TM 11-6125-256-34

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

MOTOR-GENERATOR PU-750( )/A (NSN 6125-00-101-9720)

HEADQUARTERS, DEPARTMENT OF THE ARMY

MAY 1978

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CHANGE
No 1

HEADQUARTERS
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WASHINGTON, DC *16 June 1980*

Direct Support and General Support

Maintenance Manual

MOTOR-GENERATORS

PU-750()/A AND PU-750A/A

(NSN 6125-00-101-9720)

TM 11-6125-256-34, 30 May 1978, is changed as follows

1 **The title** of the manual is changed as shown above

2 ***New*** or changed material is indicated by a vertical bar in the margin

3 **Remove** and insert pages as indicated in the page list below

Remove	Insert
Warnings (inside front cover)	**WARNING page (front of manual)**
i through v	**i through iv**
1-1 (1-2 blank)	**1-1**
2-1 through 2-5	**2-1 through 2-6**
3-1 through 3-4	**3-1 through 3-4**
3-7 through 3-10	**3-7 through 3-10**
3-13 and 3-14	**3-13 and 3-14**
None	**3-17 and 3-18**
4-1 through 4-4	**4-1 through 4-4.1**
4-7 through 4-24	**4-7 through 4-10.14**
	4-11 through 4-12.1
	4-13 through 4-18.2
	4-19 through 4-23
4-31 through 4-36	**4-31 through 4-36**
FO-1	**FO-1**
FO-2	**FO-2**
None	**FO-2.1**
FO-3	**FO-3**

4 File this change sheet in front of the manual for reference purposes

By Order of the Secretary of the Army

E C MEYER
General United States Army
Chief of Staff

Official

J C PENNINGTON
Major General, United States Army
The Adjutant General

DISTRIBUTION

To be distributed in accordance with DA Form 12-31 Direct Support and General Support Maintenance requirement for OV-1A B C and OV-ID aircraft

TM11-6125-256-34

WARNING

Dangerous voltages exist in this equipment Always deenergize the motor-generator before working with ac output circuit Serious injury or death may result from contact with these points when energized

All maintenance and maintenance facilities must conform to TB 385-4, Safety Precautions for Maintenance of Electrical/Electronic Equipment

Use approved personnel protective equipment to protect eyes and face when using compressed air Maximum allowable air pressure for cleaning operations is 30 psi Do not direct airstream towards yourself or towards another person

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DON'T TAKE CHANCES!

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No.11-6125-256-34

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WASHINGTON, DC 30 May 1978

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

MOTOR-GENERATORS PU-750()/A AND PU-750A/A

(NSN 6125-00-101-9720)

REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028–2 (Test) located in the back of the manual. Simply tear out the self-addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Forms 2028–2 (Test) in the back of your manual, use the standard DA Forms 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN DRSEL–ME–MQ, Fort Monmouth, New Jersey 07703

In either case, a reply will be furnished direct to you.

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS - Continued

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1-1. Scope

This manual describes Motor-Generators PU-750( )/ A and PU-750A/A and covers functioning, direct support maintenance, and general support maintenance Unless otherwise specified, the material contained in this manual applies to both motor-generators

1-2. Indexes of Publications

a DA Pam 310-4 Refer to the latest issue of DA Form 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment

b DA Pam 310-7 Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment

1-3. Forms and Records

a Reports of Maintenance and Unsatisfactory ***Equipment*** Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed and prescribed by TM 38-750

b Report **of** ***Packaging and Handling Deficiencies*** Fill out and forward DD Form 6 (Packaging Improvement Report) as precribed in AR 700-58/NAVSUPINST 4030 29/AFR 71-13/MCO P4030 29A and DLAR 4145 8

c ***Discrepancy in Shipment Report (DISREP) (SF*** 361) Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/ NAVSUPINST 4610 33B/AFR 75-18/MCO P4610-19C, and DLAR 4500 15

1-4. Reporting Equipment Improvement Recommendations (EIR's)

EIR's can and must be submitted by anyone who is aware of an unsatisfactory condition with the equipment design or use It is not necessary to show a new design or list a better way to perform a procedure, just simply tell why the design is unfavorable or why a procedure is difficult EIR's may be submitted on Standard Form (SF) 368, Quality Deficiency Report Mail directly to Commander, US Army Communications and Electronics Materiel Readiness Command and Fort Monmouth, ATTN DRSEL-ME-MQ, Fort Monmonth, New Jersey **07703** A reply will be furnished directly to you

1-5. Administrative Storage

For procedures, forms and records, and inspections required during administrative storage of this equipment, refer to TM 11-6125-256-20

1-6. Destruction of Army Materiel

Destruction of Army materiel to prevent enemy use shall be as prescribed in TM 750-244-2

1-7. Description

A description of the capabilities, purpose, and use of the motor-generator may be found in TM 11-6125-**256-20**

1-8. Tabulated Data

The technical specifications for the motor-generator may be found in TM 11-6125-256-20

CHAPTER 2

Functioning of Equipment

Section I BLOCK DIAGRAM ANALYSIS

2-1. General

a The motor-generator is divided into two sections an electromechanical section, consisting of the motor and the generator and an electronic section containing a voltage and frequency regulator

b The purpose, operation and interoperation of the two sections (electronic and electromechanical) of the motor-generator are explained in this chapter Familiarity with the equipment and its functioning is a valuable tool in rapid and effective troubleshooting

2-2. Block Diagram

(fig (FO-1)

a Electromechanical Section

(1) The 28-volt dc input is applied to the electromechanical section of the motor-generator through the positive (+) terminal board to the motor series field, the interpole windings, and the armature causing current to flow through the motor

(2) The reaction of the magnetic fields established by the current flowing through the motor causes the armature to rotate The motor starts as a series motor ***As*** the motor speed increases, the armature voltage rises When the armature voltage reaches a predetermined level, the armature voltage sensing relay and resistor assembly energizes, causing series field cutout current relay assembly, Type 1519-1-B, to close, shorting out the series field With the series field shorted out, the motor runs as a shunt motor The exciter field of the generator is mechanically coupled to the armature of the motor by a common shaft, therefore, the exciter also rotates

(3) An ac voltage is induced in the ac field coils of the generator by the sweep of the exciter The exciter is not energized at this time Residual magnetism in the exciter causes this voltage buildup The induced voltage is applied through radio interference filter RF1 to the ac power connector In addition a sample of the ac output is applied to voltage and frequency regulator assembly.

b Electronic Section Voltage and frequency regulator assembly controls the motor-generator frequency output by controlling the strength of the motor shunt field and thus governing the speed of the rotating section The voltage output is regulated through control of the current in the ac generator exciter

NOTE

Type 4B48-6-A is used in PU-750()/A, type 4B93-1-A is used in PU-750A/A.

(1) As the mechanical speed of the motor-generator increases, the output frequency also increases To control the frequency, the regulator controls the amount of current flow through the motor shunt coils The speed of the motor may be reduced by increasing the strength of the motor shunt field

(2) Once the ac voltage generated as a result of the residual magnetism in the exciter rises above a preset level the voltage regulator supplies current to the exciter This causes a further rise in the output voltage The current level in the generator exciter determines the magnitude of output voltage Reducing the exciter current causes a reduction of ac output voltage Output voltage is controlled by regulating the average current in the exciter

(3) The regulator performs the function of a rapidly operating switch which interrupts the current flow in both motor and generator field windings at a rate of 800 Hz (4B48-6-A) or 400 Hz (4B93-1-A). Control is accomplished with voltage-and frequency sensing circuits that establish the magnitude of current required to produce the desired output and then vary the off-time or the motor shunt coils and generator exciter field stages.

Section II OVERALL CIRCUIT *ANALYSIS*

2-3. Electromechanical Section (fig FO-1)

The electromechanical section of the motor-generator consist of the motor and the generator Both units share the same housing, with separate stationary windings The armature of the motor and the exciter of the generator share a common shaft

a Motor The motor is a four-pole series-shunt motor with windings wound in magnetic addition to each other It operates on a 28-volt dc input drawn from the aircraft electrical system

(1) Power for operation of the motor is initially applied through the series coil Four dc brushes are located at the neutral point between the four coils (poles) Therefore adjacent commutator bars on the armature reach a dc brush when no voltage (neutral point) is between brushes The neutral point is set by the position of the interpole windings

(2) When 28 volts dc is impressed upon the series coil current will flow from the positive (+) terminal through the series and interpole coil and through the armature and brushes The magnetic field resulting from the current flow through the series coil reacts with the magnetic field set up by the current flow through the armature of the motor causing the armature to rotate

(3) By rotating through a magnetic field, the armature causes a counter electromotive force (cemf) to be induced in the armature winding The speed of armature rotation continues to increase until the cemf is almost equal to the dc input The small difference between the cemf and the dc input permits the flow of enough current to keep the armature rotating

(4) The motor starts and comes up to speed as a series motor As the motor speed increases the armature voltage rises The rises in armature voltage is sensed by the series field cutout circuit which latches and shorts out the series field Without the application of the shunt field the motor would overspeed The regulator applies the shunt field as the speed approaches the equivalent of a 400-Hz generator output The shunt field average current is varied from this point on to maintain a 400-Hz generator output

b Generator The ac generator is a rotating-field type generator Direct current from the regulator is fed to the rotor through the slip rings and the four ac contact brushes

(1) When the motor starts it turns the exciter of the generator As the exciter rotates, residual magnetism and then the magnetic ***fields*** set up by the current through the exciter windings pass conductors in the ac stator and induce an alternating current

(2) Alternating current is then passed through radio interference filter RF1 and made available at the ac power connector A portion of this alternating current is fed to the electronic section for use in regulating the alternating current amplitude and frequency

2-4. Electronic Section (4B48-6-A)

a The regulator senses one phase of the motor-generator ac output separate parts of the regulator compare magnitudes of the *sensed ac* voltage and frequency to their respective present values If an error exists between either of the motor-generator controlled entities and its preset comparator the regulator will function to minimize that error maintaining ac output voltage and frequency with the desired tolerance

b The regulator controls the field currents by alternately switching the field transistor into saturated on and off states Due to the method of sensing used, this switching rate is proportional to the ac frequency The proportion of on-time and off-time, which determines the average field voltage (and so field current), is a function of the error signal

c To provide continuous shunt field current, essential for satisfactory motor-generator performance, the shunt field is connected to the armature dc voltage through a diode in the regulator commonly called a free-wheeling or commutating diode During the time that the controlling transistor is in the off state, the field current flows through this diode, decaying only slightly until the next on state occurs

2-4.1. Electronic Section (4B93-1-A)

a Motor-generator output is continuously monitored by the regulator Frequency deviations are sensed by a comparator and processed into motor-generator speed control signals which regulate output frequency Amplitude fluctuations are similarly sensed and the regulator reacts to maintain the preset output voltage

b Control of shunt field strength is accomplished by the function of switching and waveshaping timing circuits which form the driving pulses of the output amplifier Regulation of the motor-generator is maintained within the operating limits selected and the output is continuously adjusted instantly to match the energy requirements of the load

c To provide continuous field current necessary for proper motor-generator performance, **both** the shunt, and the exciter fields are connected in parallel with flywheel diodes in the regulator This results in smooth ac field **current** even though the regulator supplies a pulsating square wave

2-5. Phase Applications

a. This motor-generator may be loaded either three-phase or single-phase but not simultaneously

b When used as a single-phase motor-generator, the unit shall be connected in delta (fig 2-1) and the external load connected to terminals A (T1) and B (T2) of the ac output connecter

c When used as a three-phase motor-generator, the load for each phase leg shall not differ more than 10-percent of the rated load

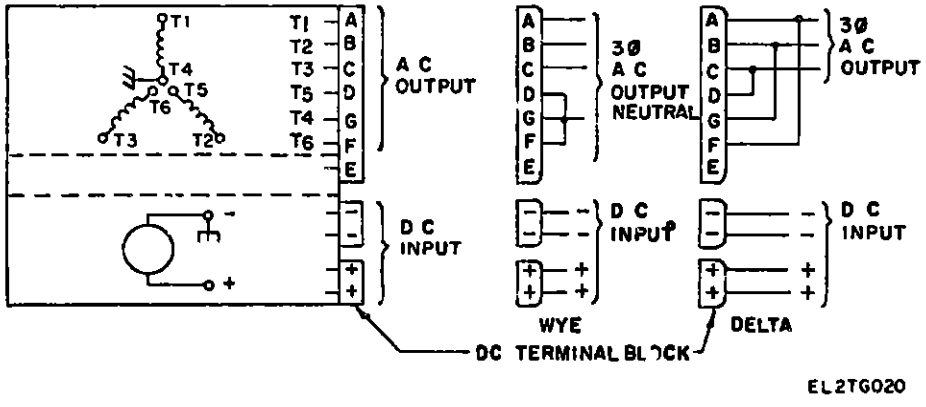


Figure 2-1. Phase connections

2-6. Voltage Regulation (4B48-6-A) (fig. FO-2)

a One side of the generator exciter field is connected to ground and the other side is connected to the collector of power transistor Q5 When the power transistor is on ***total dc voltage appears across*** the field ***When*** the transistor Q5 is off, total dc voltage appears across transistor Q5

b The sensing voltage is taken from the top of voltage adjust resistor R14 and the voltage at the emitter of transistor Q1 The sensing bridge consists of resistors R1 R2, R3 and R14 and diodes CR3, CR4 and CR5 The voltage at the junction of resistor R3 and diode CR3 is the voltage across the armature, less the drop across diode CR21 The voltage at the junction of diode CR5 and resistor R2 is the voltage across resistor R16 which, in effect is the difference between the input dc voltage and the fixed drop across diode CR23 Without any ac voltage at the primary of transformer T1, transistor Q1 is cut off, causing transistor Q3 to conduct When the transistor Q3 conducts transistor Q5 is cut off As a result, no current is applied to the exciter As the ac voltage generated as a result of the residual magnetism and the exciter core rises a point is reached where the base of transistor receives a voltage which is negative with respect to the emitter voltage When this voltage is present transistor Q1 conducts transistor Q3 cuts off and transistor Q5 conducts With transistor Q5 conducting current is applied to the exciter field and the voltage at the primary of transformer T1 rises further The ac output voltage will continue to build up until the regulation point is reached At this regulation point the voltage at the base of transistor Q1 goes positive with respect to the emitter voltage At this regulation point transistor Q1 cuts off transistor Q3 conducts and transistor Q5 cuts off This removes the exciter current At this point transistors Q1, Q3 and Q5 rapidly switch the exciter current on and off at the 800-Hz rate to regulate the output voltage

c The regulator reacts instantaneously to any change in output voltage and maintains it constantly at a preset value Free-wheeling diode CR19 is used to provide a path for the field current during the off time of power transistor Q5

2-7. Frequency Regulation (4B48-6-A) (fig. FO-2)

a One side of the motor shunt field is connected to ground and the other side is connected to the collector of power transistor Q6 When the power transistor is on, practically total dc voltages appears across the field When the power transistor is off, total dc voltage appears across transistor Q6.

b Frequency regulation is accomplished by sensing the ac potential developed across a reactance transformer of a series LC circuit tuned to approximately 475 Hz The LC circuit (capacitor C6 and inductor L2) operates at 400 Hz on the low side of the resonance curve The value of the ac potential developed is proportional to the frequency and will continue to be constant for any one frequency so long as the values of L and C remain constant This potential is then rectified (across resistor R5) and compared with another potential obtained by rectification (across resistor R6) of the ac reference voltage The two dc voltages are opposite to each other The voltage across resistor R6 and the voltage across resistor R10 aid in maintaining transistor Q2 cut off As a result transistor Q4 is conducting and transistor Q6 is cut off As a result the shunt field is not connected As the motor speed increases the voltage across resistor R5 increases until transistor Q2 switches into conduction With transistor Q2 conducting transistor Q4 is cut off and transistor Q6 is conducting With Q6 conducting current is applied to the shunt field The added field current tends to slow down the motor When the frequency drops below 400 Hz the shunt field is then cut out Due to the LC circuit of capacitor C6 and inductor L2, the shunt field voltage is switched on and off at an 800-Hz rate, maintaining the output at 400 Hz

c Any increase in frequency will cause an increase in the on-time of power transistor Q6, resulting in a higher average field current and a consequent reduction in frequency

d The regulator reacts instantaneously to any change in output frequency and maintains it constantly at a preset value

e Free-wheeling diode CR14 is used to provide a path for the field current during the off-time of power transistor Q6.

2-8. Control Circuits

(figs. FO-2 and FO-2.1)

a The dc motor starts out as a series motor As the armature voltage increases to the pickup voltage of relay and resistor assembly SW2, the relay closes, applying voltage to the contacts of the current relay assembly SW1 When SW1 closes, the starting series field is shorted out and the motor operates as a shunt motor

b Capacitors C7, C8, C11, and C13 on the positive (+) input act as radio noise filters The same function is performed by capacitors C9 and C12

c. On the 4B48-6-A (fig. FO-2), the electrical component subassembly board, consisting of diodes CR6 and CR22, resistors R16 and R17, capacitor C5, and Zener diode CR23, is a time delay circuit It allows the dc motor to come up to speed before allowing dc power to be applied to the alternator field

d. On the 4B93-1-A (fig. FO-2.1), during startup, normally open contacts on relay and resistor assembly SW2 prevent power from being applied to the alternator field. When the motor attains normal operating speed, the contacts close, allowing the alternator field to receive power.

2-9. Voltage Regulation (4B93-1-A) (fig FO-2 1)

a. AC generator output derived from phase A (ØA) is rectified by diode CR11 and divided by resistors R24, R25, R23 and R17 A portion of this voltage is filtered and shaped into a sawtooth waveform by capacitor C5 ***and*** applied to the pulse-forming amplifier consisting of transistors Q9, Q7, Q8, and Q11 The pulse width of the amplifier output varies directly with the generator output and is compared with the reference voltage established by the frequency regulator section

b When generator output voltage falls below the rated value, positive bias applied to transistor Q9 through resistors R17 and R23 increases Transistors Q9, Q7, and Q8 conduct for a larger portion of the sawtooth voltage, producing a series of output pulses with increasing pulse width from transistor Q11 As a result, generator control field excitation increases If generator output voltage rises above the rated ***value,*** positive bias applied to transistor Q9 decreases, decreasing the pulse width of the output from transistor Q11 This decreases generator control field excitation Full or maximum excitation is applied to the generator control field when output pulse width is maximum Minimum generator excitation is obtained when output pulse width is minimum

c Flywheel diode CR8 discharges inductive transients produced in the alternator field and prevents these voltages from being reflected back into the regulator

2-10. Frequency Regulation (4B93-1-A) (fig FO-2 1)

a AC generator output derived from phase A (ØA) is converted to a square wave and shaped into a sawtooth voltage having a period of one half the ac cycle The comparator circuit, transistors Q2 and Q10, has two inputs One input is the sawtooth timing voltage, the other input is an adjustable dc reference voltage used to select frequency (potentiometer R5) Control of frequency (speed) is obtained by controlling shunt field strength

b Output pulses from the comparator are amplified by transistor Q3 and integrated by capacitor C2 and resistor R11 Transistors Q4, Q5, and Q6 form an inverting amplifier which alternately conducts with the comparator Transistor Q4 is clamped at the reference voltage of Zener diode CR5 When ***transistor Q3 con***ducts, the increase in voltage across capacitor C2 cuts off transistor Q4 The resulting series of pulses drive the shunt field which controls motor-generator frequency (speed)

c An increase in frequency produces a wide pulse which increases shunt field current, decreasing operating frequency A decrease in frequency generates a narrow pulse causing shunt field current to decrease and the operating frequency to increase

d Flywheel diode CR6 discharges inductive transients produced in the shunt field and prevents reflection of these voltages back into the regulator

CHAPTER 3

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Introduction

The maintenance instructions in this and the following chapter supplement the organizational maintenance procedures in TM 11-6125-256-20 The troubleshooting which begins at the organizational level is carried to a higher level in Chapters 3 and 4

3-2. Maintenance Guidance

The maintenance and overhaul schedule outlined steps a through c should be followed Implementation of this schedule will ensure a high degree of reliability and an increase in effective motor-generator life

a Motor-generators that fail before 600 hours of service (recorded aircraft flight hours) should be sent to general support maintenance if the failure is due to bad bearings or if a replacement 4B48-6-A voltage and frequency regulator assembly is not available and the defective regulator assembly is repairable

b Motor-generators that fail at any time due to one of the following causes should be forwarded directly to the depot for repair

(1) Defect in armature assembly
(2) Defect in stator coils
(3) Worn bearing liner in end bell
(4) Fragmented housing

c In aircraft where the main and spare motor-generator (if any) are of the same type install the spare in the main position when the main motor-generator is turned in for depot overhaul Operational hours of the spare motor-generator, if only occasional, should be disregarded However, inspection testing and routine maintenance of the spare motor-generator will be performed periodically For main motor-generators presently in operation but for which no service time records are available the accumulated operational hours should be a multiple of the average weekly or monthly aircraft hours and the number of weeks or months the motor-generator has been installed

3-3. Tools and Equipment

Tools and test equipment required for Direct Support maintenance of the motor-generator are listed in section III of appendix B (Maintenance Allocation) in TM 11-6125-256-20

3-4. Organization of Troubleshooting Procedures

a General The first step in servicing a defective motor-generator is to sectionalize the fault The second step is to trace the fault to a specific defective part Some faults such as burned-out resistors, arcing brushes burned electrical leads and shorted stator windings, can often be located by sight smell or hearing Other faults must be located as described below

b Sectionalization The motor-generator consists of two major sections the electromechanical motor-generator section and the electronic regulator section The operational test of paragraph 3-5 used in conjunction with the organizational troubleshooting table in TM 11-6125-256-20, will be helpful in sectionalizing the fault

c Localization Repair and replacement of parts at Direct Support is limited to those functions and procedures specifically described in this chapter Use troubleshooting tables 3-1 and 3-2 for fault localization If this fails to correct the problem, or if symptoms not mentioned in the troubleshooting tables are noted, higher category maintenance is required

d Intermittent Trouble In making any test do not overlook the possibility of intermittent troubles If present this type of trouble may often be made to appear by tapping or jarring the equipment In addition, check the external and internal wiring connections

Section II. IN-AIRCRAFT MAINTENANCE

3-5. Operational Test

a. General **The operational test may be performed while the motor-generator is part of an aircraft installation If the motor-generator is determined to be the faulty unit, localize the trouble as outlined in trouble-shooting table 3–1**

b ***Power*** Requirements Connect an external power supply to the external power connector on the aircraft while making the operational test (Refer to the applicable aircraft technical manual) The power supply must be capable of delivering 285 amperes at 27 5 volts dc

c Procedure

(1) Turn the main power and other appropriate switches in the aircraft to the ON position Check to see that the motor-generator starts and that the aircraft dc voltmeter reads 28 volts

(2) Plug the prods of electrical power test set AN/UPM-93 into the motor-generator test joint jacks (fig 3-1) Remove the control box cover

(3) Adjust the AN/UPM-93 range selector to the 150 position

(4) Operate the motor-generator at no load (no ac components of the aircraft operating) Loosen locknut on voltage adjust resistor R14 or R23 as applicable (fig 3-1) and turn through its full range Voltage indicated on the voltmeter of the AN/UPM-93 must not be less than 110 or more than 120

(5) Apply a full load to the motor-generator by turning on all the aircraft equipment that operates from the ac supplied by the motor-generator (Refer to the applicable aircraft technical manual) Repeat the procedure given in step (4) No variation should occur in the adjustment range specified Turn off the aircraft ac components and set voltage adjustment resistor R14 or R23, as applicable, so that a 115-volt output is indicated on the voltmeter of the AN/URM-93 Tighten the locknut

(6) On 4B48-6-A, operate the motor-generator at no load and turn frequency adjust resistor R15 (fig 3-1) through its full range The limits, as indicated on the frequency meter of the AN/UPM-93, must be **390 to 410Hz.** ***On 4B93–1–A, frequency adjust resistor R5 has been preset by higher echelon and locked in place No adjustment can be made***

NOTE

An error in output frequency could result in the aircraft being several miles off course over a long flight period On the 4B48-6-A, ensure that frequency adjust resistor R15 is set to the proper output frequency as described in steps (7) and (8) below On the 4B93-1-A, this adjustment is not made so perform only step (8) below

(7) On the 4B48-6-A only, apply a full load and turn frequency adjust resistor R15 through its full range No variation should occur in the range specified in step (6) above Turn off the aircraft components and reset R15 to provide a 400-Hz output

(8) Turn on the aircraft components, one at a time, until the motor-generator is fully loaded Voltage variation between no load and full load must be less than 5 volts The frequency variation must be less than 20 Hz from the 400-Hz setting

NOTE

If the voltage and frequency outputs are not within the limits specified in step (8) above, the motor-generator must be removed from the aircraft for maintenance

(9) Upon completion of the operational test, remove the AN/UPM-93 prods from the motor-generator Turn off the aircraft master switch and disconnect the external power source from the aircraft Replace the control box cover

3-6. In-Aircraft Troubleshooting Table

If the operational test of paragraph 3-5 indicates a malfunction, localize it, using in-aircraft troubleshooting table 3-1 If the procedures in the table fail to correct the fault, or if a malfunction not mentioned in the table is noted, remove the motor-generator from the aircraft and bench test as described in section III

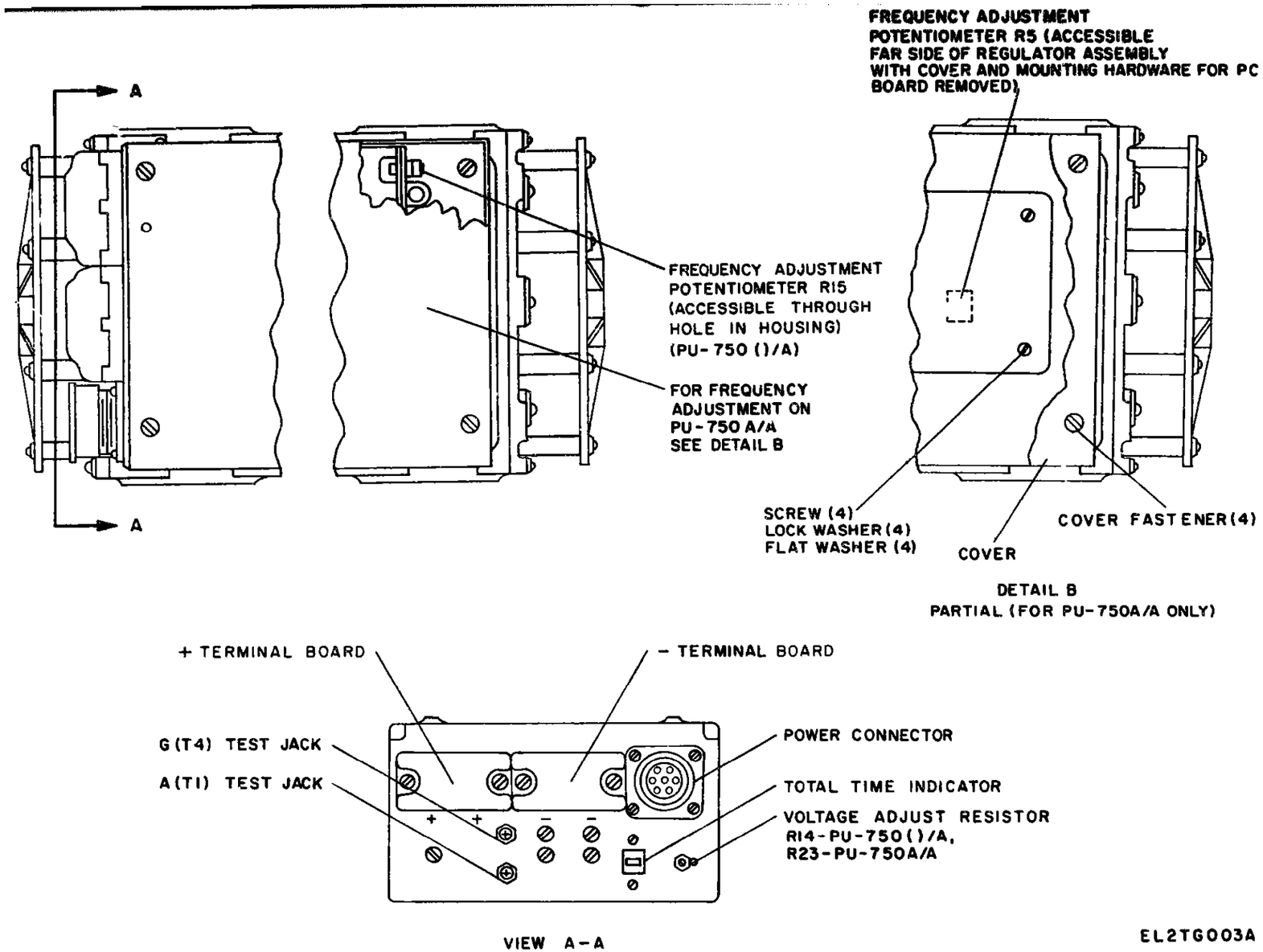


Figure 3-1. Voltage and frequency adjustments

Table 3-1. In-Aircraft Troubleshooting

NOTE

All checks are the be conducted with the motor-generator for normal use

Malfunction	Probable Cause		Corrective Action	
Motor-generator fails to start	*a.*	Blown fuse or circuit breaker in dc line	*a*	Check dc fuse or circuit breaker (1) Clean and tighten fuse contacts. Replace blown fuse (2) Reset circuit breaker
	b.	Short circuit in dc line	*b*	If circuit breakers or fuses are blown, inspect wiring between fuses or circuit breakers and the motor-generator Repair or replace as necessary
	c	Open circuit in dc line	*c*	Check wiring and input connection for open circuit Repair or replace as necessary
Motor generator starts but delivers no output voltage	*a*	Ac circuit open	*a*	Check exterior wiring and connections for open circuit Repair or replace as necessary
	b	Regulator failure	*b*	Remove motor-generator to replace voltage and frequency regulator assembly as described in paragraph 3-11 or 3 14.Refer voltage and frequency regulator assembly to higher category maintenance
Output voltage is low	*a*	Dc input voltage low	*a*	Check dc voltage at power supply and correct
	b	Voltage potentiometer out of adjustment	*b*	Readjust voltage potentiometer as described in Tm 11-6125-256-20
	c	Regulator failure	*c*	Remove motor-generator to replace voltage and frequency regulator assembly, as described in paragraph 3-11 or 3-14.Refer voltage and frequency regulator assembly to higher category maintenance
Output voltage is high	*a*	Input voltage higher than 30 volts	*a.*	Check dc voltage at power supply and correct
	b	Voltage potentiometer out cf adjustment	*b*	Readjust voltage potentiometer as described in Tm 11-6125-256-20
	c	Regulator failure	*c*	Remove motor-generator to replace voltage and frequency regulator assembly as described in paragraph 3-11 or 3-14.Refer voltage and frequency regulator assembly to higher category maintenance

Table 3-1 In-Aircraft ***Troubleshooting - Continued***

Malfunction		Probable Cause		Corrective Action
Output voltage unstable	*a.*	Loose connections	*a.*	Check for loose connections in the motor generator tighten as necessary
	b	Open or shorted windings in ac stator coils	*b*	Refer motor-generator to higher category maintenance
Output frequency incorrect	*a*	Frequency potentiometer out of adjustment	*a.*	Readjust frequency potentiometer as described in paragraph 3-12
	b	Open or short in dc stator coil	*b*	Refer motor-generator to higher category maintenance
Motor-generator overheats	*a*	Poor external ventilation	*a*	Check for adequate air circulation around unit Correct as necessary
	b	Poor internal ventilation	*b*	Check to see that air louvers are free of obstructions Correct as necessary
	c	Worn bearings	*c*	Feel bearing housings in ac and dc endbell assemblies If hot to the touch, refer motor-generator to higher category maintenance
	d	Excessive load	*d*	Check and correct as necessary
Excessive noise	*a*	Motor-generator or associated hardware not firmly mounted	*a*	Check mounting bolts and other bolts and screws tighten as necessary
	b	Worn bearings	*b*	Feel and listen for roughness in bearings If any roughness detected refer motor-generator to higher category maintenance
	c	Armature dragging or striking on polepiece	*c*	Feel and listen for indication of interference If interference is evident refer motor-generator higher category maintenance
	d	Shorted armature coil	*d*	Refer motor-generator to higher category maintenance
	e	Unbalanced armature	*e*	Feel for excessive vibration if felt refer motor-generator to higher category maintenance
Interference in aircraft radio system		Defective radio interference filter RFI		Refer motor-generator to higher category maintenance
Output voltage and frequency cannot be measured at test point jacks		Test point jacks or wiring defective		Check condition of test point jacks

Section III BENCH TESTING

3-7. Bench Testing Motor-Generator

a When to ***Bench*** Test Localize motor-generator malfunctions, using bench troubleshooting tabel 3-2, when any of the following conditions apply

(1) When the motor-generator is being serviced apart from the aircraft and the nature of the aircraft and the nature of the abnormal symptoms is not known

(2) When abnormal symptoms are reported from operational tests (paragraph 3-5), and in air-craft trouble-shooting fails to locate and correct the fault

b Condition *for* ***Bench Test*** Prepare the motor-generator for bench testing as follows

(1) Mount the motor-generator on a test bench Make sure the areas of contact between the mounting base of the motor-generator and the corresponding areas of the test bench are clean and free of oil or grease to ensure good electrical grounding

(2) Interconnect the motor-generator and motor-generator test set AN/GSM-65 () (paragraph 3-8)

3-8. Test Setup

Bench test of the motor-generator requires connection of ***the motor-generator, the AN/GSM-65(),*** and a 26- to 29-volt, 285-ampere (minimum) dc power source as shown in figure 3-2

NOTE

Test set cable assembly No 7 of the AN/GSM-65() should be used for interconnection Refer to the applicable AN/GSM-65() technical manual for cable assembly description

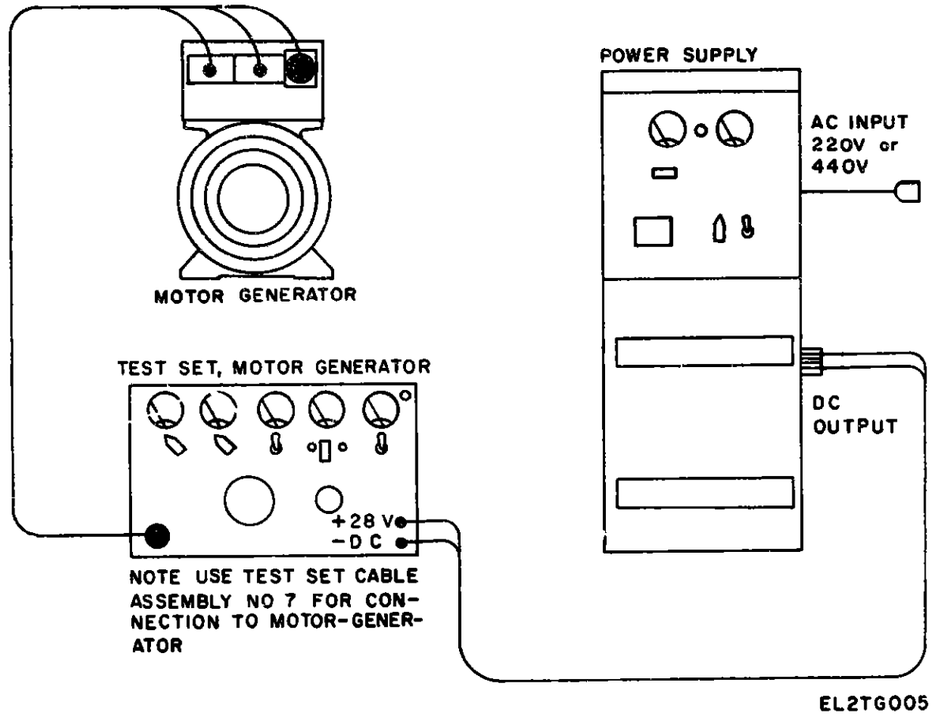


Figure 3-2. Connections for performance tests

Table 3-2. Bench Troubleshooting

NOTE
All checks are to be conducted with the motor-generator connected for normal use

Malfunction		Probable Cause		Corrective Action
Motor-generator fails to start	*a.*	Dc brushes not making contact with commutator	*a*	Check for sticking, worn or broken brushes Replace as described in paragraph 3-10 If brush holders or brush springs are defective refer motor-generator to higher category maintenance
	b	Armature jammed	*b*	Remove fan cover and try to turn armature assembly by hand Check for obstructions in airgap If jammed refer to motor-generator to higher category maintenance
Motor-generator starts, but delivers no output voltage	*a.*	Ac contact brushes not making contact with slip rings	*a*	Replace defective brushes
	b	Short or open circuit in generator exciter winding	*b*	Remove ac brush covers (5 fig. FO-3) and use multimeter to check resistance between the slip rings Resistance must be 2.61 to 3 19 ohms If the multimeter indicates much higher or zero *resistance refer motor-generator to higher* category maintenance
	c	Regulator failure	*c*	Replace voltage and frequency regulator assembly as described in paragraph 3-11 or 3-14. Refer voltage and frequency regulator assembly to higher category maintenance
Output voltage is low	Regulator failure		Replace voltage and frequency regulator assembly as described in paragraph 3-11 or 3-14. Refer voltage and frequency regulator assembly to higher category maintenance	
Output voltage is high	*a*	Regulator failure	*a*	Replace voltage and frequency regulator assembly as described in paragraph 3-11 or 3-14. Refer defective voltage and frequency regulator assembly to higher category maintenance
	b	Shorted coil in dc armature windings.	*b*	Refer to higher category maintenance.

Table 3-2. Bench Troubleshooting-Continued

Malfunction		Probable Cause		Corrective Action
Output voltage unstable	*a.*	Poor commutation or poor brush contact at slip rings.	*a.*	Remove ac and dc brush covers (4 and 5 fig FO-3) and check condition of commutator and slip rings Check brushes brush holder and brush springs. Replace if defective If commutator or slip rings are dirty or pitted refer motor-generator to higher category maintenance
Output frequency incorrect	*b.*	Open or short in dc stator coil Open or shorted windings in ac stator coils	*b*	Refer motor-generator to higher category maintenance Refer motor-generator to higher category maintenance
Excessive sparking at brushes	*a.*	Commutator or slip rings dirty or pitted	*a*	Remove ac and dc brush covers (4 and 5 fig. FO-3), and check condition of commutator or slip rings If dirty or pitted refer motor-generator to higher category maintenance
	b	Grounded circuit in armature coils.	*b*	Check input current if it is more than 285 amperes, a short circuit is present Refer motor-generator to higher category maintenance
Motor-generator overheats	*a.*	Worn bearings	*a.*	Feel bearing housing in ac and dc endbell assemblies If hot to the touch refer motor-generator to higher category maintenance
	b	Defective fan(s)	*b.*	Remove fan covers and inspect fans for broken or bent blades Refer motor-generator to higher category maintenance if defective
Excessive noise	*a.*	Worn bearings	*a.*	Remove either fan cover and rotate armature counterclockwise by hand, feel and listen for roughness in bearings If roughness is detected refer motor-generator to higher category maintenance
	b	Armature dragging or striking on pole-piece	*b*	Remove either fan cover and rotate armature counterclockwise by hand, feel and listen for indications of interference If interference is evident, refer motor-generator higher category maintenance

Section IV. MAINTENANCE

3-9. Cleaning

Cleaning of the exterior of the motor-generator is carried out primarily at the Organizational level If such cleaning is necessary the procedures in TM 11-6125-256-20 should be applied In addition, clean the interior of the generator section as follows

a. Remove ac and dc brush covers.

WARNING

To be used for cleaning, the compressed air source must limit the nozzle pressure to no more than 29 pounds per square inch (PSIG). Goggles must be worn while cleaning with compressed air.

b. Remove loose carbon dust and dirt from the interior with a stream of dry, low pressure compressed air.

c. Replace ac and dc brush covers.

3-10. Replacement of Brushes

(fig 3-3)

Both ac and dc brushes are replaced at the Direct Support level as described in steps a and ***b The motor-generator*** must be removed from the aircraft for brush replacement

a AC Brushes

(1) Remove ac brush covers by loosening screws, lock washers, and washers

(2) Remove screws, flat washers, and lock washers securing each brush lead

(3) Raise each brush arm (part of ac end bell) and remove brush from brush holder

(4) Raise brush arm and slide each replacement brush (4 required) into associated brush holder Lower tension on brush arm

(5) Connect each brush lead with screw, washer, and lock washer removed in step (2)

(6) Reinstall ac brush covers

b DC Brushes

(1) Remove dc brush covers by loosening screws lock washers, and washers

CAUTION

DC brushes are critical items, therefore, use only brushes specified for use on this equipment Refer to TM 11-6125-256-34P

(2) Remove the retaining screws and flat washers from the leads of each of 8 dc contact brushes (2 per brush holder)

(3) Lift up the brush springs and pull the brushes clear of their holders

(4) Install new brushes by lifting the brush springs and sliding the new brushes into the holders (2 brushes in each holder) The curved face of the brush must fit the curve of the commutator Make certain that the brushes slide easily without binding The brush springs must straddle the brushes without interference from the leads leads

(5) Secure the brush leads to the dc end bell with the screws removed in step (2)

(6) Reinstall the dc brush covers

c. Brush Run-in and Preseating. Preseat and final brush seating must be accomplish after the brushes have been installed. Con the motor-generator (fig. 3-4) and operate for for two hours each at 1000, 2000, and volt-amperes. Then operate it for one hour at 3500, 4000, 4500, and 5000 volt-amperes Check the brush contacts area for shading. shes must be seated as specified in steps and (2) below. Minor variations in shading occasionally appear and should be disregar

(1) AC contact brushes 75 percent of brush contact area

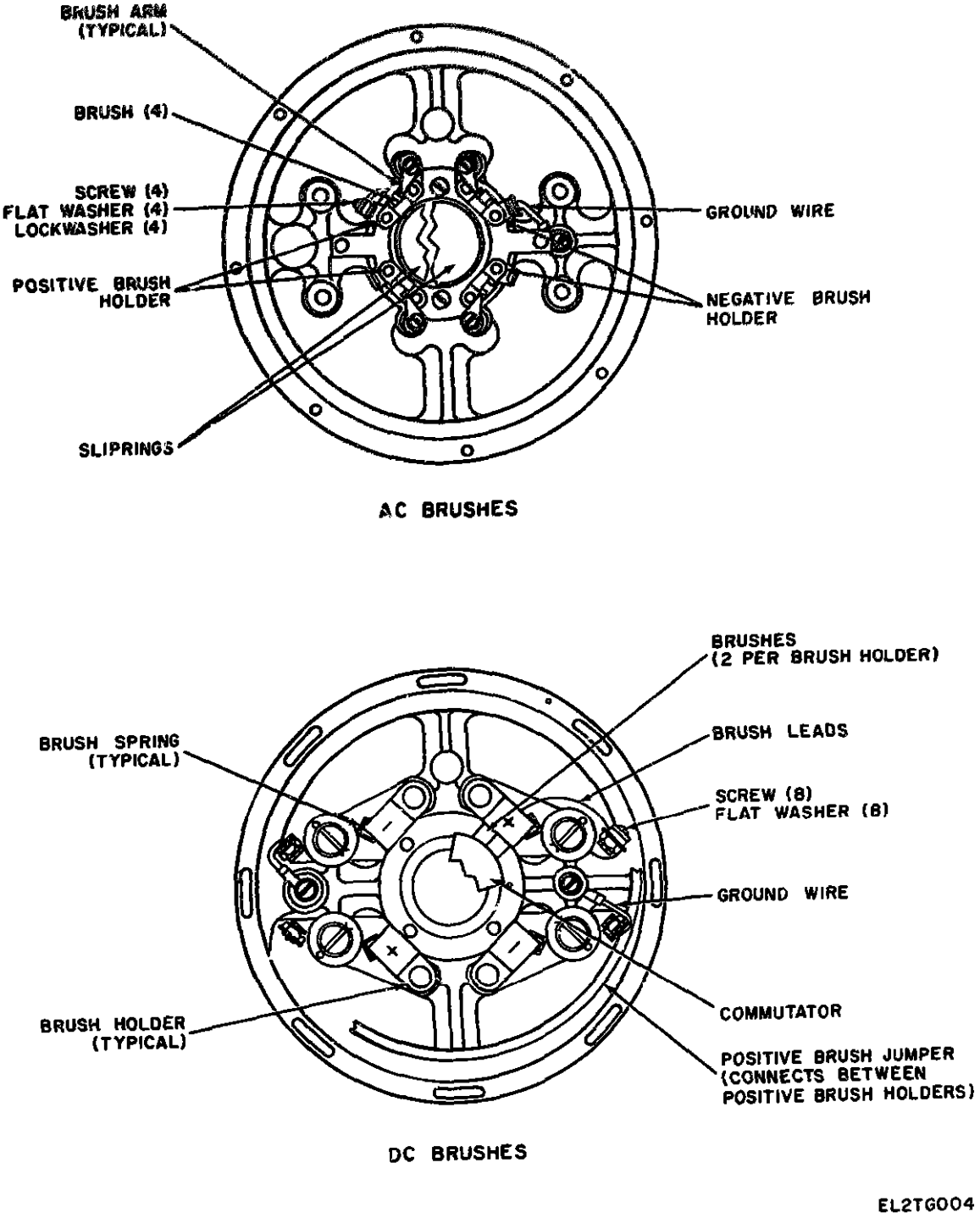


Figure 3-3. Replacement of brushes

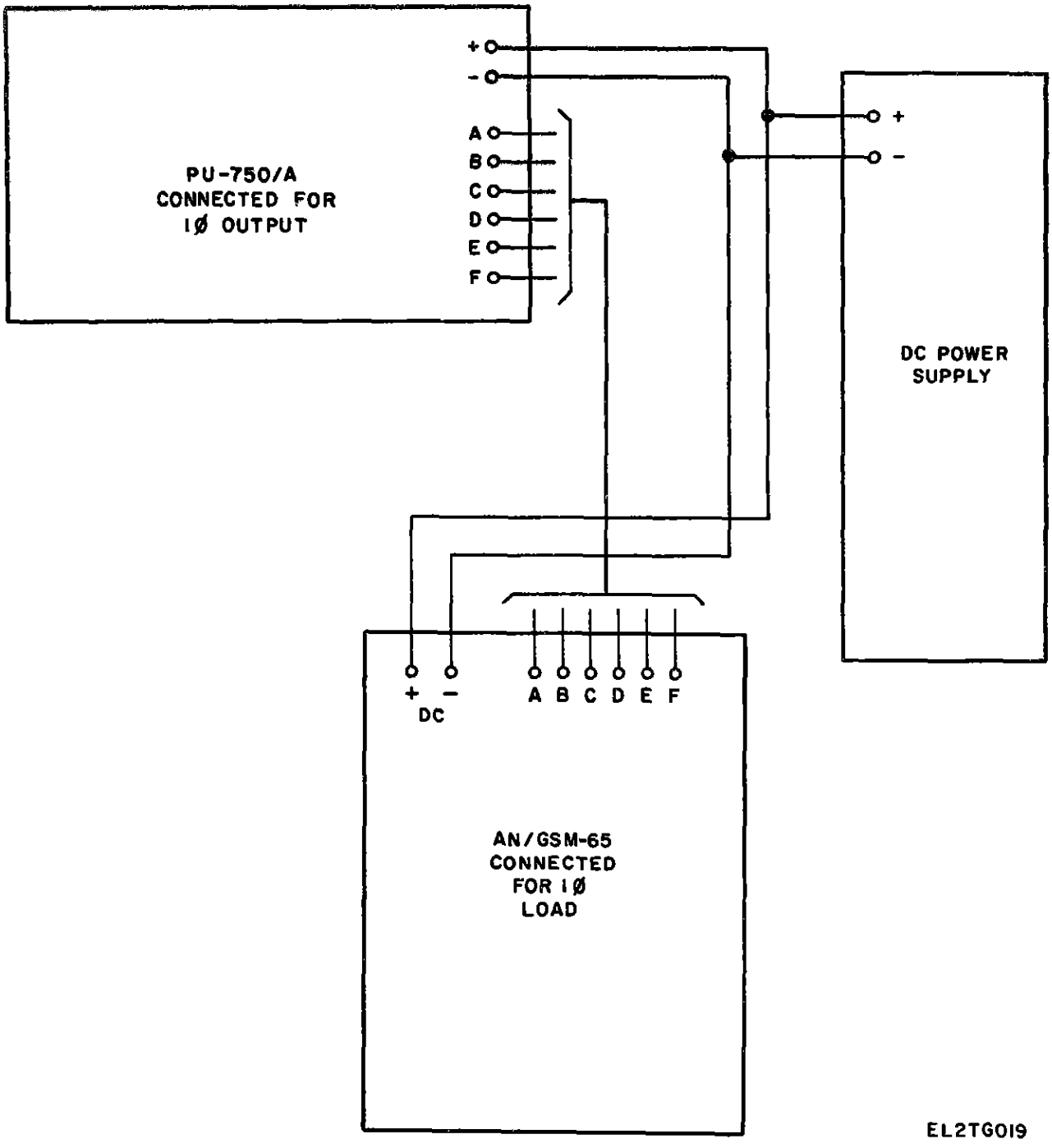


Figure 3-4. Connections for brush run-in.

(2) DC contact brushes 100 percent in the direction of armature rotation, and 75 percent in brush thickness.

3-11. Replacement of Voltage and Frequency Regulator Assembly, Type *4B48-6-A.*

(fig. 3-5)

a Removal

(1) Remove the control box cover

(2) Remove jam nut, hex nut, and internal tooth lock washer and remove variable resistor R14 from control box assembly front panel Cut ties from harness to free leads

(3) Disconnect the leads at the regulator connection board and at the mounting screw for capacitor C9 (ground screw)

(4) Remove two screws, flat washer, and lock washers, which secure the center portion of the circuit board to the control box assembly

(5) Remove the remaining four screws, flat washers, and lock washers and remove the voltage and frequency regulator assembly from the control box assembly

b Installation

(1) Position the voltage and frequency regulator assembly in the control box assembly and secure with the four screws, flat washers, and lock washers.

(2) Install the two screws, flat washers, and lock washers securing the center of the circuit board

(3) Connect the leads at the regulator connection board and at the mounting screw for capacitor C9 (ground screw)

(4) Attach variable resistor R14 to control box assembly with the internal tooth lock washer and hex nut Loosely install jam nut. Do not tighten jam nut until voltage adjustment has been performed (paragraph 3-5) Tie lead wires from variable resistor R14 to wiring harness

(5) Install the control box cover

3-12. Adjustment of Output Frequency (4B48-6-A)

Use the operational test procedure given in paragraph 3-5 to test the output frequency

3-13. Tests and Procedures (4B48-6-A)

Equipment which meets the performance standards in tables 3-3 and 3-4 may be considered acceptable for service Perform each step of the tables in sequence For each step, perform all the actions in the control setting columns and then perform the specific procedure and verify it against its performance standard If any abnormal actions or reading occur, refer to the troubleshooting procedures listed in table 3-2

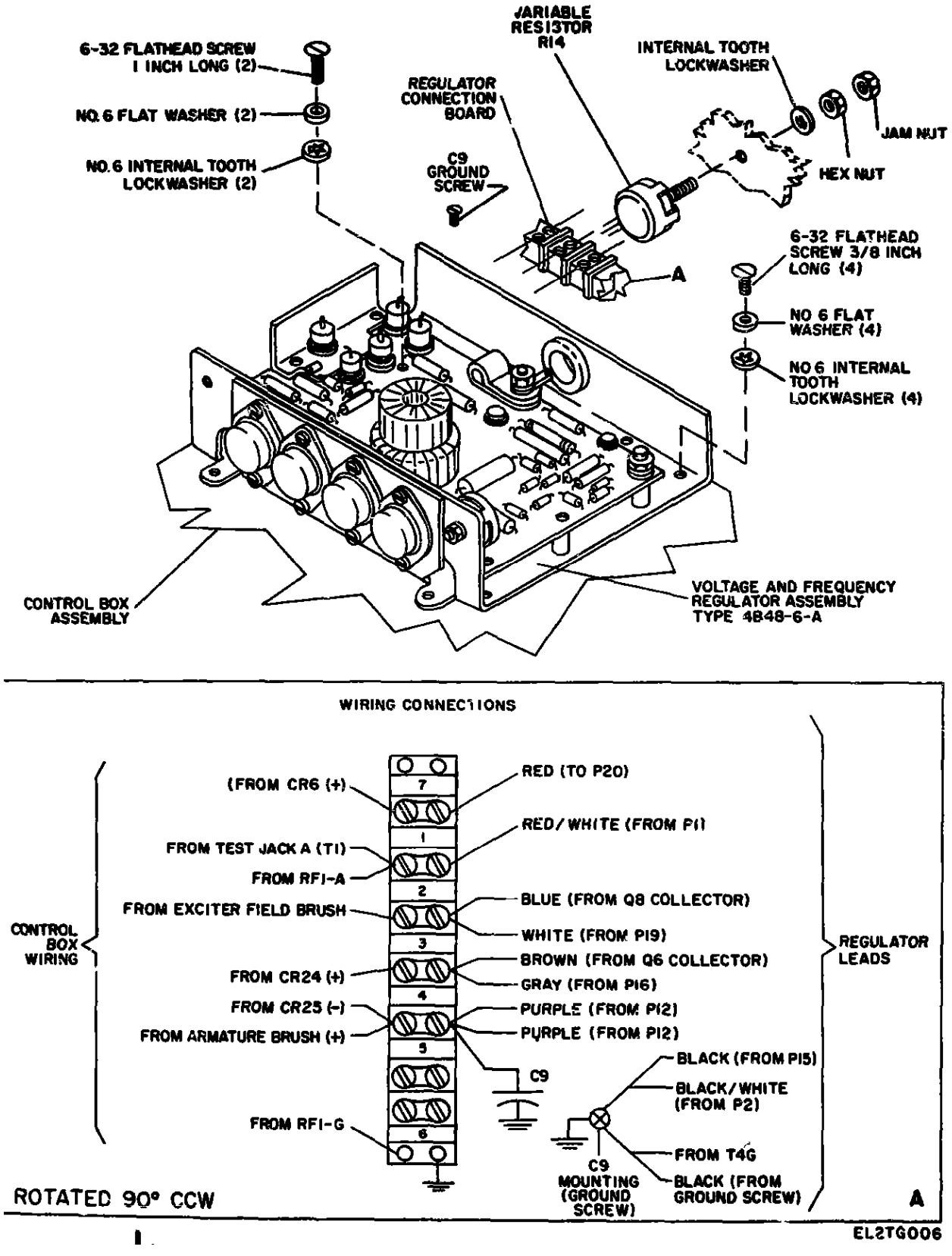


Figure 3-5. Removal and installation of voltage and frequency regulator assembly 4B48-6-A

Table 3-3. Physical Tests and Inspections

Step No	Control Settings: Test Equipment	Control Settings: Equipment Under Test		Test Procedure		Performance Standard
1	N/A	N/A		Inspect exterior and interior for overall cleanliness		No dust grease dirt, or carbon particles on surfaces
2	N/A	N/A	*a.*	Inspect mechanical assemblies for loose or missing screws, bolts, or nuts	*a*	Screws bolts and nuts must be tight with none missing
			b	Inspect ac connector and test points for looseness and damage	*b*	No looseness or damage evident
3	N/A	N/A	*a*	Inspect all components for cracked burned, or otherwise damaged installation	*a*	No cracks burns or other damage evident
			b	Check voltage and frequency regulator assembly for security of mounting	*b*	No looseness evident
			c	Check all leads inside unit for security	*c*	No looseness evident
4	N/A	N/A		Check each ac contact brush in turn for proper condition and seating. Refer to paragraph 3-10		Brushes must be in good condition and seating must be satisfactory Refer to paragraph 3-10

Table 3-4. Voltage and Frequency Test

Step No	Control Settings: Test Equipment	Control Settings: Equipment Under Test	Test Procedure	Performance Standard
1	N/A	N/A	Ensure that all toggle switches on the motor-generator test set are in the OFF position and connect equipment as shown in fig 3-4.	N/A
2	Adjust power supply to 27 5 Vdc on test set D C. VOLTS meter	N/A	Zero all test set meters, if necessary	N/A
3	Set test set controls as follows D C AMMETER RANGE to START A.C AMMETER RANGE to 50 LOAD CONTROL to 0. D C POWER to ON LIVE CIRCUIT switch to ON	N/A		N/A
4	N/A	N/A	Adjust LOAD CONTROL for a reading of 90A on D C AMP meter of test set	Reading on A C VOLTS meter must be 115±6 Vac
5	Adjust power supply to 29 Vdc on test set D C VOLTS meter	N/A	Return LOAD CONTROL to 0, and note indications on A C VOLTS and FREQUENCY meters	Readings on A C VOLTS and FREQUENCY meters must be 115± 6 Vac and 400±10 Hz respectively
6	Adjust power supply to 26 Vdc on test set D C VOLTS meter	N/A	Adjust LOAD CONTROL for a reading of 170A on D C AMP meter of test set NOTE Ensure that reading does not exceed the rating on the data plate	Same as above

3-14. Replacement of Voltage and Frequency Regulator Assembly, Type 4B93-1-A. (fig 3-6)

a Removal

(1) Remove the control box cover

(2) Remove jam nut, hex nut, and internal tooth lock washer and remove variable resistor R23 from control box assembly front panel Cut ties from harness to free leads

(3) Remove the regulator board leads from terminals 1 through 6 and 10, by removing seven screws and lock washers

(4) Remove four screws, flat washers, and lock washers and remove the voltage and frequency regulator assembly from the threaded spacers in the control box assembly

b Installation

(1) Install the regulator board leads to terminals 1 through 6 and 10, by fastening them with seven screws and washers

(2) Check that frequency adjustment has been performed (para 3-5)

(3) Position the voltage and frequency regulator assembly in the control box assembly and secure with four screws, flat washers, and lock washers onto four threaded spacers

(4) **Attach** variable resistor R23 to control box assembly with the internal tooth lock washer and hex nut Loosely install jam nut Attach wires between van- ***able resistor R23*** at terminals 8, 9, and 11 (fig 3-6) Do not tighten jam nut until voltage adjustment has been performed (para 3-5) Tie lead wires ***from van-*** able resistor R23 to wiring harness

(5) Install the control box cover

3-15. Adjustment of Output Frequency (4B93-1-A)

Use the operational test procedure given in paragraph 3-5 to test the output frequency

3-16. Tests and Procedures (4B93-1-A)

Equipment which meets the performance standards in tables 3-3 and 3-4 may be considered acceptable for service Perform each step of the tables in sequence For each step, perform all the actions in the control setting columns and ***then*** perform the specific procedure and verify it against its performance standard If any abnormal actions or readings occur, refer to the troubleshooting procedures listed in table 3-2

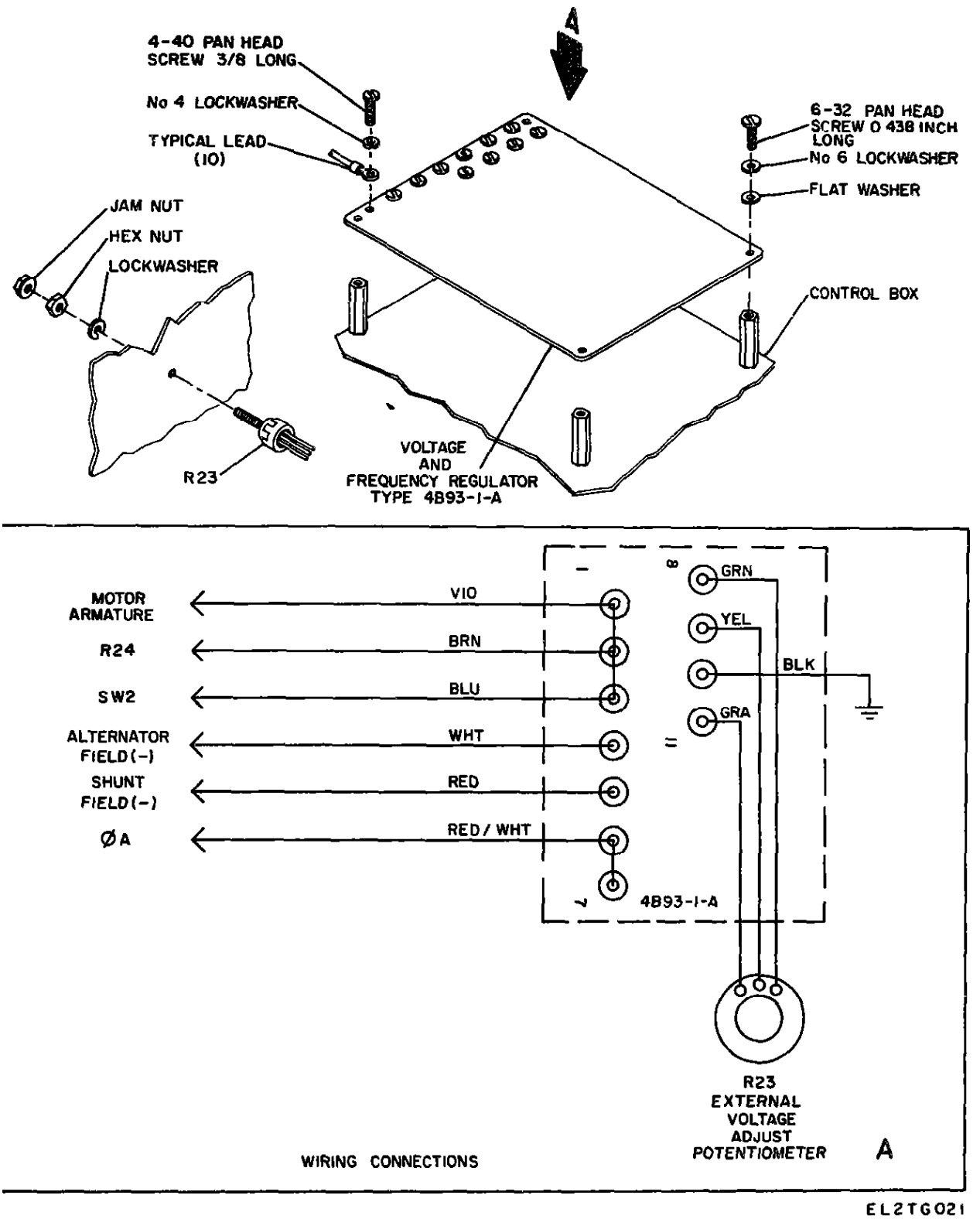


Figure 3-6. Removal and replacement of voltage and frequency regulator assembly 4B93-1-A

CHAPTER 4

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Introduction

The maintenance instructions in this chapter suplement the Direct Support Maintenance procedures outlined in chapter 3 and the organizational maintenance procedures in Tm 11-6125-256-20 The troubleshooting which begins at these levels is expanded here to include actual repair of the motor-generator by replacement of defective parts Except for the armature all repair parts are available to General Support

4-2. Maintenance Guidance

Refer to paragraph 3-2 for an outline of the maintenance schedule for the motor generator

4-3. Tools and Test Equipment

Tools and test equipment needed for general support maintenance of the motor-generator are listed in section III of appendix C (Maintenance Allocation) in Tm 11-6125-256-20

Section II. TROUBLESHOOTING

4-4. General

a Troubleshooting of voltage and frequency regulator assemblies and subsequent repair procedures are given in applicable sections III and III.I of this chapter.

b Troubleshooting of motor generator and control box assembly components consists of the dielectric test given in paragraph 4-25 and the resistance tests given in paragraph 4-5

4-5. Resistance Measurements

With all power off make resistance measurements as follows (fig 4-1 or 4-2.1)

NOTE

All values given are applicable at 68°F (20°C)

a Generator Stator

(1) Measure resistance from terminal A to terminal G

(2) Repeat step (1) for terminals B and D

(3) Repeat step (1) for terminals C and F

(4) Check that the measurements of steps (1) through (3) are between 0 1413 and 0 1627 ohm and that they are within 2 percent of each other

b Generator Exciter Rotor

(1) Remove the ac brush access cover and the ac fan end cover

(2) Disconnect the lead at the No 2 slip ring

(3) Check for continuity between the disconnected lead and terminal 2 of the regulator connection board

(4) Measure the resistance across the slip rings Resistance must be between 2 61 and 3 19 ohms

NOTE

It is not necessary to reconnect the lead at the No 2 slip ring since further disassembly is required

c Motor Stator

(1) Remove the dc brush access covers

(2) Disconnect shunt field return lead at ground brush and the two leads at the positive brush

(3) Check that the contacts of current relay assembly SW1 are open Closed contacts will give false resistance readings If necessary, disconnect leads

(4) Measure resistance across starting series field (positive input terminal to high side of capacitor C12) If necessary, disconnect leads from current relay assembly SW1 Resistance should be between 0 01188 and 0 01452 ohm

(5) Measure resistance across interpole field (high side of capacitor C12 to large terminal lead disconnected from positive brush) If necessary, disconnect leads from current relay assembly SW1 REsistance should be between 0 002250 and 0 002750 ohm

(6) Measure resistance across shunt field (shunt field lead disconnected from ground brush to negative ***side of diode CR24 (4B48-6-A) or red shunt*** field lead disconnected from terminal 5 (4B93-1-A). Resistance should be between 2.628 and 3.212 ohms.

(7) On PU-750()/A only, check diodes CR24 and CR25 by measuring forward and reverse resistances.

NOTE

It is not necessary to reconnect leads since further disassembly is required

d Control Box Assembly Continuity and Resistance Measurements

(1) If necessary, use fig. 4-1 or 4-2. as an aid in making continuity measurement

(2) If it is necessary to check the electrical components within the control box assembly, refer to Section V for electrical test values

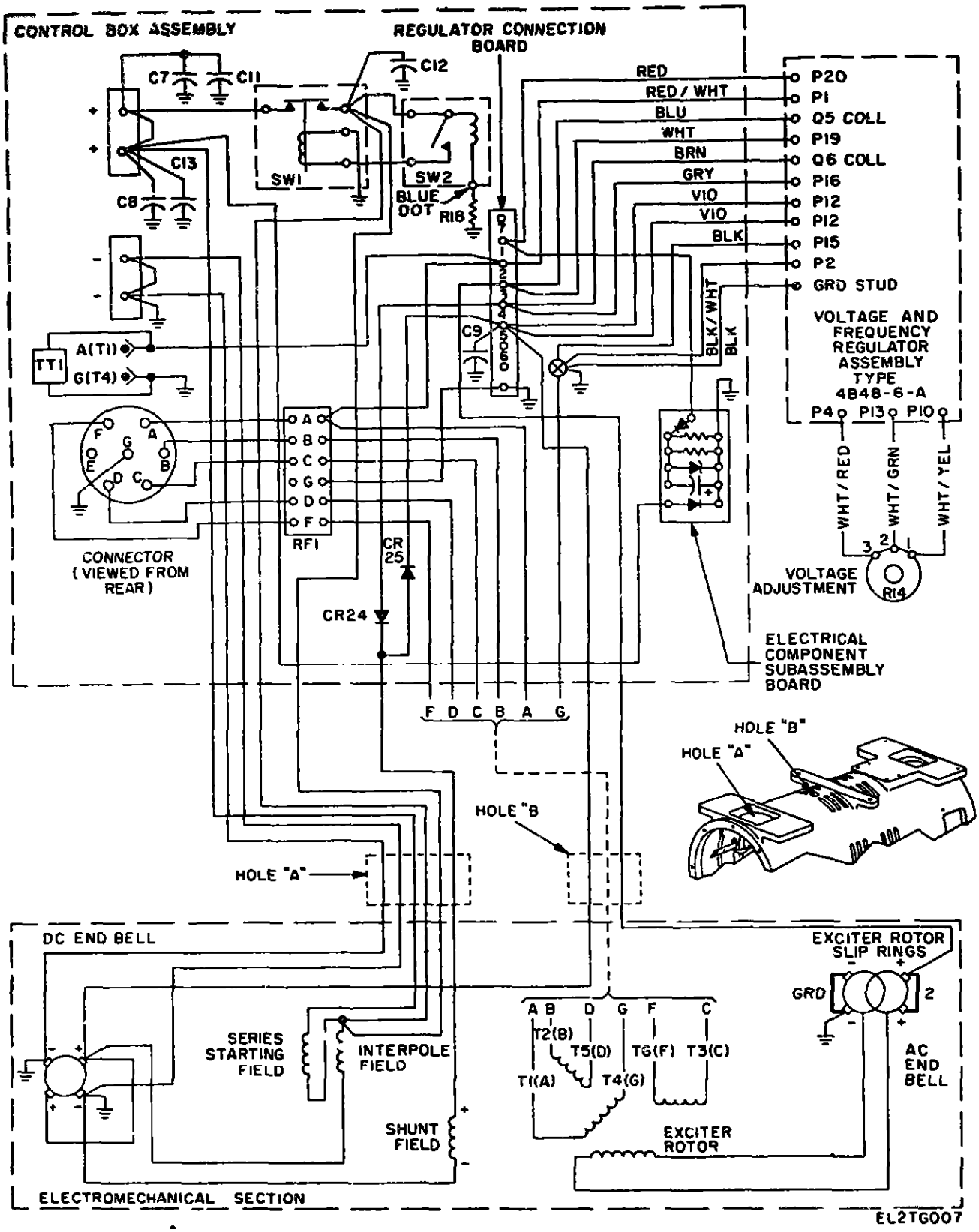


Figure 4-1. Interconnection wiring diagram and motor-generator PU-750()/A

Section III. REPAIR OF VOLTAGE AND FREQUENCY REGULATOR ASSEMBLY 4B48-6-A

4-6. Inspection (fig. 4-5)

a Inspect printed circuit board subassembly (29, fig 4-5) for signs of damage

b Inspect wiring harness (61) leads for breaks and for loose or broken connections Fig. 4-3 shows the wiring connections for the voltage and frequency regulator assembly

c Check adjustable resistors R14 and R15 (14 and 15, fig 4-5), fixed resistors R12 and R3 (20), and heat-sink mounted transistors Q3 through Q6 (11 and 12) for signs of overheating or other damage

4-7. Test Setup for Troubleshooting Voltage and Frequency Regulator Assembly

a Install the voltage and frequency regulator assembly in known good ***motor-generator*** Pu-750( )/A as described in paragraph 3-11b

b Connect the motor-generator for testing as described in table 3-4, using an input voltage of 28 volts dc and no load on the generator If the motor speed is in excess of the 400-Hz speed to a point where the motor attempts to run away, turn off power and perform the following procedure

(1) Connect the shunt field slide wire resistor as shown in fig. 4-2

(2) Connect the frequency regulator lead disconnected from the regulator connection board to ground through a 30-ohm 300-watt resistor (This resistor will place a shunt field load on the regulator)

(3) Reapply the 28-volt dc input and adjust the shunt field slide wire resistor for a 400-Hz output

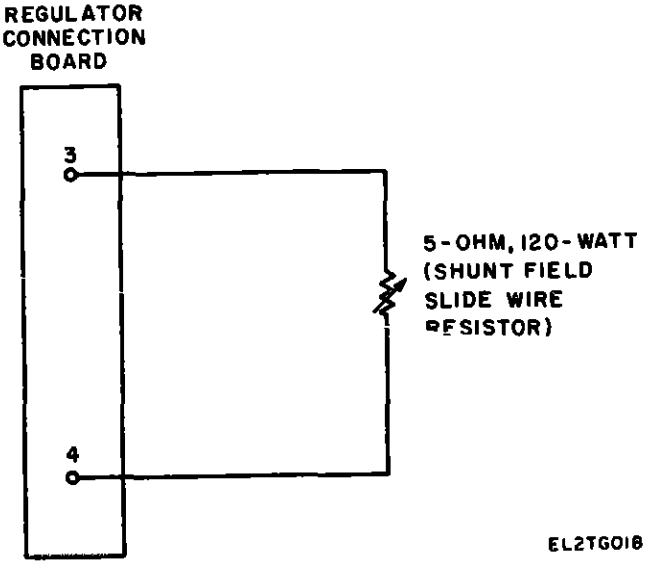


Figure 4-2. Shunt field wire resistor connections for voltage and frequency regulator assembly 4B48-6-A.

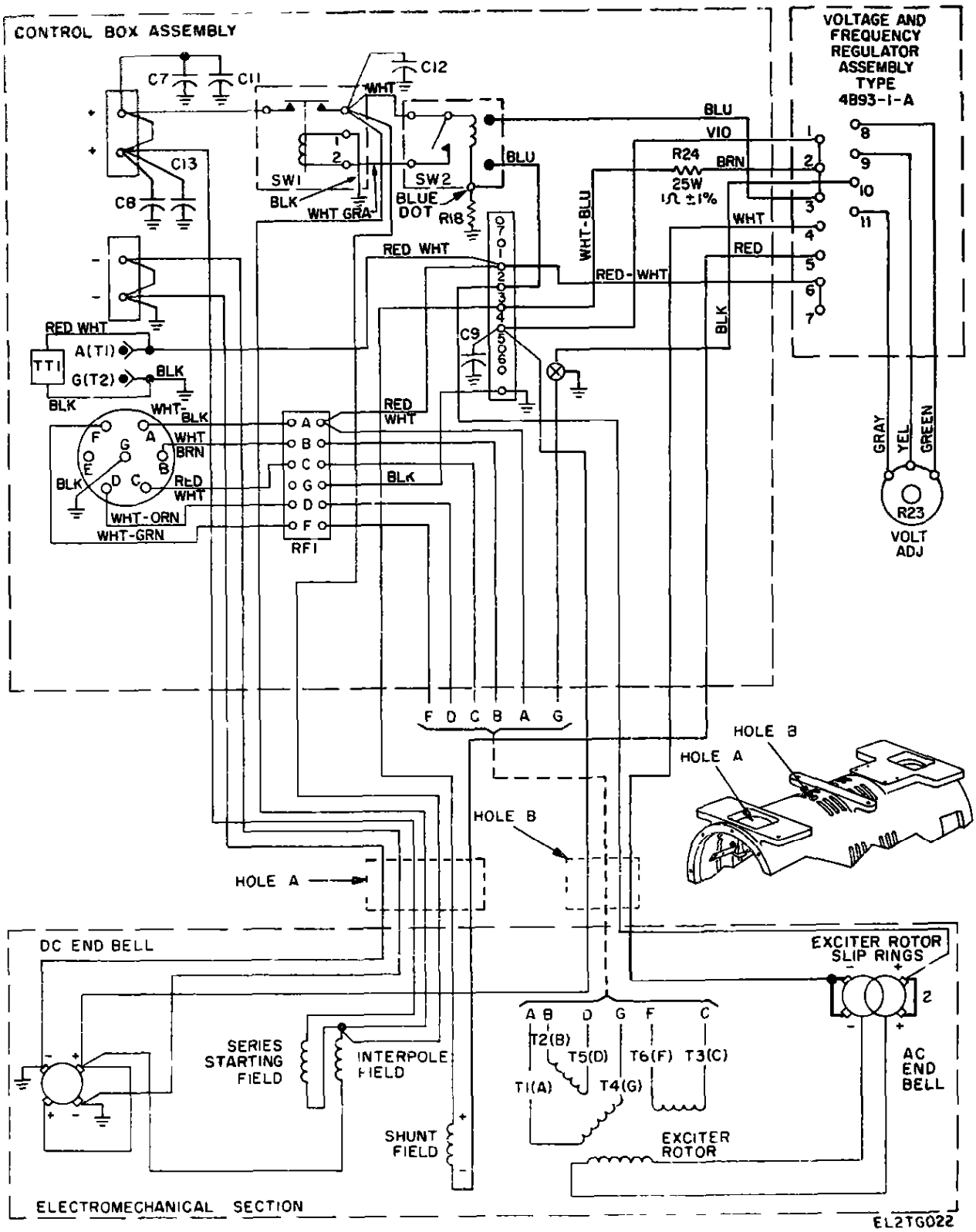


Figure 4-2.1. Interconnection wiring diagram for motr-generator PU-750A/A

c Check that the following regulator input voltage are present at the regulator connection board

(1) 16.3 volts dc between terminal 7 and ground

(2) At least 27 4 volts dc across the armature, measured at terminal 4 to ground

(3) 115 to 117 volts ac from terminal 1 to ground (residual magnetic buildup voltage)

d To ensure that an operational voltage and frequency regulator assembly has not been returned for General Support Maintenance make the following check

(1) Reduce the dc input to 27 5 volts

(2) While observing the phase A to neutral output voltage rotate the voltage adjust potentiometer (fig 3-1) fully counterclockwise and then fully clockwise If the output voltage can be varied between the limits of 110 and 120 volts the voltage regulation circuits are probably operational, If the output voltage range is obtained, adjust the output to 116 volts and perform step (3) If the range is not obtained, make troubleshooting voltage measurements as described in paragraph 4-8.

(3) Rotate the frequency adjustment potentiometer fully counterclockwise and then fully clockwise while observing the phase A to neutral output frequency and voltage If the output frequency can be varied between the limits of 390 and 410 Hz while the ac output remains approximately 116 volts, the frequency regulation circuits are probably operational However, to prevent an assembly with an intermittent problem from being returned to service, subject the known good motor-generator with the questionable regulator assembly to general support commutation and spin tests If these tests are satisfactorily performed, the assembly may he returned to service If incorrect results are obtained, make troubleshooting voltage measurements as described in paragraph 4-8

FROM		TO		AWG** WIRE SIZE	COLOR
CONNECTION	TERMINATION*	CONNECTION	TERMINATION*		
Q3-C	T	R12-1	PT/S		White/Brown
Q3-C	T	Q5-B	PT		Orange
Q3-B	PT	P17	PT/S		White/Violet
Q3-E	PT	P11	PT/S		White/Blue
Q5-C	LT	RCB-2	T	18	Blue
Q5-E	PT	P14	PT/S	18	Yellow
Q6-C	LT	RCB-3	T	18	Brown
Q6-B	PT	Q4-C	T		White/Gray
Q6-E	PT	P14	PT/S	18	Green
Q4-C	T	R13-1	PT/S		Orange/White
Q4-B	PT	P18	PT/S		Yellow/Red
Q4-E	PT	P11	PT/S		Blue/White
R14-1	LS	P10	PT/S		White/Yellow
R14-2	LS	P13	PT/S		White/Green
R14-3	LS	P4	PT/S		White/Red
R15-1	LS	P9	PT/S		Brown/White
R15-1	LS	R15-2	LS		Brown/White
R15-3	LS	P3	PT/S		White/Orange
Ground	T	C9-Ground Screw	T		Black
R12-2	SC	Ground	T		
R13-2	Sc	Ground	T		
P1	PT/S	RCB-1	T		Red/White
P2	PT/S	C9-Ground Screw	T		Black/White
P12	PT/S	RCB-4	T	18	Violet
P12	PT/S	RCB-4	T	18	Violet
P15	PT/S	C9-Ground Screw	T	18	Black
P16	PT/S	RCB-3	T	18	Gray
P19	PT/S	RCB-2	T	18	White
P20	PT/S	RCB-7	T		Red

* Termination Definitions

LS - Long Strip
LT - Large lug terminal
PT - Push-on terminal
PT/S - Push-on terminal (soldered in place)
RCB - Regulator connection board
SC - Soldered connection
T - Terminal lug

** Unless otherwise specified all wire is AWG size 22

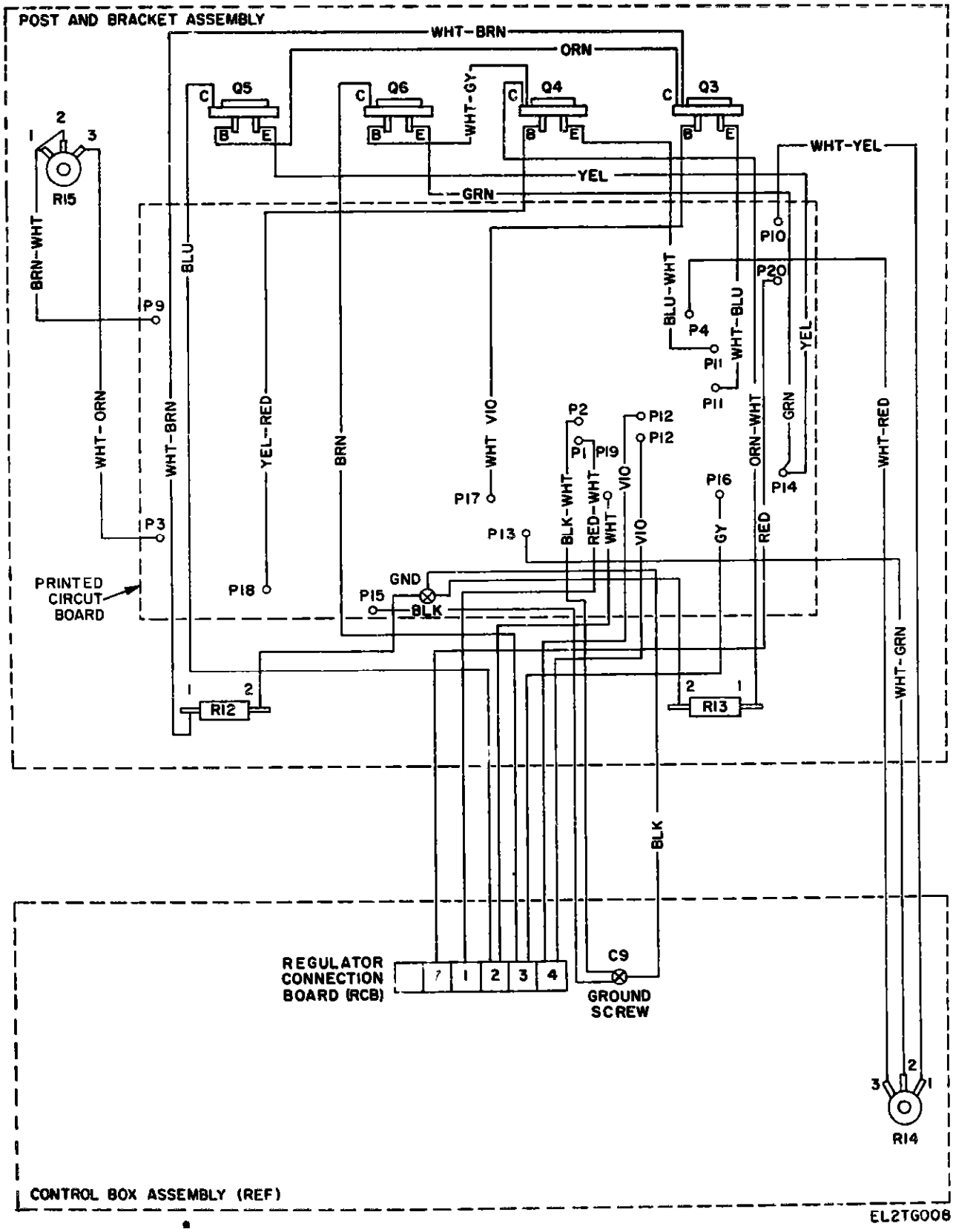


Figure 4-3. Interconnection wiring diagram for voltage and frequency regulator assembly 4B48-6-A

4-8. Troubleshooting Voltage Measurements

A pointed probe will be required to puncture the protective coating when making voltage, continuity, and resistance checks. After repairs are completed, this coating must be restored in accordance with paragraph 4-10 step f

a Voltage Regulation Circuits **Check the voltage regulation circuits as follows**

(1) Measure the voltage across terminals T1-7 and T1-8 The voltage should be approximately 0 042 volt ac If the voltage is too low, but the input to transformer (terminal 1 to ground) is as specified in paragraph 4-7, ***step c(3)*** check for shorted rectifier CR1 or CR2 or shorted capacitor C1 If these components are functioning properly check transformer T1 for shorts Resistance from T1-1 to T1-2 should be between 3917 and 4887 ohms Resistance from T1-7 to T1-9 should be between 1149 2 and 1554 8 ohms

(2) Measure the voltage across capacitor C1 The voltage should be approximately 0 37 volt dc If the voltage is too low, check for open rectifier CR1 or CR2 or open capacitor C1

(3) If the voltage measured in step (2) is as specified measure the base-to-collector voltage for transistor Q1 This is the voltage regulation control voltage and should be approximately 0 38 volt dc with the emitter positive with respect to the base In addition measure the emitter-to-ground voltage The voltage should be approximately ***0 76 volts*** dc If either voltage is incorrect check resistors R1 R2, R3, and R14 Check resistance of diodes CR3 and CR4 in both directions to ensure that they are not open or shorted Check that breakdown voltage of Zener diode CR5 is 8 55 to 9 55 volts dc at 7 5 milliaperes and that transistor Q1 is not shorted

(4) If the base-to-collector voltage for transistor Q1 measured in step (3) is as specified check transistors Q1 Q3, and Q5 and resistors R9, R10, R12 Check resistance of diodes CR16 through CR19 and CR21 in both directions to ensure that they are not open or shorted

b Frequency ***Regulation*** Circuit If the voltage regulation circuits are functioning properly, check frequency regulation circuits as follows

(1) Measure the voltage across terminals T1-3 and T1-4 (28 volts ac), and across terminals T1-5 and T1-6 ***(65*** 8 volts ac) If either voltage is too low, check for shorted associated diodes CR8 through CR15 If diodes are not shorted, check for shorted transformer T1 Resistance from T1-3 to T1-4 and from T1-5 to T1-6 should be 1489 2 to 2014 8 ohms

(2) If the voltage in step (1) is correct, measure the voltage across resistor R6 The voltage should be approximately 12 5 volts dc If the voltage is incorrect, check diodes CR8 through CR11, resistors R4, R6, and R15, and capacitor C4

(3) If the voltage in step (2) is correct, measure the emitter-to-base voltage across transistor Q2 This is the frequency regulator control voltage and should be approximately 0 65 volt dc with the transistor cut off (emitter negative with respect to base) If the voltage is incorrect, check capacitor C3 C4, C6, inductors L1 and L2 resistor R6, and diodes CR7, CR12 through CR15 and CR26 ***and transistor Q2***

(4) If the voltage in step (3) is correct check transistors Q4 and Q6 resistors R11 and R13 and diode CR20

4-9. Removal and Repair

a Shut off dc input power

b Remove the voltage and frequency regulator assembly from the motor-generator as described in paragraph 3-11a

c Remove self-locking nuts (21 fig 4-5) screws (19, 25 and 26), lock washers (22), washers (23) loop clamp (28) electrical lead (27), and sleeve spacers (24)

d Without stressing wiring harness (61) leads, position printed circuit board subassembly (29) so that components can be unsoldered

e Check the suspected component(s) Section VI gives the electrical component test values for the voltage and frequency regulator assembly components

f Check to see that replacement parts are available To replace the faulty parts proceed as follows

(1) Using a 23- to **37** 5-watt pencil-type soldering iron, heat and peel off the polyurethane coating from the component to be replaced

(2) Using the soldering iron and a vacuum solder removing tool remove solder from the component leads and remove the component leads Where necessary use an appropriate heat sink to prevent damage to adjacent components

CAUTION

Do not clean printed circuit board assembly (29) unless absolutely necessary as cleaning solvents may damage coating

(3) Using the old component as a guide form and cut the replacement component leads as required After positioning the component or leads in place solder securely as follows

NOTE

Equivalent soldering materials may be used

(a) Use the 23- to 37 5-watt soldering iron Be sure the tip is clean, free from oxides and coated with a film of solder

(b) Use Kester solder 66-37 (3/64-inch diameter core) and Kester No 1544 liquid flux (Kester Solder Company, Newark New Jersey) The solder consists of 63 percent tin and 37 percent lead and has a melting temperature of 357°F (181°C)

(c) Clean the joints with Lonco flux remover (London Chemical Co, Melrose Park Illinois)

4-10. Replacement of Regulator Board

a Secure printed circuit board assembly (29, fig 4-5) to bracket and post assembly (84) with self-locking nuts (21), screws (19, 25, and 26), lock washers (22) washers (23), and sleeve spacers (24) Be sure that electrical lead (27) is placed onto center screw (26) before installing loop clamp (28)

b Repeat the procedures of paragraph 4-1 If the measurements of paragraph 4-7, steps d(1) through d(3), are satisfactorily made, the assembly has been repaired satisfactorily

c Turn off dc input power

d Remove the voltage and frequency regulator assembly from the motor-generator as described in paragraph 3-11a

e Remove self-locking nuts (21, fig 4-5) screws (19 25 and 26), lock washers (22), washers (23), loop clamp (28) electrical lead (27) and sleeve spacers (24)

f With the exception of the two 1/2-inch diameter mounting holes at the center of the board the adjustment shafts and bushings for resistors R14 and R15 and the bottom of the post and bracket assembly spray the voltage and frequency regulator assembly with Hysol PC 28 STD urethane coating (Hysol Division of the Dexter Corporation Olean **NY)** as follows

WARNING

Contents of spray can are under pressure and flammable Do not spray near fire, flame or heated surfaces Do not store can at a temperature above 120°F (48 8°C) Avoid breathing of vapors prolonged contact with the skin contact with open breaks in the skin and ingestion Wash hands thoroughly after handling and before eating and smoking

(1) Shake spray can a few times to completely mix material in spray can

(2) While spraying, hold spray can approximately 6 inches from area to be srayed

(3) Allow coating to cure for a minimum of 4 hours at room temperature before handling sprayed surfaces Allow 24 hours at room temperature for complete curing

g Assemble printed circuit board subassembly to bracket and post assembly (84 fig 4-5) with self-locking nuts (21) screws (19 25 and 26) lock washers (22) washers (23) and sleeve spacers (24) Be sure that electrical lead (27) is placed onto center screw (26) before installing loop clamp (28)

Section III.1 REPAIR OF VOLTAGE AND FREQUENCY REGULATOR ASSEMBLY 4B93-1-A

4-10.1. Inspection

a Inspect printed wiring board (43, fig 4-5 1) for signs **of** damage

b Inspect wiring for loose or broken connections Fig 4-3 1 shows the wiring connections for the voltage and frequency regulator assembly

c Check variable resistors R5 and R23 (13 and 1, fig 4-5 1) and heat-sink mounted transistors Q6 and Q11 (17) for signs of overheating or other damage

4-10.2. Test Setup for **Troubleshooting Voltage and Frequency Regulator Assembly**

a Install the voltage and frequency regulator assembly in a known good motor-generator PU-750A/A as described in paragraph 3-14b

b Connect the motor-generator for testing as described in table 3-4, using an input voltage of 28 volts dc and no load on the generator If the motor speed is in excess of the 400-Hz speed to a point where the motor attempts to run away, turn off power and perform the following procedure

(1) Connect the shunt field slide wire resistor as shown in fig *4-3 2*

(2) connect terminals 5 and 10 of the voltage and frequency regulator assembly to ground through a 3 0-ohm, 300-watt resistor (This resistor will place a shunt field load on the regulator)

(3) Reapply the 28-volt dc input and adjust the shunt field wire resistor for a 400-Hz output

c Check that the following regulator input voltages are present

(1) At least 27 4 volts dc across the armature, measured at terminal 4 to ground

(2) 115 to 117 volts ac from terminal 1 to ground (residual magnetic buildup voltage)

d To ensure that an operational voltage and frequency regulator assembly has not been returned for General Support Maintenance, make the following check

(1) Reduce the dc input to 27 5 volts

(2) While observing the phase A to neutral output voltage, rotate the voltage adjust potentiometer (fig 3-1) fully counter-clockwise and then fully clockwise If the output voltage can be varied between the limits of 110 and 120 volts, the voltage regulator circuits are probably operational If the output voltage range is obtained, adjust the output to 116 volts and perform step (3) If the range is not obtained, make troubleshooting voltage measurements as described in paragraph 4-10 3

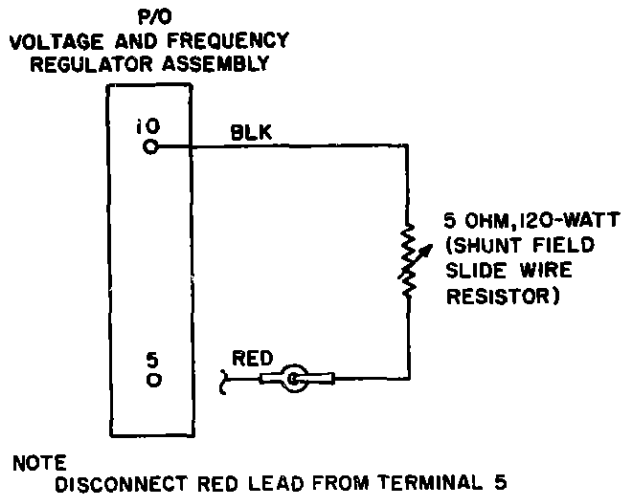


Figure 4-3.1. Shunt field slide wire resistor connections for voltage frequency regulator assembly 4B93-1-A

(3) Rotate the frequency adjustment potentiometer fully counterclockwise and then fully clockwise while observing the phase A to neutral output frequency and voltage If the output frequency can be varied between the limits of 390 and 410 Hz while the ac output remains approximately 116 volts, the frequency regulation circuits are probably operational However, to prevent an assembly with an intermittent problem from being returned to service, subject the known good motor-generator with the questionable regulator assembly to general support commutation and spin tests If these tests are satisfactorily performed, the assembly may be returned to service If incorrect results are obtained, make troubleshooting voltage measurements as described in paragraph 4-10 3

4-10.3. Troubleshooting Voltage Measurements

A pointed probe will be required to puncture the protective coating when making voltage checks After repairs are completed, this coating must be restored in accordance with paragraph 4-10 5, step e

NOTE

All measurements are to be made with a 28-volt dc input and a 115-volt 400-Hz ac no-load output

a Voltage Regulation Circuits Check the voltage regulation circuits as follows

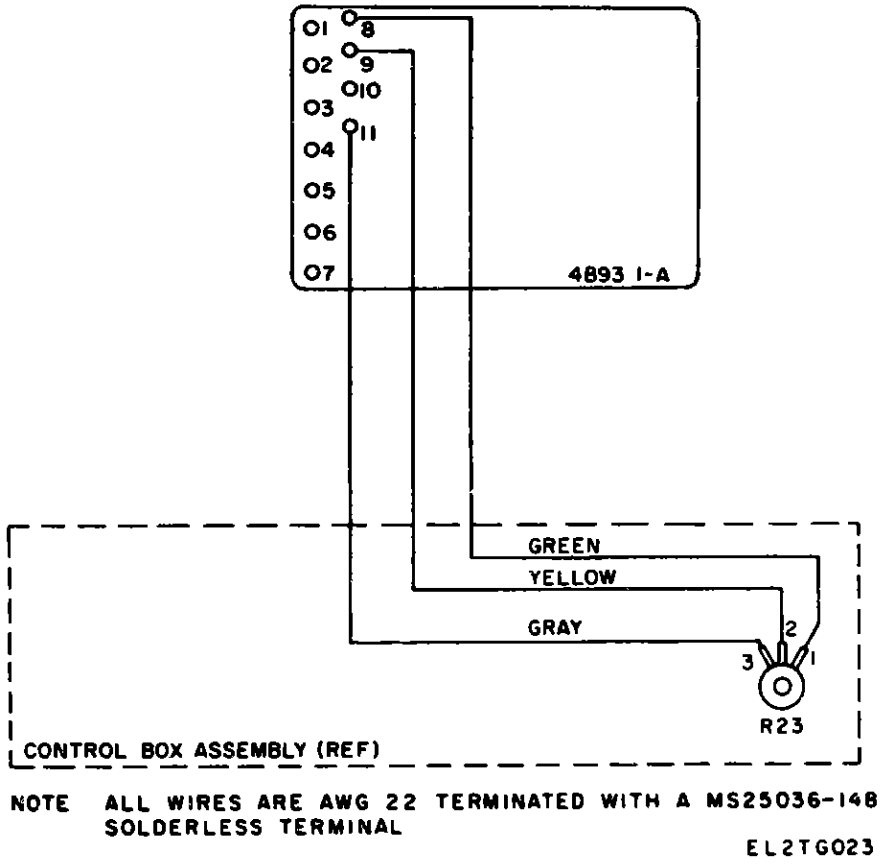


Figure 4-3.2. Interconnection wiring diagram for voltage and frequency regulator assembly 4B93-1-A

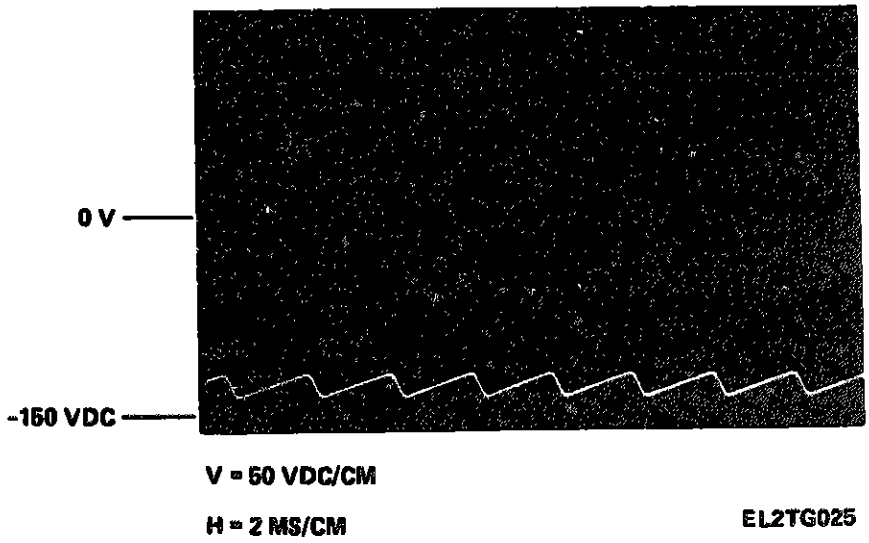


Figure 4-3.3. Typical waveshape across capacitor C5

NOTE

In the following voltage measurements, the typical waveshapes given are for a normal operating regulator During troubleshooting, while the ac output is below 120 volts ac (until the problem is corrected), the measurements obtained will be similar to those shown, but at a reduced amplitude When the problem is localized to a particular circuit, use fig. FO-2 1 as an aid in localizing the fault to a component within this circuit

(1) **Measure** the voltage across capacitor C5 The voltage should be as shown in fig 4-3 3 If the voltage **is not as** specified, check diode CR11, resistor R24, and capacitor C5 for a faulty component

(2) If the waveshape measured in step (1) indicates that diode CR11 and associated components are functioning normally, make measurements at the base and collector of transistor Q9 If the measurements are not approximately as shown in fig 4-3 4, localize the failure within this circuit

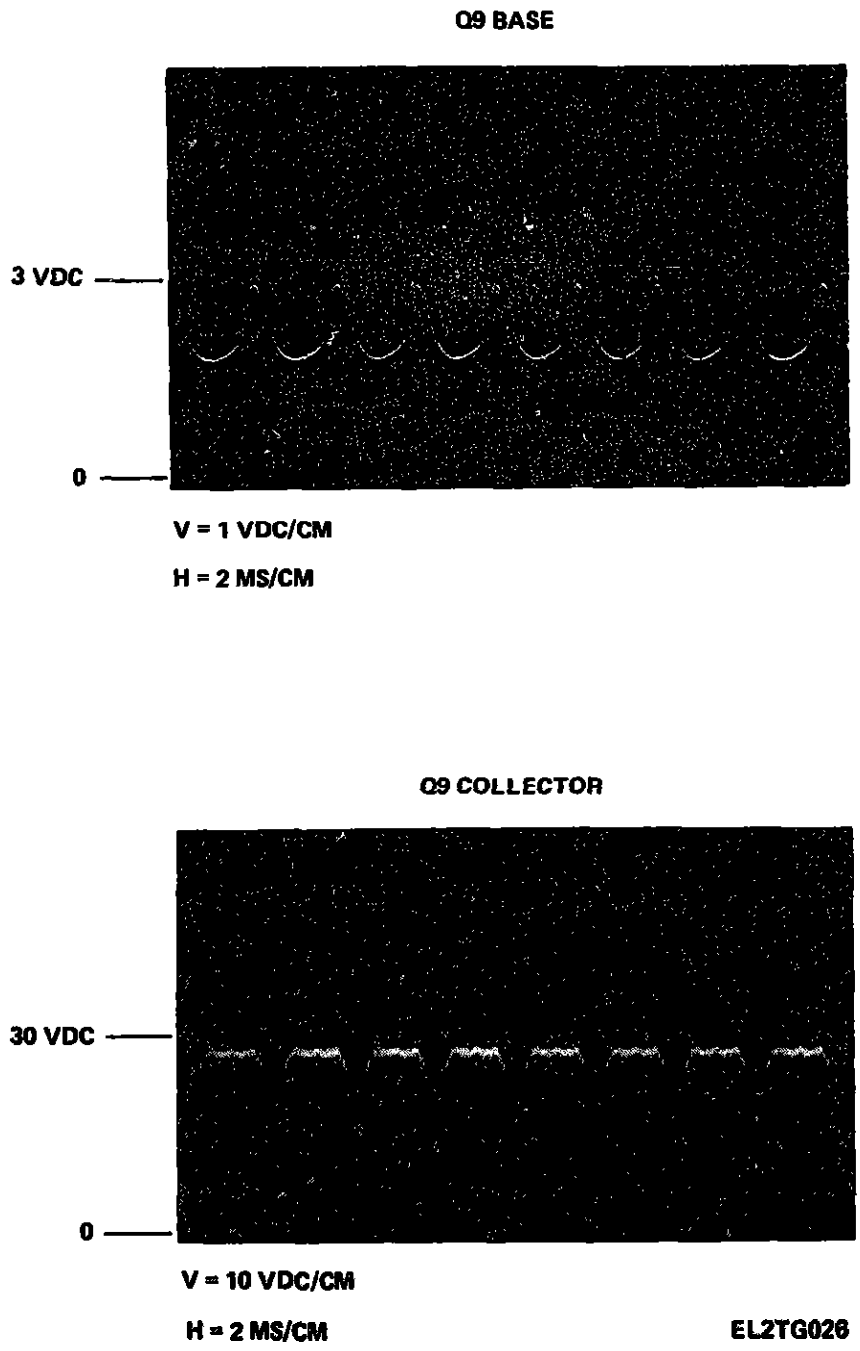


Figure 4-3.4. Typical waveshape at transistor Q9

(3) If the waveshapes measured in step (2) indicate that transistor Q9 and associated components are functioning normally, make measurements at the base and collector of transistor Q7 If the measurements are not approximately as shown in figure 4-3 5, localize failure within this circuit

(4) If the waveshapes measured in step (3) indicate that transistor Q7 and associated components are functioning normally, make a measurement across capacitor C4 If the measurement is not approximately **as shown in fig 4-3** 6, check diode CR9 and resistors R20 and R19 for a faulty component

(5) If **the waveshapes measured in** step (4) indicates that capacitor C4 and associated components are functioning normally, make measurements at the base and collector of transistor Q8 If the measurements are not approximately as shown in fig 4-3 7, localize failure within this circuit.

(6) If the waveshapes measured in step (5) indicate that transistor Q8 and associated components are functioning normally, make measurements at the base collector of transistor Q11 If the measurements are not approximately as shown in fig 4-3 8, localize **failure within this circuit**

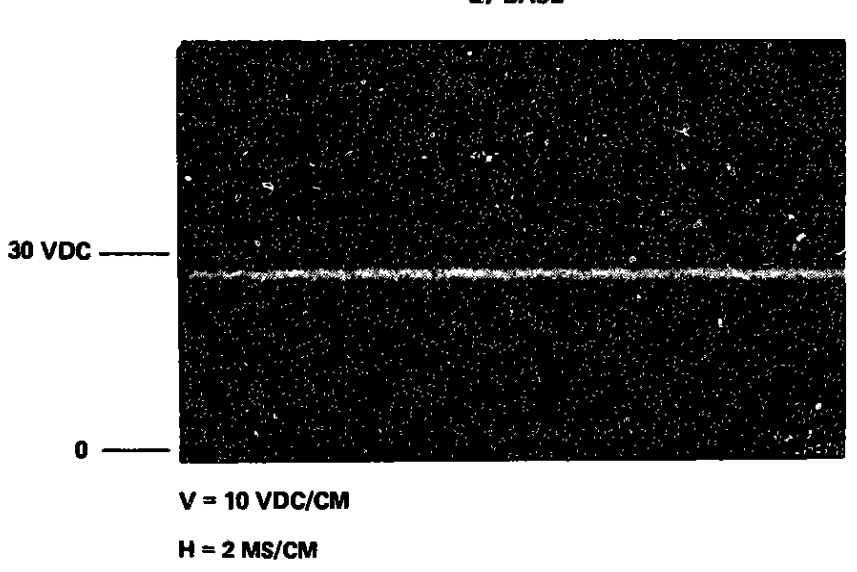


Figure 4-3.5. Typical waveshapes at transistor Q7

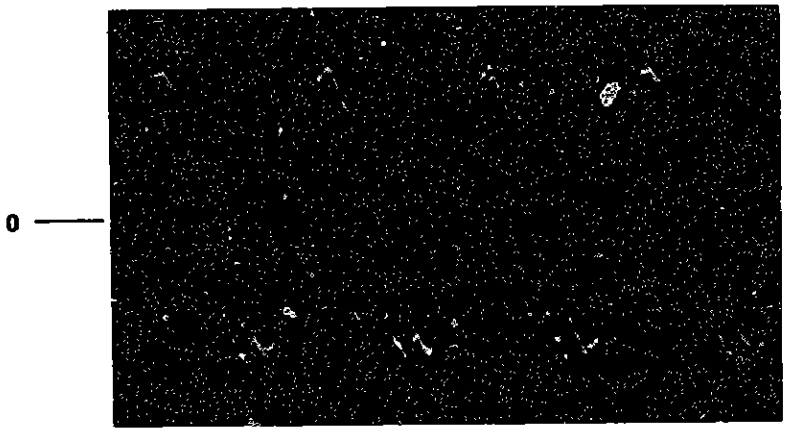


Figure 4-3.6. Typical waveshape across capacitor C4

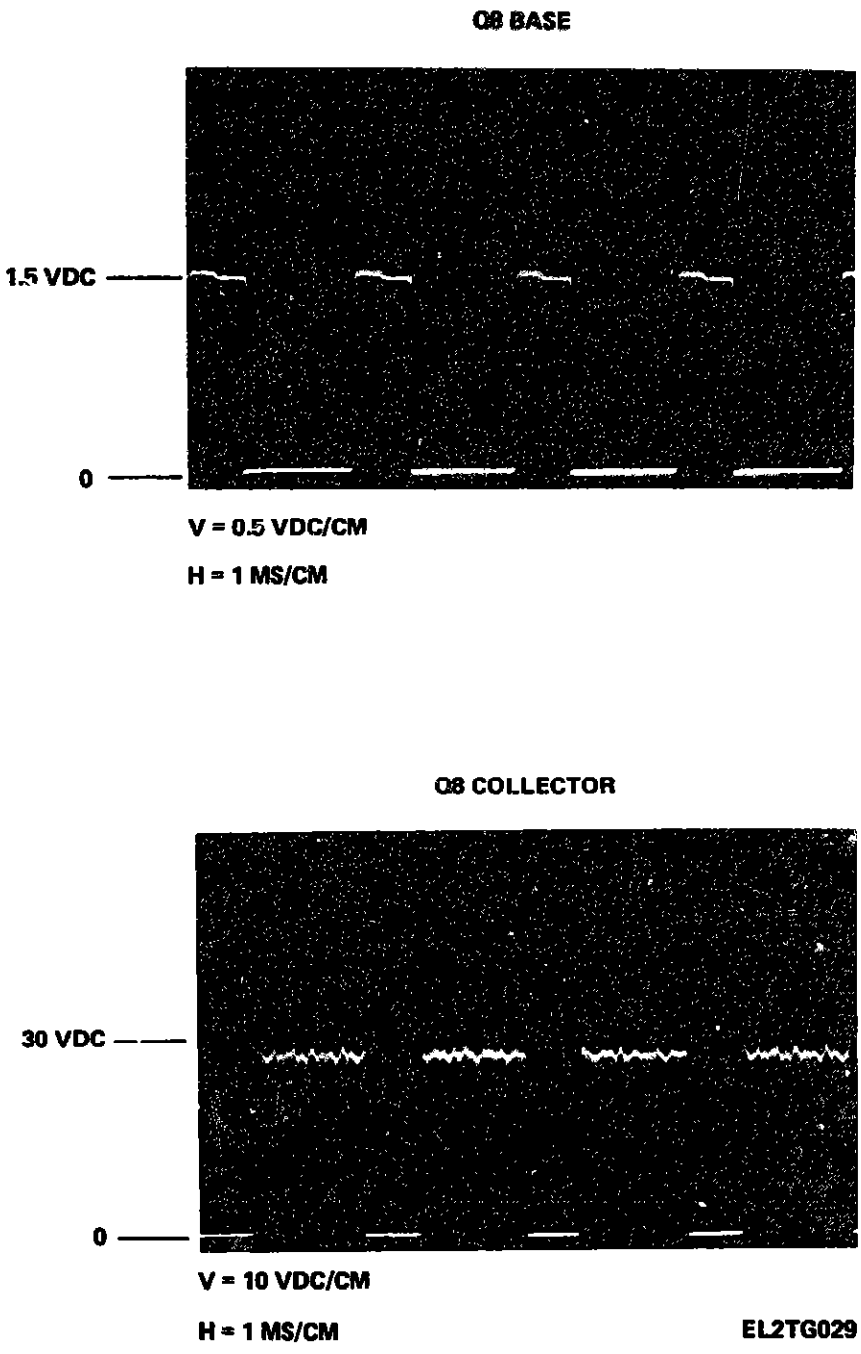


Figure 4-3.7. Typical waveshapes at transistor Q8

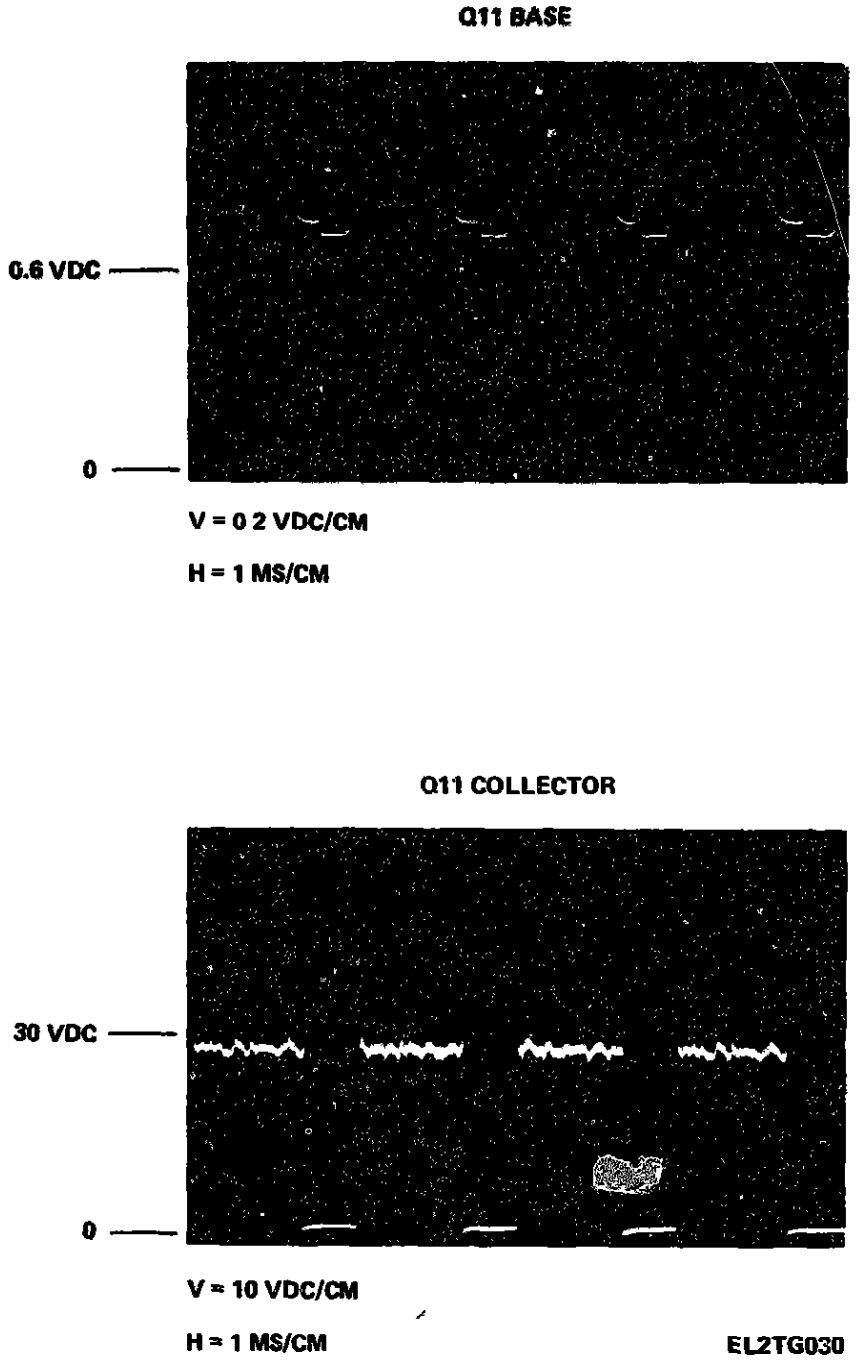


Figure 4-3.8. Typical waveshapes at transistor Q11

b Frequency Regulation Circuit If the voltage regulation circuits are functioning properly, check frequency regulation circuits as follows

NOTE

In the following voltage ***measurements, the*** typical waveshapes given are for a normal operating requlator During troubleshooting, while the frequency is incorrect (until the problem is corrected), the measurements obtained will be similar to those shown, but at a reduced amplitude When the problem is localized to a particular circuit, use fig FO-2 1 as an aid in localizing the fault to a component within this circuit

(1) Measure the voltage at the junction of resistors R7 and R17 The voltage should be as shown in fig. 4-3 9 If the voltage is not as specified, **check** diodes CR2 through CR5 for a faulty component.

(2) If the waveshape measured in step (1) indicates that diodes CR2 through CR5 are functioning normally, make measurements at the base and collector of transistor Q1 If the measurements are not approximately as shown in fig 4-3 10 localize the failure within this circuit

(3) If the waveshapes ***measured in*** step (2) indicate that transistor Q1 and associated components are functioning normally, measure the voltage across capacitor C1 If the measurement is not approximately as shown in fig 4-3 11 localize failure within this circuit

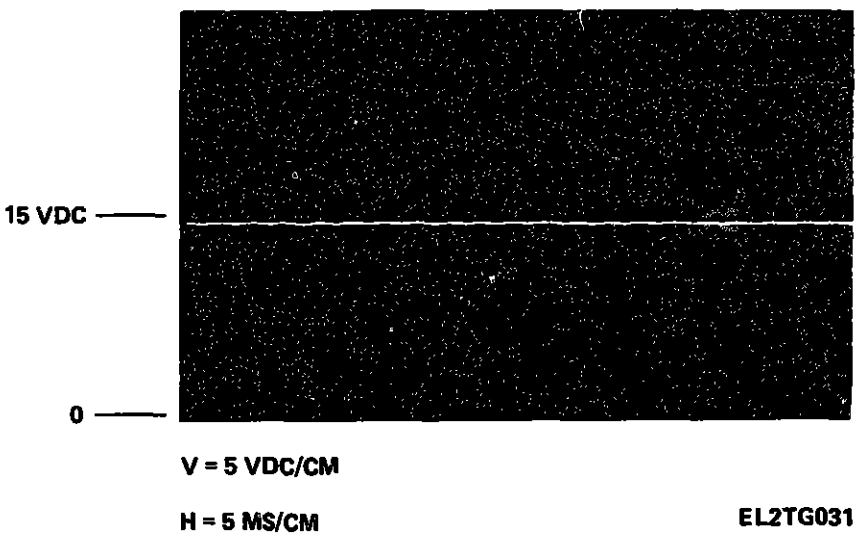


Figure 4-3.9. Typical waveshape at the junction of resistors R7 and R17

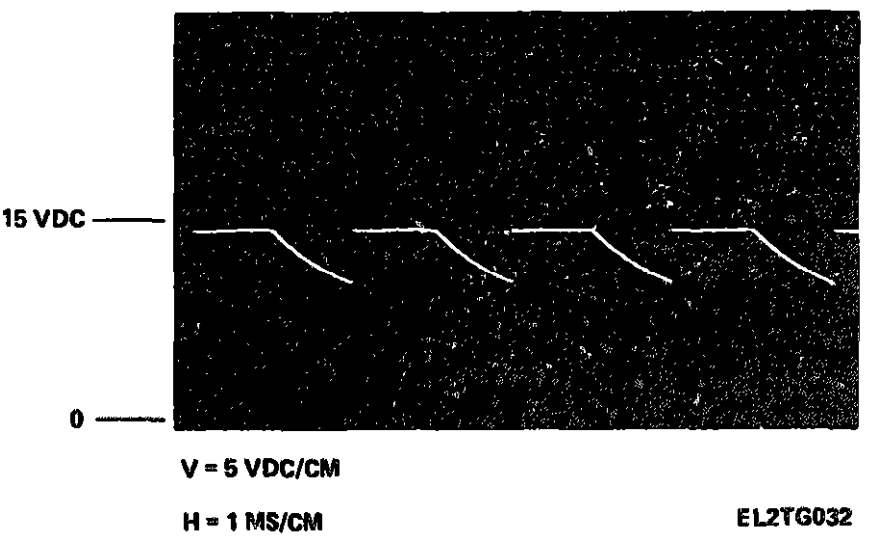


Figure 4-3.10. Typical waveshape at the base of transistor Q1

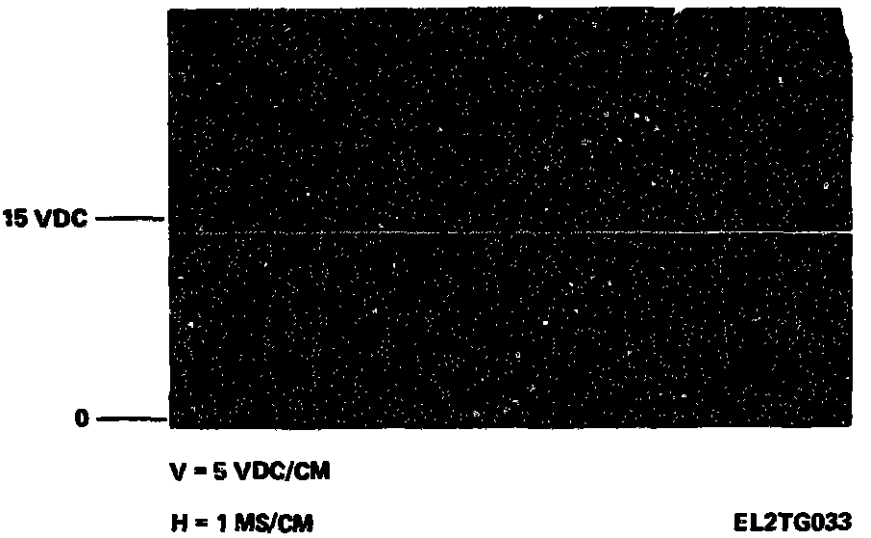


Figure 4-3.11. Typical waveshape across capacitor C1

(4) If the waveshapes measured in step (3) indicate that capacitor C1 **and** associated components are **functioning** normally, make measurements at the base and collector of transistor Q2 If the measurements are not approximately as shown in fig 4-3 12, localize failure within this circuit

(5) If the waveshapes measured in step (4) indicate that transistor Q2 and associated components are functioning normally, make measurements at the base **and** collector of transistor Q3 If the measurements are not approximately as shown in fig. 4-3 13, localize failure within this circuit

(6) If the waveshapes measured in step (5) indicate that transistor Q3 and associated components are functioning normally make measurements at the base collector of transistor Q4 If the measurements are not approximately as shown in fig 4-3 14, localize failure within this circuit

(7) If the waveshapes measured in step (6) indicate that transistor Q4 and associated components are functioning normally, make measurements at the base collector **of** transistor Q5 If the measurements are not approximately as shown in fig 4-3 15, localize failure within this circuit

(8) If the waveshapes measured in step (7) indicate that transistor Q5 and associated components are functioning normally, make measurements at the base collector of transistor Q6 If the measurements are not approximately as shown in fig 4-3 16, localize failure within this circuit

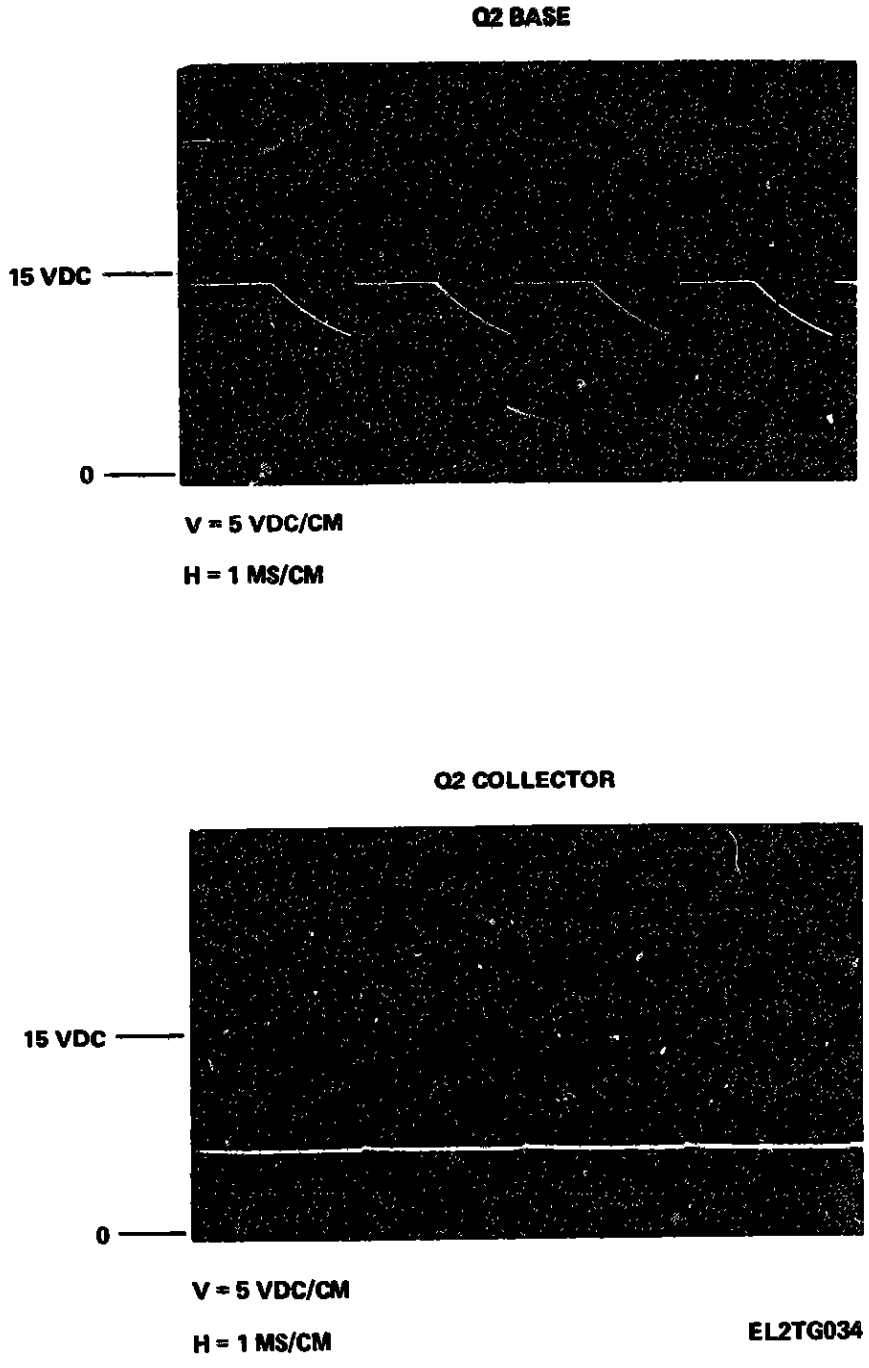


Figure 4-3.12. Typical waveshapes at transistor Q2

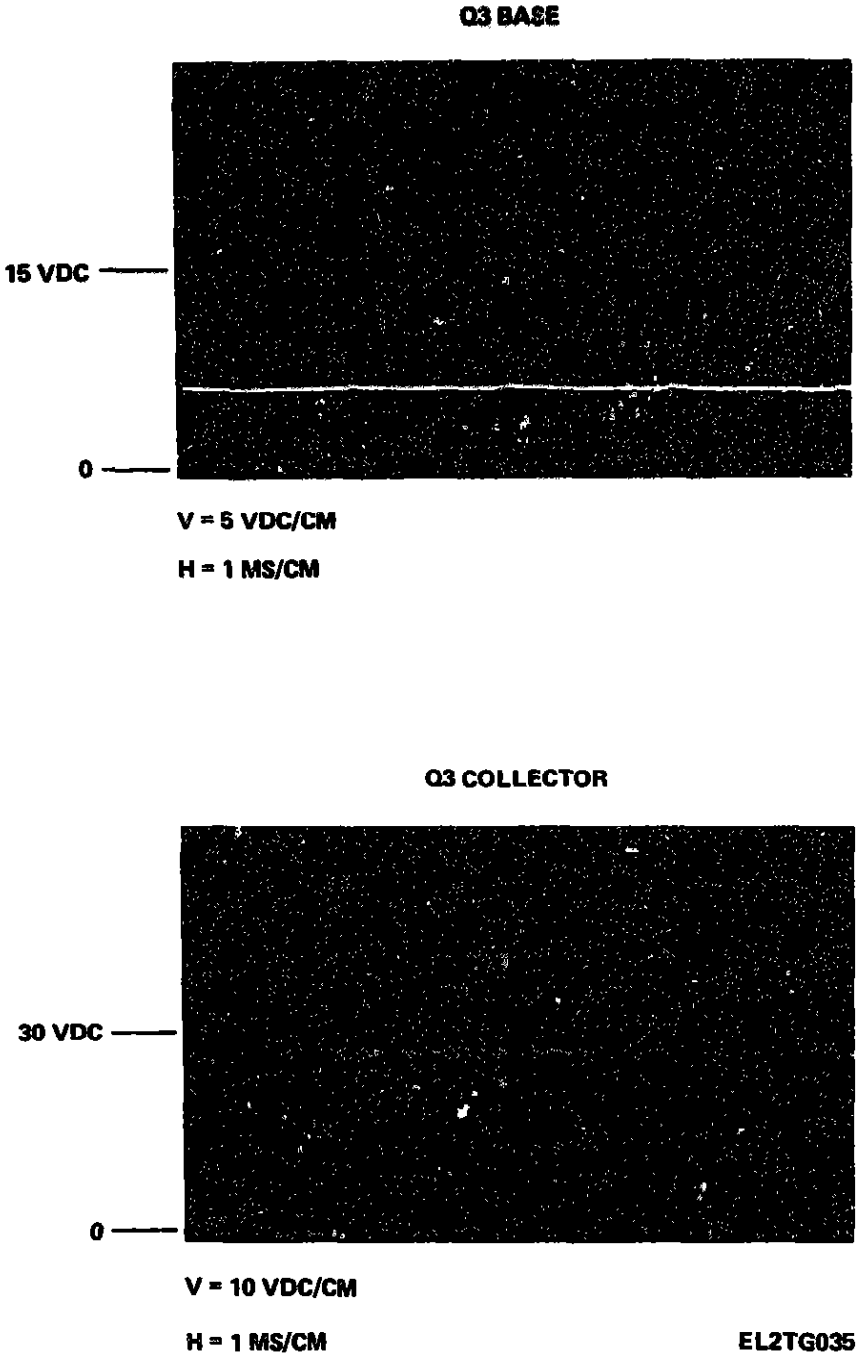


Figure 4-3.13. Typical waveshapes at transistor Q3

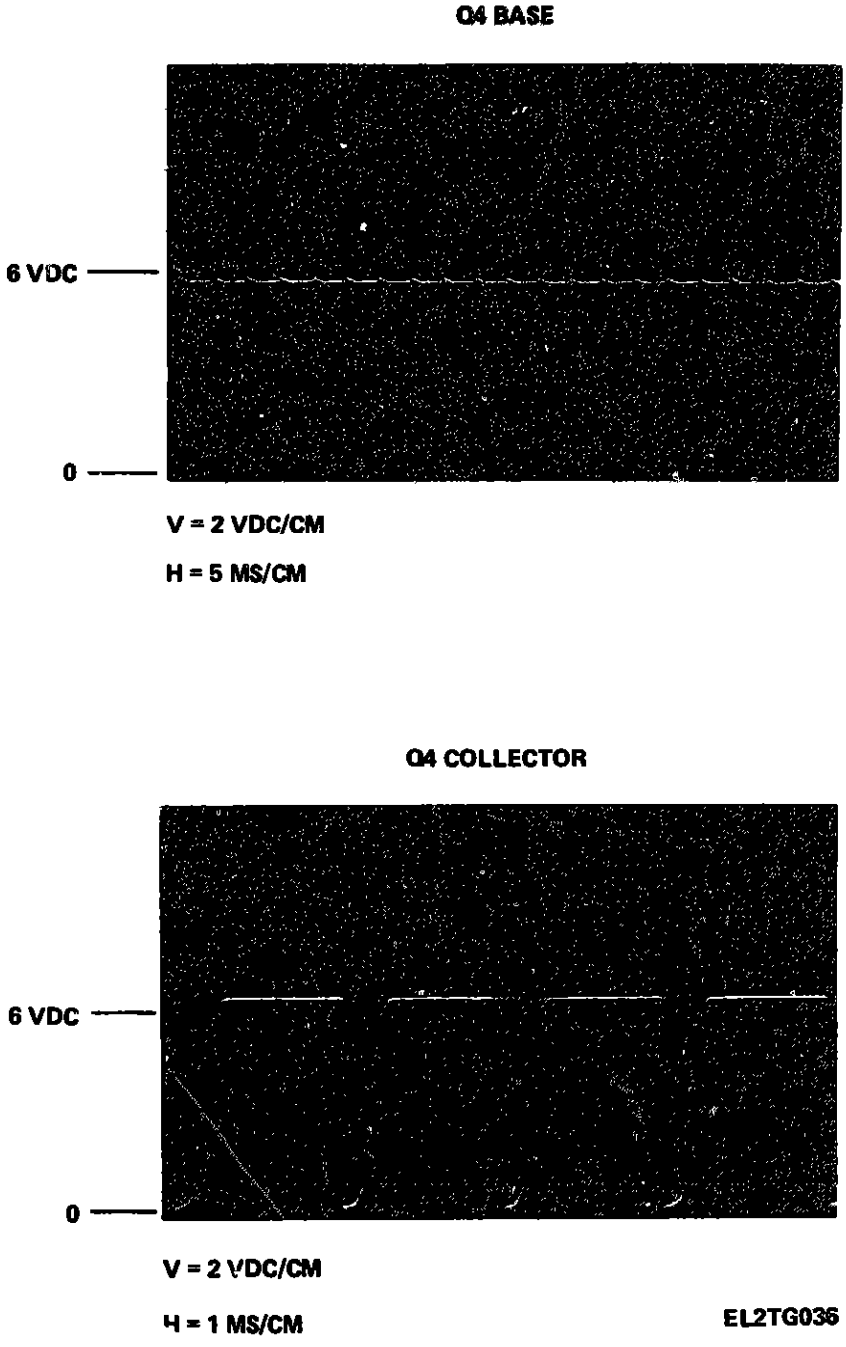


Figure 4-3.14. Typical waveshapes at transistor Q4

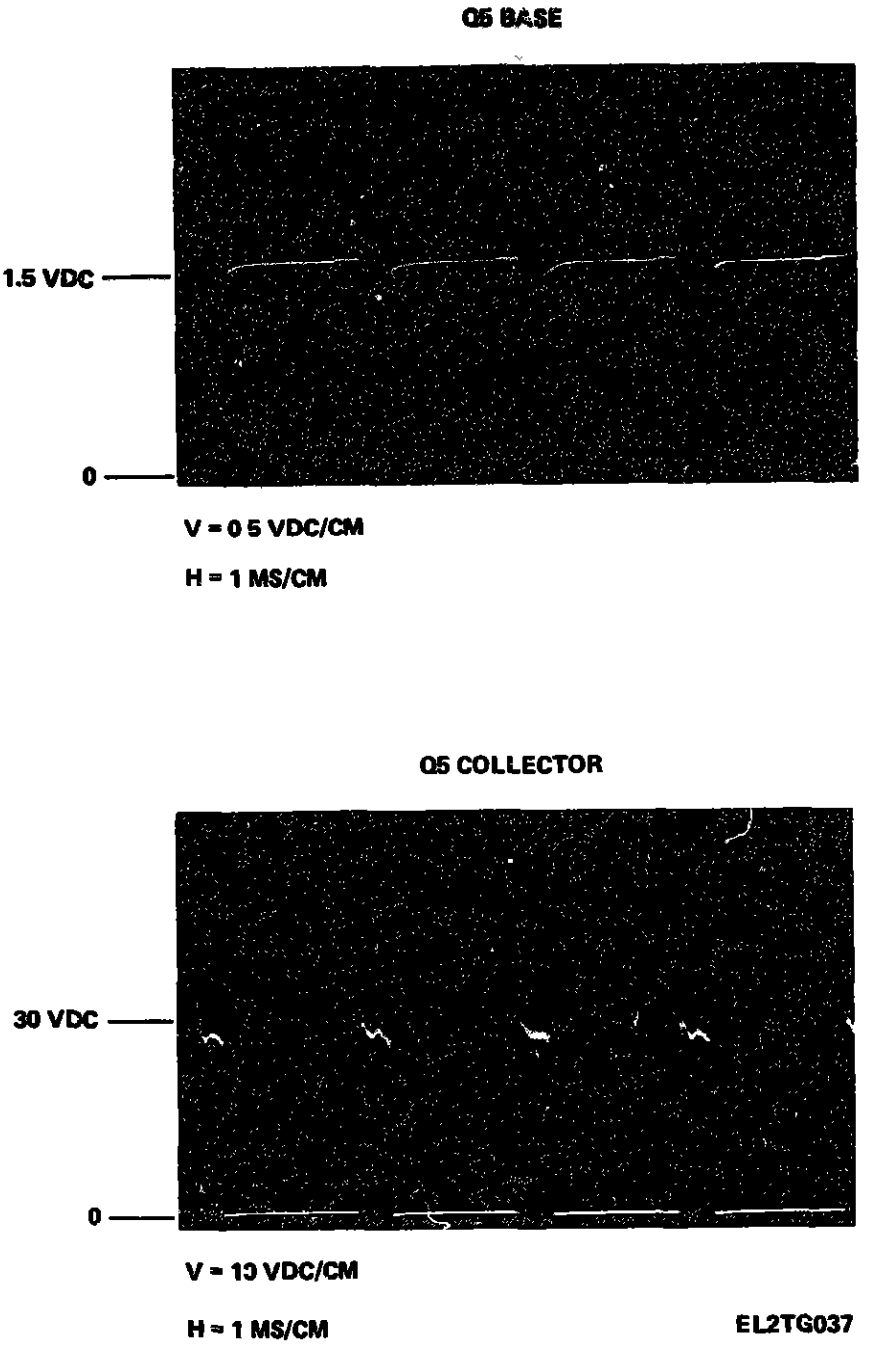
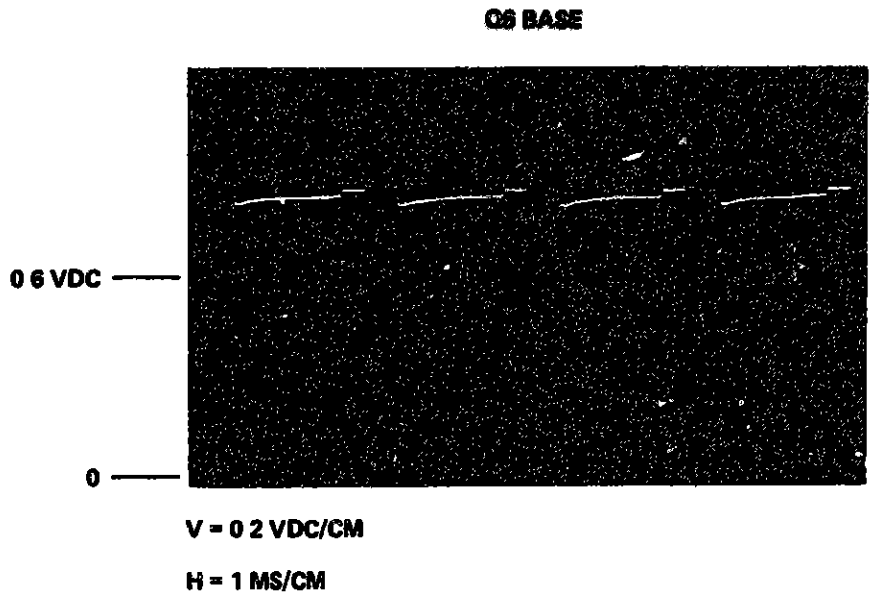


Figure 4-3.15. Typical waveshapes at transistor Q5



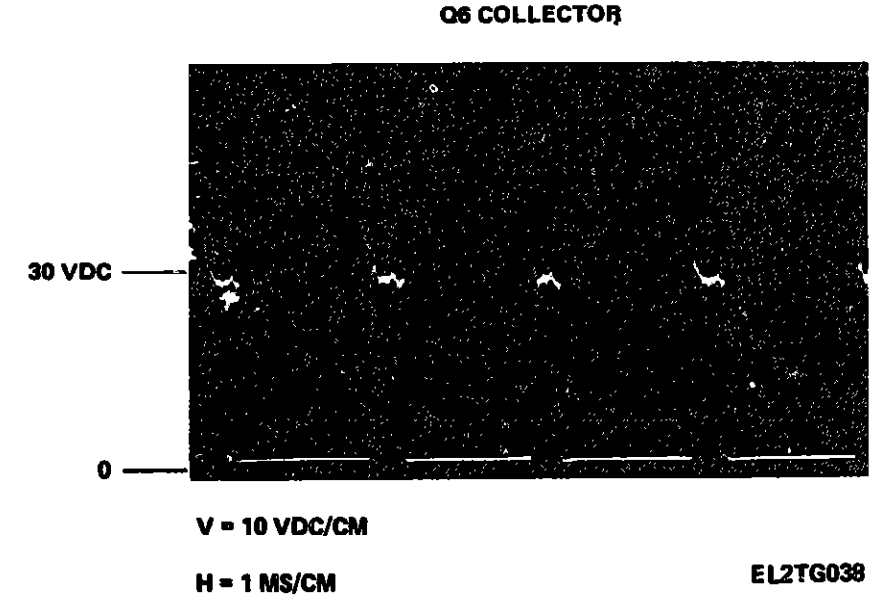


Figure 4-3.16. Typical waveshapes at transistor Q6

4-10.4. Removal and Repair

a Shut off dc input power

b Remove the voltage and frequency regulator assembly from the motor-generator as described in paragraph 3-14a

c Check the suspected component(s) Section VI gives the electrical component test values for the voltage and frequency regulator assembly components

d Check to see that replacement parts are available To replace the faulty parts, proceed as follows

(1) Using a 23- to 37 5-watt pencil-type soldering iron, heat and peel off the polyurethane coating from the component to be replaced

(2) Using the soldering iron and a vacuum solder removing tool, remove solder from the component leads and remove the component leads Where necessary, use an appropriate heat sink to prevent damage to adjacent components

CAUTION

Do not clean printed wiring board assembly (43, fig 4-5 1) unless absolutely necessary as cleaning solvents may damage coating

(3) Using the old component as a guide, form and cut the replacement component leads, as required After positioning the component or leads in place, solder securely as follows

NOTE

Equivalent soldering materials may be used

(a) Use the 23- to 37 5-watt soldering iron Be sure the tip is clean, free from oxides, and coated with a film of solder

(b) Use Kester solder 66-37 (3/64-inch diameter core) and Kester No 1544 liquid flux (Kester Solder Company, Newark, New Jersey) The solder consists of 63 percent tin and 37 percent lead and has a melting temperature of 357°F (181° C)

(c) Clean the joints with Lonco flux remover (London Chemical Co, Melrose Park, Illinois)

4-10.5. Replacement of Regulator Board

a Replace the voltage and frequency regulator assembly as described in paragraph 3-14b

b Repeat the procedures of paragraph 4-10 2 If the measurements of paragraph 4-10 2, steps d(1) through d(3), are satisfactorily made, the assembly has been repaired satisfactorily

c Turn off dc input power

d Remove the voltage and frequency regulator assembly from the motor-generator as described in paragraph 3-14a

NOTE

Do not remove voltage adjust resistor (R23) from control box assembly Remove hardware and disconnect leads from terminals 8, 9, and 11

e ***With*** the exception of transistors Q6 and Q11, associated heatsinks and hardware, terminal clinch-nut threads, the areas within 1/4 inch diameter of the clinch-nuts on the copperside, and within 7/16 inch diameter of the mounting holes on both sides of the board, spray the voltage and frequency regulator assembly with Hysol PC 28 STD urethane coating (Hysol Division of the Dexter Corporation, Olean, NY) as follows

WARNING

Contents of spray can are under pressure and flammable Do not spray near fire, flame, or heated surfaces Do not store can at a temperature above 120°F (48 8°C) Avoid breathing of vapors, prolonged contact with the skin, contact with open breaks in the skin, and ingestion Wash hands thoroughly after handling and before eating and smoking

(1) Shake spray can a few times to completely mix material in spray can

(2) While spraying, hold spray can approximately 6 inches from area to be sprayed

(3) Allow coating to cure for a minimum of 4 hours at room temperature before handling sprayed surfaces Allow 24 hours at room temperature for complete curing

Section IV. REPAIR OF CONTROL BOX ASSEMBLY COMPONENTS

4-11. Inspection

a. ***Check wiring harness and leads for broken wires,*** damaged insulation, and damaged terminals

b Inspect terminal blocks components (15 through 21 fig. 4-6), terminal board (1) and electrical receptacle connector (11) for damaged or missing parts

c Inspect electrical components (81 through 89) on subassembly board for damage

d. Check current relay assembly (92) as follows

(1) Check coil assembly (35, fig 4-7) for signs of overheating. Resistance should be between 62.37 and ***63 63 ohms***

(2) Inspect stationary contacts (28) and movable ***contact (12)*** for burned areas Replace burned contacts

(3) Compress compression spring (9) to length of 0.375 inch Compression force must be 4.0 to 4.5 pounds Replace spring if not serviceable

(4) Compress compression spring (15) to a length of 0.375 inch. Compression force must be 1 35 to 1 65 pounds Replace spring if not serviceable

e Inspect relay and resistor assembly (53 and 54, fig. 4-6) **for** damaged or loose parts

4-12. Testing

a. Check capacitors ***as described in paragraph 4-14.***

b. **Check resistors as described in paragraph 4–18.**

c **Check diodes as described in paragraph 4–15.**

d Test radio interference filter RF1 (67, fig. 4-6) as ***follows***

(1) Using ohmeter ZM-21A/U, check for continuity between terminals A and A, B and B, C and C, D and D, and F and F Limit is 0 1 ohms, maximum There should **not be any** continuity between **terminal G and** the **three** metal spacers

(2) Using insulation breakdown test set AN/GSM-6, apply 750 volts ac at 60 Hz for 1 second between terminals A, B, C, D, and F tied together and each of the three metal spacers

(3) Using capacitor test set ZM-3( )/U, check capacitance between terminals A and G, B and G, C and G, D and G, and F and G Capacitance should be between 0.1076 and 0.1364 microfarad

e Check relay (54) for a coil resistance of approximately 400 ohms The dropout voltage should be between 1 5 and 9 4 volts dc The pickup voltage should be approximately 14 5 volts All measurements should be at an ambient temperature of 77° F (25°C)

f Check resistor (53) for a value of 348 3 to 351 8 ohms

4-13. Repair and Reassembly.

a Replace all damaged or missing parts for which replacement parts are authorized and for which no repair procedure is given

b **Replace parts on current relay assembly (fig 4–7) as follows**

(1) If core (37) was removed, screw into magnetic case and bracket assembly (40)

(2) Position core tube (36), coil assembly (35), spacer spring (34) and end plate (33) into magnet case and bracket assembly (40) If desired stake end plate in two places to secure in place

(3) If terminal posts (30) were removed assemble posts along with spring washers (29) and terminal post ***clips (31)*** to relay base (32) Spin over posts to secure in place

(4) Install new stationary contacts (28) to relay base *(32)*

(5) Assemble screws (24), lock washers (23), and nuts *(22)* to relay base

(6) Attach relay base (32) to magnet case and bracket assembly (40) using screws (19), lock washers (20), and washers (21)

NOTE

Coat threads of screws (19) with red glyptal before assembly

(7) Assemble plunger (14), insulator (13), movable contact assembly (10 11, and 12) and compression spring (9) using retainer spring clip (8)

(8) Install the parts assembled in step (7) over screws (24) and loosely install nuts (7) lock washers (6) and nuts *(5)*

(9) Adjust nuts (7) to set contact gap at 0 040 to 0 050 inch Tighten nuts (5) to retain setting

(10) Manually close contacts The air gap between core (37) and plunger (14) should be 0 012 to 0 016 inch With contacts closed to check this dimension, screw core in until it bottoms against the plunger then back off core approximately 2/3 turn Stake end plate in two places to retain adjustment

(11) Install contact cover (4)

(12) Install flexible silicone-impregnated spun glass tubing over the leads of resistor (53 fig 4-5) Crimp terminal *(52)* over tubing wiring on one lead and soldering on the other lead to relay (54) terminal marked with the blue bead Bend terminal to fix against relay mounting base Cement resistor to relay case, using a suitable epoxy resin

(13) Assemble capacitors (36, 42 45, and 98) into loop clamps (34, 40, 43 and 96) Install heat-shrinkable tubing over positive (+) leads Attach solderless terminals to positive (+) leads Solder remaining lead of each capacitor to associated loop clamp as described in paragraph 4-22b(2)

Section V. ELECTRICAL COMPONENT TESTS

4-14. Capacitors

a Using capacitor test set ZM-3( )/U or equivalent, measure the capacitance and dissipation factor of the capacitors while applying the specified ac voltage and dc bias voltage given in table 4-1

CAUTION

The dc bias voltage applied during capacitor tests should not exceed the dc voltage rating of the capacitor, and the polarity on the capacitor must ***not be reversed***

b With a microammeter (ultra sensitive) and 1000-ohm resistor connected in series with the **positive** capacitor lead, apply the specified dc bias voltage and measure the leakage current The leakage current must be below the maximum value given within the specified time

4-15. Semiconductor Devices (Diodes)

To test the semiconductor devices (diodes) set up the conditions given in tables ***4-2 and 4-2.1,*** as applicable, and check for the specified values.

Table 4-1. Capacitor Test Values

Location		Capacitance Measurements			Leakage Current Measurements	
Ref Des	Figure and Index No	Ac Voltage and Frequency	DC Bias Voltage	Capacitance (uf)	DC Bias Voltage and Time	Leakage Current ua max)
C7	4-6-42	1 0 vrms 120 Hz	3 0 v	34 0 to 48.0	75 v 5 min	6 0
C8	4-6-36	0 5 vrms 120 Hz	50 v (working)	0 08 to 0 12		
C9	FO-3-46	120 Hz	200 v (working)	0 9 to 1 1		
C11	4-6-45	120 Hz	50 v (working)	1 8 to 2 2		
C12	4-6-61	120 Hz	300 v (working)	0 008 to 0 012		
C13	4-6-98	120 Hz	50 v (working)	0 198 to 0 242		
			4B48-6-A (PU-750( )/A)			
C1	4-5 39	0 5 vrms 120 Hz	23 v	42 3 to 51 7	35 v 5 min	10
C3	4-5 38	1000 Hz	300 v (working)	0 9 to 0 11		
C4	4-5-54	0 5 vrms 120 Hz	35 v	1 6 to 2 4	50 v 5 min	2
C5	4-6-82	0 5 vrms 120 Hz	7 0 v	176 0 to 264 0	10 v 5 min	20
C6	4 5 56	120 Hz	50 v (working)	0 423 to 0 517		
			4B93 1-A (PU-750A/A)			
C1	4 5A-41	1000 Hz	100 v (working vdc)	0 045 to 0 049		
C2	4-5A-10	0 5 vrms 120 Hz	14 v	1 2 to 1 8	20 v 5 min	0 6
C3 C6	4-5A 27	0 5 vrms 120 Hz	24 5 v	0 8 to 1 2	35 v 5 min	0 5
C4	4-5A 32	0 5 vrms	14 v	8 to 12	20 v 5 min	4
C5	4-5A-33	1000 Hz	400 v (working vdc)	0 176 to 0 264		
C7	4-5A-40	1000 Hz	10 v (working vdc)	3 76 to 5 64		
C8	4-5A 26	1000 Hz	35 v (working vdc)	0 176 to 0 264		
C9	4-5A-3	1000 Hz	200 v (working vdc)	0 009 to 0 011		

Table 4-2. Semiconductor Device Test Values for 4B48-6-A

Ref Des	Figure and Index No.	Positive Terminal	Negative Terminal	Load Resistance RL (ohms)	DC Current Idc (ma)	Leakage Current (ma max)	Zener Voltage VZ (volts max)	Source Voltage EDC (volts max)	Rectifier Voltage VR (volts max)
CR1, CR2, CR7 thru CR15 CR21	4-5-36	Striped end			400	0.2		225	1 0
CR3 CR4	4-5-41	Striped end			100	0 1 (ua)		2	1 0
CR5	4-5-45	Striped end		1000	7 5		8 55 to 9.45		
CR6, CR22	4-6-81	Striped end			400	0.2		225	1 0
CR16	4-5-44	Case and stud	Solder terminal		1 6	0.5		50	1 3
CR17 CR18	4-5-46	Case and stud	Solder terminal		12 (amp)	10		50	1 3
CR19 CR20	4-5-50	Case and stud	Solder terminal		6	10		50	1 1
CR23	4-6-83	Striped end		1000	10		7 6 to 8.4		
CR24	4-6-76	Solder terminal	Case and stud		10 (amp)	10		200	1 2
CR25	4-6-77		Striped end		3 (amp)	10 (ua)		200	1 0
CR26	4-5-58		Striped end		1 (amp)	1 (ua)		200	1 2

Table 4-2.1. Semiconductor Device Test Values for 4B93-1-A

Ref Des	Figure No	Index No	Positive Terminal	Forward Voltage Drop		Reverse Characteristics		Zener Voltage	
				V_F max	I_F	Leakage Current I_R max	Reverse Voltage V_R	V_Z	I_Z
CR1 CR3 CR4 CR9	4-5 1	4	Striped end	1 0v	400 ma	0 2 ua	225v	—	—
CR2, CR5	4-5 1	8	Striped end					5 89 to 6 51v	7 5 ma
CR6, CR7 CR8 CR10	4-5 1	18	Striped end	1 0v	3 amp	5 ua	100v		
CR11	4-5 1	37	Striped end	1 0v	400 ma	0 2 ua	600v	—	—

4-16. Transformer and Reactors (PU-750()/A)

Test the encapsulated transformer and the reactors (32, 33, and 35, fig 4-5), as follows

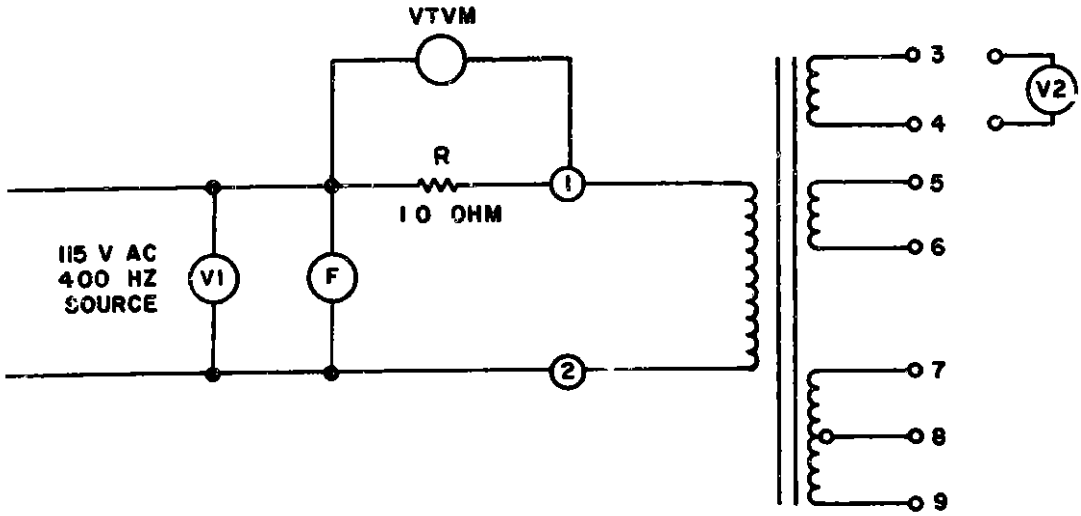
a Connect transformer primary terminals 1 and 2 into the test circuit shown in fig 4-4 With the primary energized at 115 volts ac, 400 Hz and all secondary leads open, measure the millivolt drop across the 1 0-ohm resistor The millivolt reading is equivalent to the no-load magnetizing current to milliamperes, a maximum of 20 milliamperes

b Remove the 1 0 ohm resistor and the vacuum tube voltmeter from the test circuit With the primary energized at 115 volts ac, 400 Hz, measure the no-lead secondary voltages The voltage across terminals 3 and 4 and 5 and 6 should be between 37 5 and 38 5 volts, across terminals 7 and 8 and 8 and 9 between 14 8 and 15 4 volts, and across terminals 7 and 9 between 29 7 and 30 7 volts

c Remove the transformer from the test setup Ground check the transformer windings by applying 750 volts ac, 60 Hz, between all windings and between each winding and the core (if exposed) for 1 second

d Check the reactors L1 and L2 meet the following specifications

Reactor	*Value in Henries*
L1	1 09 to 1 15
L2	**0 220 to 0 260**



V1 – A-C VOLTMETER, 0-150 V, WESTON MODEL 622
V2 – A-C VOLTMETER, 0-50 V, WESTON MODEL 622
R – 10 OHM
F – FREQUENCY METER, WESTON MODEL 339
VTVM – VACUUM TUBE VOLTMETER, BALLANTINE MODEL 300

EL2TG009

Figure 4-4. Test setup for transformer T1

4-17. Transistors

a. 4B48-6-A. To check silicon transistors Q1 and Q2 (53, fig. 4-5), set up the conditions specified in table 4-4 and check for the specified values, using Transistor Test Set TS-1836()/U. To check power transistors Q3 through Q6 (11 and 12, fig. 4-5), see table 4-4.

b. 4B93-1-A. To check transistors Q1 through Q11 (7, 14, 16, 17, and 29, fig. 4-5.1), test set up conditions specified in table 4-4.1 and check for specified values, using the TS-1836()/U.

4-18. Resistors. Using resistance bridge ZM-4B/U, measure the values of resistance specified in table 4-5 or 4-5.1.

a. Ground check resistors R12 and R13 ***(20,*** fig. 4-5) by applying 750 volts ac, ***60*** Hz, between the terminals and the case for one second.

b With the wipers placed for maximum resistance and terminals shorted together, ground check potentiometers R14 and R15 (11 and 28, fig. 4-5) or R5 ***and 23*** (13 and 1, fig. 4-5.1) by applying ***500 volts ac, 60 Hz*** between the ***terminals*** and the case for one minute.

c Check the temperature coefficient of the potentiometers as follows:

(1) With the wipers set for maximum resistance, place the potentiometer under test in a controlled ambient temperature of 77° F (25°C) ±5°F (9°C) for 30 minutes and measure and record the resistance value

(2) With the controlled ambient temperature adjusted to 257°F (125°C), heat the potentiometer under test for 30 minutes and measure and record the resistance value

(3) Using the resistance values obtained in steps (1) and (2), calculate the temperature coefficient of resistance by means of the following formula (where R = resistance)

$$\text{Temperature coefficient} = \frac{R_{125°C} - R_{25°C}}{100 \times R_{25°C}}$$

d The temperature coefficient calculated in step c should not exceed 20 ppm per degree (°C)

Table 4-3. Silicon Transistor Test Values for 4B48-6-A

	I_{EBO}		I_{CBO}		h_{FE}		V_{CE} (Saturation)	
Ref Des	Condition	Limit	Condition	Limit	Condition	Limit	Condition	Limit
Q1 Q2	V_{EB} 2.0v	I_{EBO} 100 ua (max)	V_{EB} 30 v	10 ua (max)	V_{CE} 10 v IC 150 ma	I_B 50 ma	I_B 15 ma IC 150 ma	V_{CE} 1.5 v (max)

Table 4-4. Power Transistor Test Values for 4B48-6-A

Ref Des	Transistor Type	I_{CER} or I_{CEO} Condition	I_{CER} or I_{CEO} Limit	BV_{CEO} Condition	BV_{CEO} Limit	h_{FE} Condition	h_{FE} Limit	V_{CE} (Saturation) Condition	V_{CE} (Saturation) Limit
Q3, Q4	MJ2500	V_{CE} 30 v IB 0	I_{CEO} 1 0 ma	C 100ma IB 0	V_{CE} 60 v	V_{CE} 3 v IC 5 amp	I_B 5 ma (max)	I_C 5A	V_{BE} 3 0 v (max)
Q5, Q6	MJ4031	V_{CE} 80 v T_C 125°	I_{CER} 10 ma	I_C 100 ma I_B 0	V_{CE} 80 v	V_{CE} 3 v I_C 10 amp	I_B 10 ma (max)	I_B 10 ma I_C 5A	V_{BE} 3.0 v (max)

Table 4-4.1. Transistor Test Values for *PU-750A/A*

			Collector To Base Breakdown Voltage		DC Current Gain		Collector Saturation Voltage		Emitter To Base Cutoff Current		Collector Leakage Current Base Open		Collector To Emitter Cutoff Current		Base-To-Emitter Voltage		Emitter-To-Base Breakdown	
			BV_{cbo}		H_{fe}		V_{ce}		I_{ebo}		I_{ceo}		I_{cer}		V_{be}		BV_{ebo}	
Reference Symbol	Fig No	Index No.	Cond	Limits (max)	Cond	Limits (max)	Cond	Limits (max)	Cond	Limits (max)	Cond	Limit (max)	Cond	Limits (max)	Cond	Limits (max.)	Cond	Limits (max)
Q1, Q2 Q10	4-5 1	7	I_{cbo} 10 ua	BV_{cb} 50v	V_{ce} 1v I_c 10 ma	I_b 0 1 ma	I_c 10 ma I_b 1 ma	V_{ce} 0 25v									I_{ebo} 10 ua	BV_{eb} 5v
Q3, Q5 Q8	4-5 1	16			V_{ce} 1v I_c 150 ma	I_b 1 5 ma	I_c 150 ma I_b 15 ma	V_{ce} 0 25v							I_c 150 ma I_b 15 ma	V_{be} 1 1v	I_{ebo} 10 ua	BV_{eb} 5v
Q4 Q7	4-5 1	14	I_{cbo} 10 ua	BV_{ebo} 60v	V_{ce} 10v I_c 10 ma	I_b 0 1 ma	I_c 150 ma I_b 15 ma	V_{ce} 0 4v									I_{ebo} 10 ua	BV_{ebo} 5v
Q6 Q11	4-5 1	17			V_{cc} 4v I_c 10 amp	I_b 166 to 667 ma	I_c 10 amp I_b 1 amp	V_{ce} 1 4 v			V_{ce} 50v	I_{ceo} 10					I_{ebo} 5 ma	BV_{eb} 7v
Q9	4-5 1	29			V_{cc} 4v I_c 150 ma	I_b 6 ma	I_c 150 ma I_b 15 ma	V_{ce} 0 5 v	V_{eb} 7v	I_{ebo} 10 ua			V_{ce1} 90v	I_{cer} 1 ua				

TABLE 4-5. Resistance Tests for PU-750()/A

Location		
Ref Des	Figure and Index No	Resistance Measurement (ohms)
R1	4-5-43	135 8 to 144 2
R2	4-5-42	164 9 to 175 1
R3	4-5-40	970 to 1030
R4	4-5-37	291 to 309
R5	4-5-57	582 to 618
R6	4-5-52	388 to 412
R9	4-5-52	388 to 412
R10	4-5-51	1940 to 2060
R11	4-5-55	1925 to 2075
		97 to 103
R12	4-5-20	97 to 103
R13	4-5-20	50 (variable)
R14	4-5-14	750 (variable)
R15	4-5-15	14550 to 15450
R16	4-6-85	3880 to 4120
R17	4-6-84	339 5 to 460 5
R18	4-6-53	

Section VI. MAINTENANCE OF MOTOR-GENERATOR

4-19. Disassembly of Motor-Generator

a Main Assembly (fig FO-3)

(1) Unlock Dzus fasteners (19) and remove control box cover subassembly (20)

(2) If necessary remove voltage and frequency regulator assembly (21 or 25F) as described in paragraph 3-11a or 3-14a as applicable.

(3) Remove dc and ac brush electrical covers (4 and 5)

(4) If necessary tag and disconnect leads of dc end bell assembly (66), ac end bell assembly (67) and electrical rotating equipment housing assembly ***(79)*** from control box assembly (50 or 50A) as applicable.

(5) To remove control box assembly (50) from electrical rotating equipment housing assembly (79) remove screws (51 and 53) and lock washers (52) and separate the control box assembly from the electrical rotating equipment housing

(6) Remove screws (10) and washers (11) Use a brush hook to lift dc brush springs and remove contact dc electrical brushes (9)

(7) Remove screws (13) lock washers (14) and washers (15) Use a brush hook to lift ac brush springs and remove ac brush assemblies (12) Cut tie and disconnect lead (number 2) from positive (+) slip ring brush box

(8) Remove screws (2) lock washers (3) and dc fan cover (1) Repeat procedure for ac fan cover (1)

(9) Remove nut (57) and flat washer (58) from the rotor shaft

(10) Remove screws (68) lock washers (69) and washers (70) from ac end bell assembly (67) Remove ac end bell assembly (67) with rotor assembly (78) ball bearings (65 and 73), and ac fan (56) attached from electrical rotating equipment housing (79) Remove ac fan (56) from shaft

Table 4-5.1. Resistance Tests for PU-750A/A

Location		
Ref Des	Figure and Index No	Resistance Measurement (ohms)
R1	4-5 1-5	9900 to 10100
R2	4-5 1-2	37026 to 37774
R3	4-5 1-5	9900 to 10100
R4	4-5 1-6	24651 to 25149
R5	4-5 1-13	10,000 (variable)
R6	4-5 1-39	999 to 1010
R7	4-5 1-36	494 to 503 9
R8	4-5 1 39	999 to 1010
R9	4-5 1-5	9900 to 10100
R10	4-5 1-22	99 to 101
R11	4-5 1-9	11979 to 12221
R12	4-5 1-30	14850 to 15150
R13	4-5 1 12	1980 to 2020
R14	4-5 1 11	2465 to 2514
R15	4 5 1 28	742 5 to 757 5
R16	4-5 1-12	1980 to 2020
R17	4-5 1-38	6741 9 to 6878 1
R18	4-5 1-5	9900 to 10100
R19	4-5 1-35	25839 to 26361
R20	4-5 1-34	49401 to 50399
R21	4-5 1-25	4941 to 5039
R22	4-5 1 23	2980 to 3040
R23	4-5 1 1	5000 (variable)
R24	4-5 1 23	2980 to 3040
R25	4-5 1-31	69102 to 70498
R26	4 5 1-24	1980 to 2020
R27	4-5 1-2	37026 to 37774

(11) Repeat step (10) to remove dc end bell assembly (66) and armature assembly (77) Remove dc fan (55) from shaft

(12) Use a puller to remove end bells with ball bearings (65) from the shafts of armature assembly (77) and rotor assembly (78).

(13) Remove screws (61), lock washers (62), flat washers (63), and bearing retainer (60)

(14) Place dc and ac end bell assemblies (66 and 67), with outside flat surface down on bench, and press ball bearings (65) from end bells with a bearing pusher

(15) Remove spline (76) from armature assembly (77) or rotor assembly (78), as applicable

(16) Using retaining ring pliers, remove retaining ring (72) Using a bearing puller, remove ball bearings (73) from armature assembly (77) and rotor assembly (78)

(17) Remove bearing springs (75) from electrical rotating equipment housing assembly (79)

b Voltage and Frequency Regulator Assembly (fig. 4-5 or 4-5.1).

For repair of the voltage and frequency regulator assembly, refer to Section III or III.I.

c Control Box Assembly **(fig. 4–6)**

NOTE

Refer to paragraphs 4–11 through 4–13 for control box assembly repair procedures

LEGEND FOR FIGURE 4-5

1	Self-locking nut
2	Washer
3	Nut
4	Tooth lock washer
5	Metallic washer
6	Insulating bushing
7	Plate insulator
8	Washer
9	Screw
10	Screw
11	Transistor (Q3, Q4)
12	Transistor (Q5, Q6)
13	Heat sink
14	Adjustable resistor (R14)
15	Adjustable resistor (R15)
16	Nut
17	Lock washer
18	Washer
19	Screw
20	Resistor (R12, R13)
21	Self-locking nut
22	Lock washer
23	Washer
24	Spacer sleeve
25	Screw
26	Screw
27	Electrical lead
28	Loop clamp
29	Printed circuit board assembly
30	Nut

LEGEND FOR FIGURE 4-5 (Cont)

31	Bushing
32	Reactor assembly (L1)
33	Transformer (T1)
34	Screw
35	Reactor assembly (L2)
36	Semiconductor device (CR1 CR2 CR7 through CR15, CR21)
37	Resistor (R4)
38	Capacitor (C3)
39	Capacitor (C1)
40	Resistor (R3)
41	Semiconductor device (CR3, CR4)
42	Resistor (R2)
43	Resistor (R1)
44	Semiconductor device (CR16)
45	Semiconductor device (CR5)
46	Semiconductor device (CR17 CR18)
47	Washer
48	Terminal
49	Blank panel
50	Semiconductor device (CR19 CR20)
51	Resistor (R10)
52	Resistor (R6, R9)
53	Transistor (Q1 Q2)
54	Capacitor (C4)
55	Resistor (R11)
56	Capacitor (C6)
57	Resistor (R5)
58	Semiconductor device (CR26)
59	Printed circuit board
60	Identification plate
61	Wiring harness
62	Terminal
63	Terminal
64	Terminal
65	Terminal
66	Terminal
67	Terminal
68	Terminal
69	Terminal
70	Terminal
71	Pin type solderless terminal
72	Terminal
73	Pin type solderless terminal
74	Terminal
75	Pin type solderless terminal
76	Pin type solderless terminal
77	Pin type solderless terminal
78	Pin type solderless terminal
79	Pin type solderless terminal
80	Pin type solderless terminal
81	Terminal
82	Terminal
83	Grommet
84	Bracket and post assembly

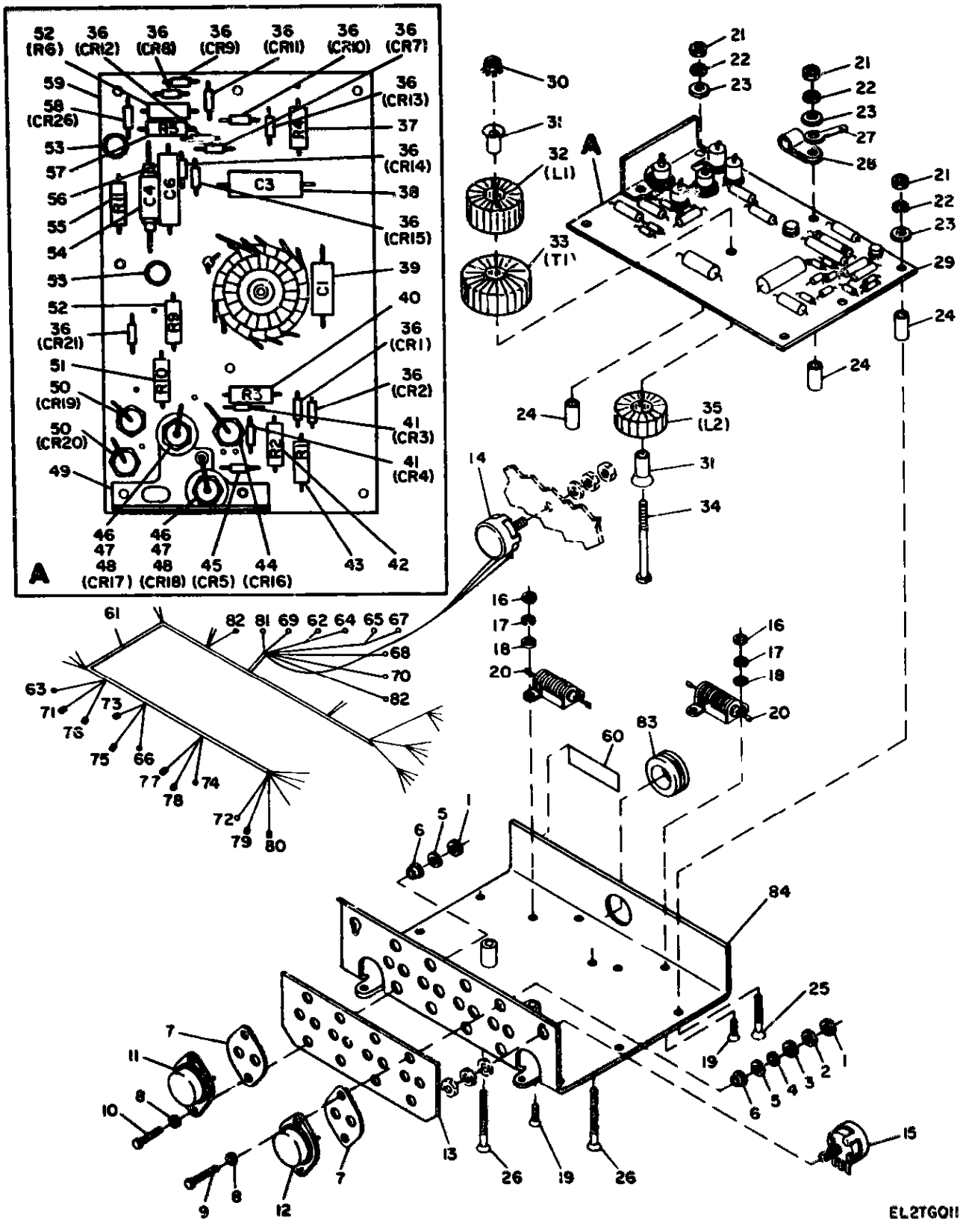


Figure 4-5. Voltage and frequency regulator assembly

Legend for Figure 4-5 1

1 Variable resistor (R23)
2 Resistor (R2, R27)
3 Capacitor (C9)
4 Diode (CR1 CR3 CR4, CR9)
5 Resistor (R1 R3 R9 R18)
6 Resistor (R4)
7 Transistor (Q1 Q2 Q10)
8 Diode (CR2 CR5)
9 Resistor (R11)
10 Capacitor (C2)
11 Resistor (R14)
12 Resistor (R13 R16)
13 Variable resistor (R5)
14 Transistor (Q4, Q7)
15 Transistor adapter
16 Transistor (Q3 Q5, Q8)
17 Transistor (Q6 Q11)
18 Diode (CP6 CR7 CR8 CR10)
19 Binding head screw
20 Nut and lock washer
21 Transistor heat sink
22 Resistor (R10)
23 Resistor (R22 R24)
24 Resistor (R26)
25 Resistor (R21)
26 Capacitor (C8)
27 Capacitor (C3 C6)
28 Resistor (R15)
29 Transistor (Q9)
30 Resistor (R12)
31 Resistor (R25)
32 Capacitor (C4)
33 Capacitor (C5)
34 Resistor (R20)
35 Resistor (R19)
36 Resistor (R7)
37 Diode (CR11)
38 Resistor (R17)
39 Resistor (R6 R8)
40 Capacitor (C7)
41 Capacitor (C1)
42 Clinch nut
43 Printed wiring board

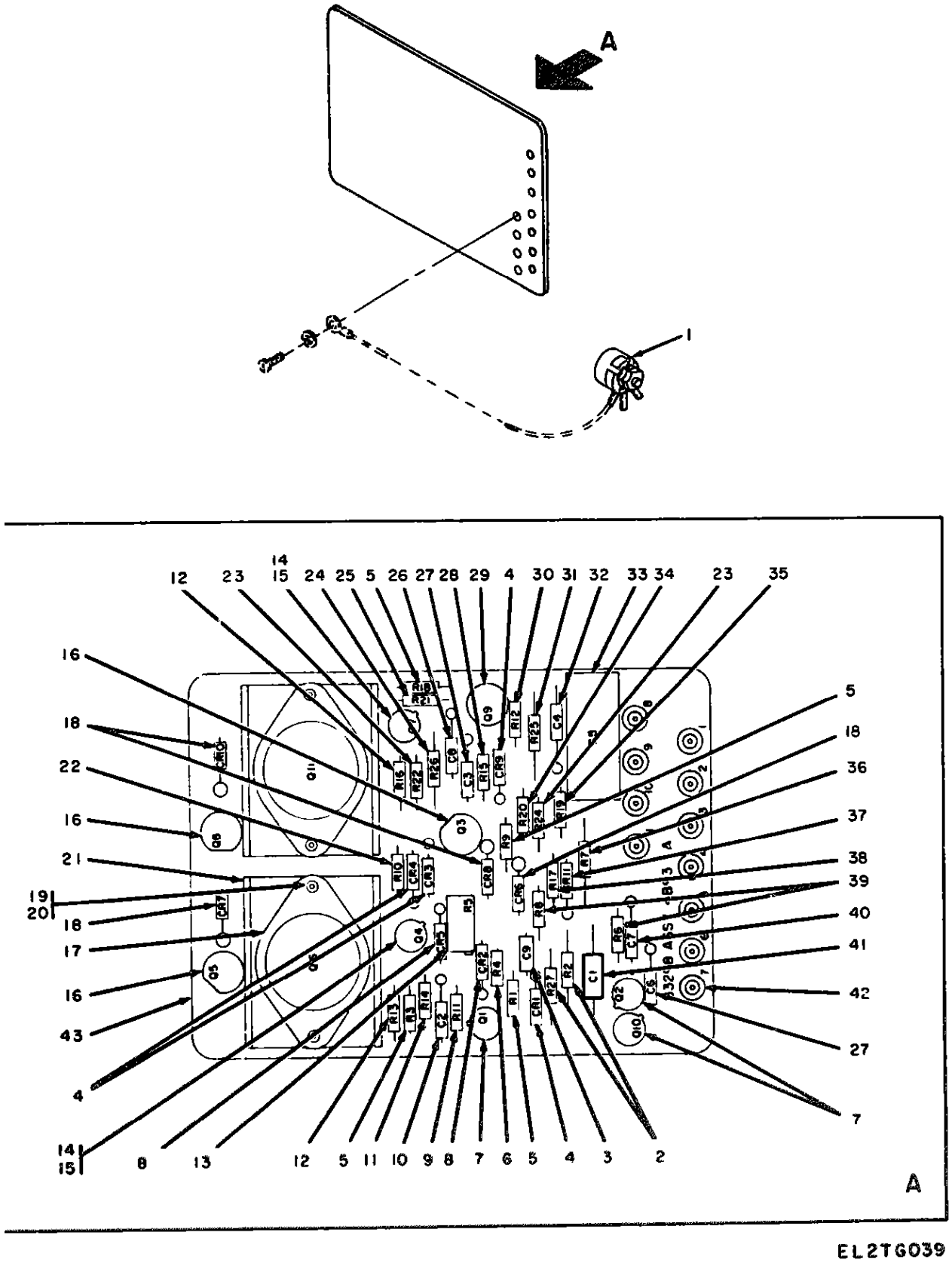


Figure 4-5.1. Voltage and frequency regulator assembly (4B93-1-A)

Legend for Figure 4-6

1 Terminal board
2 Hex nut
3 Lock washer
4 Flat washer
5 Flat head screw
6 Plain washer
7 Hex nut
8 Filister head screw
9 Solderless terminal
10 Solderless terminal
11 Receptacle connector
12 Filister head screw
13 Lock washer
14 Washer
15 Terminal block cover
16 External relieved body screw
17 Washer
18 Hex nut
19 Lock washer
20 Washer
21 Terminal block
22 Solderless terminal
23 Solderless terminal*
24 Terminal
25 Solderless terminal
26 Solderless terminal
27 Solderless terminal
28 Solderless terminal
29 Pin jack
30 Lock washer
31 Terminal support bracker
32 Elastic stop nut
33 Flat head screw
34 Loop clamp
35 Solderless terminal
36 Capacitor (C8)
37 Hex nut
38 Plain washer
39 Flat head screw
40 Loop clamp
41 Solderless terminal
42 Capacitor (C7)
43 Loop clamp
44 Solderless terminal
45 Capacitor (C11)
46 Time totalizing meter (TTI)
47 Pan head screw
48 Nut and lock washer assembly
49 Machine
50 Flat washer
51 Self locking nut
52 Terminal
53 Resistor (R18)
54 Relay
54A Resistor (R24)**
54B Hex nut**
54C Flat washer**
54D Lock washer**
54E Pan head screw**
55 Capacitor mounting bracket
56 Flat head screw
57 Plain washer
58 Self locking nut
59 Solderless terminal
60 Solderless terminal
61 Capacitor (C12)
62 Solderless terminal*
63 Solderless terminal*
64 Hex nut
65 Lock washer
66 Plain washer
67 Radio interference filter (RF)
68 Filister head screw
69 Lock washer
70 Flat washer
71 Solderless terminal
72 Plain washer*
73 Insulating washer*
74 Insulator bushing*
75 Terminal*
76 Diode (CR24)*
77 Diode (CR25)*
78 Terminal*
79 Filister head machine screw*
80 Lock washer*
81 Diode (CR6, CR22)*
82 Capacitor (C5)*
83 Diode (CR23)*
84 Resistor (R17)*
85 Resistor (R16)*
86 Standoff terminal*
87 Standoff terminal*
88 Threaded and shouldered post*
89 Solder type terminal*
90 Solderless terminal
91 Solderless terminal
92 Current relay assembly SW1 (see fig 4-7)
93 Filister head screw
94 Plain washer
95 Self locking nut
96 Loop clamp
97 Solderless terminal
98 Capacitor (C13)
99 Grommet
100 Grommet
100A Flat head screw**
100B Threaded post**
101 Control box assembly

* PU-750( )/A only
** PU-750A/A only

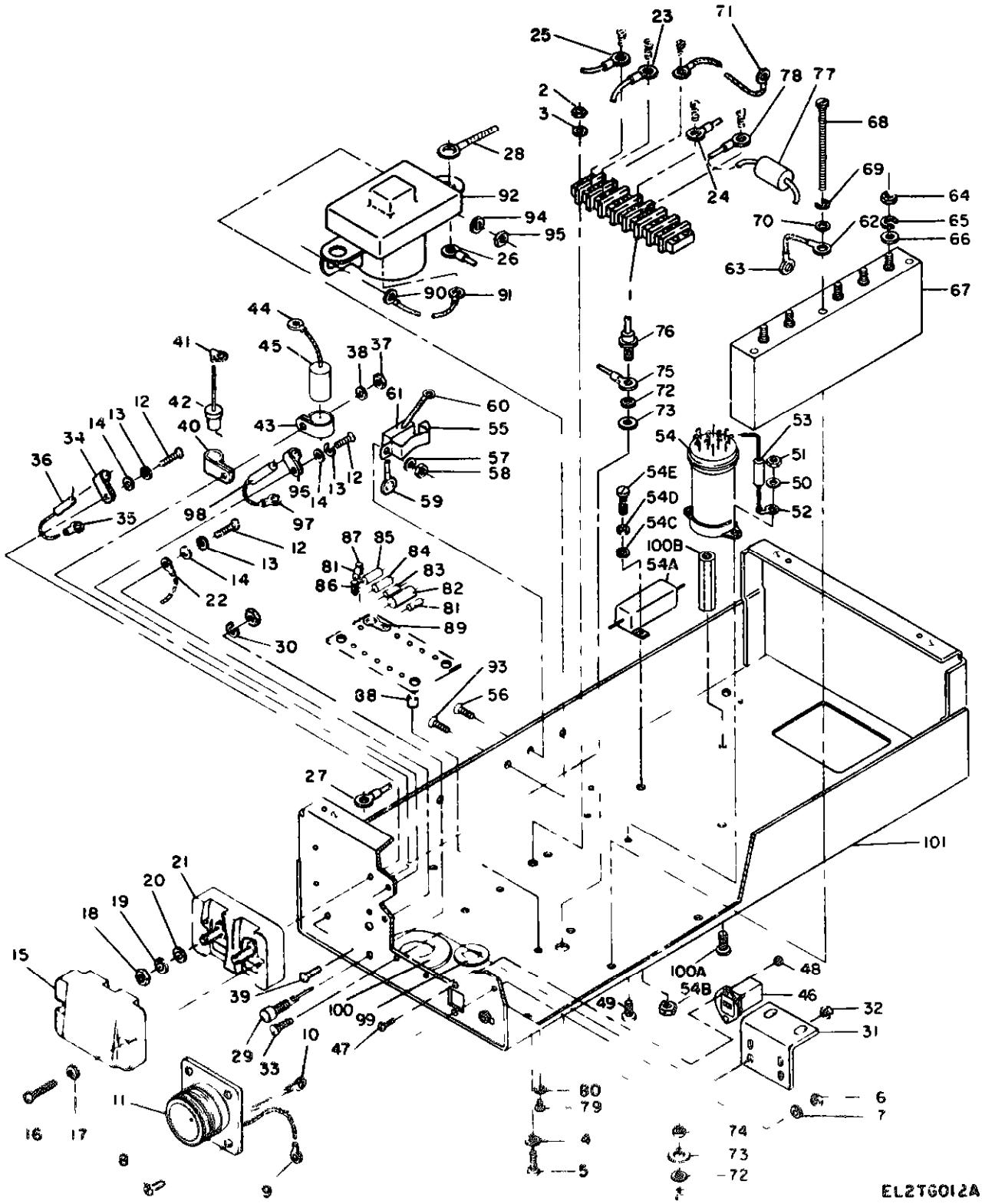


Figure 4-6. Control box assembly

(1) Tag and disconnect leads to current relay assembly SW1 (92)

(2) Remove self locking nuts (95) washers (94) screw (93), and current relay assembly (92)

(3) Disassemble the control box assembly only to the extent necessary to make repairs Tag all leads before removing parts

d Current Relay Assembly (fig 4-7)

NOTE

The current relay assembly is a subassembly of the control box Refer to paragraphs 4-11 through 4-13 for control box assembly repair procedures

(1) Remove nuts (1) lock washers (2) washers (3) and contact cover (4)

(2) Carefully remove retainer spring clip (8) and compression spring (9)

(3) Remove nuts (5) lock washers (6) nuts (7) and movable contact assembly (items 10 11 and 12) Do not disassemble **parts**

(4) Remove insulator (13) spring (15) and plunger (14)

(5) Remove screws (25) lock washer (26) washers (27) and stationary contacts (28)

(6) Remove nuts (16) lock washer (17) and washers (18)

(7) Remove screws (19) lock washers (20) washers (21) and relay base (32) with parts attached from magnet case and bracket assembly (40) Do not remove parts from relay base unless replacement is necessary

LEGEND FOR FIGURE 4-7

1	Nut
2	Lock washer
3	Washer
4	Contact cover
5	Nut
6	Lock washer
7	Nut
8	Retainer spring clip
9	Compression spring
10	Eyelet
11	Contact support plate
12	Movable contact
13	Insulator
14	Plunger
15	Compression spring
16	Nut
17	Lock washer
18	Washer
19	Screw
20	Lock washer
21	Washer

LEGEND FOR FIGURE 4-7 (Cont)

22	Nut
23	Lock washer
24	Screw
25	Screw
26	Lock washer
27	Washer
28	Stationary contact
29	Spring washer
30	Terminal post
31	Terminal post clip
32	Relay base
33	End plate
34	Spacer spring
35	Coil assembly
36	Core tube
37	Core
38	Drive screw
39	Identification plate
40	Magnet case and bracket assembly

(8) Remove end plate (33), spacer spring (34), and coil assembly (35) from magnet case and bracket assembly (40)

(9) Do not disassemble current relay assembly further unless parts replacement is necessary

e DC End Bell Assembly (fig 4-8)

(1) Inspect inside diameter of bearing liner (23) If the ***liner*** is worn the motor-generator should be forwarded to the depot for repair

(2) If lead assemblies (4) are damaged remove screws (1), lock washer (2), washers (3), and lead assemblies

(3) Only if necessary for replacement, remove cable assembly with terminals (5)

f AC End Bell Assembly (fig 4-9)

(1) Inspect inside diameter of bearing liner (16) If the liner is worn, the motor-generator should be forwarded to the depot for repair

(2) If necessary for replacement, remove screws (1), lock washers (2), washers (3), and ground leads containing terminals ***(4*** and 5)

g Electrical Rotating Equipment Housing Assembly Inspect the inside diameter of bearing liner (23, fig 4-10) If the liner is worn, the motor-generator should be forwarded to the depot for repair

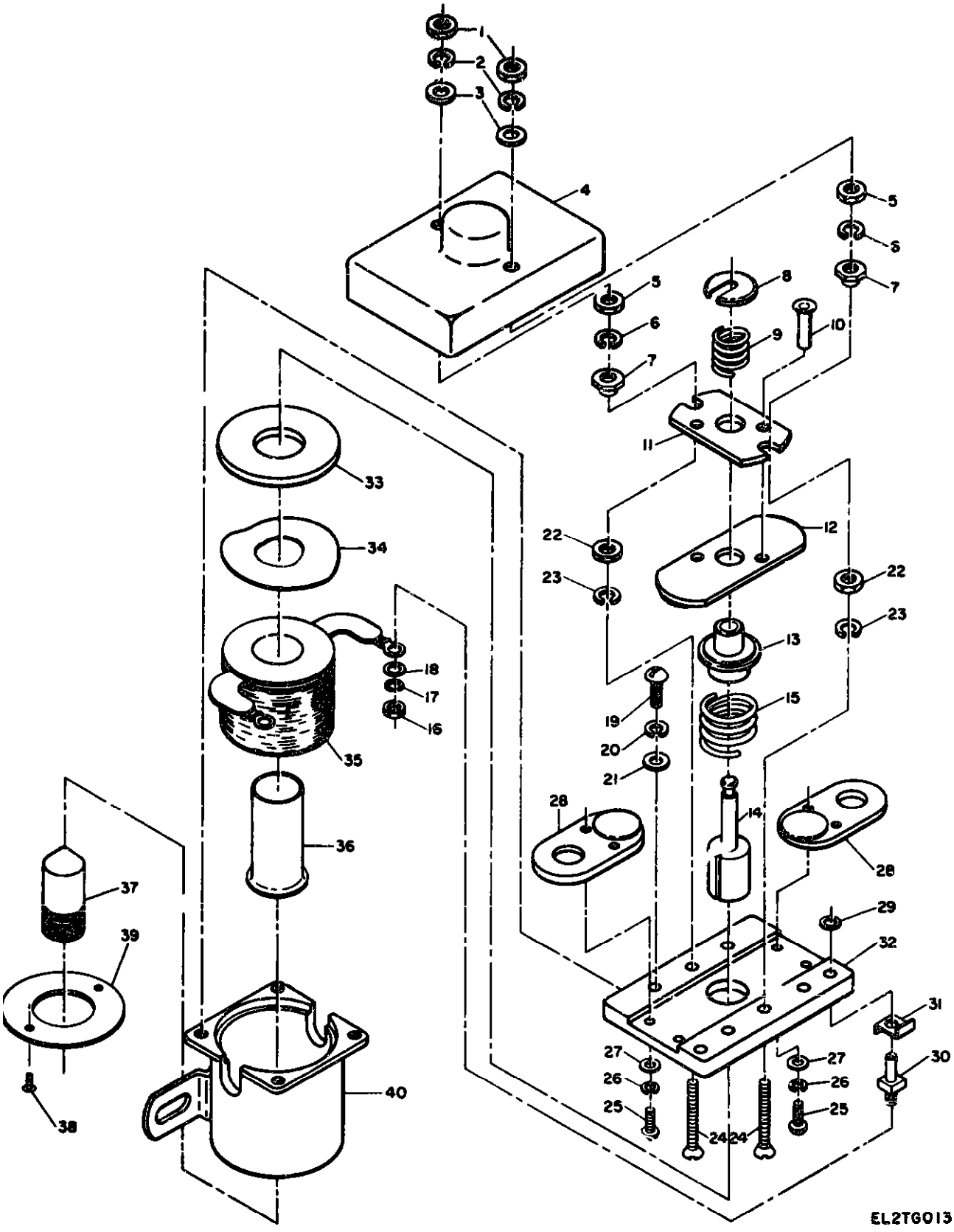


Figure 4-7. Current relay assembly

LEGEND FOR FIGURE 4-8

1	Screw
2	Lock washer
3	Washer
4	Lead assembly
5	Terminal
6	Cotter pin
7	Retaining washer
8	Torsion spring
9	Spring post
10	Rivet
11	Washer
12	Washer
13	Washer
14	Insulating washer
15	Insulating washer
16	Brush holder
17	Brush holder
18	Spacer
19	Insulator
20	Insulating tube
21	Dc end bell
22	Spring pin
23	Bearing liner

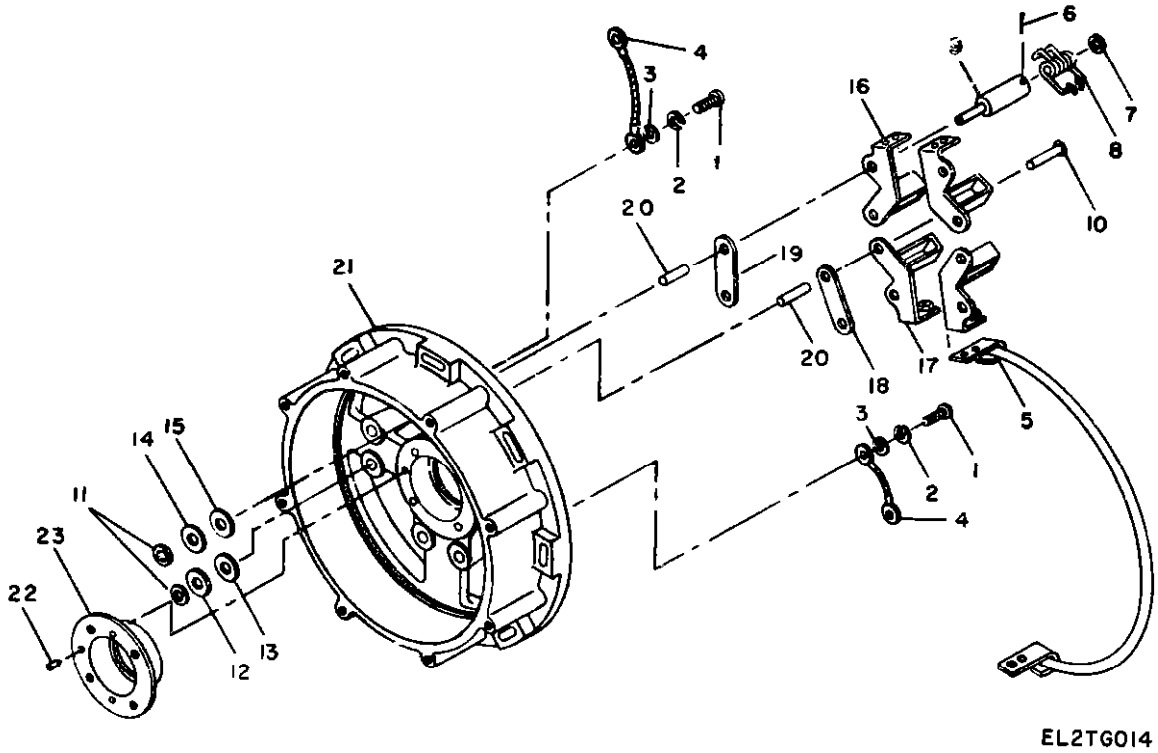


Figure 4-8. Dc end bell assembly

LEGEND FOR FIGURE 4-9

1	Screw
2	Lock washer
3	Washer
4	Terminal
5	Terminal
6	Screw
7	Lock washer
8	Washer
9	Brush board spacer
10	Brush board
11	Lock ring
12	Brush spring
13	Brush arm
14	Ac end bell
15	Spring pin
16	Bearing liner

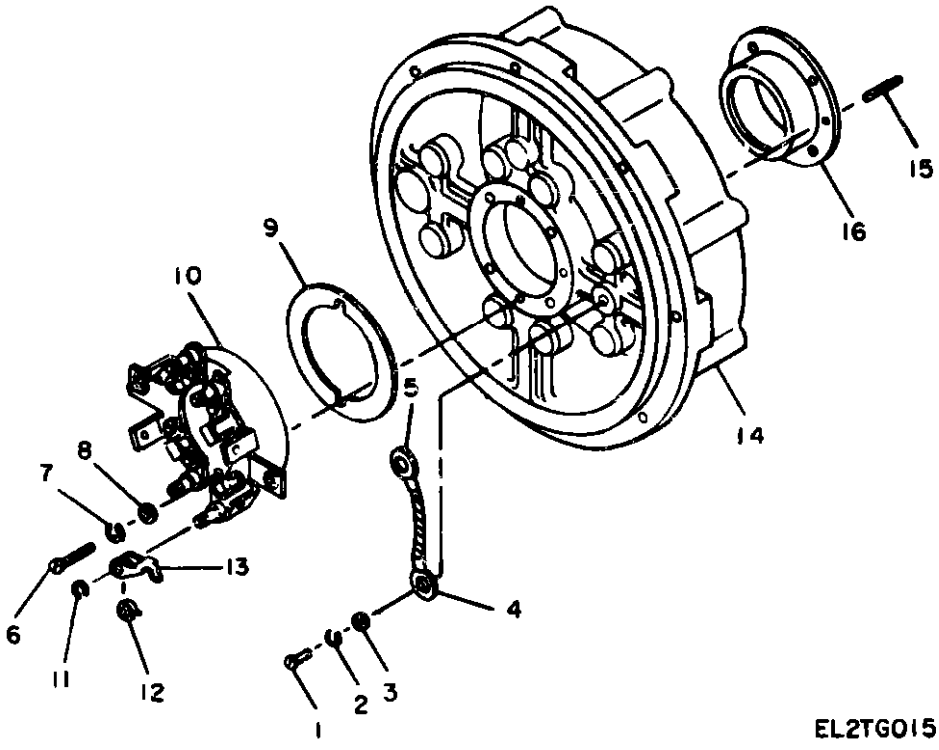


Figure 4-9. Ac end bell assembly

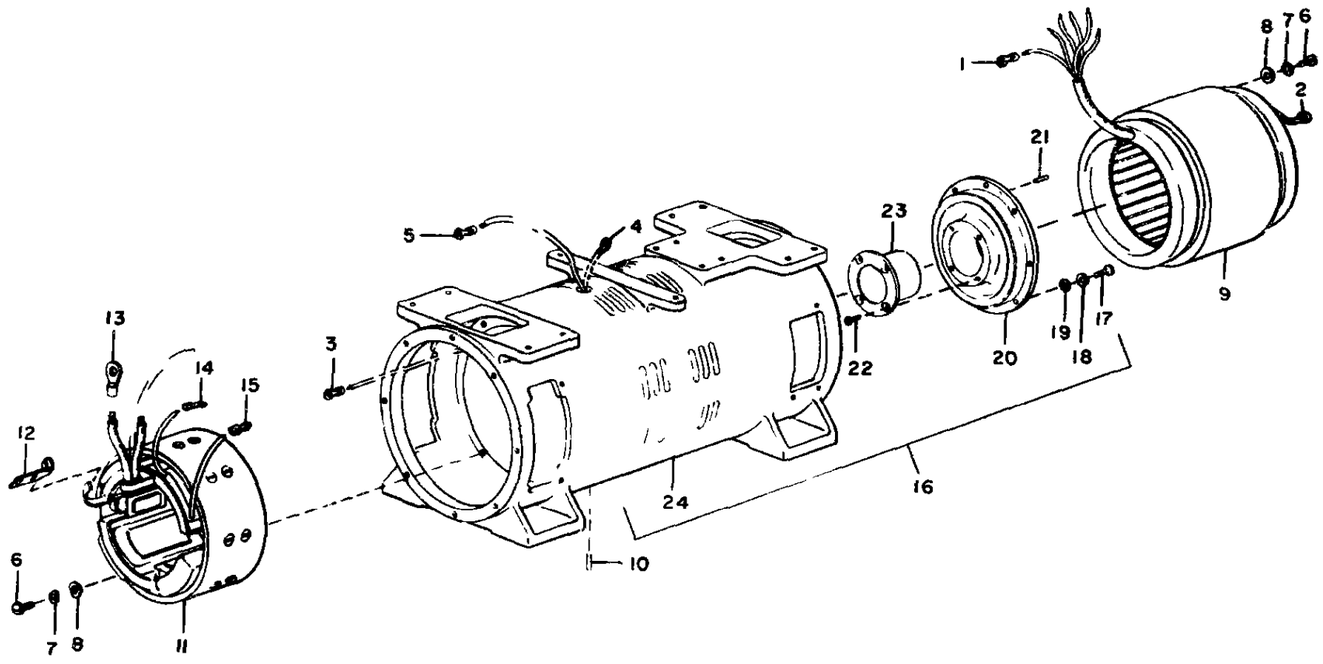


Figure 4-10. Electrical rotating equipment housing assembly

LEGEND FOR FIGURE 4-10

1	Solderless terminal
2	Terminal
3	Terminal
4	Terminal
5	Terminal
6	Screw
7	Lock washer
8	Washer
9	Ac motor generator stator
10	Spring pin
11	Dc Stator
12	Terminal
13	Solderless terminal
14	Terminal
15	Terminal
16	Housing and support assembly
17	Screw
18	Lock washer
19	Washer
20	Dual bearing support
21	Straight pin
22	Screw
23	Bearing liner
24	Housing

WARNING'

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame, the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with the skin should be avoided. **When** necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

4-20. Cleaning

a. General. After disassembly, clean all mechanical parts using only Trichlorotrifluoroethane **(NSN 6850-00-105-3084) naphtha, an aliphatic hydrocarbon, or a solvent conforming to Federal Specification P-D-680. Use a stiff, non-wire brush to** scrub parts thoroughly **Do not allow parts to soak or remain in the solvent. Dry parts with a clean, lint-free cloth.**

b Rotating Equipment Parts

(1) Dip a paint brush in a container of solvent and wash armature assembly (77, fig. FO-3), rotor assembly (78), dc end bell and liner (21, 22, and 23, fig. 4-8), ac end bell and liner (14, 15, and 16, fig. 4-9), and housing support and liner (20 and 23, fig. 4-10) Remove all carbon and copper particles between the commutator bars and the slip rings.

(2) After cleaning, bake metal parts in an oven for 2 hours at 121°C (250°F) or 3 hours at 93°C (200°F) After baking, apply a light film of oil, Military Specification MIL-L-7870, or an approved anticorrosion preparation to all ferrous-metal surfaces to prevent rusting.

WARNING'

To be usable for cleaning, the compressed air source must limit the nozzle pressure to no more than 29 pounds per square inch (PSIG). Goggles must be worn at all times while cleaning with compressed air.

CAUTION!

Do not apply oil to the commutator or slip rings.

c Electrical Parts To clean electrical parts and **assemblies, blow out dust and dirt with clean, dry compressed air If necessary, use a clean, lint-free cloth moistened with a solution of 50 percent isopropyl alcohol, Military Specification MIL-F-5566, and 50 percent water**

4-21. Inspection

a General

(1) After cleaning, inspect the various subassemblies and detail parts for wear damage, and deterioration Replace all worn or damaged parts except where a repair procedure is given

(2) Check for stripped or damaged threads Check screws, washers, nuts, retainers, covers, brackets, housings, terminal blocks, etc, for distortion and wear

(3) Inspect the electrical components for bums, cracks, damaged leads or insulation, insecure terminals, and other signs of physical damage

b Armature and rotor Assemblies Inspect armature assembly (77, fig. FO-3) and rotor assemble (78) as follows

(1) Check the banding wires and clips to see that they are firm and tight Check that commutator bars and slip rings are tight and in alignment Measure the depth of undercut between commutator bars, the depth should not be less than 0 021 inch Check for high bars Inspect the contact surfaces of the commutator and slip rings, which should be even, highly burnished, and copper in color If the contact surfaces are rough, pitted, scored, burned, or have a film of carbon or oil that cleaning will not remove, forward the motor-generator to the depot for overhaul

NOTE

Badly burned commutator bars are usually the result of open-circuited or shorted armature coils

(2) Inspect the armature and rotor windings for burned, cracked, or frayed insulation Check that all conductors are firmly brazed to the commutator risers The depths of the conductors in the armature slots should be approximately equal, and each conductor should be firmly fixed in its slot Check for flaring on the conductors at the drive ends of the core The rotating field coils should be firmly wedged into the rotor slots, with all insulation and taping in place The punchings of the rotating field should be tight

(3) The check and rebalancing of armature and rotor assemblies is performed at depot level If an out-of-balance condition is suspected, forward the motor generator to the depot for overhaul

(4) Use armature test set TS-965( )/U to check armature for shorts

(5) Using insulation breakdown test set AN/GSM-6, apply 300 volts ac 60 Hz, for 1 second between each rotor assembly (78, fig FO-3) slip ring and the shaft

(6) Apply 250 volts ac, 60 Hz, for 1 minute between a commutator bar and the shaft of armature assembly (77)

c End Bell and Housing Assemblies Inspect dc end bell assembly (66 fig FO-3) ac end bell assembly (67), and electrical rotating equipment housing assembly (79) for wear and damage If dc end bearing liner (23, figure 4-8), ac end bearing liner(16, fig 4-9), or dual bearing support (20, fig 4-10) bearing liner is worn, forward the motor-generator to the depot for repair

d Spline

(1) Check spline (76, fig FO-3) for wear by comparing the old spline with a new spline

(2) When inspecting for evidence of overheating, note that although discoloration may indicate weakened spline shaft, the condition can also be present in a sound shaft Uniform discoloration along the pencil section of a new shaft may be disregarded However, localized or blotchy discoloration indicates overheating in service If a slight bluing is present, the shaft may still be serviceable, provided a magnetic particle inspection (Military Specification MIL-I-6868) at depot level reveals no surface cracks If black discoloration is present, discard the spline Conditions which produces worn spline such as overload and excessive vibration, should be eliminated

e ***Electrical Components*** Check suspected electrical components as described in SECTION VI

f AC Stator

(1) Apply 750 volts ac 60 Hz for 1 second between windings A-G B-D and C-F and between each winding and the yoke

CAUTION

Do not apply voltage across windings

(2) Using resistance bridge ZM-4B/U measure the resistance of windings A-G B-D, C-F Resistance should be between 0 1413 and 0 ***1627*** ohm All readings must be within 2 percent of each other

g DC Stator Apply 300 volts ac, 60 Hz, for 1 second between the shunt winding and the yoke and between the series and shunt windings

4-22. Repair or Replacement

a General

(1) Replace all ball bearings and brush assemblies at each overhaul New brushes must be run-in before the final test procedure (refer to paragraph 4-28)

(2) Replace all electrical components having a rating outside the tolerances specified in SECTION VI

(3) Replace all worn or damaged parts except where a repair procedure is given and authorized

b Soldering

CAUTION

Do not use an acid core solder or an acid flux
Do not burn insulation during soldering

(1) When soldering terminals (5 fig 4-8) of the dc end bell lead assembly, use Eclipsaloy No 27 Grade 3 (The Bendix Corporation, Electric & Fluid Power Division, Eatontown, N J) This solder consists of 15 percent silver, ***80*** percent copper, and 5 percent phosphorus and has a melting range of 1200°F (650°C) to 1300°F (705°C) (no Government equivalent specification available)

(2) When soldering connections, use Eclipsaloy No 9, Grade 10 (The Bendix Corporation) This solder consists of 63 percent tin and 37 percent lead, has a melting temperature of 357°F (181°C) and conforms to Military Specification MIL-S-6872

(3) Wash all soldered joints with Lonco flux remover (London Chemical Co) and blow dry with low-pressure compressed air

c Wiring and Sleeving Replacement When replacing worn or damaged wiring and sleeving, use the old wiring and sleeving as guides for size and length

4-23. Reassembly

a Control Box ***Assembly*** (fig 4-6) Since the control box assembly is basically ***an electronic*** assembly, reassembly is limited to replacing damaged parts and installing a repaired current relay assembly

(1) When making wiring connections, refer to fig. 4-1 or 4-1.1 as applicable.

(2) Attach current relay assembly SW1 (92, fig 4-6) using screws (93), and washers (94), and self-locking nuts ***(95)***

(3) When replacing diode CR25 (77), secure in place with a suitable epoxy resin adhesive

(4) For all soldering operations, use solder specified in paragraph 4-22b(2)

b Voltage and Frequency Regulator Assembly Repair of the voltage and frequency regulator assembly is covered in SECTION IV

c Motor-Generator (fig FO-3) Refer to fig 4-1 when making motor-generator wiring connections Assemble the motor-generator as follows

(1) Install bearing springs (75, fig FO-3) into bearing liner of electrical rotating equipment housing assembly (79)

(2) Check that ball bearings (73) have the same part numbers as those removed Heat ball bearings for one-half hour at 250°F (121°C) Support armature assembly (77) and rotor assembly (78) with a suitable support Position slingers (74) and, using a screwdriver press, a swivel adapter and a bearing pusher, press ball bearings ***(73)*** onto the inner ends of the armature and rotor shafts Install retainer ring (72)

(3) Use a base adapter to support the dc and ac end bell assemblies (66 and 67), position one slinger (64), and then press new ball bearings (65) into the bearing liners with a bearing pusher Position remaining slingers (64) and install bearing retainer (60)

(4) Clean the internal splines of armature assembly (77) and rotor assembly (78) and lubricate with Eclipse No 31 spline lubricant (available from The Bendix Corporation, Navigation & Control Group Teterboro, NJ), or equivalent

(5) Install armature assembly (77) through ball bearing (65) and slinger (64) in ac end bell assembly (66)

(6) Install rotor assembly (78) through ball bearing (65) and slinger (64) in ac end bell assembly (67)

(7) Install spline (76) into rotor assembly (78) Slide the rotor assembly into housing and attach ac end bell with screws (68), lock washers (69), and washers (70)

(8) Using a suitable hook, lift ac brush arms and install ac brush assemblies (12) Connect wiring

(9) Slide armature assembly (77) into housing, engage spline, and attach dc end bell with screws (68), lock washers (69), and washers (70)

(10) Using a suitable hock, lift dc brush springs and install two contact dc electrical brushes (9) in each brush holder Connect wiring

(11) Install fans (55 and 56)

(12) Install fan covers (1)

(13) Guide housing leads through holes in control box assembly (50 or 50A). Align the control box assembly and secure in place. Connect wiring.

(14) Install voltage and frequency regulator assembly (21) as described in paragraph 3-11b or 3-14b as applicable.

(15) Install all covers after all tests of SECTION VI have been successfully performed

Section VII. GENERAL SUPPORT TEST PROCEDURE

4-24. General

Motor-generators that pass the test procedures given in this section may be considered accetable for return to service

4-25. Dielectric Test.

Perform the dielectric test as follows

a Disconnect the leads to capacitors C7 and C8

b Disconnect stator T4G lead, the negative brush box lead, and the negative input lead from ground

c Apply 250 volts ac 60 Hz between the dc positive input terminal and ground for one minute

d. **Apply 625 volts ac, 60 Hz, between each ac output terminal and ground for one minute**

e Reconnect all components and leads

4-26. Test Setup

Use the test setup outlined in the Direct Support brush run-in (See fig 3-4)

4-27. Phase Rotation Test

Operate the motor-generator with a 115-volt ac 400-Hz output Check that the phase rotation is A-B-C

4-28. Brush Run-In

a Using the voltage and frequency regulator assembly to control voltage at 115 volts ac and frequency at 400 Hz and the set-up shown in figure 3-4 operate the motor-generator in accordance with the brush run-in load schedule given in table 4-6

b **As shown in fig 4 1' the face of each commutator brush should contact the commutator 100 percent in the direction of rotation and at least 75 percent of the brush dimension parallel to the shaft**

Table 4-6. Brush Run-In Load Schedule

Time (Hours)	Load (Volt-Amperes)
2	1000
2	2000
2	3000
1	3500
1	4000
1	4500
1	5000

c The face of each ship ring brush should contact its slip ring for at least 75 percent of the brush area

d There should be no evidence of excessive grooving or other surface damage to the face of the brushes

4-29. Setting Brush Neutral

a Apply a 27 5-volt dc input and a no-load output

b Measure the shunt field current and then remove input power

c Loosen the screws securing the dc end bell assembly to the housing.

d Shift the dc end bell assembly for minimum shunt field current at no load and for the best commutation at full load

e Tighten the ***dc*** end bell assembly screws

f Drill and install spring pins (71, fig FO-3) to retain the end bell assembly setting

4-30. Voltage and Frequency Potentiometer Spread

a Apply a 27 5-volt dc input and a no-load output

b Monitor output voltage and adjust the voltage adjust potentiometer (fig 3-1) fully counterclockwise and then fully clockwise Output voltage, at minimum, must vary between 110 and 120 volts Adjust output voltage to 116 volts

c. Monitor output frequency. Frequency must be 400 Hz ±10 Hz. See ***paragraph*** 3-5.

4-31. Commutation Test

a Remove the dc brush access covers

b Apply a 26-volt dc input and a no-load output Observe brush commutation The commutation must produce only fine pin points

c Apply a 3-phase, 5000-watt unity power factor load The commutation must produce only fine pin points

d Repeat step b and c with a 29-volt dc input The commutation must produce only fine pin points

e Turn off input power and install the dc brush access covers

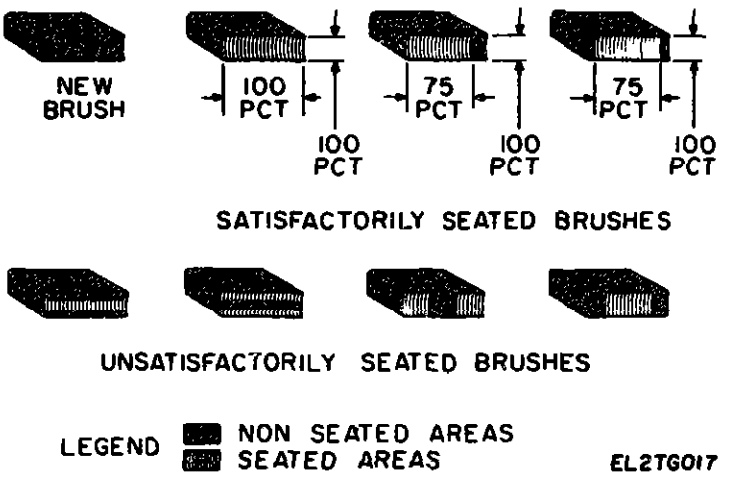


Figure 4-11. Typical brush seating

4-32. Rotational Balance Test

a Place the motor-generator on a flexible resilient pad

b Apply a 5000-watt load

c Check the vibration at both ends of the motor-generator If vibration is excessive forward the motor-generator to the depot for repair

4-33. Elapsed Time Indicator

Operate the motor-generator for two minutes at no load Observe that the elapsed time indicator operates and advances two minutes

4-34. Spin Check

Operate motor-generator at one-half load and at full load with a 28-volt dc input The output voltage must be between 112 5 and 117 5 volts ac and the output frequency must be between 390 and 410 Hz

4-35. Modification Work Orders (MWO's)

At the time of this publication there were no MWOs pertaining to this equipment For a listing of recent MWO's refer to DA PAM 310-7

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DATE 10 July 1975

PUBLICATION NUMBER	DATE	TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/MPQ-76

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PAGE NO	PARAGRAPH	FIGURE NO	TABLE NO	
2-25	2-28			Recommend that the installation antenna alignment procedure be changed to specify a 2° IFF antenna lag rather than 1° REASON Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 20 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train Hunting is minimized by adjusting the lag to 2° without degradation of operation
3-10	3-3		3-1	Item 5, Function column Change "2 db" to "3db " REASON The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator
5-6	5-8			Add new step f 1 to read, "Replace cover plate removed in step 1, above ' REASON To replace the cover plate
		F03		Zone C 3 On J1 2, change "+24 VDC to "+5 VDC " REASON This is the output line of the 5 VDC power supply + 24 VDC is the input voltage

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LEGEND FOR FIGURE FO-2

VOLTAGE AND FREQUENCY REGULATOR ASSEMBLY TYPE 4B48 6-A

REFERENCE DESIGNATION	DESCRIPTION
C1	Capacitor 47 0 uf ± 10% 35 vdc
C3	Capacitor 0 10 uf ± 10% 300 vdc
C4	Capacitor 2 0 uf ± 20% 50 vdc
C6	Capacitor 0 47 uf ± 10% 50 vdc
CR1	Diode 1N645
CR2	Diode 1N645
CR3	Diode SG22
CR4	Diode SG22
CR5	Zener diode 1N936A (8 55 to 9 55 vdc)
CR7	Diode 1N645
CR8	Diode 1N645
CR9	Diode 1N645
CR10	Diode 1N645
CR11	Diode 1N645
CR12	Diode 1N645
CR13	Diode 1N645
CR14	Diode 1N645
CR15	Diode 1N645
CR16	Diode 1N1227
CR17	Diode 1N1199
CR18	Diode 1N1199
CR19	Diode 1N1341
CR20	Diode 1N1341
CR21	Diode 1N645
CR26	Diode SCE1
L1	Reactor (1 09 to 1 15 H)
L2	Reactor (0 220 to 0 260 H)
Q1	Transistor 2N1132
Q2	Transistor 2N1132
Q3	Transistor SP2259
Q4	Transistor SP2259
Q5	Transistor 2N1559
Q6	Transistor 2N1559
R1	Resistor 140 ohms ± 3% 3 w
R2	Resistor 170 ohms ± 3% 3 w
R3	Resistor 1K 3% 3 w
R4	Resistor 300 ohms ± 3% 3 w
R5	Resistor 600 ohms ± 3% 3 w
R6	Resistor 400 ohms ± 3% 3 w
R9	Resistor 400 ohms ± 3% 3 w
R10	Resistor 2K ± 3% 3 w

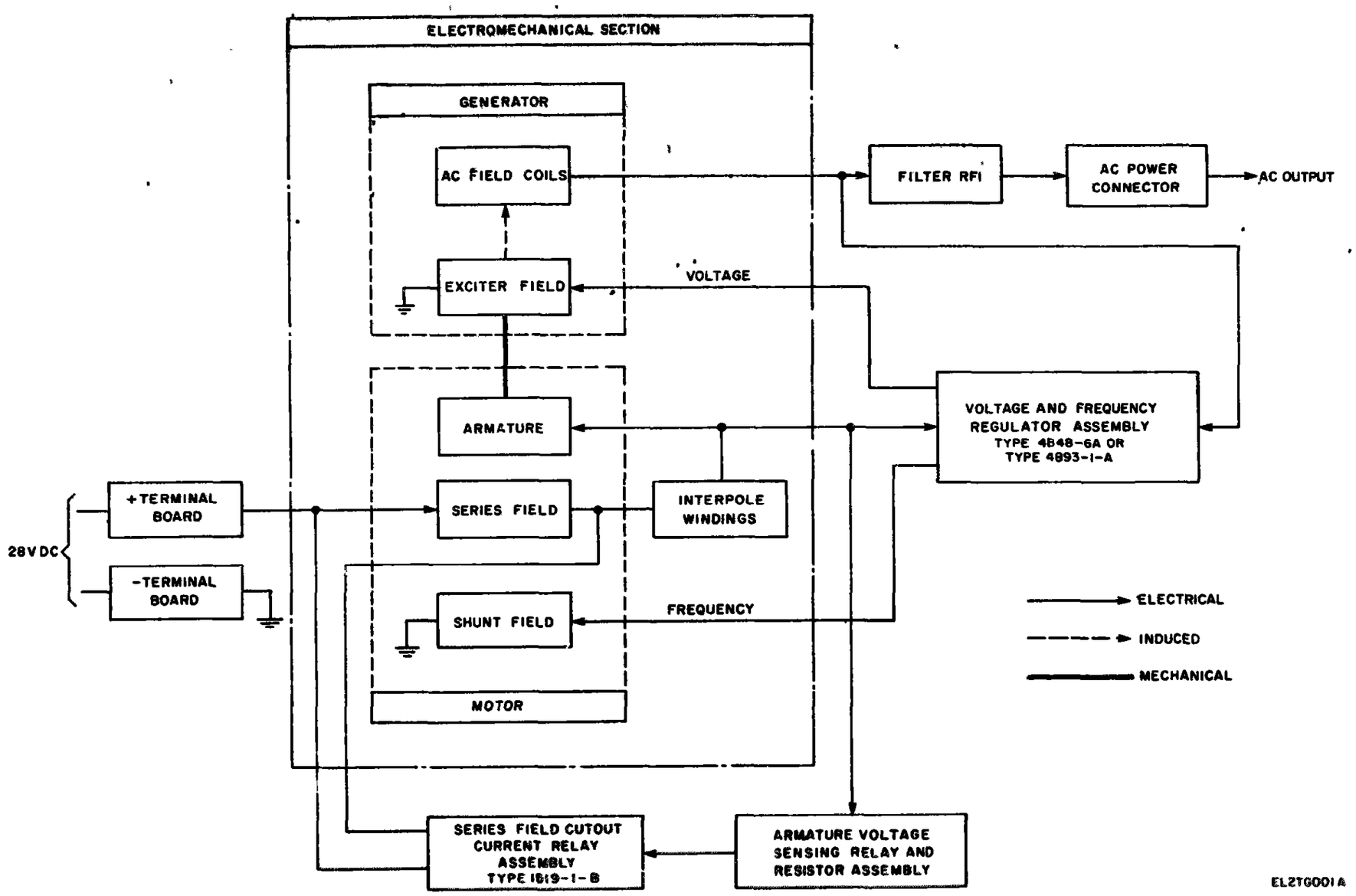

Figure FO-1. Block diagram for motor-generator

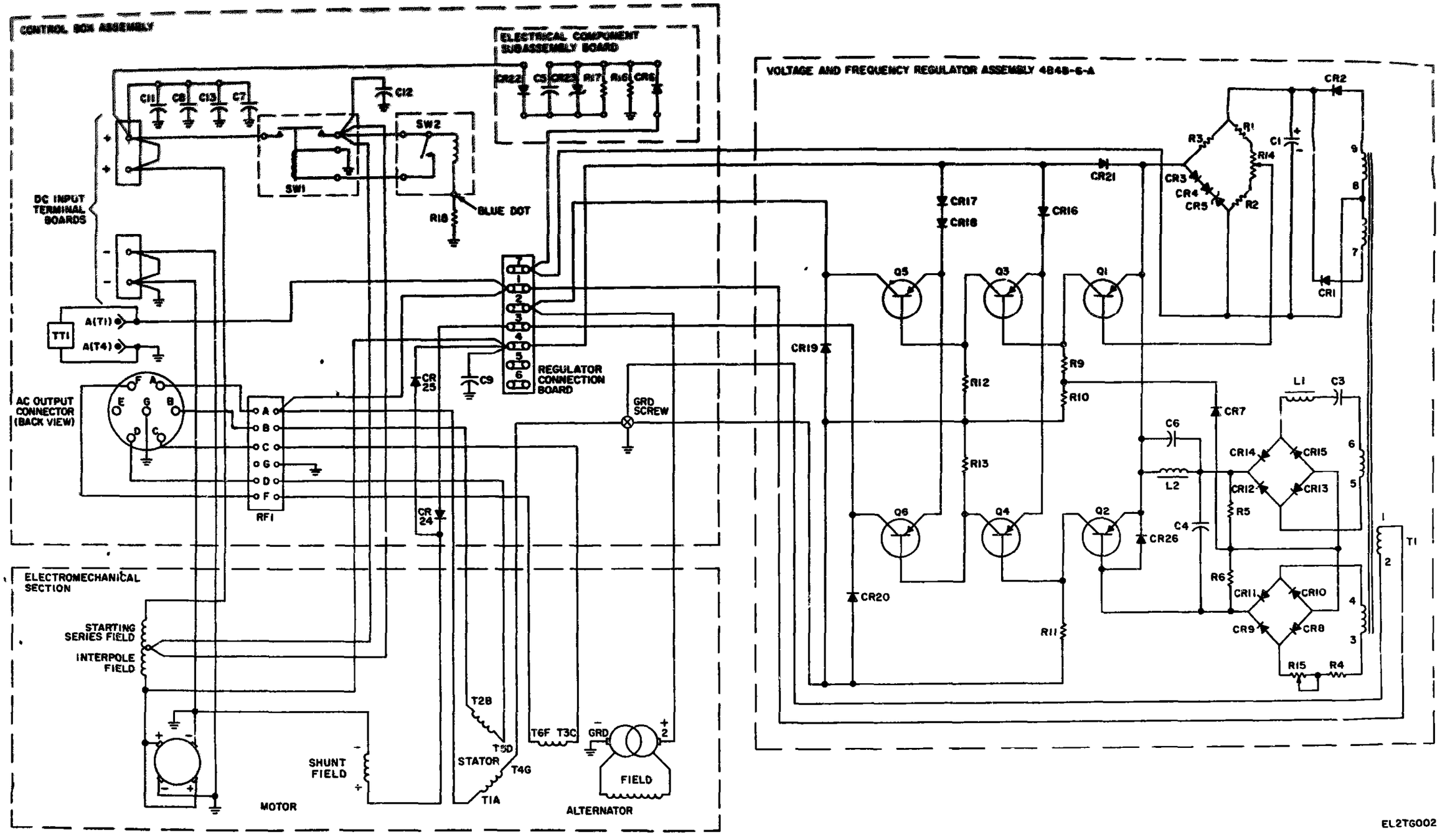

Figure FO-2. Schematic diagram for motor-generator PU-750( )/A

LEGEND FOR FIGURE FO-2 1
VOLTAGE AND FREQUENCY REGULATOR ASSEMBLY
TYPE 4B95-1-A

Reference Designation	Description
C1	Capacitor, 0.047 uf, ±5%, 100 vdc
C2	Capacitor, 1.5 uf, ±20%, 20 vdc
C3	Capacitor, 1.0 uf, ±20%, 35 vdc
C4	Capacitor, 10 uf, ±20%, 20 vdc
C5	Capacitor, 0.22 uf, ±20%, 400 vdc
C6	Capacitor, 1.0 uf, ±20%, 35 vdc
C7	Capacitor, 4.7 uf, ±20%, 10 vdc
C8	Capacitor, 0.22 uf, ±20%, 35 vdc
C9	Capacitor, 0.01 uf, ±10%, 200 vdc
CR1	Diode, 1N645
CR2	Zener diode, 1N823A (5 89 to 6.51 vdc)
CR3	Diode, 1N645
CR4	Diode, IN645
CR5	Zener diode, 1N823A (5 89 to 6.51 vdc)
CR6	Diode, A15A
CR7	Diode, A15A
CR8	Diode, A15A
CR9	Diode, 1N645
CR10	Diode, A15A
CR11	Diode, 1N649
Q1	Transistor, 2N3251
Q2	Transistor, 2N3251
Q3	Transistor, 2N3569
Q4	Transistor 2N2907A
Q5	Transistor, 2N3569
Q6	Transistor, 2N5772
Q7	Transistor, 2N2907*
Q8	Transistor, 2N3569
Q9	Transistor, 2N2219-A
Q10	Transistor, 2N3251
Q11	Transistor 2N5772
R1	Resistor, 10K, ±1%, 1/8w
R2	Resistor, 37 4K, ±1% 1/4w
R3	Resistor, 10K, ±1%, 1/8w
R4	Resistor 24.9K, ±1%, 1/8w
R5	Variable Resistor, ±5%, lw
R6	Resistor, 1k, ±1%, 1/8w
R7	Resistor, 499 ohms, ±1%, 1/2w
R8	Resistor, 1K, ±1% 1/8w
R9	Resistor, 10K, ±1%, 1/8w
R10	Resistor 100 ohms, ±1% 1/8w
R11	Resistor, 12 1K, ±1% 1/8w
R12	Resistor, 15K, ±1%, 1/8w
R13	Resistor, 2K, ±1%, 1/8w
R14	Resistor, 2.49K, ±1% 1/8w
R15	Resistor, 750 ohms, ±1% 1/8w
R16	Resistor 2K, ±1% 1/8w
R17	Resistor, 6.81K, ±1%, 1/8w
R18	Resistor 10K, ±1%, 1/8w
R19	Resistor 26.1K, ±1% 1/8w
R20	Resistor, 49.9K, ±1% 1/8w
R21	Resistor, 4.99K, ±1%, 1/8w
R22	Resistor 3.01K, ±1% 1/8w
R23	Variable resistor 5K, ±10% 1 5w
R24	Resistor, 3 01K ±1% 1 8w
R25	Resistor, 69 8K, ±1%, 1/2w
R26	Resistor 2, ±1%, 1/4w
R27	Resistor, 37.4K, ±1% 1/4w
	CONTROL BOX ASSEMBLY COMPONENTS
C7	Capacitor 40.0 uf +20%, −15% 75 vdc
C8	Capacitor, 0 1 uf ±20%, 50 vdc
C9*	Capacitor 1 0 uf ±10% 200 vdc
C11	Capacitor 2.0 uf ±10% 50 vdc
C12	Capacitor, 0 01 uf ±20%, 300 vdc
C13	Capacitor 0.22 uf ±10%, 50 vdc
R18	Resistor 350 ohms ±3% 3w
R24	Resistor, 100 ohms, ±1% 25w
RFI	Radio interference filter
SW1	Current relay assembly 1519 1B
SW2	Relay and resistor assembly
TTI	Time totalizing indicator

*For schematic and wiring diagram purposes capacitor C9 is considered part of control box assembly

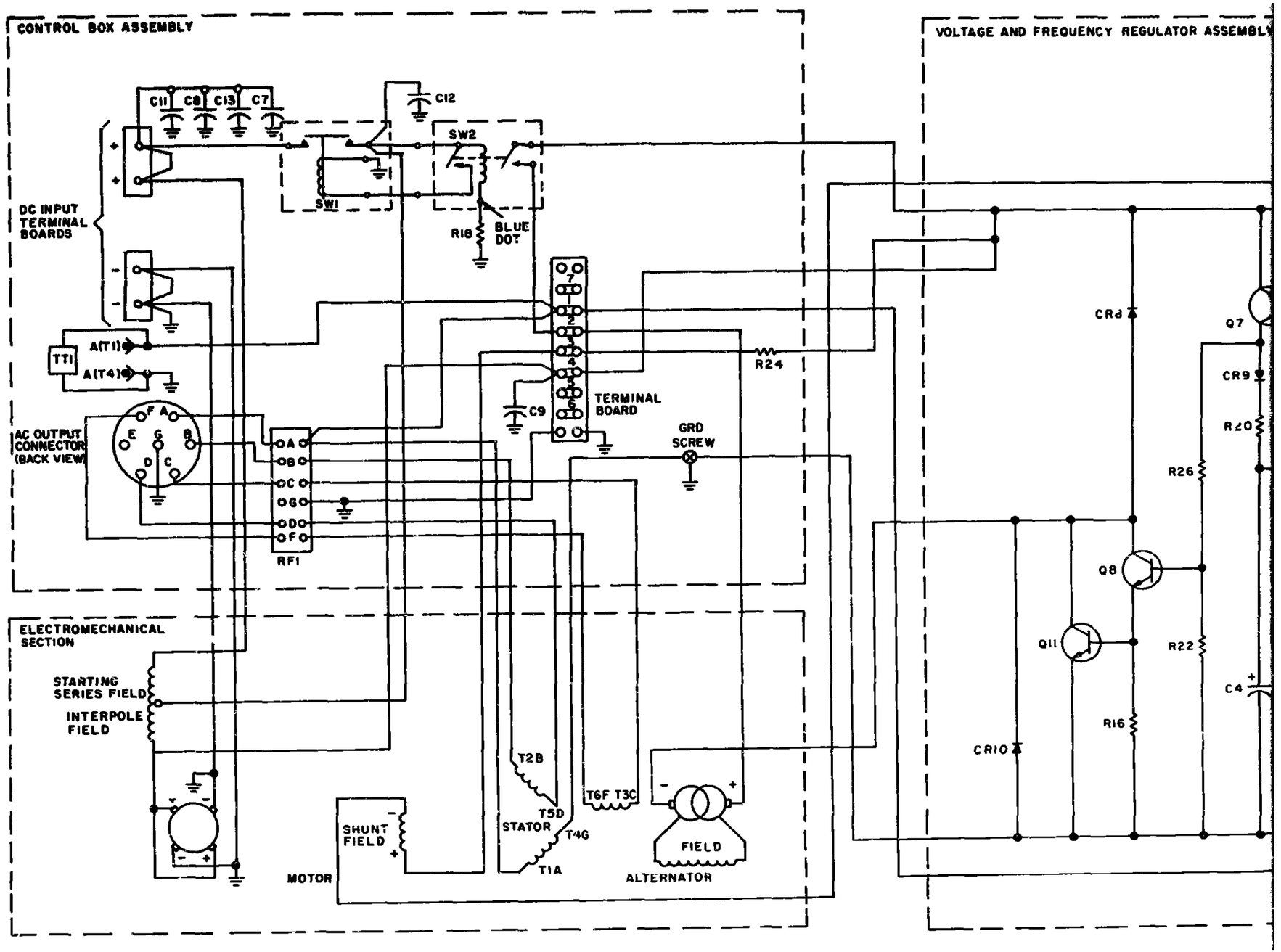

Figure FO-2.1. Schematic diagram for motor-generator PU-750A/A

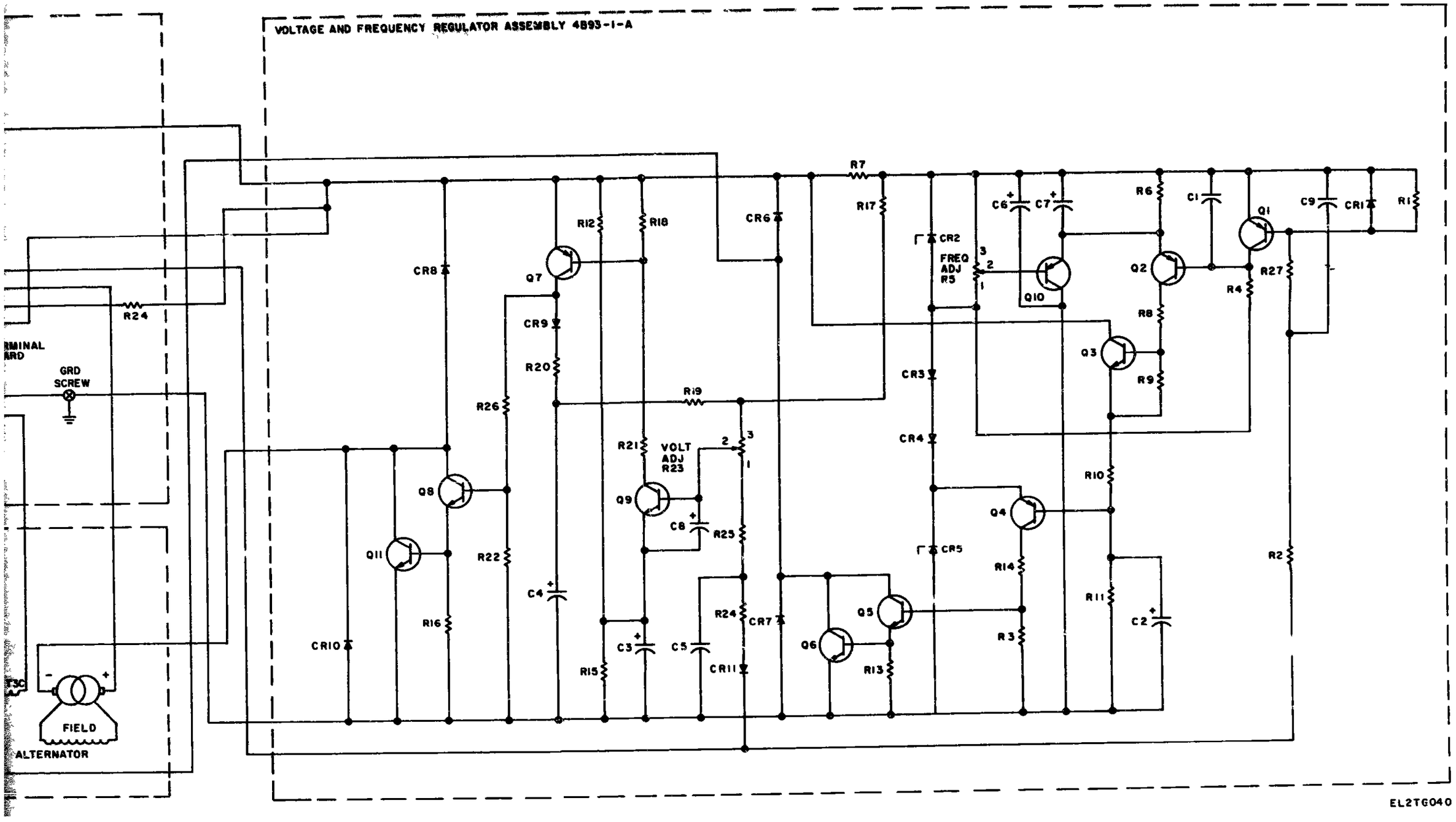

Figure FO-2.1. Schematic diagram for motor-generator PU-750A/A

Legend for Figure FO-3

1 Fan cover
2 Cover screw
3 Lock washer
4 Dc brush electrical cover
5 Ac brush electrical cover
6 Machine screw
7 Lock washer
8 Flat washer
9 Contact dc electrical brush
10 Screw
11 Plain washer
12 Ac brush assembly
13 Screw
14 Lock washer
15 Data plate
16 Data plate
17 Pan head screw
18 Instruction plate
19 Dzus fastener
20 Control box cover subassembly
21 Voltage and frequency regulator assembly Type 4B48-6-A (see fig. 4-5)*
22 Filister head screw*
23 Filister head screw*
24 Lock washer*
25 Plain washer*
25A Pan head screw**
25B Lock washer**
25C Solderless terminal**
25D Solderless terminal**
25E Solderless terminal**
25F Voltage and frequency regulator assembly Type 4B93-1-A. (See fig. 4-5 1)**
25G Pan head screw**
25H Lock washer**
25I Flat washer**
26 Hex nut
27 Lock washer
28 Flat washer
29 Hex head bolt
30 Jumper
31 Solderless lug terminal
32 Lug terminal
33 Solderless lug terminal
34 Lug terminal
35 Strap
36 Terminal board jumper
37 Special identification plate
38 Self-tapping screw
39 Hex nut
40 Lock washer
41 Plain washer
42 Filister head screw
43 Lock washer
44 Plain washer
45 Solderless terminal
46 Capacitor (C9)
47 Loop clamp
48 Jumper
49 Dust cap
50 Control box assembly (see fig. 4-6)**
50A Control box assembly (see Fig. 4-6)**
51 Filister head screw
52 Tooth lock washer
53 Flat head screw
54 Instruction plate
55 Dc fan
56 Ac fan
57 Nut
58 Flat washer
59 Woodruff key
60 Bearing retainer
61 Machine screw
62 Lock washer
63 Flat washer
64 Slinger
65 Ball bearing
66 Dc end bell assembly (see fig 4-8)
67 Ac end bell assembly (see fig. 4-9)
68 Machine screw
69 Lock washer
70 Flat washer
71 Spring pin
72 Retainer ring
73 Ball bearing
74 Slinger
75 Bearing spring
76 Spline
77 Armature assembly
78 Rotor assembly
79 Electrical rotating equipment housing assembly (see fig. 4-10)

* PU-750( )/A only
** PU-750A/A only

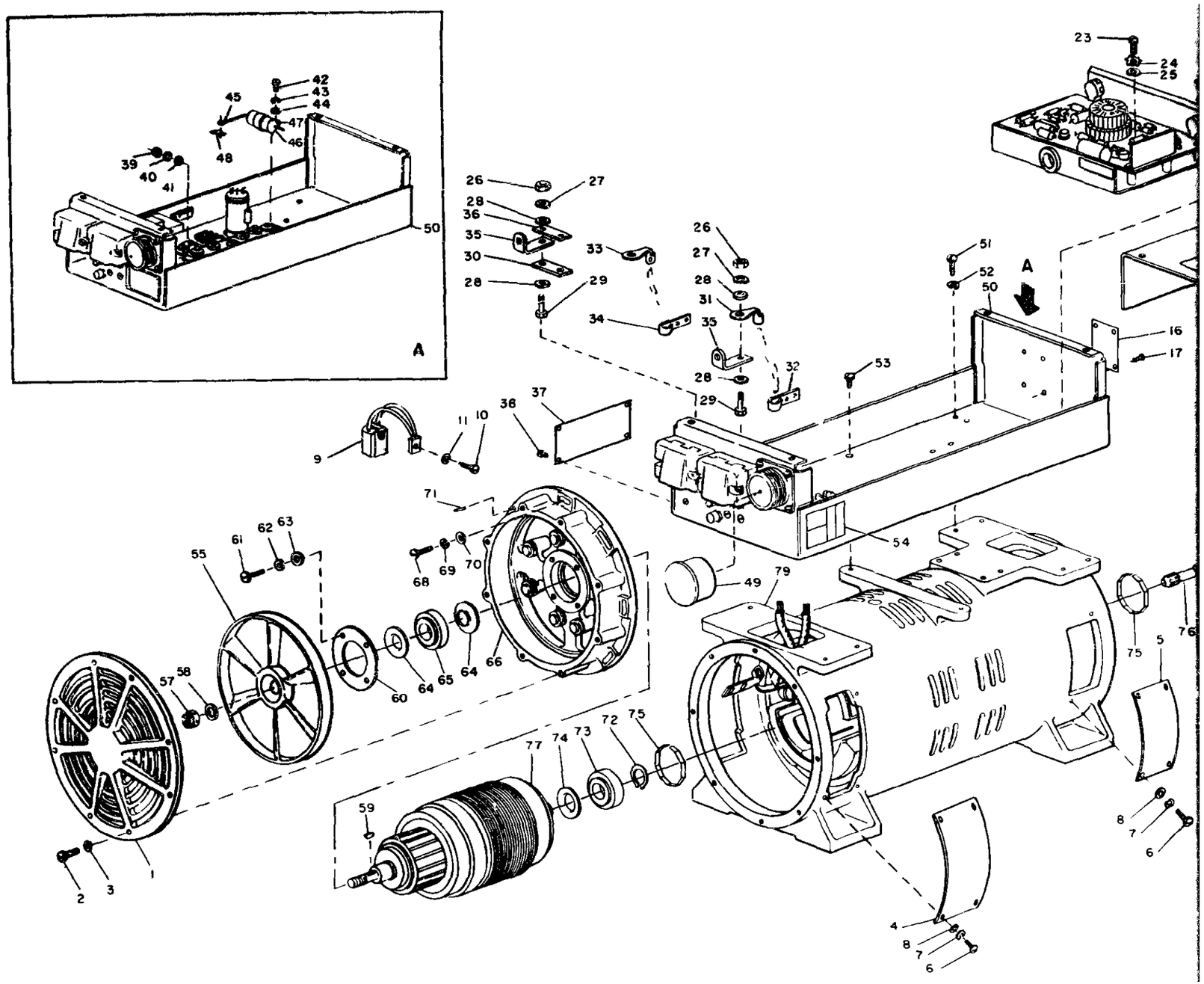

Fig. FO-3

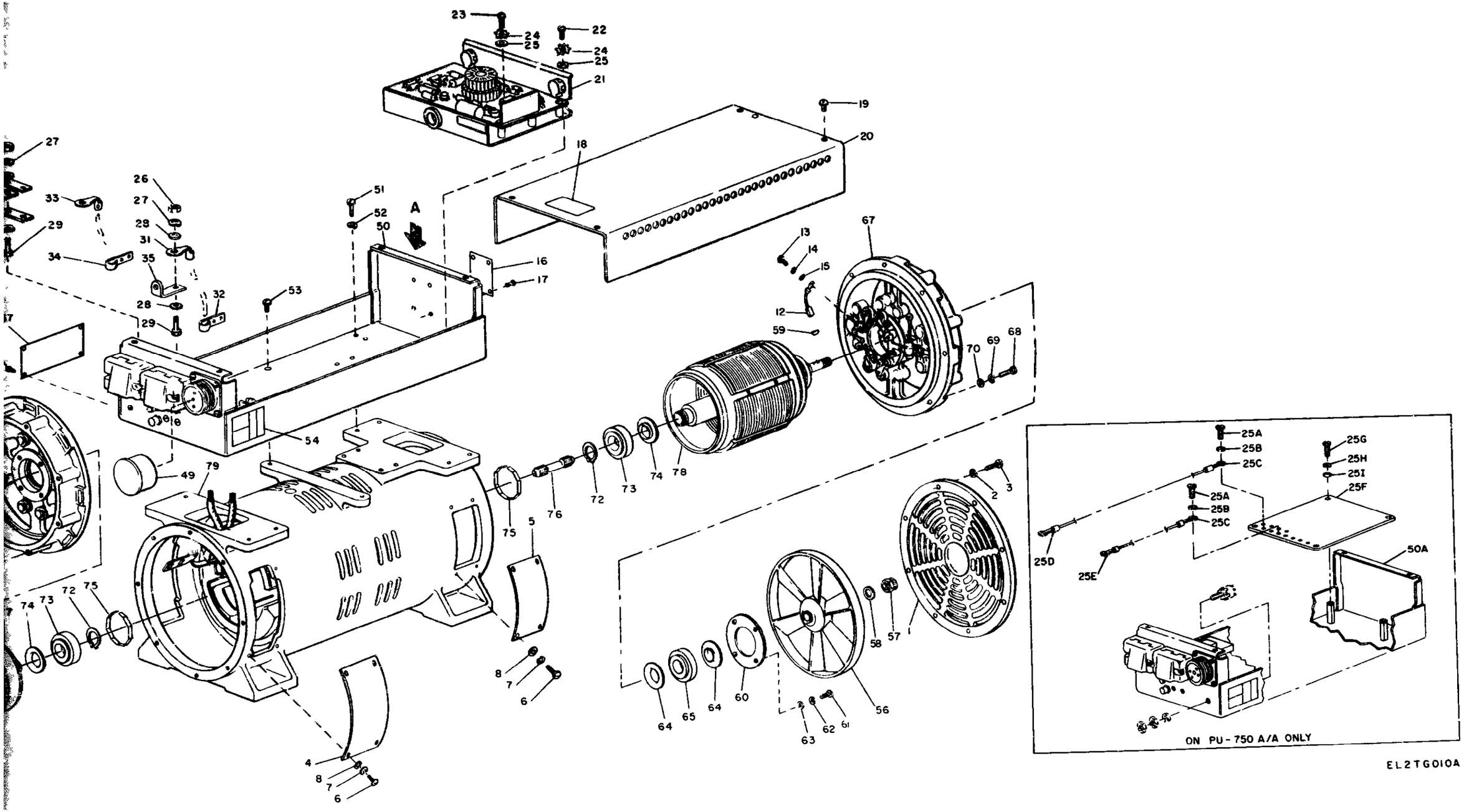

Figure FO-3. Motor-generator

.r of the Secretary of the Army

BERNARD W ROGERS
General United States Army
Chief of Staff

J C PENNINGTON
r General United States Army
The Adjutant General

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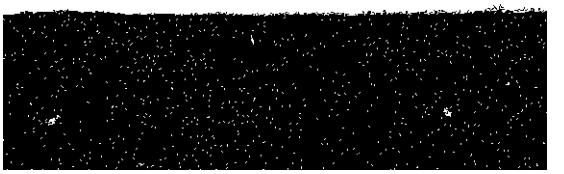

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