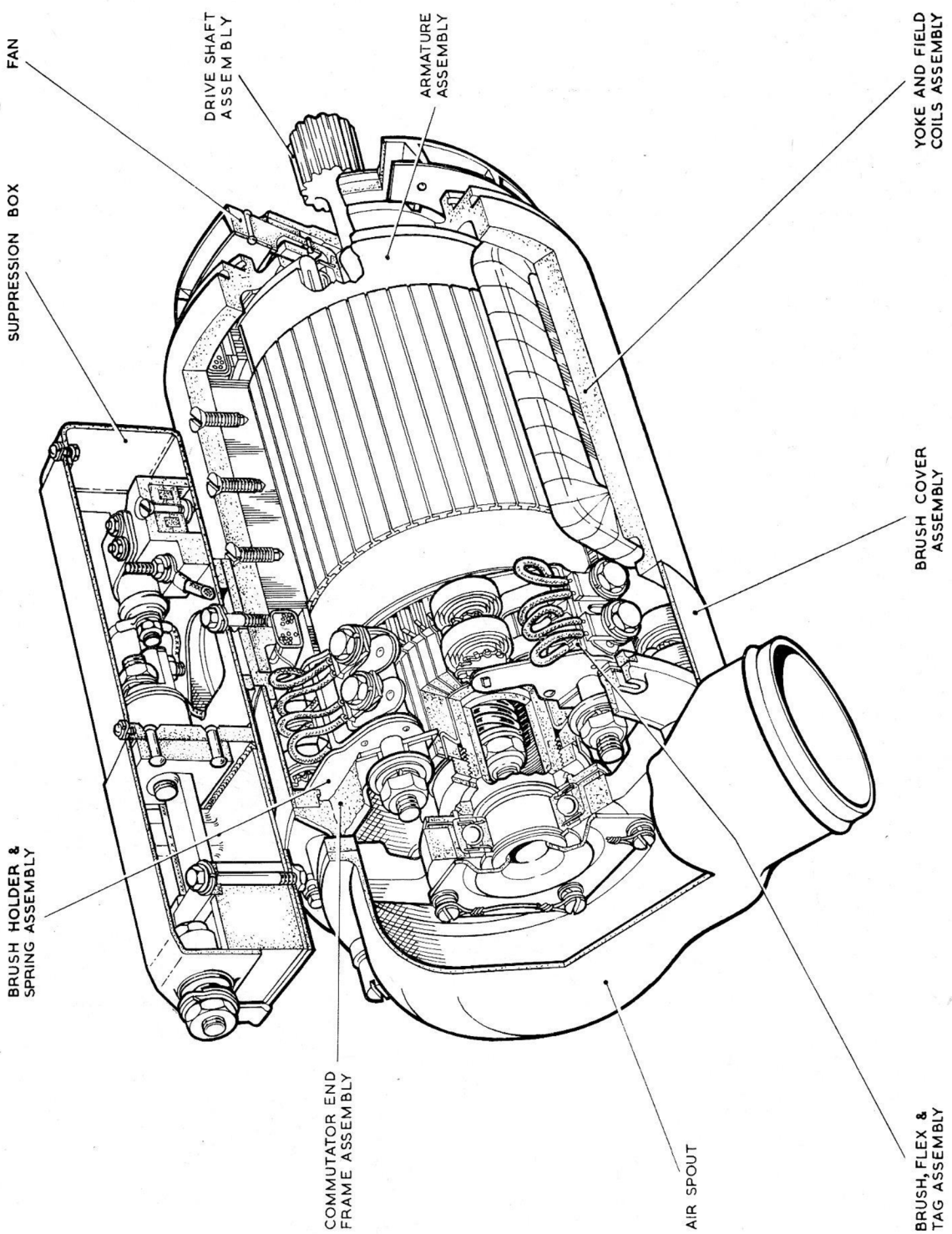


**Fig. 1. Sectional view of starter-generator**

coils, exhausting to atmosphere at the opposite end. A fan is fitted at the drive end to assist cooling when the machine is operating under ground running conditions.

## OPERATION

**7.** When the starting switch is depressed, a current passes from the battery bus-bar through the field contactor and applies maximum exitation to the starter-generator field coils. Initially this starting current is high but rapidly falls to approximately 450A, and is maintained at this level until the aircraft engine 'lights-up'. The starting current then decreases as the engine accelerates until the external overspeed relay releases, disconnecting the starter-generator from the bus-bar.

**8.** At this stage the generator is running at ground idle speed and its field circuit completed through the voltage regulator. A supply from the external time switch flows to the voltage regulator which, in turn, causes a pulse of high voltage to pass to the field coils of the generator. Voltage at the generator output rises until sufficient to close the generator contactor and then passes through the generator switching unit which operates, connecting the generator to its bus-bar.

## INSTALLATION

**9.** An adapter flange (Rotax ZA 19602) together with an air shroud assembly are secured to the aircraft engine in the required position. The starter-generator is located on the adapter flange in any one of 150 positions by rotating the unit in increments of 2.40 degrees. When the required position is achieved the five pins on the face of the adapter flange are located in their respective holes in the yoke and field coils assembly, and the drive coupling into its socket. The starter-generator is secured to the adapter flange by a manacle ring.

**10.** The drive coupling is in the form of a spline with 16 teeth at 20/30 pitch and 30 degree pressure angle with a root diameter of 0·713 in.

**Electrical connections**

**11.** Electrical connections to the starter-generator are made to two 0·375-24 UNF terminals and two 10-32 UNF terminals positioned in the suppressor box.

## SERVICING

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

## DISMANTLING

**Removal of the suppressor box** (Fig. 2)

**13.** (1) Remove the screws securing the covers to the suppressor box and lift the covers from the box.

(2) Remove the nuts and spring washers securing the terminal assemblies at their ends adjacent to capacitors (1) and (2).

(3) Remove the bolt, plain washer and spring washer securing the terminal clamp. Lift the clamp from the terminal moulding.

(4) Disconnect the electrical leads connecting to the choke assembly and to capacitor. (1).

(5) Unscrew the two U.N.F. 0·375 in nuts positioned on the undersides of the connectors, and release the thackray washers, plain washers and the conductors connecting to the field coils.

(6) Withdraw the terminal assemblies.

(7) Unscrew and remove the two suppressor box securing screws positioned adjacent to the walls of the box.

(8) Unscrew and remove the suppressor box securing bolt positioned centrally.

(9) Unscrew and remove the knurled cap-nut positioned adjacent to capacitor (2).

(10) Lift the suppressor box from the yoke, ensuring that the field coil conductors do not become damaged.

**Removal of the drive shaft and air spout**

**14.** (1) Cut the tie-wire and remove the five nuts and washers securing the air spout.

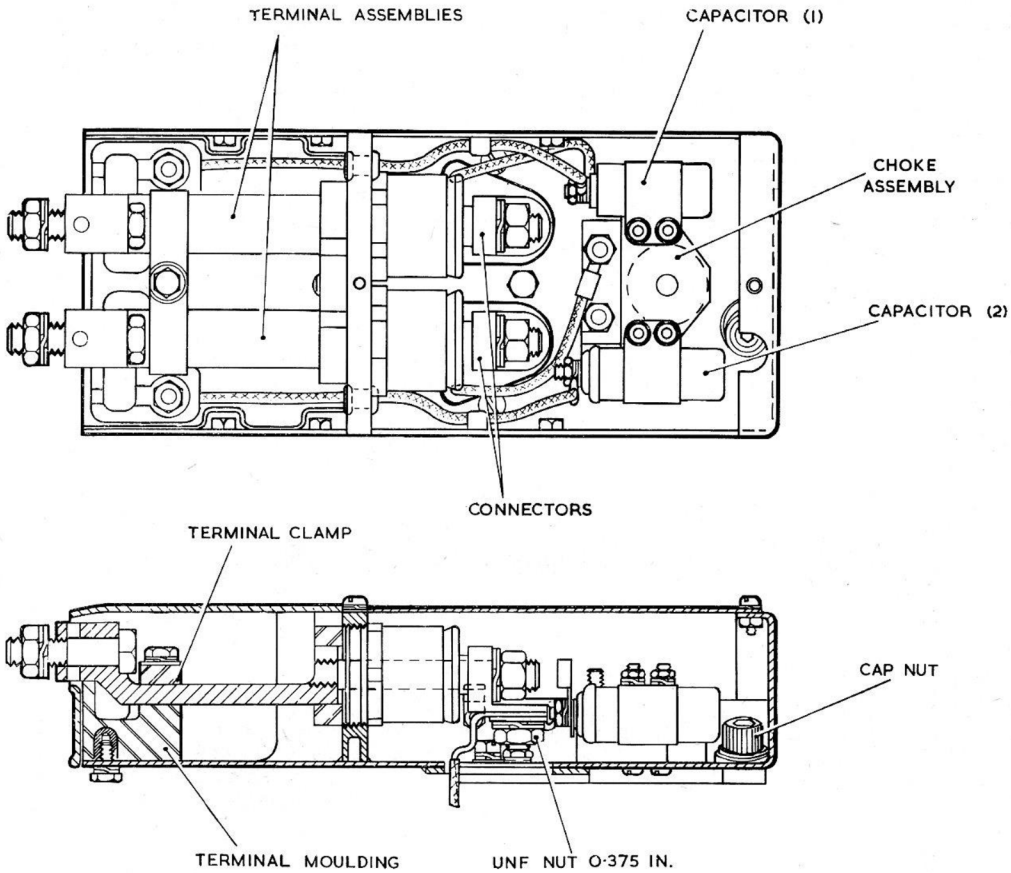


**Fig. 2. Suppressor box**

(2) Lift the air spout from the commutator end-frame assembly.

(3) Cut the tie-wire and remove the four screws, grover washers and plain washers securing the bearing cover plate.

(4) Lift the bearing cover plate from the commutator end frame assembly.

(5) Position the splined end of the drive shaft in a suitable holding block and remove the self-locking nut, positioned at the commutator end of the drive shaft, the spring and plain washer.

(6) Withdraw the drive shaft and collect the fan assembly.

**Removal of the brushes and spacing ring**

**15.** (1) Remove the six screws, securing the spacing ring, and lift the ring from the commutator end-frame assembly.

(2) Collect the five air spout securing screws from the rear of the spacing ring.

(3) Release and remove the brush cover assembly.

(4) Remove the eight screws, plain washers and spring washers. Lift the tails of the brush springs and remove the eight brush, flex and tag assemblies from their holders. Identify each brush, by marking with its holder.

**Removal of the commutator end-frame assembly**

**16.** (1) Remove the lock-ring and oil slinger from the drive end.

(2) Cut the tie-wire, and using a suitable torque spanner remove the eight screws with their plain and spring washers.

(3) Carefully withdraw the commutator end-frame assembly together with the armature assembly and collect an oil slinger from the drive end.

**Removal of the drive end ball bearing**

**17.** Remove the four screws, two bearing retainers and four bushings. Press out the drive end bearing from the drive end frame.

**Removal of the commutator end bearing**

**18.** (1) Remove the lock-ring and slinger positioned adjacent to the commutator end ball bearing. Withdraw the commutator end frame and the ball bearing from the armature shaft.

(2) Collect the bearing retainer and using a suitable extractor remove the ball bearing from the commutator end frame.

## EXAMINATION

**19.** All component parts of the dismantled starter-generator must be examined for mechanical and electrical defects in conjunction with A.P. 4343, Vol. 6, Part 2. The procedures for skimming the commutator, bedding brushes and fitting bearings may also be found in A.P.4343. and the relevant Air Diagrams.

**Brushes**

**20.** The brushes must be examined and renewed if pitted, chipped or burned, or if the brush length, measured on the long face is less than the miniumum length given in the Leading Particulars of this Chapter, or may reach the miniumum permissible length before the next Scheduled Servicing.

**Brush Springs**

**21.** Using a suitable spring balance, measure the tension of the brush springs at the point where the spring bears upon the brush. The, measurement should be made when the bearing point of the spring is level with the top of the brush box and should be $48 \pm 3$ oz. Adjustment of the tension is made by rotating the spring adjuster. This can only be carried out after removing the spring roll pin, details of which are given in the repair and reconditioning instructions.

## ASSEMBLY

**Re-fitting the commutator end ball bearing**

**22.** Using a suitable assembly tool, press the ball bearing into its housing. Fit the slinger and lock-ring, and slide the end of the armature shaft into the bore of the bearing inner race.

**Re-fitting the drive end ball bearing**

**23.** Press the drive end ball bearing into its housing, and fit the bearing retainers, the four bushings and the four securing screws.

**Note . . .**

*Apply fluorescent Loctite grade A, Ref. DTD 900/4588 to screw threads.*

**Re-fitting the commutator end frame assembly**

**24.** Position the commutator end frame assembly, complete with armature assembly, and secure with the eight screws, plain washers and spring washers. Using a suitable torque spanner, tighten the screws to $35 \, ^{+3}_{-0}$ lb.ft. Lock the screws with tie-wire (0·028 in. dia. stainless steel). Fit the slinger and lock-ring to the drive end of the armature shaft.

**Re-fitting the brushes and spacing ring**

**25.** (1) Lift the tails of the brush springs and fit the eight brush,flex and tag assemblies into their respective holders, and position the lead connecting terminal lugs. If new brushes are fitted they should be bedded as instructed in A.P.4343, Vol. 1, Sect. 1, Chap. 2.

(2) Secure each brush, flex and tag assembly with a plain washer, a spring washer and a securing screw.

(3) Refit the brush cover assembly. Tie-wire lock. (0·028 in. dia. stainless steeel.)

(4) Fit the five air spout securing screws to the spacing ring.

(5) Position the spacing ring and secure with the six fixing screws.

(6) Fit the air spout on to the five screws projecting from the spacing ring.

**Note . . .**

*Apply Fluorescent Loctite Grade A to the threads of the fixing screws.*

(7) Secure the air spout with the five nuts and plain washers. Lock with tie-wire (0·028 in. dia. stainless steel).

**Re-fitting the drive shaft and air spout**

**26.** (1) Pass the drive shaft through the centre of the armature shaft with the end plate abutting the fan assembly.

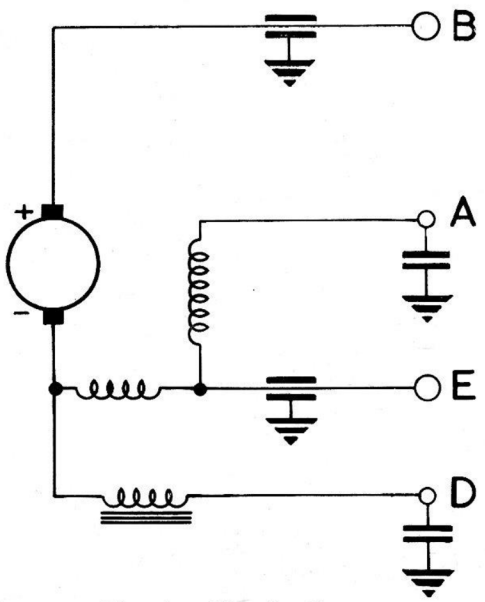


**Fig. 3. Circuit diagram**

(2) Place the splined end of the drive shaft in a suitable holding block and to the opposite end fit the plain washer, spring and self-locking nut.

(3) Tighten the nut until the spring is sufficiently compressed to bring the end plate of the drive shaft firmly against the fan assembly. Do not allow the spring to become fully compressed.

(4) Fit the bearing cover plate to the commutator end-frame assembly and secure with four plain washers, grover washers and fixing screws.

(5) Secure the fixing screws with tie-wire (0·028 in. dia. stainless steel)

(6) Position the air spout on the commutator end-frame assembly and secure with the five nuts and washers.

(7) Lock the fixing nuts with tie-wire (0·028 in. dia. stainless steel)

**Re-fitting the suppressor box** (Fig. 2).

**27.** (1) Position the suppressor box on the yoke, feed the field and coil conductors through the base of the suppressor box. Ensure that the conductors receive no damage.

(2) Fit the knurled nut, positioned adjacent to capacitor (2).

(3) Fit the centrally positioned suppressor box securing bolt.

(4) Fit the two suppressor box securing screws positioned adjacent to the walls of the box.

(5) Position the terminal assemblies and the connectors.

(6) Fit the conductors to the underside of the connectors and secure with the plain washers, thackray washers and the 0·375 in. U.N.F. fixing nuts.

(7) Make the electrical connections to the choke assembly and to capacitor (1).

(8) Fit the terminal clamp to the terminal moulding and secure with the plain washer, spring washer and fixing bolt.

(9) Fit the nuts and spring washers securing the connectors to the terminal assemblies.

(10) Tighten all nuts and screws previously fitted.

(11) Position and secure the suppressor box covers.

## Testing

**28.** When assembly has been completed and all locking devices have been checked for security, test the machine in accordance with the Standard Serviceability Test, Appendix A to this Chapter.

# Appendix A

# STANDARD SERVICEABILITY TEST FOR STARTER-GENERATOR ROTAX, Type BC 0107

**Introduction**

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

**2.** To complete the tests a circuit (Fig. 1) will require to be assembled embodying a regulator (Newton, Type 70/60907, A.M. Stores, Ref. No. 5UC/6715).

## TEST EQUIPMENT

**3.** The following test equipment will be required:—

(1) Bridge-megger tester, Type B. (Ref. No. 5G/1078).

(2) Ammeter, 0 — 500A d.c.

(3) Voltmeter, 0—50 Vd.c.

(4) Spring balance.

(5) Suitable torque test set (if available).

(6) A 100V insulation resistance tester.

(7) Generator test bench, Ref No. 5G/3188.

## TEST PROCEDURE

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

**Resistance of windings**

**5.** (1) The shunt field is found by passing 5A between terminals A and E (Where A is connected to the positive side of a variable d.c. supply). The resistance calculated from the applied voltage and current ratio should be between 2·22 and 2·34 ohm at 20 deg.C.

(2) The series field resistance is measured using a bridge megger connected between terminals D and E and should be between 0·0043 and 0·0046 ohm at 20 deg.C.

**Starter performance**

**6.** For these tests an external resistance of 1·25 ohm (including connecting leads) is to be inserted between the positive and shunt terminals of the machine. The resistance and leads should be of at least 10A rating. Care should be taken not to overheat the starter-generator particularly at the high load points.

**Load points**

**7.** Machine terminal voltage 28V constant

(1) No load.
With the machine run on no load the speed must be between 2,100 and 2,400 rev/min and the supply current must not exceed 28A.

(2) 100 per cent load.
Set the load to give a torque of 35 lb/ft. The supply current must not exceed 430A, and the speed should be not less than 1440 rev/min.

**Starter commutation**

**8.** Throughout the starter performance tests the commutation should be no worse than light intermittent sparking.

**Generator performance**

**9.** With the starter-generator mounted on a suitable generator test rig run the machine at 8000 rev/min with a load of 300A, 30V for twenty minutes. At the end of this warming-up period the following tests should be made.

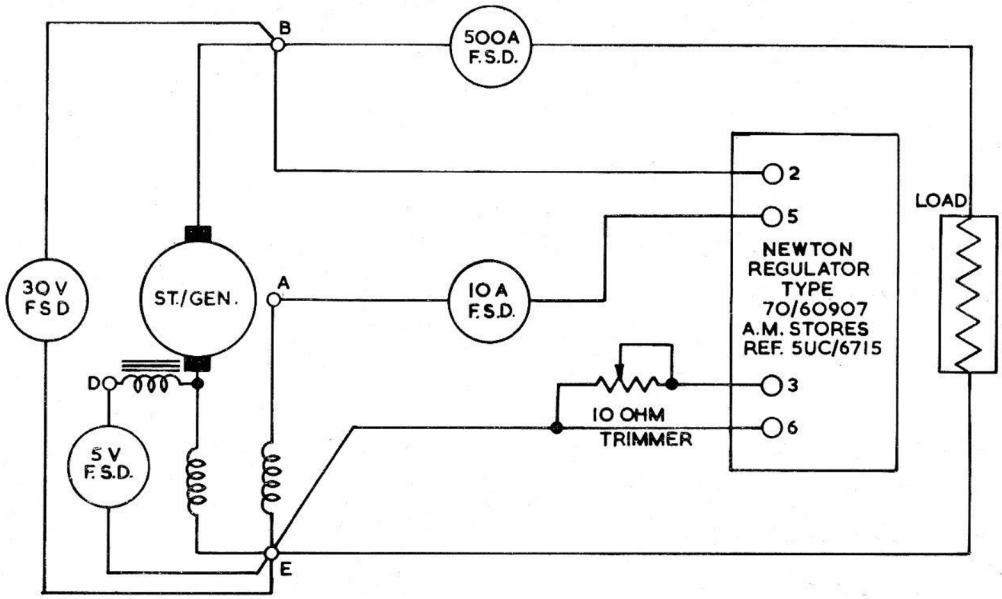


**Fig. 1. Test circuit**

(1) Run the generator at 3500 rev/min with a load of 300A, 30V, the shunt field current, shown on a suitable ammeter should not exceed 8·6A.

(2) Run the generator at 8,000 rev/min, terminal voltage 30V. Increase the load from no load to full load. This should result in an increase of field current.

**Insulation resistance tests**

**10.** Using a 100V insulation resistance tester, measure the insulation resistance between all live parts and the frame. A reading of at least 50,000 ohms shall be obtained for each test.

**Note . . .**

*In order to avoid possible damage to capacitors an insulation resistance tester above 100V should not be used.*



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