Chapter 29

ROTARY INVERTER, PLESSEY, TYPE 107

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF APPENDICES

LEADING PARTICULARS

Rotary inverter, Plessey, Type 107	*Ref. No.* 5*UB*/6821
Input	
Voltage	24 *to* 29*V d.c.*
Current	150*A max.* (*at full load*)
Output	
Voltage	200*V a.c.* (*r.m.s.*)
Frequency	400 *c/s*
Power	2,000*W*
Power factor	0·8 *lagging*
Speed	8000 *rev/min.*
Rotation (*viewed from fan end*)	*Clockwise*
Commutator brushes	
Grade	*K.C.E.G.*14
New length	0·86-0·9 *in.*
Minimum length (*on longest side*)	0·56 *in.*
Spring pressure	900-1100*g*

Note . . .
Inverters post Mod. Elec. B/505 *are fitted with brushes Grade PEG*.14 *and inverters post Mod. Elec. B*/545 *are fitted with brushes Grade E4PM.*

Slipring brushes	
Grade	*KC.CM.5B*
New length	0·52-0·56 *in.*
Minimum length (*on longest side*)	0·33 *in.*
Spring pressure	100-130*g*

Note . . .
Inverters post Mod. Elec. B/603 *are fitted with brushes Grade PEG*.14.

	Max. dia.	*Min. dia.*
Commutator dimensions	2·312-2·317 *in.*	2·187 *in.*
Bar to bar variation		·0001 *in.*
Depth of mica undercut		·015-·030 *in.*
Concentricity		·001 *in.*
Bearing (*motor end*)		*SKF Type* 6204 (2 *dot fit*)
Bearing (*a.c. end*)		*SKF Type* 6203 (2 *dot fit*)
Grease (*XG*-275)		*Ref. No.* 34*B*/9100512

Introduction

1. This rotary inverter (fig. 1) provides the necessary supplies for radio and instruments on aircraft. It produces an output of 200 volts 3-phase and is capable of supplying a continuous load of 2000 watts at a power factor of 0·8 to unity. The frequency of the supply is 400 c/s corresponding to a speed of 8000 rev/min. A starting and protection circuit contained in a panel is mounted on top of the inverter frame.

2. A control panel Plessey, Type 21, is separately mounted, works in conjunction with the inverter and controls the voltage and frequency output. A description and operation of this panel will be found in A.P.4343B, Vol. 1, Book 2, Sect. 7.

3. This inverter is capable of operating on a fully insulated system, but provision is made for earthing the negative lead of the d.c. supply. The inverter is self-cooled up to altitudes of 20000 ft., and at altitudes between 20000 and 60000 ft., cooling is by ram air through standard ducting to inlet and outlet unions fitted to either end of the inverter.

DESCRIPTION

Inverter

4. The inverter, a sectional view of which is shown in (fig. 2), consists of a motor driving an alternator. The motor of this unit is a four-pole fully compensated type, and the alternator is a six-pole, salient pole type.

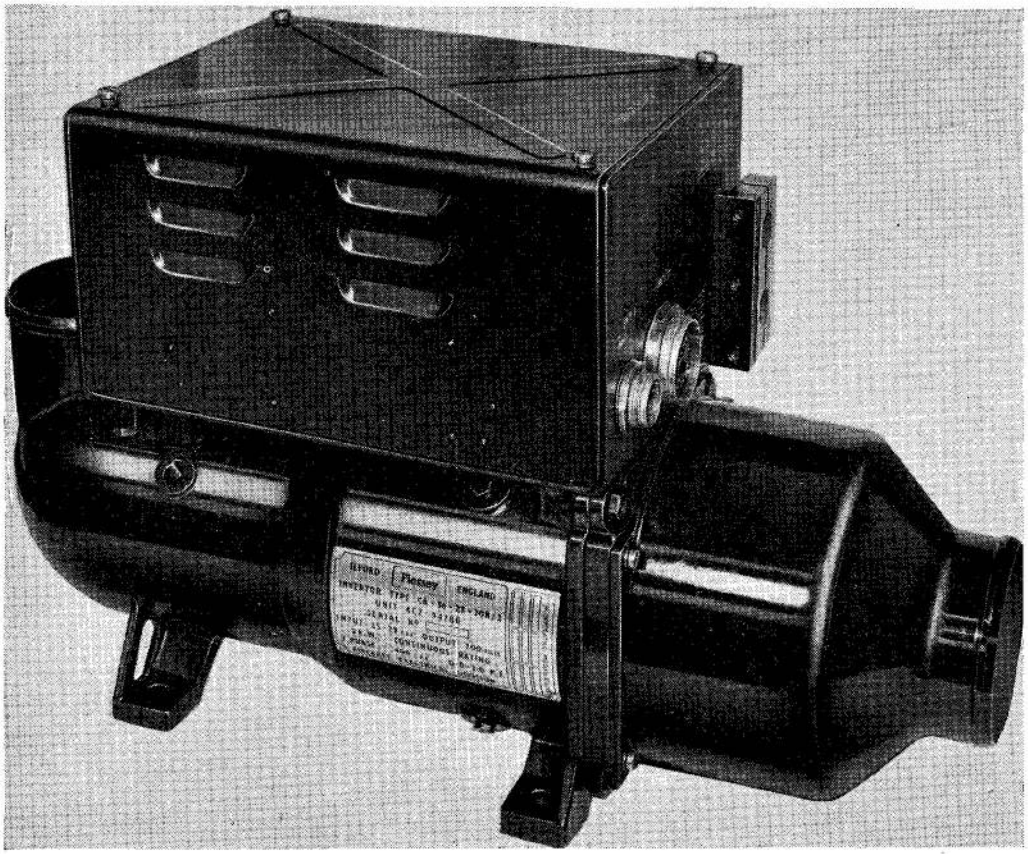

Fig. 1. Rotary inverter, Plessey, Type 107

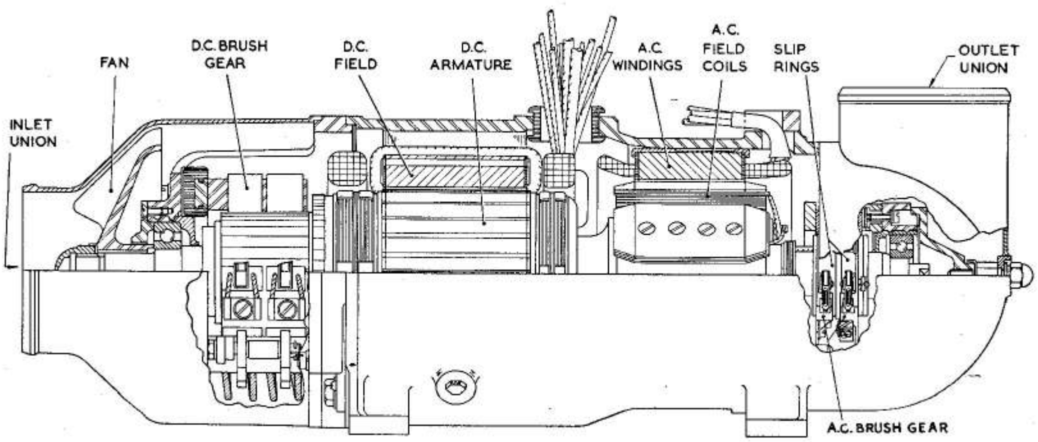

Fig. 2. Sectional view of inverter

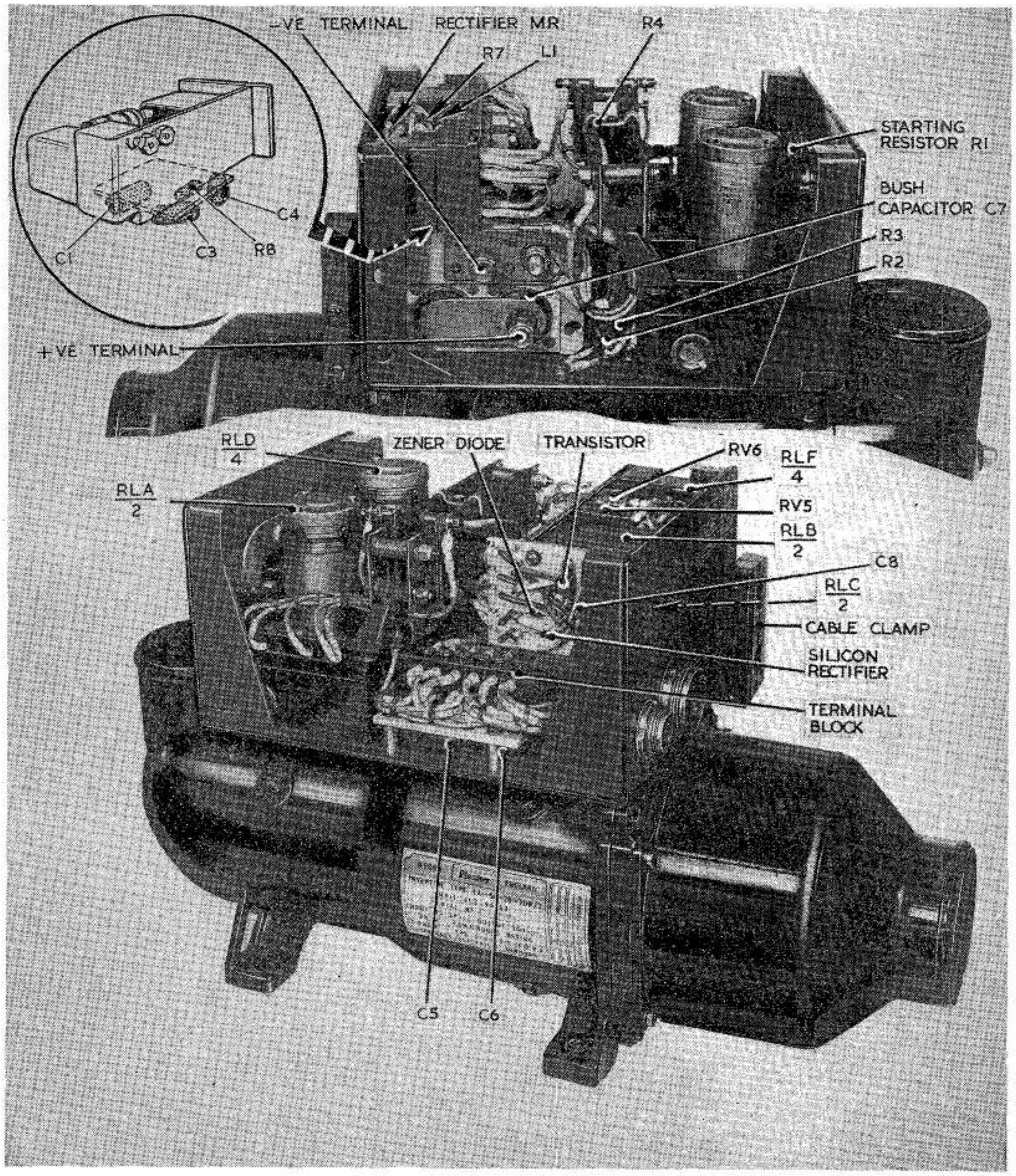

Fig. 3. View of starting and protection panel

5. The motor and alternator are contained in a common frame. The motor armature and the alternator rotor are carried on a common shaft which is supported within the frame by ball bearing journals situated at either end of the inverter frame.

Motor brush gear assembly

6. This assembly consists of four pairs of brush boxes, equally disposed around the commutator, by way of mountings to an insulated ring which is secured to the end housing by four screws.

7. The brushes are of high altitude grade carbon and are fitted with brass caps. A flanged portion on the brass cap limits the amount to which the brush may wear. A recess in the top of the cap is provided for the bearing end of the coiled spring, which is secured to the brush box.

Motor field

8. These field coils consist of the normal series and shunt winding, together with a compensating winding. These are wound on the pole core with a feedback winding and control winding. The control winding is fed from the control panel and is for controlling the speed of the motor. The feedback winding compensates for transient load switching. The compensating winding is wound along the pole face. A schematic diagram (fig. 5), shows the field and corresponding terminal lettering.

Alternator brush gear

9. This brush gear consists of two sets of brush boxes and brushes, three per set, each set being equally disposed around the two sliprings by way of mountings to separate insulated rings which are secured to the end housing. The brushes are of high altitude grade carbon; minimum length of brushes and spring pressures are given in the Leading Particulars.

Alternator field and stator

10. The alternator field consists of six poles equally spaced round the rotor. The d.c. supply to this field system is through the two sliprings located on the rotor shaft. The stator winding is star connected with an available neutral. The four leads to the stator windings are brought out together with the two supply leads to the sliprings, through a bushed hole provided in the top of the inverter frame.

Starting and protection panel

11. Two views of the panel with the covers removed are shown in fig. 3. The starting circuit comprises relay $\frac{RLD}{4}$, $\frac{RLD}{3}$, $\frac{RLA}{4}$ and starting resistor R1, which is a heavy duty, low value current limiting resistor.

12. The protection circuit functions to shut down the inverter in the event of over voltage, under voltage or over frequency. The over voltage circuit comprises a bridge rectifier MR, which produces a d.c. voltage, smoothed by capacitor C8, across the voltage sensing circuit comprising resistors RV6, R7 and R8, transistor VT and Zener diode Z1. The under voltage circuit comprises relay $\frac{RLB}{2}$ which is connected in series with the resistor RV5 across the output of MR. The over frequency circuit comprises the parallel network choke L1 and capacitor C1.

13. Connection to the 28V d.c. supply is provided by two heavy-duty terminals arranged on one side of the panel. A bushed capacitor C7 is connected to the positive terminal and is provided for radio interference suppression. Two holes in the casing adjacent to the terminals are for cable entry, and a clamp fixed to the outside casing, enables these cables to be clamped in position.

14. Connection to the remotely operated start switch is made through a 3-pole socket on the panel.

15. The output of the inverter is taken from a 9-pole socket mounted adjacent to the 3-pole socket.

OPERATION

General

16. Reference should be made to the circuit diagram (fig. 4) when following the operation of the starting and protection circuits given in para. 17 to 25.

Starting

17. When the start switch is made, the positive of the supply is completed to the coil of relay $\frac{RLD}{4}$ through normally closed contacts F4 and C1. Relay $\frac{RLD}{4}$ is thus energized and closes its normally open contacts D1, D2, D3 and D4. Contacts D1 complete the positive of the supply to the motor through the starting resistor R1; the shunt field winding circuit being completed through contact D1 and resistor R4.

18. The machine starts, and when it reaches a pre-determined speed (approximately three-quarters of its normal speed) the back e.m.f. produced from the motor will be developed across the coil of relay $\frac{RLA}{3}$. Operation of $\frac{RLA}{3}$ closes its normally open contacts A1, A2 and A3. Contacts A1 short-circuit the starting resistor R1 and allow the machine to reach full speed; at the same time the negative of the supply to the alternator field is completed through contact A2, and contact A3 completes the over-voltage bridge network.

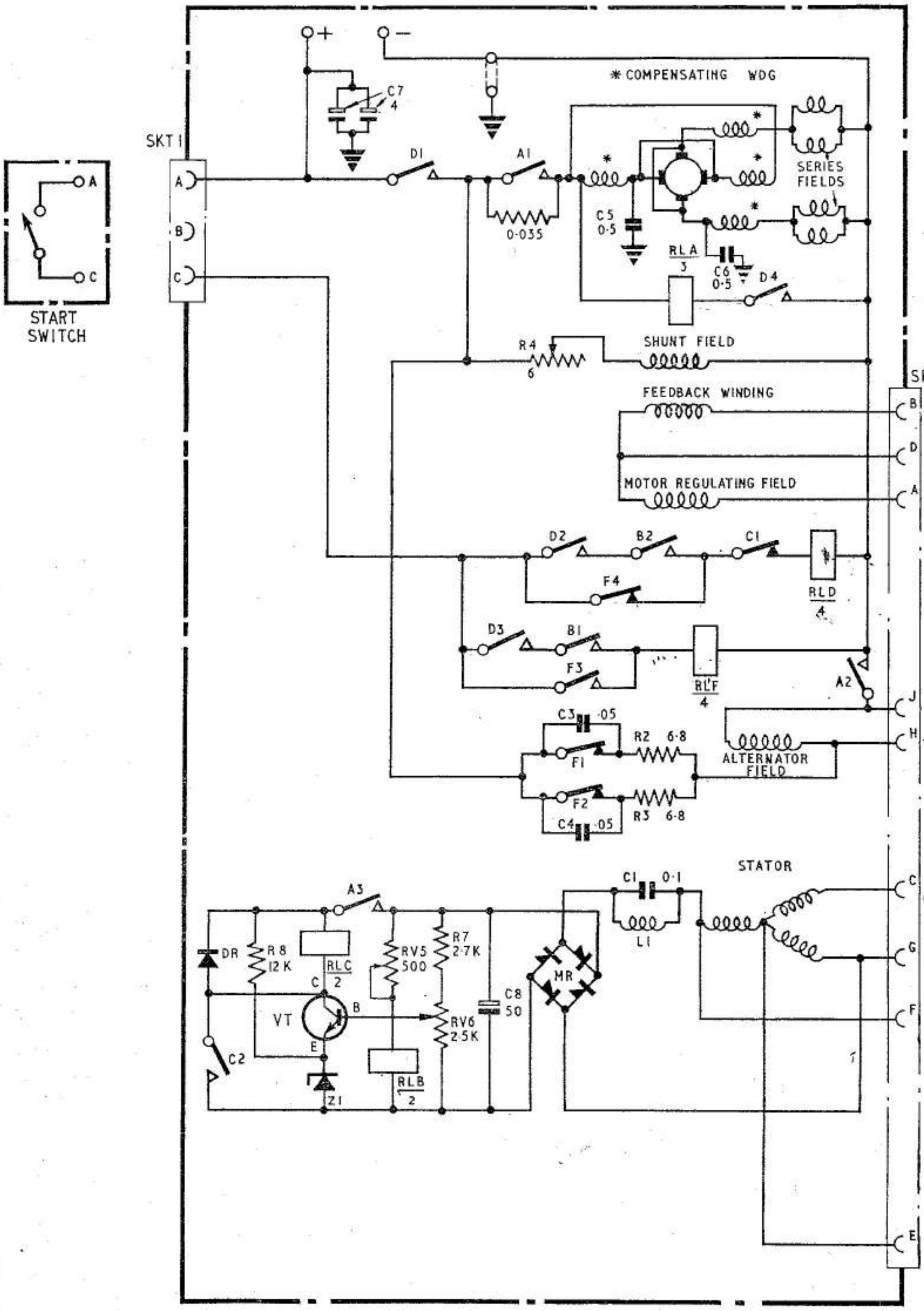

Fig. 4. Circuit diagram

RESTRICTED

19. With the alternator field energized, the a.c. voltage builds up, and at a pre-determined d.c. voltage produced across the bridge rectifier MR, the relay coil of $\frac{RLB}{2}$ becomes energized and operates the relay.

20. When relay $\frac{RLF}{4}$ is energized, the normally open contact F3 closes completing the relay hold-in circuit and the normally closed contacts F1, F2 and F4 open, thus removing the d.c. supply to the alternator field and setting the circuit so that the operation of the protection relays $\frac{RLB}{2}$ and $\frac{RLC}{2}$ control the motor. The d.c. supply to the alternator field is now fed from the control panel, Type 21, through pins H and J on the 49-hole socket.

Protection circuit

21. In the event of the alternator output failing the d.c. voltage across rectifier MR falls and results in the relay coil of relay $\frac{RLB}{2}$ becoming de-energized, contact B2 opens and breaks the hold-circuit of relay $\frac{RLD}{4}$, contact B1 opens breaking the positive supply to the motor and the motor shuts down.

22. Where a single-pole switch is used, starting is prevented since the positive of the supply would still be applied through terminals A and C through F3 to the coil of relay $\frac{RLF}{4}$. In order to restart the machine the switch must first be operated to the OFF position, thereby breaking the connection between A and C, and thus de-energizing relay $\frac{RLF}{4}$.

Over voltage and over frequency protection

23. The over voltage protection circuit operates in the following manner. The voltage sensing network consisting of RV6, R7, R8 and Z1 are arranged so that the transistor VT is biassed beyond cut-off. A large increase in voltage across the network results in the network becoming unbalanced, the bias on VT rises above the cut-off potential and the transistor starts conducting.

24. A current is, therefore, produced in the coil of relay $\frac{RLC}{2}$, which is now energized. The normally closed contact C1 will now open and the machine will shut down.

25. The parallel circuit L1 and C1 is arranged so that the voltage produced across it is proportional to frequency. The voltage produced across the circuit, when the frequency reaches a preset value above normal, is sufficient to affect the voltage sensing network and will similarly shut down the machine.

INSTALLATION

26. Four mounting feet drilled to take a $\frac{3}{8}$ in. bolt are provided on the base of the yoke for securing the inverter in position. A 3 in. diameter cooling duct is secured to either end of the inverter, the outlet pipe being adjustable to any desired radial position. A block diagram of the electrical connections between inverter and control panel will be found in the chapter dealing with the control panel Type 21 in A.P.4343B, Vol. 1, Book 2, Sect. 7.

SERVICING

27. The inverter should be serviced in accordance with the relevant Servicing Schedule and with the instructions given in this Chapter. Clean and examine the exterior of the inverter, and examine the starting and control panel for damage and security. Remove the protection covers from the starting panel and examine all cables and components for damage and security.

Brush gear

28. Access to the a.c. and d.c. brushes is gained by the removal of the inlet and outlet union housing. Remove the inlet and outlet union houses, examine the brush boxes and springs for damage, corrosion and security, and clean as necessary.

29. The brushes should be examined for sufficient length and freedom of movement in the brush boxes. New brushes should be fitted if the rate of wear indicates that the minimum length may be reached before the next servicing period or examination. The procedure for brush bedding is given in para. 50 and 51.

Commutator and slipring

30. The commutator and sliprings should be examined for signs of wear, scoring and burning. Where serious scoring or burning is evident the inverter must be removed for repair.

Bearings

31. The bearings are of the single row, open type, and are precision selected thus when renewal is necessary the same type of bearing should be used. At bay servicing periods the bearings should be filled to $\frac{1}{4}$ of their capacity with grease XG-275.

Dismantling

32. As it is considered inadvisable to separate the components into detail parts, the following procedure does not contain comprehensive instructions for completely dismantling the unit.

Armature assembly and end frames

33. (1) Remove the domed nut and washers and detach the air outlet cover. Remove the four securing screws and detach the air intake cover; discard the washers.

(2) Lift the a.c. and d.c. brushes off the sliprings and commutator respectively, but leave them clipped in their respective brush boxes. Disconnect the two leads secured to the a.c. brush gear tags.

(3) Remove the three screws and washers securing the bearing cover to the slipring end frame and remove the cover.

(4) Detach the domed nut at the armature shaft, discard the washer and extract the fan. Remove the locating key.

(5) Remove the three screws and washers securing the slipring end frame to the inverter body, and carefully withdraw the slipring end frame, together with the armature assembly. Extract the end frame with the attached a.c. brush gear assembly from the armature shaft.

(6) Remove the four screws and washers attaching the commutator end frame to the inverter body, and separate the body from the end frame.

Slipring end frame assembly

34. (1) Remove the three screws and washers securing the inner slipring brush gear mounting ring to the end frame, and withdraw the ring together with the inner brush gear from the frame.

(2) Similarly, remove the three screws and washers securing the outer brush gear mounting ring and withdraw the ring together with the outer brush gear.

(3) Extract the bearing from its housing in the end frame.

Commutator end frame assembly

35. (1) Remove the three screws and washers securing the bearing cap to the commutator end frame and remove the cap. Extract the bearing from the end frame.

(2) Remove the four screws plain and spring washers attaching the d.c. brush gear assembly to the end frame, and carefully withdraw the brush gear assembly from the frame. Remove and retain the insulating washer.

Assembling

36. All lockwashers, tab washers, grommets and split-pins that have been disturbed should be renewed when the machine is assembled.

Commutator end frame assembly

37. (1) Install the d.c. brush gear assembly without brushes in the commutator end frame, interposing the insulating washer between the faces of the mounting ring and the end frame; ensure that the brush gear mounting and end frame location marks coincide. Secure the brush gear to the frame with four sets of plains washers, spring washers and ch.hd. screws.

(2) Fill $\frac{1}{4}$ of the available space in the commutator end bearing with grease XG-275. Slowly rotate the inner race to spread the lubricant and wipe off any excess. Press the bearing into the commutator end frame. Fit the spigoted bearing cap and secure it with three serrated lockwashers and csk.hd. screws.

Slipring end frame assembly

38. Fill $\frac{1}{4}$ of the available space in the slipring end bearing with grease XG-275. Slowly rotate the inner race to spread the

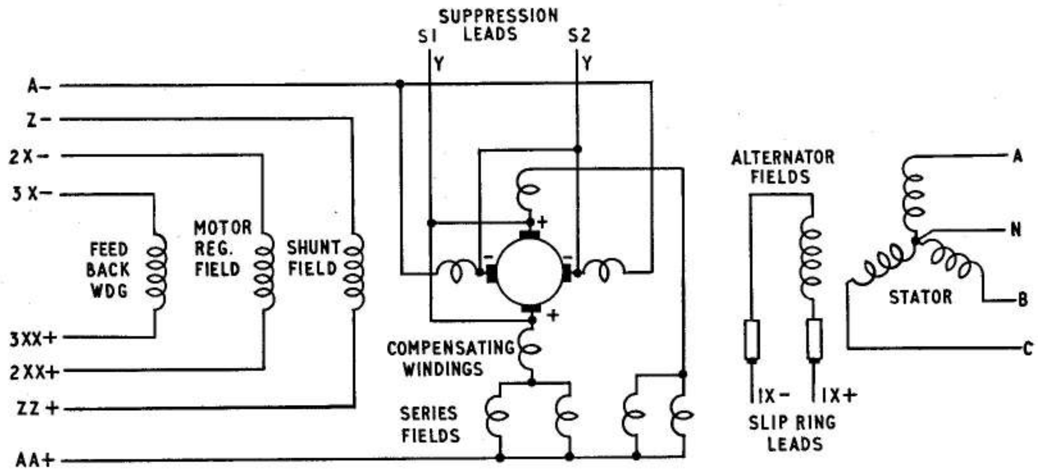

Fig. 5. Schematic circuit diagram of inverter

lubricant, and wipe off any excess. Press the bearing into the slipring end frame.

(2) Select the outer slipring brush gear assembly, identified by the circular mounting ring, and secure it, without brushes, to the smaller diameter flange of the end frame, using three ch.hd. screws and spring washers.

(3) Similarly, attach the inner slipring brush gear assembly without brushes to the other flange of the slipring end frame using three ch.hd. screws and spring washers.

Armature assembly and end frame to inverter body

39. Fit the assembled commutator end frame to the inverter body. Manipulate the assemblies so that the end frame spigot locates in the body recess and the mounting holes align. In this final position each field coil tag must be poised above a brush holder. Secure the end frame to the body with four hex.hd. screws and tab washers.

(2) Carefully press the assembled slipring end frame onto the rotor shaft journal until the inner race of the bearing in the end frame butts against the shoulder on the shaft.

(3) Pass the assembled armature centrally through the inverter body until the armature shaft enters the bearing in the commutator end frame. Press the shaft firmly home and secure the slipring end frame to the body with three hex.hd. screws and tab washers.

(4) Fit the bearing cover with the mounted stud to the slipring end frame and secure with three ch.hd. screws and spring washers.

(5) Fit the fan on the armature shaft using the key to establish its position; the shank of the fan should bear against the inner race of the bearing in the commutator end frame, whilst the key must not stand proud of the outer face of the fan boss. Secure the fan to the shaft using the lockwasher and domed nut.

(6) Lift the d.c. brush springs and insert the d.c. brushes into the holders ensuring that the brushes slide freely in the apertures. Check that each of the four d.c. field coil tags is correctly positioned over a brush holder. Locate the brush tags over the field coil tags and secure each pair of tags to the appropriate brush holder with a phosphor-bronze spring washer and ch.hd. brass screw.

(7) Lift the a.c. brush springs and insert the a.c. brushes into the holders ensuring that the brushes slide freely. Connect the two slipring leads, IX, IXX, to the brush gear tags, one lead to an inner brush gear tag and one to an outer; each lead must

be attached to the most convenient brush gear tag together with an appropriate (closest) brush tag, a ch.hd. screw and a spring washer being used to make the connection. Secure the four remaining brush tags to the appropriate brush gear tags using ch.hd. screws and spring washers.

Brush bedding

40. If new brushes have been fitted, they should be bedded on the commutator and sliprings in accordance with the procedure detailed in A.P.4343, Vol. 1, Sect. 1, Chap. 2.

41. For the final brush bedding, run the inverter should be connected to a 28V d.c. supply and run on a light load (about 200W) at 8000 rev/min. until the brushes are bedded satisfactorily over their full thickness and over 80 per cent of their axial width.

Brush setting

42. After the brushes have been bedded, operate the inverter at 27V d.c. on loads of 2000W and 600W respectively at 400 c/s. If poor commutation is observed during these tests the brush gear must be reset by loosening the screws securing the d.c. brush gear assembly to the end frame and swivelling the brush gear in gradual stages until good commutation is obtained.

Testing

43. Details of tests which may be applied to verify the serviceability of this machine will be found in Appendix A to this Chapter.

Appendix A

STANDARD SERVICEABILITY TEST FOR ROTARY INVERTER, TYPE 107

Introduction

1. The tests detailed in this Appendix should be applied to the machine before it is put into service, or at any time when its serviceability is suspect.

Note . . .

The test values given for the functional test, and setting of the protection circuit for machines used in the R.N. differ from those of the R.A.F. The values given in parenthesis are for the R.N.

TEST EQUIPMENT

2. The following test equipment is required; for the R.A.F. items No. (1) to (7), and for the R.N., where the inverter is tested without the inverter tester items No. (4) to (12) are required.

General

3. For test purposes the inverter should be connected in circuit with its associated control panel, a variable 25-28V d.c. input and a 3-phase load capable of dissipating the maximum machine output. The 3-phase output should be measured across each phase to ensure that the output is balanced.

Brush gear

4. Check the brush spring tension and brush length. The spring tension should be within the limits of 900g and 1100g and 100g to130g, and the minimum length, measured on the longest side, should be not less than 0·56 in. and 0·33 in. for the d.c. and a.c. ends respectively.

	Ref. No.	Description	Qty.
(1)	5G/564	Inverter tester	1
(2)	6C/610	Stroboscope, Stroboflash, Dawes Type 1200E	1
(3)	10W/1252	Resistor variable, 15 ohm, 16A (RV1)	1
(4)	5UC/6460	Control panel, Type 21	1
(5)	1H/97	Spring balance 0-4 lb.	1
(6)	1H/59	Tension gauge, No. 3	1
(7)	5CW/6435	Switch	1
(8)	5QP/10610	Tester meter, Type D (or equivalent)	1
(9)	N.I.V.	Suitable 3-phase load	1
(10)	N.I.V.	Resistor variable, 26·3 ohm, 6·5A (RV1)	1
(11)	5Q/100-3731	Frequency meter	1
(12)	0557/A.P.48A	Multimeter (complete with shunts)	1

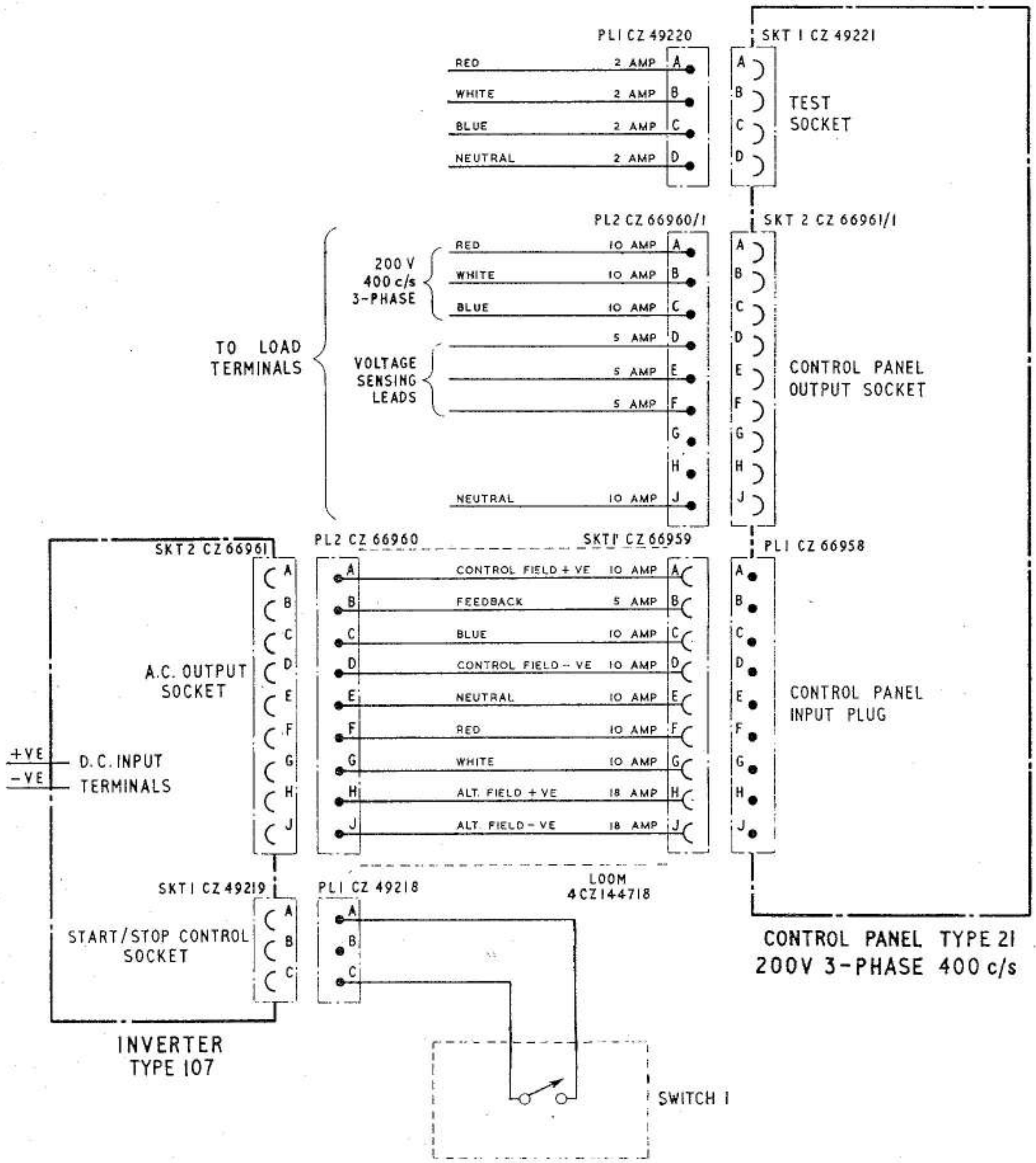

Fig. 1. Test Circuit Diagram

Functional test

5. Connect the inverter to the test circuit as shown in fig. 1 and test as follows.

(1) Set switch 1 to the ON position and check that the inverter starts and runs up to speed.

(2) With the input voltage adjusted to 28V d.c. and no load applied, check that:—

(*a*) The d.c. input current is less than 40A (44A).

(*b*) The output line voltage is within the limits of 195V and 205V (196V and and 204V).

(*c*) The output frequency is within the limits of 392 c/s and 408 c/s.

(3) Set switch 1 to the ON position, adjust the input voltage to 25V d.c. and apply a load of 2000W, check that:—

(*a*) The d.c. input current is less than 150A.

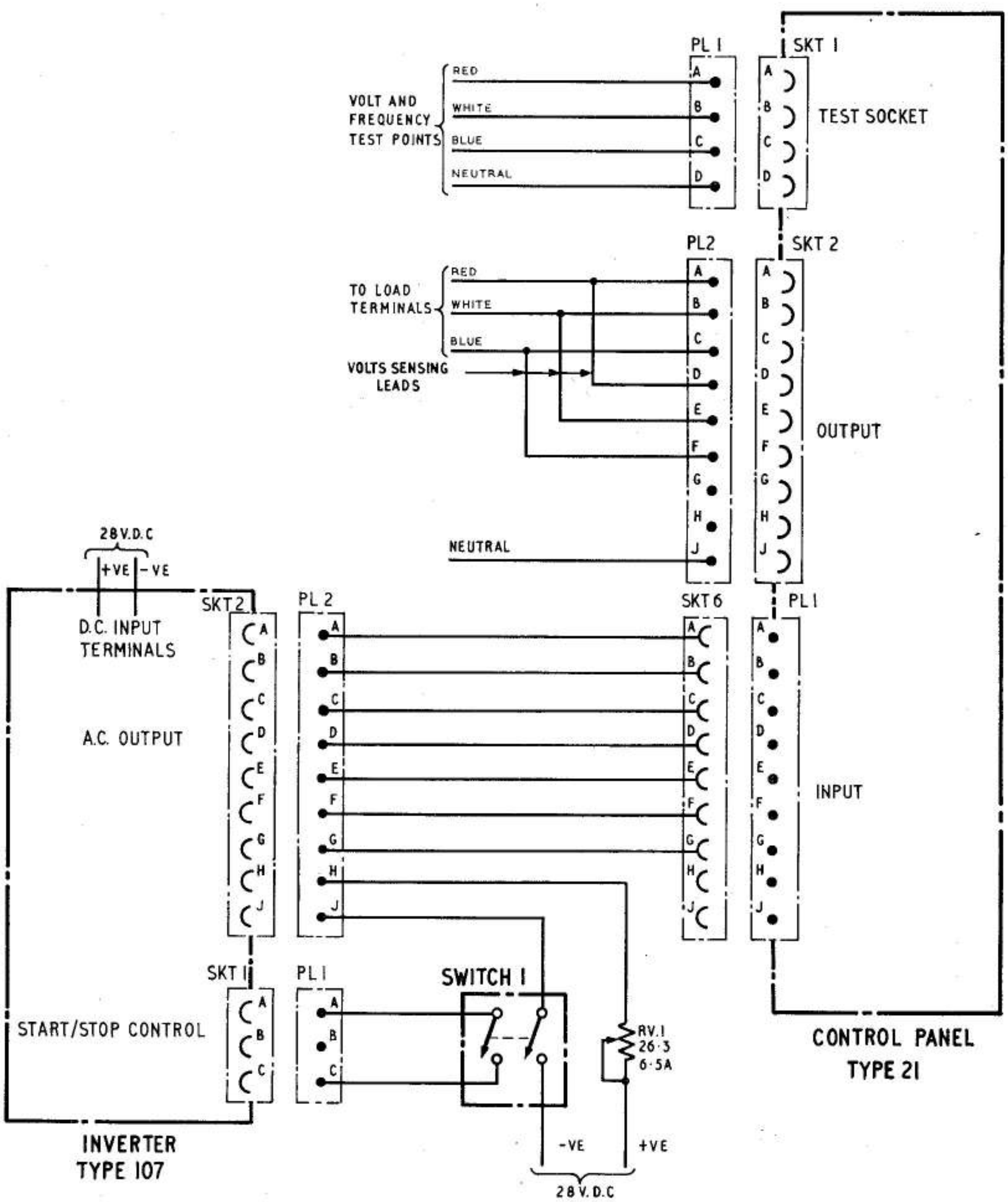

Fig. 2. Protection Test Circuit Diagram

(*b*) The output line voltage is within the limits of 195V and 205V (196V and 204V).

(*c*) The output frequency is within the limits of 392 c/s and 408 c/s.

Protection circuit test

Note . . .

When checking the protection circuit care is to be taken to prevent damage to the inverter and control panel. Adjustment of the cut-out voltage and frequency is made by resistor RV6, located in the starting and protection panel, clockwise rotation will lower the cut-out value; because of the sensitivity of the circuit, only minute movement of RV6 adjusting screw is required. When tightening the locknut on RV6 care must be taken not to cause further movement of the adjusting screws.

6. Connect the inverter to the test circuit as shown in fig. 2. Set RV1 to maximum resistance and test as follows:—

(1) Set switch 1 to the ON position and check that the inverter starts and runs up to speed.

(2) Increase the output voltage by means of RV1, while maintaining the frequency constant at 400 c/s by means of the frequency trimmer on the Type 21 control panel. Check that the voltage at which the inverter shuts down is within the limits of 250V and 260V (235V and 245V). Adjust RV6 as necessary.

(3) Increase the output frequency by means of the frequency trimmer on the Type 21 control panel while maintaining the voltage constant at 200V by means of RV1. Check that the frequency at which the inverter shuts down is within the limits of 500 c/s or 10 000 rev/min. and 520 c/s or 10 400 rev/min. (485 c/s and 520 c/s). Adjust RV6 as necessary. Set the frequency trimmer to the mid-position.

7. If adjustment to RV6 is made to bring the frequency within limits, the tests given in para. 6, sub-para (2) and (3), should be repeated. On completion of the tests given in para. 6 the functional test (para. 5) should be repeated.

Printed for H M Stationery Office by Chorley & Pickersgill Ltd Leeds
P32332/281417/168 2125 7/63 Gp 375


CPL V WOOTON
23