TM 11-6125-253-35

TECHNICAL MANUAL

DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

MOTOR-GENERATOR PU-733/A

HEADQUARTERS, DEPARTMENT OF THE ARMY
DECEMBER 1971

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Serious injury or death may result from contact with the 115 volts ac output of Motor-Generator PU-733/A. Be extremely cautious when working with the equipment.

DO NOT TAKE CHANCES

TECHNICAL MANUAL
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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 8 December 1971

DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

MOTOR GENERATOR PU/733/A

ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

1-1. Scope

This technical manual contains information for the maintenance of the Motor Generator FU-733/ A. Included are instructions for and repair, calibration and test procedures to be used in the performance of DS, GS, and depot maintenance.

1-2. Indexes of Publications

a. ***DA Pam*** 310-J. Refer to DA Pam 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) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750

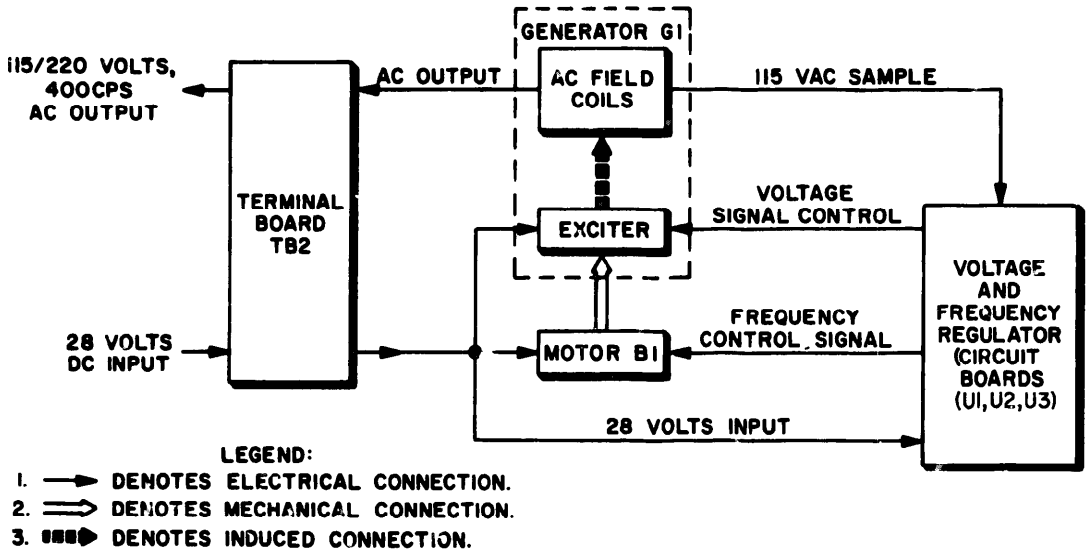
b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of 'Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army)/NAVSUP Publication 378 (Navy)/AFR 71-4 (Air Force)/ and MCO P4630.29 (Marine Corps).

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 (Army)/NAVSUP Pub 459 (NAVY)/AFM 75-34 (Air Force)/ and MCO P4610.19 (Marine Corps).

d. Reporting of Equipment Manual Improvements. Reporting of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forward direct to Commanding General, US Army Electronics Command, ATTN: AMSEL-ME-NMP-AN, Fort Monmouth, NJ 07703.

CHAPTER 2

FUNCTIONING OF EQUIPMENT



EL6125-253-35-TM-I

Figure 2-1. PU-733/A block diagram.

2-1. General

The motor-generator may be divided into two sections: a mechanical section consisting of motor B1 and generator G1, and an electrical regulator section consisting of voltage and frequency regulator circuit boards Ul, U2, and U3. The mechanical and electrical sections are described in paragraph 2-2 and 2-3.

2-2. Block Diagram Analysis

a. Mechanical Circuits.

(1) The 28-volt dc input is applied to the mechanical section of the motor-generator by means of terminal board TB2 (see fig. 2-l) to motor Bl and the exciter portion of generator Gl, causing current to flow in each of the components.

(2) Application of 28 volts dc to the motor causes the motor armature to rotate. Since the exciter portion of the AC generator is mechanically coupled to the motor armature (on the same shaft), the exciter portion of the generator rotates.

(3) As the motor rotates, an ac voltage is induced in the generator field coils. The ac voltage induced in the field coils is applied to the terminal board TB2 as an output voltage. A sample of the ac output voltage is also applied to the regulator circuits.

b. Regulator Electrical Circuits.

(1) Control of the voltage and frequency of the motor-generator output is accomplished in the regulator section by establishing control time for current flow through the field winding, of the motor and excitation windings of the generator.

(2) The ac output voltage sample from the generator field windings is applied to the regulator circuits. The sample signal is converted to voltage and frequency error signals and processed to provide control signals for application to the motor and generator.

(3) The frequency control signal is applied to the motor field winding to control the motor rotation speed. The voltage control signal establishes the conduction time on of current flow through the generator excitation windings to control the output voltage level.

(4) The 28-volt dc input voltage is also applied to the regulator circuits for the operation of the control circuits.

2-3. Circuit Analysis

a. Mechanical Section.

(1) The mechanical section of the motor-generator consists of a DC motor and AC generator. Both units share the same housing, with separate stationary windings. The dc armature of the motor and the ac rotor of the generator share a common shaft.

(2) The motor is a series-shunt motor with windings wound in magnetic opposition to each other. It operates from the 28-volt dc input power applied to it from the aircraft electrical system.

(a) Power for operation of the motor is applied through a set of series coils and shunt coils. The series coils and the shunt coils are connected so that they are always magnetically opposed to each other. The dc brushes are located at the neutral point between the four pairs of coils (poles). Therefore, adjacent commutator bars on the motor armature reach a dc brush when no voltage is between brushes.

(b) When 28 volts is impressed upon series coils, current will flow through the series coils, the shunt coils, the positive dc brushes, the motor armature, and the negative dc brushes to ground. The magnetic field, resulting from the current flow through coils, reacts with the magnetic field set up by the current flow through the motor armature, causing the armature to rotate. Since the coils are magnetically opposed, the field is always such that it will cause the armature to rotate.

(c) By rotating through a magnetic field, the armature causes a counter electromotive force (cemf) to be induced into the armature winding. The armature rotation speed increases 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.

(3) The AC generator is a rotating field-type generator. Direct current from the external source is fed to the rotor through the sliprings and ac brushes. When the dc motor starts, it turns the rotor of the AC generator. As the rotor revolves, magnetic fields set up by the current through the sliprings, and ac brushes pass conductors in the ac stator and induce an alternating current in the ac stator winding. Alternating current is then available at the terminal board TB2.

b. Regultor Circuits.

(1) The regulator consists of three interconnected module-type circuit boards (Ul, U2, and U3). Mechanical and electrical connections between circuit boards are made by means of stainless-steel screws and copper connectors, which are part of the terminal board.

(2) The regulator controls the motor-generator frequency output by governing the speed of the rotating section; this is done by controlling the strength of the motor shunt field. The voltage output is regulated through control of the current in the AC generator exciter.

(a) As the mechanical speed of the motor-generator increases, the output frequency increases. To control the output frequency, the regulator controls the current flow through the motor shunt coils. The speed of the motor may be reduced by increasing the strength of the motor shunt field. The regulator controls the amount of current in the shunt field winding to establish the speed level necessary for the desired frequency.

(b) 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 flow of current in both motor and generator field windings simultaneously at approximately twice line frequency. Control is accomplished by establishing the appropriate instant for turn-on of conduction through the controlled rectifier power stage. This turn-on function is established by the frequency sensing and the voltage control stages. Frequency and voltage gate turn-on stages are arranged so that, in the absence of any ac

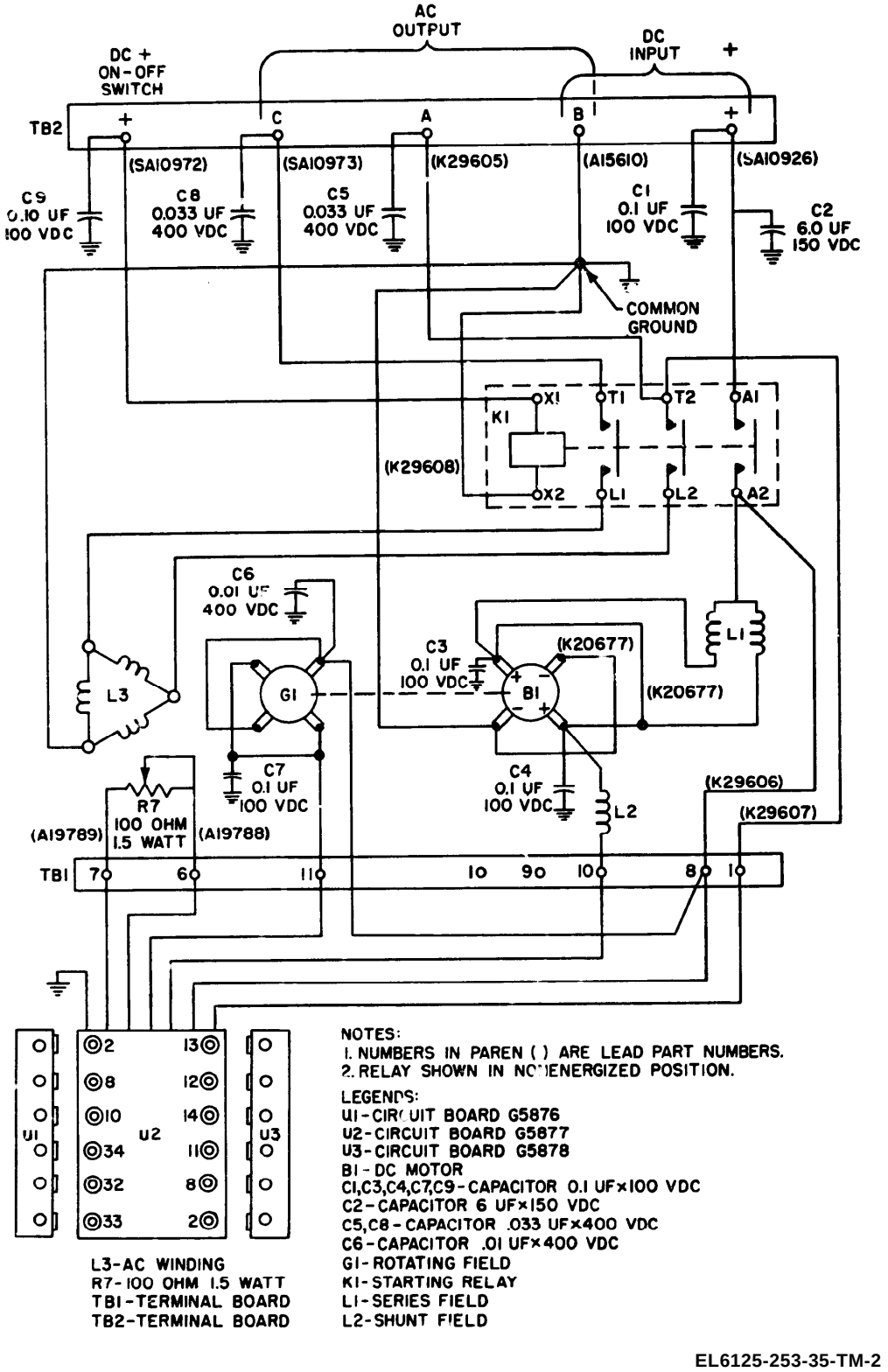


Figure 2-2. PU733/A wiring diagram.

voltage, a continuous sequence of pulses is produced until the gates of the controlled rectifier power stage are fired. The shutoff energy is derived from the motor-generator output. There is always a pulse available to permit conduction, but conduction can be stopped only when the motor-generator is producing a normal output potential.

2-4. Circuit Board Stage Analysis

a. Circuit Board U2.

(1) Circuit board U2 contains the frequency sensing, voltage control, dc regulator and controlled rectifier power circuits.

(2) The frequency sensing circuit compares two voltage signals, both dependent on frequency changes. The resultant error signal is applied to circuit board Ul. If the frequency is too high, the signal will be negative. If the frequency is too low, the signal will be positive.

(3) The voltage control circuit develops a calibrated dc voltage signal that is applied to circuit board U3.

(4) The dc regulator circuit rectifies and sends a controlled voltage signal to the voltage gate turn-on stage and a clipped half-sinusoidal wave to the voltage gate shutoff stage.

(5) The controlled rectified power circuit is operated by signals from circuit boards Ul and U3. This circuit controls the amount of current applied to the motor shunt field winding to establish motor speed for frequency control. It also regulates the average current in the generator exciter.

(6) When the motor-generator starts, there is a sudden current surge that produces a high negative-going potential across the motor shunt field. The controlled rectifier stage loads the circuit to prevent exceeding the reverse voltage rating of the diodes.

b. Circuit Board U1. A frequency error signal from the frequency sensing stage of circuit board U2 is applied to circuit board Ul. This signal is converted by Ul into a pulse-time sequence signal and, by means of a frequency gate turn-on stage, gates the controlled rectifier power circuit of circuit board U2 to control the current, in the motor shunt field.

c. Circuit Board US, General. Circuit board U3 accepts a voltage signal from the voltage control stage of circuit board U2, compares it against a referenced Zenor diode, and converts the resulting error signal to a pulse sequence which gates the controlled rectifier power circuit of circuit board U2 to control the generator exciter field. Circuit board U3, simultaneously at twice frequency, interrupts conduction of the flow of current in the motor field winding and the generator exciter winding.

CHAPTER 3

DIRECT SUPPORT MAINTENANCE

Section I. GENERAL

3-l. Scope of Direct Support Maintenance

Scope of Direct Support Maintenance is detailed in the Maintenance Allocation chart. Refer to TM 11-6125-253-20.

3-2. Tools, Test Equipment, and Materials Required

a. The following chart lists the test equipment required for the DS support of the generators. Also listed are the associated technical manual and the assigned common names for the equipment.

b. Tools, Test Equipment, and Materials Required.

Tool or device	*Location*	Use
Multimeter, Electronic ME-26B/U	Bench test	Measure voltages and resistances.
Multimeter TS-352B/U	Bench test	Motor-generator test and brush neutral settings.
Power Supply PP-ll04A/G	Bench test	Used in conjunction with test set.
Test Set AN/GSM-65	Bench test	Test Motor-generator.
Tool Kit TK-100/G	Work area	Repair of motor-generator.
Torque Wrench FSN 5120-541-3002	Work area	Torquing hardware at reassembly.

Section II. DIRECT SUPPORT TROUBLESHOOTING

WARNING

When servicing the motor-generator, be extremely careful to avoid contact with the ac output circuits.

3-3. General Instructions

The DS troubleshooting procedures in this chapter cover the duties and responsibilities of DS Maintenance as indicated by the Maintenance Allocation Chart. The systematic troubleshooting procedure, which begins with the operational and sectionalization check that can be performed at an organizational level is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting are more advanced.

3-4. Organization of Troubleshooting Procedures

a. ***General.*** The first step when servicing a defective motor-generator is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. ‘Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing brushes, burned electrical leads, and shorted stator windings can often be located by sight, smell, and hearing. Some faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. Listed below is a group of tests arranged to aid in tracing troubles in a defective motor-generator.

(1) ***Visual inspection.*** The purpose of visual inspection is to locate faults without testing or measuring circuits. Visual signs should be observed and an attempt made to sectionalize the fault to a particular component.

(2) Operational tests. Operational tests frequently indicate the general location of trouble. These tests will often help in determining the exact nature of the fault.

c. Localization. The tests listed will aid in isolating the trouble. First localize the trouble to either the rotating section, or the regulator section, and then isolate the trouble as follows:

(1) Voltage and frequency measurements. Voltage and frequency measurements by direct support level personnel are restricted. Make voltage and frequency measurements in this equipment ***only as specified.*** This equipment is transistorized. Observe all cautions given to prevent transistor damage use Electrical Power Test Set AN/GSM-65 to determine ac output voltage and frequency ***as specified*** for voltage and frequency measurements. Compare readings taken from AN/UPM-93A with those obtained from the aircraft voltage and frequency meters.

(2) Troubleshooting chart. The trouble symptoms listed in the chart will aid in localizing trouble to a component part.

(3) Intermittent troubles. In making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the external and internal wiring connections to the motor-generator.

CAUTION

Do not attempt removal or replacement of parts before reading paragraphs 3-5 and 3-6.

3-5. Operational Test

a. General. If the motor-generator output is determined to be out of limits localize the trouble as outlined in paragraph 3-7. If no fault is indicated, the fault may be in the wiring of the aircraft. Refer to the applicable aircraft manual for the interconnecting wiring diagram.

b. Power Requirements. The power supply must be capable of supplying 24 amperes at 28 volts dc.

CAUTION

Use a fine tipped screwdriver to adjust variable resistor to prevent damage to slots in the resistors. Loosen the outer lock nut on voltage adjustment resistor R7 before attempting to adjust. Tighten again at completion of test.

c. Test Procedure.

(1) Turn on the aircraft ac components one at a time until the motor-generator is fully load. ed. The voltage variation between no load and full load must be less than 2 l/2-volt.

(2) If any abnormal indications (3) through (6) are noted, remove the motor-generator from the aircraft and test using Test Set AN/UPM-93A.

(3) Turn off main power switch at completion of test and remove multimeter loads.

3-6. Localizing Troubles

a. Use of Troubleshooting Chart. The troubleshooting chart will aid in localizing troubles to the components of the motor-generator. The troubleshooting chart supplements the equipment performance checklist in TM 11-6125-253-20. When no operational symptoms are known, perform the operational test, and then proceed to the troubleshooting chart until trouble is located. If the localizing procedures in the troubleshooting chart do not correct the fault, remove the motor-generator from the aircraft for bench testing and repair.

b. Conditions for Tests. All checks in the troubleshooting chart are to be conducted with the motor-generator connected for normal use.

3-7. Direct Support Troubleshooting Chart

Item No.	*Trouble symptom*	*Probable trouble*	*Checks and corrective measures*
1	Motor-generator fails to start	a. No de power supply	***a.*** Check dc fuse or circuit breaker. (1) Clean and tighten fuse contacts, if applicable. Replace blown fuse. (2) Reset controls.
		b. Dc input circuit open.	b. Check test set wiring and connection to the motor-generator for an open circuit. Repair or replace defective test set wiring or connection.
		c. Dc brushes not making contact with commutator.	c. If visual inspection indicates this condition, or worn or broken brushes, replace the brushes.
		d. Armature jammed	d. Refer the motor-generator to the next higher category of maintenance for repair.
		e. Defective relay	e. Replace relay.
2	Motor-generator virbrates	***a.*** Loose or missing hardware.	a. Tighten or replace missing hardware.

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
		b. Motor-generator improperly seated.	**b.** See that mounting surface is clean and free of foreign objects.
		c. Unbalanced armature	c. Refer to higher category of maintenance.
3	Motor-generator runs but fails to deliver ac voltage or frequency.	a. Ac circuit open	a. Connect Multimeter TS-352/U to each of the ac terminals connections and ground in turn. Turn on necessary aircraft switches to start motor-generator. If multimeter indicates between 109 and 121 volts ac, check exterior wiring and connections for an open circuit. Repair or replace defective wiring. If multimeter does not indicate between 10p- and 121-volt ac, refer to paragraph 3-11 and adjust voltage and frequency. If readings are still out of limits refer the motor-generator to a higher category for repair.
		b. Defective relay	h. Replace relay.
		c. Regulator failure	c. Refer motor-generator to next higher category of maintenance for repair.
4	Frequency is outside range of 395 to 405 cps or ac voltage outside range of 108 to 123 volts.	a. Dc input voltage high or low.	a. Check dc voltage at power supply.
		b. Regulator out of adjustment.	b. Refer to paragraph 3-11 and adjust voltage and frequency. If still out of limits refer motor-generator to next higher maintenance category.
		c. Failure of motor-generator or regulator.	c. Refer Motor-generator to a higher category of maintenance for repair.
5	Output voltage unstable	a. Loose connections	a. Check for loose connections and tighten.
		b. Poor commutation	**b.** Refer motor-generator to next higher category of maintenance for repair.
		c. Worn or broken brushes.	c. Replace.
6	Motor-generator is noisy	a. Motor-generator not firmly mounted, or parts are loose.	a. Check mounting bolts and other bolts and screws. Tighten if loose.
		b. Worn bearings	b. Remove dc end fan cover and turn armature by hand; feel and listen for roughness in bearings. If bearings are worn refer motor-generator to higher maintenance category.
		c. Armature dragging	c. Remove dc end fan cover and rotate armature by hand; feel and listen for indications of interference. If interference is evident refer motor-generator to higher maintenance category.
		d. Brushes sparking	**d.** Replace brushes.

3-8. Bench Testing Motor-Generator

a. When to Bench Test. Bench test the motor-generator when any of the following conditions apply:

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

(2) When abnormal symptoms reported from operational tests (para 3-5) indicate the need for higher category repair,

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

(1) Mount the motor-generator on a test bench.

(2) Interconnect the motor-generator and the bench test set (para 3-10).

3-9. Test Equipment Required for Bench Testing

The following equipment is required for bench testing the motor-generator :

a. Test Set, Motor-Generator AN/GSM-65 (bench test set).

b. Power Supply PP-1104A/G.

3-10. Test Setup

Bench tests of the motor-generator require connection to the bench test set and to a 26- to 29-volt, 50-ampere dc power source. Prepare the bench test set for testing the motor-generator as outlined in a through j below.

a. All of the test will be performed with the motor-generator mounted on a test bench.

NOTE

Testing will be simplified if connections and tester control settings are made initially and modifications are made as required for the individual tests.

b. Use cable CX-12083/GSM-65 (cable No. 2) of AN/GSM-65 test set. See figure 3-l for motor-generator test hook-up.

CAUTION

Remove all unused cable sets from the storage compartment in the cabinet top to prevent cable damage due to heat generated during testing.

c. Set the following test set AN/GSM-65 switches and controls.

Switch or control	***Setting/position***
AC AMP METER RANGE	10
Volt/AMP switch	A
LOAD switch	3 PHASE
LIVE CIRCUIT	OFF
DC POWER	OFF
LOAD CONTROL	**100**
DC AMP METER RANGE	100

d. Remove the terminal board cover and connect the cable to the terminal board of the motor-generator and to the test set. Connect the power supply to the test set.

WARNING

The lead with the insulated alligator clip (connected to DC ON-OFF switch) provides line (28 vdc) voltage when the LIVE CIRCUIT switch is in the on position regardless of the position of the dc POWER switch.

3-11. Test Procedure

a. Place the bench test set LIVE CIRCUIT and POWER ON switches to the ON position. The motor-generator should start.

b. Loosen the motor-generator voltage adjustment locknut, and turn voltage Adjustment potentiometer through its full range. The minimum reading at the extreme low voltage setting must not exceed 109 volts, and the reading at the extreme maximum setting must not be less than, 121 volts.

c. Adjust the bench test set LOAD CONTROL until the AC AMPS meter indicates 2.17 amperes and the AC VOLTS meter indicates 115 volts. Turn the voltage adjustment through its full range. No variation in the adjustment range (b above) is permitted. Place the LOAD CONTROL at 0, and set the motor-generator voltage adjustment to provide an output of 115 volts ac. Tighten the adjustment locknut.

d. With the bench test set LOAD CONTROL at 0, vary the input voltage from 26 to 29 volts. The motor-generator output voltage should not vary more than 2.3 volts. The frequency should not vary more than 10 Hz.

e. Adjust the bench test set LOAD CONTROL until the AC AMPS meter indicates 2.17 amperes and the AC VOLTS meter indicates 115 volts. Vary the input voltage from 26 to 29 volts. The output voltage should not vary more than 2.3 volts; the frequency should not vary more than 10 Hz.

f. Adjust the motor-generator input to 29 volts with the LOAD CONTROL set at 0. Using the LOAD CONTROL, apply and remove a 2.17 ampere ac load. Repeat this procedure with the input adjusted to ***26*** volts. Voltage and frequency variations must be within the limits specified in e above.

NOTE

Maximum allowable input current during performance tests given in d, e, and f above is 13 amperes at zero load, ***24.8*** ampcres at full load, single-phase.

g. If the indications in o through f above are abnormal, meter to the troubleshooting chart.

h. When, satisfactory operation is obtained, place the bench test set LIVE CIRCUIT and POWER ON switches at OFF. Turn off or place all switches in the lowest numbered or lettered positions. Disconnect the motor-generator and the power supply leads.

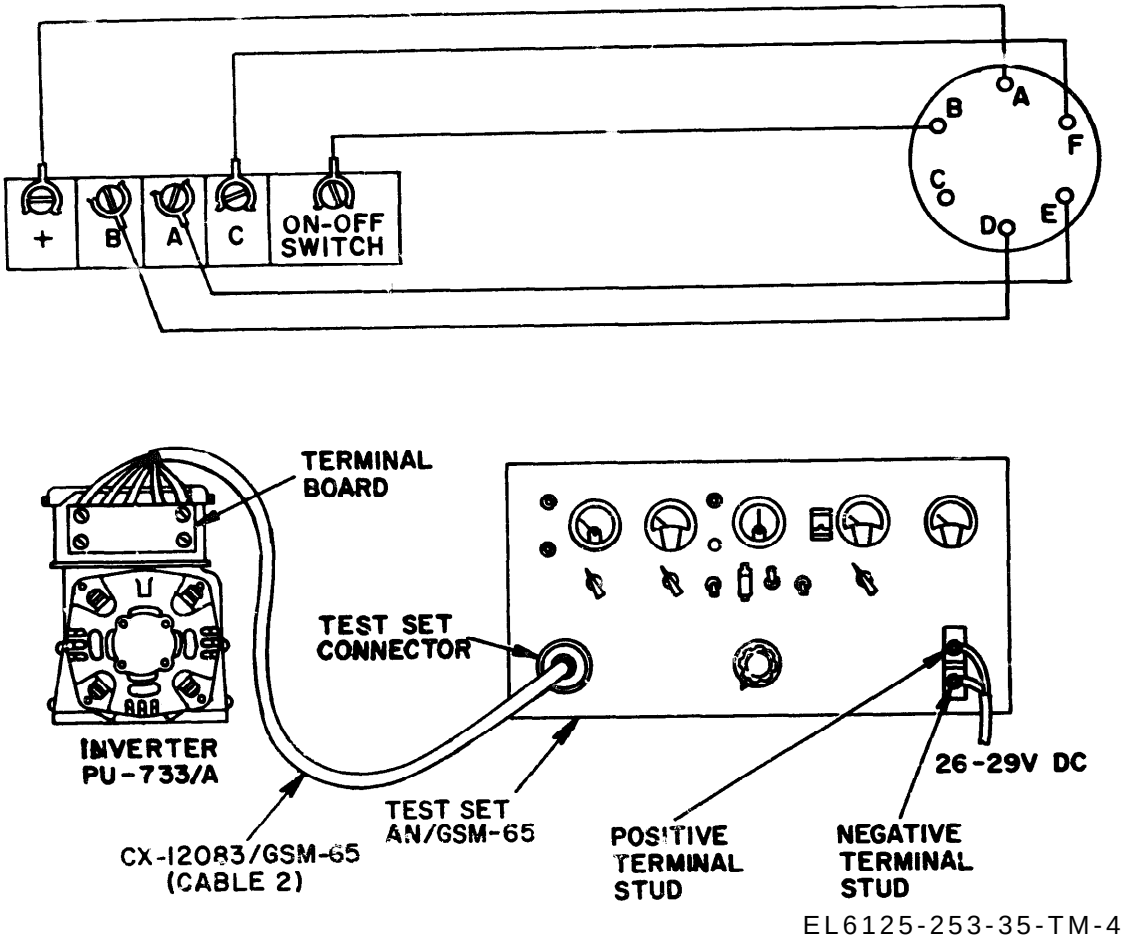


Figure 3-1. Motor-generator test hook-up.

Section III. ADJUSTMENT, ALIGNMENT, REPAIR, REMOVAL AND REPLACEMENT

3-12. Voltage and Frequency Adjustments

Adjustment of voltage and frequency is covered in paragraph 3-11.

3-13. Relay Testing and Replacement (fig. 3-2)

NOTE

Test relay before removing from the motor-generator.

a. Requirements and Test Procedure.

Operating Voltage	***26-30*** vdc
Contacts	3 PST-NO
Capacity	1 set, 30 amps @ 30 volts DC
	2 sets, 3 amps @ 115 volts, 400Hz
Coil Current:	500 ma max.
Pick-up volts @ 125°C	19 or less
Drop out volts @ 125°C	9 or less

(1) See figure 3-3 for location of all components.

(2) Remove screws (1) lockwashers (2), flat washers (3) and lift cover (4) from motor-generator.

(3) Connect motor-generator to the test set as described in paragraph 3-10.

(4) LIVE CIRCUIT and DC POWER switches must be in the OFF position. All other switches and controls will not function during this test.

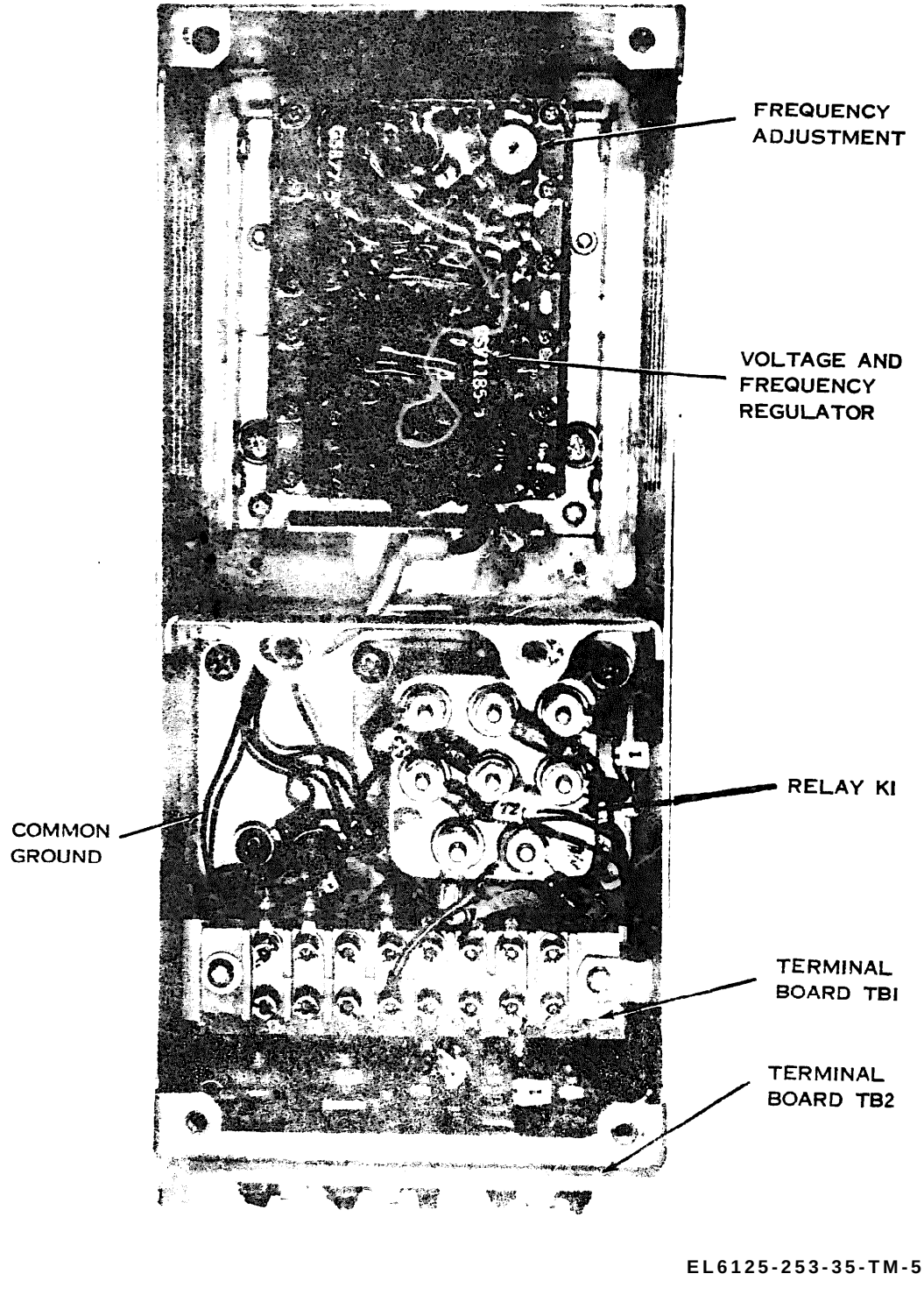


Figure 3-2. Location of components.

(5) Set POWER SUPPLY to 28 vdc and move LIVE CIRCUIT switch to the ON position.

(6) Use Multimeter TS-352B/U to check continuity on ac contacts (Tl-Ll, T2-L2).

(7) Move LIVE CIRCUIT switch to OFF. Place multimeter TS-352B/U leads across one of the three sets of contacts. Move LIVE CIRCUIT switch to ON and vary the dc input from approximately 8 vdc to 20 dvc and check the drop out and pick-up voltages.

(8) Move LIVE CIRCUIT switch to OFF and disconnect motor-generator from test set.

b. Removal and Replacement.

(1) If relay must be removed, disconnect leads attached to relays and remove screws (5), lockwashers (6), and flat washers (7). Lift relay (8) from motor-generator.

(2) Place new relay (8) in position and secure with screws (5) and washers (6 and 7).

(3) Connect leads as indicated by figures 2--2 and 3-4.

(4) Secure cover (4) in place using screws (1) and washers (2 and 3).

3-14. Ac Brush Replacement (fig. 3-3)

NOTE

Inspect brushes after each 500 hours of motor-generator operation.

Remove four caps (9, fig. 3-4). Pull brushes (10 and 11) from their respective brush holders.

NOTE

Always replace an entire set of four brushes. Replace brushes with authorized brushes only.

b. See figure 3-5 for brush dimensions and check brushes. Replace if worn beyond wear mark.

c. Slide brushes (10 and 11, fig. 3-3) into the brush holders and install caps (9).

d. Refer to paragraph 3-16 for brush run-in procedure.

3-15. Dc Brush Replacement (fig. 3-3)

NOTE

Do not attempt to remove end bell. If end bell is moved, brush neutral must be reset by next higher maintenance level.

a. Remove four screws (12) lock washers (13) and fan cover (143. Remove four screws (15), flat washers (16) and pull the brushes (17) from their respective brush holders.

NOTE

Always replace brushes as complete set using authorized brushes only.

b. See figure 3-5 for brush dimensions and check brushes. Replace brushes if worn beyond wear marks.

c. Slide brushes (17) into their brush holders and secure with flat washer: (16) and screws (15).

d. Refer to paragraph 3-16 for brush run-in procedure.

3-16. Brush Run-In

After installing new brushes, run in the brushes so that the face of each commutator brush will contact its commutator 100 percent in the direction of rotation for at least 85 per cent of the brush width (dimension parallel with armature) (see fig. 3-6). The face of each slipring brush must contact its slipring surface at least 85 percent of the brush surface. There must be no evidence of grooving or other surface damage to the face of each brush. Run in brushes as follows :

a. Connect the motor-generator to bench Test Set AN/GSM-65. Connect the bench test set to 28-volt dc source power supply PP-1104A/G. Perform the bench test procedure (para 3-10).

b. At 28-volt input, no load, set the voltage adjustment at 115 volts at no load and the frequency adjustment at 400 Hz.

c. Adjust the bench test set LOAD CONTROL so that the A.C. AMPS meter reads 0.6 ampere. Run motor-generator approximately 2 hours or until there is visible evidence that the brushes contact the commutator and sliprings as specified.

d. After obtaining proper seating, set the LOAD CONTROL until the A.C. AMPS meter reads 1.3 amperes, and run the motor-generator until there is visible evidence of proper filming of the commutator (indicated by a visible darkening or discoloration of the commutator surface) (see fig. 3-6).

e. After completion of brush run-in, turn off dc power. Replace dc end fan cover.

f. Perform motor-generator bench test procedure given in paragraphs 3-10 and 3-11.

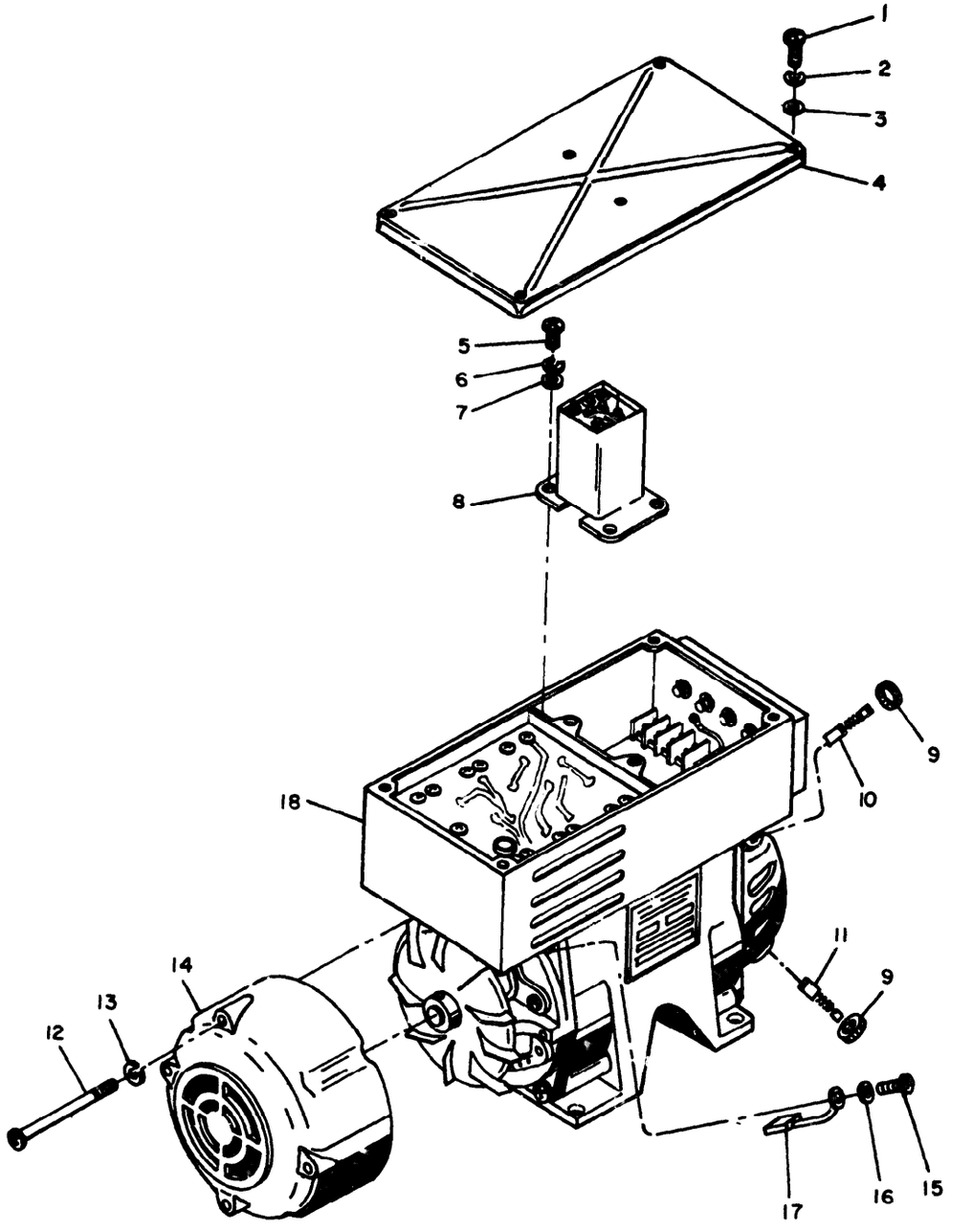


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Figure 3-3. Replacement of relay and brushes.

1 Screw, machine-pan head, cross recessed 8-32 by 3/8 inch (6 rqr)
2 Washer, lock 3/8 (6 rqr)
3 Washer: flat 3/8 (6 rqr)
4 cover, regulator, access
5 Screw, machine-pan, head cross recessed 10-32 by l/2 inch (4 rqr)
6 Washer, lock l/2 (4 rqr)
7 Washer, flat l/2 (4 rqr)
Relay, armature
8 Cap, electrical (4 rqr)
10 Brush, electrical contact (2 rqr)
11 Brush, electric contact (2 rqr)
12 Screw, machine (special) (4 rqr)
13 Washer, lock No. 10 (4 rqr)
14 Cover, fan
15 Screw, assembled washer (special) (4 rqr)
16 Washer, flat No. 10 (4 rqr)
17 Brush, electric contact (4 rqr)
18 Motor-generator

Figure 3-3-Continued.

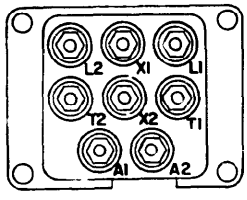

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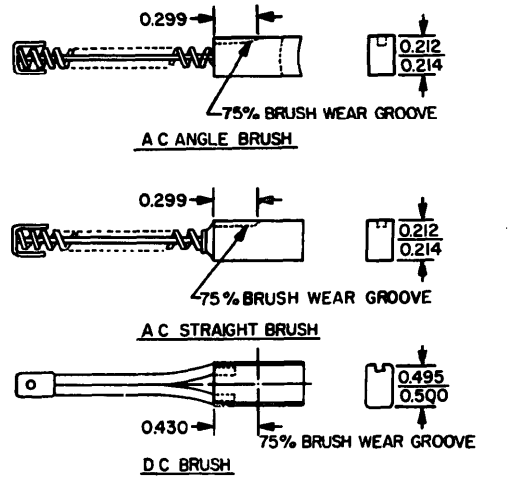
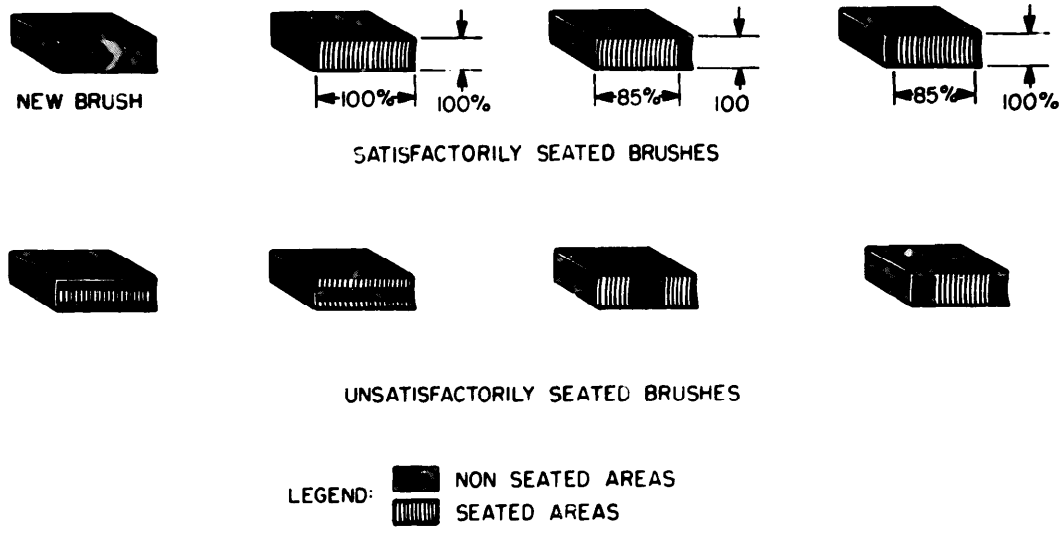
Figure 3-4. Relay connections.



EL6125-253-35-TM-8

Figure 3-5. Brush dimensions.



EL6125-253-35-TM-9

Figure 3-6. Brush run-ix.

Section IV. DIRECT SUPPORT TESTING PROCEDURES

3-17. Tests and Procedures

a. Tests are limited to those that can be performed with the tools, test equipments, and materials allocated to direct support maintenance by the maintenance allocation chart.

b. Refer to paragraphs 3-8 through 3-11 for correct test procedures.

3-18. Performance Standards

a. The criterion for performance standards is whether repaired equipment meeting the standards will perform its mission when returned to the users. Performance standards are not based on the original design specifications for the equipment; performance standards shall never exceed, and should rarely equal, the depot overhaul standards.

b. Direct support performance standards provide a direct go-no-go basis on which the tester can reject or pass the repaired equipment.

c. Refer to paragraph 3-8 Through 3-11 for performance standards.

CHAPTER 4

GENERAL SUPPORT MAINTENANCE

Section I. GENERAL

4-1. Scope of General Support Maintenance

Scope of General Support Maintenance is detailed in the Maintenance Assignment Chart. Refer to TM 11-6125-253-20.

4-2. Tools, Test Equipment, and Materials Required

a. The following chart lists the test equipment required for the GS Support of the motor-generator and the assigned common names for the equipment.

b. Tools, Test Equipment, and Materials Required.

Tool or device	Location	*Use*
High Voltage **Tester,** Model 106	Bench test	Test motor-generator dielectric
Mechanical Puller	Work area	Remove bearings
Multimeter, Electronic ME-26R/U	Bench test	Motor-generator test
Multimeter TS-352B/U	Bench test	Motor-generator test and brush neutral settings
Test Set AN/GSM-65	Bench test	Test motor-generator (3 phase).
Tool Kit TK-100G	Work area	Repair of motor-generator
Torque Wrench FSN 5120-541-3002	Work area	Torquing hardware at reassembly
Oscilloscope AN/USM-281	Work area	Neutral settings

Section II. GENERAL SUPPORT TROUBLESHOOTING

WARNING

When servicing the motor-generator, be extremely careful to avoid contact with the ac output circuits.

4-3. General Instructions

The GS troubleshooting procedures in this chapter cover the duties and responsibilities of GS maintenance as indicated by the Maintenance Allocation Chart. The systematic troubleshooting procedure, which begins with the operational and sectionalization check that can be performed at an organizational level is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting are more advanced.

4-4. Organization of Troubleshooting Procedures

a. The first step when servicing a defective motor-generator is to sectionalize the faults. The next step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing brushes, burned electrical leads and shorted stator windings can often be located by sight, smell, and hearing. Some faults, however, must be isolated by checking voltages and resistances.

b. The tests listed will aid in isolating the trouble. First localize the trouble to either the rotating section, or the regulator section, and then isolate the trouble as follows :

(1) Make voltage and frequency measurements in this equipment only as ***specified.*** This equipment is transistorized. Observe all cautions given to prevent transistor damage. Use Multimeter TS-352B/U.

(2) The trouble symptoms listed in the troubleshooting chart will aid in localizing trouble to a component part.

(3) In making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the

external and internal wiring connections to the motor-generator.

CAUTION

Do not attempt removal or replacement of parts before reading paragraphs 4-5 and 4-6.

4-5. Operational Test

a. ***General.*** If the motor-generator is determined to be faulty, localize the trouble as outlined in paragraph 3-6. Make continuity checks to determine if an open or broken connection exists.

b. ***Bench*** Test. Bench test motor generator in accordance with paragraphs 3-8 through 3-11.

c. Troubleshooting Chart. When use of the troubleshooting chart results in the discovery of trouble in the regulator section of the motor-generator, follow the isolating procedure given in paragraph 4-6.

4-6. Regulator Voltage Measurements

CAUTION

The regulator portion of this equipment is transistorized. To prevent transistor damage, make only those measurements specified.

a. Conditions for Measurement.

(1) Interconnect the equipment as described in paragraph 3-10.

(2) Operate the motor-generator as dcscribed in paragraph 3-11.

(3) Set the multimeter to read dc voltage and to the scale appropriate for the voltages given in the voltage charts (b and c below). Take voltage measurements at the regulator test points given in the voltage chart and as shown in figure 2-2.

(4) Set the power supply to provide a 26-volt dc input and set the bench test set to supply a full load on the motor-generator. Make the measurements given in the voltage measurements charts. If all readings agree with those in the voltage charts, increase the dc input to 28 volts dc and measure the voltages at the same test points. Remove and load from the motor-generator, adjust the input voltage to 29 volts dc, and repeat the measurements.

b. Chart.

Regulator terminals		*Input voltages*		
Negative probe	*Positive probe*	*26 VDC (full load)*	*28 VDC (full load)*	*29 VDC (no load)*
2	to 33	9.3±0.5	9.3±0.5	9.3±0.5
2	to 10	15.4±0.5	16.0±0.5	14.4±0.5
2	to 8	24.5±0.5	26.4±0.5	27.5±0.5
2	to 13	9.9±0.5	9.9±0.5	9.9±0.5
2	to 11	8.0±0.5	9.7±0.5	14.7±0.5
8	to 10	9.1±0.5	10.4±0.5	13.1±0.5
8	to 11	16.5±0.5	16.7±0.5	12.8±0.5
2	to 14	9.9±0.5	9.9±0.5	9.9±0.5
2	to 34	9.3±0.5	9.3±0.5	9.3±0.5

4-7. GS Troubleshooting Chart, Rotating Section

NOTE

Neutral setting must be checked and reset whenever there is a change of rotor, DC end bell, DC stator or repair of the rotor. If rotor or bearings are removed new bearings must be installed upon reinstallation of rotor.

Item No.	*Trouble symptom*	*Probable trouble*	*Checks and corrective measures*
1	Motor-generator vibrates	a. Unbalanced rotor	a. Refer unit to higher echelon of maintenance.
2	Motor-generator fails to start	a. No power supply	***a.*** Check DC power supply.
		b. Loose or blown fuse in test.	***b.*** Check dc fuse or test set. (1) Clean and tighten fuse contacts, if applicable. Replace blown fuse. (2) Reset controls.
		c. Dc input circuit open	c. Check wiring and terminal boards for broken connections. Replace defective wiring or terminal board.
		d. Dc brushes not making contact with commutator.	***d.*** Check for weak or broken brush holder spring. Replace brush holder assembly if springs are broken. Replace brushes if necessary.

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
		e. Rotor jammed	e. Remove fan cover and try to rotate rotor by hand. If rotor is jammed, refer to higher echelon of maintenance.
		f. Defective relay	f. Replace relay. Refer to relay test procedure paragraph 3-13.
3	Motor generator runs but fails to deliver ac voltage or frequency.	a. AC circuit open	a. Check wiring and connections for open circuit. Repair or replace defective wiring.
		b. AC brushes not making contact with sliprings.	b. Check for broken brushes and springs. Replace brushes if broken or worn. Check for sticking brushes. Clean brush holders.
		c. AC rotor windings open	c. Check for continuity between sliprings. If open, replace rotor.
		d. Regulator failure	*d.* Refer to paragraphs 4-6 and 4-8.
4	AC output voltage is low	a. Regulator out adjustment	a. Readjust voltage adjustment resistor, paragraphs 3-12 and *3-13.*
		b. Regulator defective	b. Refer to regulator troubleshooting &art.
5	AC output voltage is high	a. Voltage regulator out of adjustment.	a. Readjust voltage adjustment resistor, paragraphs 3-12 and *3-13.*
		b. Regulator failure	b. Refer to regulator voltage measurement paragraph 4-6, troubleshooting chart paragraph 4-7, and regulator troubleshooting paragraph 4-8.
		c. Generator field grounded (regulator side)	c. Disassemble generator: see paragraph 4-17. Perform dielectric test on stator. If grounded, refer to higher echelon maintenance.
		d. Defective capacitor C6 or *C7 (26,27, fig. 4-4)* on ac endbell.	d. Replace defective component.
6	Frequency is above or below normal.	a. Frequency adjustment resistor out of adjustment.	a. Adjust frequency to 400 cps.
		b. Open or short circuit in shunt field.	b. See paragraph 4-17. Check for continuity, resistance and perform dielectric test. If defective refer unit to higher echelon maintenance.
7	Voltage unstable	*a.* Loose or dirty connections.	a. Check for presence of loose or dirty connections in the motor-generator ; clean and tighten.
		b. Poor ac brush contact at sliprings.	h. Check condition of sliprings. Check brushes and brush holders. Replace brushes: clean sliprings. If sliprings require refinishing refer to higher echelon of maintenance.
		c. Regulator defective	c. Refer to regulator voltage measurement paragraph 4-6, trou-b1eshooting chart, paragraph 4-

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
			7, and regulator troubleshooting paragraph 4-8.
		d. Defective relay	d. Replace relay. Refer to relay test procedure paragraph 3-13.
8	Excessive sparking at brushes	a. Brushes stuck in holder or broken.	a. Check brushes and brush holders. Replace faulty brushes. Clean brush holders.
		b. Commutator or sliprings dirty or pitted. High commutator bar.	b. Check condition of commutator or sliprings. If too dirty or pitted, refer to higher echelon maintenance.
		c. Grounded generator field; see paragraph 4-17.	c. Check ac rotor for open, shorts or grounded. If defective, discard and replace with a new armature.
		d. Grounded motor armature ; see paragraph 4-17.	d. Check armature for open, shorts or grounded. If defective, replace with a new armature.
9	Motor-generator overheats	a. Poor external ventilation.	a. Check for adequate air circulation around motor-generator. Provide ample circulation.
		b. Poor internal ventilation	b. Check to see that air passages are free of obstructions. Clean air passages.
		c. Faulty bearings	c. Feel bearing housings in endbells. If hot to the touch, replace the bearings.

4-8. Regulator Troubleshooting

a. Conditions.

(1) If any of the measurements taken vary from those given in the regulator chart make the measurements given in the regulator troubleshooting chart. Set the multimeter to measure dc voltage as specified in the chart, and make the measurements as indicated.

(2) The abnormal conditions listed in the troubleshooting charts refer to the motor-generator output as indicated on the bench test set. The peak voltage measurements are made between ground and the terminals indicated in the chart headings (see fig. 2-2). All measurements specified for each item must be made. Make only the voltage measurements listed. Any variation from the readings indicated for each item will indicate the defective circuit board. Follow the instructions given in the remedy column of the charts.

b. Regulator Troubleshooting Chart.

Abnormal condition	From	To	Voltage	Remedy
High voltage	- 2	+13	More than 10.5v	Replace U3.
High voltage	- 2	+11	Less than 2v	Replace U3.
High voltage	-12	+13	Less than 10.2v	Replace U2.
Low voltage	- 2	+13	Less than 8.5v	Replace U2.
Low voltage	- 2	+11	More than 20v	Replace U3.
High frequency	- 2	+33	Less than 8.5v	Replace Ul.
High frequency	- 2	+10	More than 20v	Replace U1.
Low frequency	- 2	+33	More than 10.5v	Replace U1.
Low frequency	- 2	+10	Less than 7.0v	Replace U1.
Low frequency	-32	+33	Less than 10.5v	Replace U2.

4-9. Bench Testing

Refer to paragraphs 3-8 through 3-11 for all bench test procedures.

TECHNICAL MANUAL
IO. 11-6125-253-35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 8 *December 1971*

DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

MOTOR-GENERATOR PU-733/A

ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

I-I. Scope

This technical manual contains information for the maintenance of the Motor Generator FU-733/ A. Included are instructions for and repair, calibration and test procedures to be used in the performance of DS, GS, and depot maintenance.

I-2. Indexes of Publications

a. ***DA Pam 310-4.*** Refer to DA Pam 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) pertaining to the equipment.

I-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army)/NAVSUP Publication 378 (Navy)/AFR 714 (Air Force)/ and MCO P4630.29 (Marine Corps).

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 (Army)/NAVSUP Pub 459 (NAVY)/AFM 75-34 (Air Force)/ and MCO P4610.19 (Marine Corps).

d. Reporting of Equipment Manual Improvements. Reporting of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forward direct to Commanding General, US Army Electronics Command, ATTN: AMSEL-ME-NMP-AN, Fort Monmouth, NJ 07703.

CHAPTER 2

FUNCTIONING OF EQUIPMENT

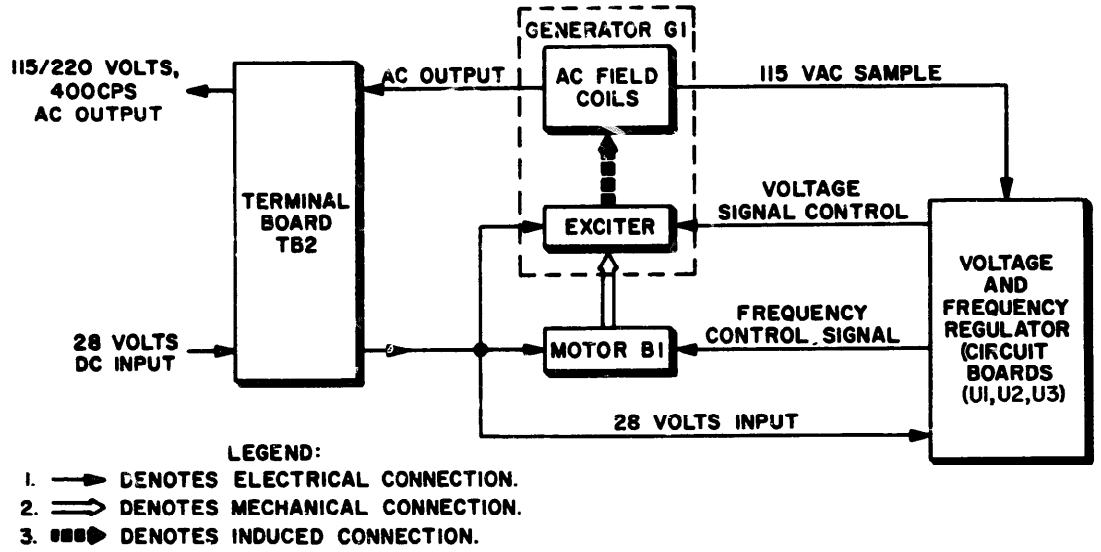


Figure 2-1. PU-733/A block diagram.

2-1. General

The motor-generator may be divided into two sections : a mechanical section consisting of motor B1 and generator G1, and an electrical regulator section consisting of voltage and frequency regulator circuit boards U1, U2, and U3. The mechanical and electrical sections are described in paragraph 2-2 and 2-3.

2-2. Block Diagram Analysis

a. ***Mechanical Circuits.***

(I) The 28-volt dc input is applied to the mechanical section of the motor-generator by means of terminal board TB2 (see fig. 2-l) to motor B1 and the exciter portion of generator G1, causing current to flow in each of the components.

(2) Application of 28 volts dc to the motor causes the motor armature to rotate. Since the exciter portion of the AC generator is mechanically coupled to the motor armature (on the same shaft), the exciter portion of the generator rotates.

(3) As the motor rotates, an ac voltage is induced in the generator field coils. The ac voltage induced in the field coils is applied to the terminal board TB2 as an output voltage. A sample of the ac output voltage is also applied to the regulator circuits.

b. Regulator Electrical Circuits.

(1) Control of the voltage and frequency of the motor-generator output is accomplished in the regulator section by establishing control time for current flow through the field windings of the motor and excitation windings of the generator.

(2) The ac output voltage sample from the generator field windings is applied to the regulator circuits. The sample signal is converted to voltage and frequency error signals and processed to provide control signals for application to the motor and generator.

(3) The frequency control signal is applied to the motor field winding to control the motor rotation speed. The voltage control signal establishes the conduction time on. of current flow through the generator excitation windings to control the output voltage level.

(4) The 28-volt dc input voltage is also applied to the regulator circuits for the operation of the control circuits.

2-3. Circuit Analysis

a. Mechanical Section.

(1) The mechanical section of the motor-generator consists of a DC motor and AC generator. Both unit:. share the same housing, with separate stationary windings. The dc armature of the motor and the ac rotor of the generator share a common shaft.

(2) The motor is a series-shunt motor with windings wound in magnetic opposition to each other. It operates from the 28-volt dc input power applied to it from the aircraft electrical system.

(a) Power for operation of the motor is applied through a set of series coils and shunt coils. The series coils and the shunt coils are connected so that they are always magnetically opposed to each other. The dc brushes are located at the neutral point between the four pairs of coils (poles). Therefore, adjacent commutator bars on the motor armature reach a dc brush when no voltage is between brushes.

(h) When 28 volts is impressed upon series coils, current will flow through the series coils, the shunt coils, the positive dc brushes, the motor armature, and the negative dc brushes to ground. The magnetic field, resulting from the current flow through coils, reacts with the magnetic field set up by the current flow through the motor armature, causing the armature to rotate. Since the coils are magnetically opposed, the field is always such that it will cause the armature to rotate.

(c) By rotating through a magnetic field, the armature causes a counter electromotive force (cemf) to be induced into the armature winding. The armature rotation speed increases 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.

(3) The AC generator is a rotating field-type generator. Direct current from the external source is fed to the rotor through the sliprings and ac brushes. When the dc motor starts, it turns the rotor of the AC generator. As the rotor revolves, magnetic fields set up by the current through the sliprings, and ac brushes pass conductors in the ac stator and induce an alternating current in the ac stator winding. Alternating current is then available at the terminal board TB2.

b. Regulator Circuits.

(1) The regulator consists of three interconnected module-type circuit boards (U1, U2, and U3). Mechanical and electrical connections between circuit boards are made by means of stainless-steel screws and copper connectors, which are part of the terminal board.

(2) The regulator controls the motor-generator frequency output by governing the speed of the rotating section; this is done by controlling the strength of the motor shunt field. The voltage output is regulated through control of the current in the AC generator exciter.

(a) As the mechanical speed of the motor-generator increases, the output frequency increases. To control the output frequency, the regulator controls the current flow through the motor shunt coils. The speed of the motor may be reduced by increasing the strength of the motor shunt field. The regulator controls the amount of current in the shunt field winding to establish the speed level necessary for the desired frequency.

(b) The current level in the generator exciter determines the magnitude of output volt age. Reducing the exciter current causes a re duction of ac output voltage. Output voltage is controlled by regulating the average current in the exciter.

(3) The regulator performs the function on a rapidly operating switch which interrupts the flow of current in both motor and generator field windings simultaneously at approximately twice line frequency. Control is accomplished by estab lishing the appropriate instant for turn-on of conduction through the controlled rectifier power stage. This turn-on function is established by the frequency sensing and the voltage control stages. Frequency and voltage gate turn-on stage are arranged so that, in the absence of any a

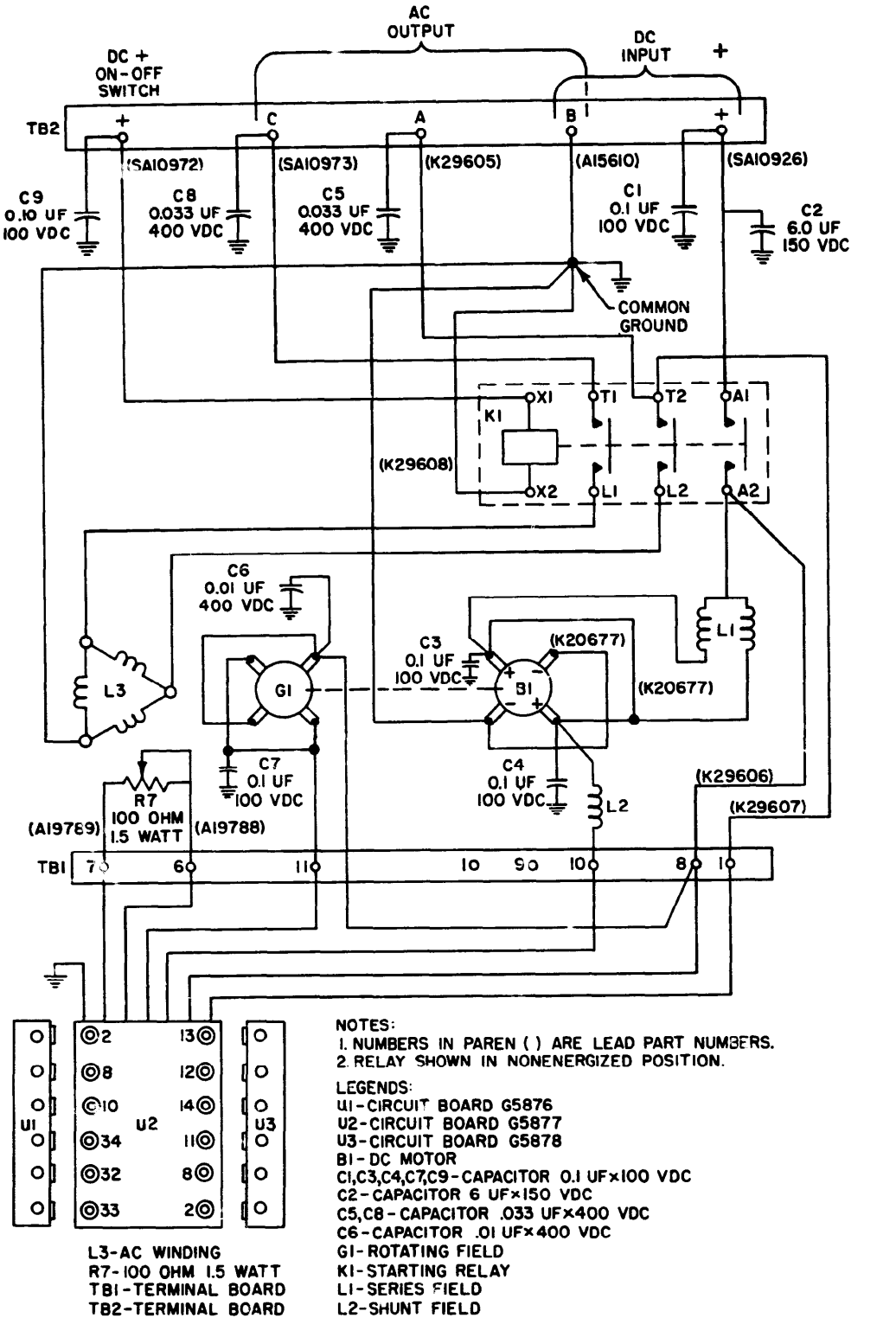


Figure 2-2. PU-733/A wiring diagram.

voltage, a continuous sequence of pulses is produced until the gates of the controlled rectifier power stage are fired. The shutoff energy is derived from the motor-generator output. There is always a pulse available to permit conduction, but conduction can be stopped only when the motor-generator is producing a normal output potential.

2-4. Circuit Board Stage Analysis

a. Circuit Board U2.

(1) Circuit board U2 contains the frequency sensing, voltage control, dc regulator and controlled rectifier power circuits.

(2) The frequency sensing circuit compares two voltage signals, both dependent on frequency changes. The resultant error signal is applied to circuit board U1. If the frequency is too high, the signal will he negative. If the frequency is too low, the signal will be positive.

(3) The voltage control circuit develops a calibrated dc voltage signal that is applied to circuit board U3.

(4) The dc regulator circuit rectifies and sends a controlled voltage signal to the voltage gate turn-on stage and a clipped half-sinusoidal wave to the voltage gate shutoff stage.

(5) The controlled rectified power circuit is operated by signals from circuit boards U1 and U3. This circuit controls the amount of current applied to the motor shunt field winding to establish motor speed for frequency control. It also regulates the average current in the generator exciter.

(6) When the motor-generator starts, there is a sudden current surge that produces a high negative-going potential across the motor shunt field. The controlled rectifier stage loads the circuit to prevent exceeding the reverse voltage rating of the diodes.

b. Circuit Board U1. A frequency error signal from the frequency sensing stage of circuit boards U2 is applied to circuit board U1. This signal is converted by U1 into a pulse-time sequence signal and, by means of a frequency gate turn-on stage, gates the controlled rectifier power circuit of circuit board U2 to control the current in the motor shunt field.

c. ***Circuit Board*** U3, General. Circuit board U3 accepts a voltage signal from the voltage control stage of circuit board U2, compares ii against a referenced Zenor diode, and converts the resulting error signal to a pulse sequence which gates the controlled rectifier power circuit of circuit board U2 to control the generator exciter field. Circuit board U3, simultaneously at twice frequency, interrupts conduction of the flow of current in the motor field winding and the generator exciter winding.

CHAPTER 3

DIRECT SUPPORT MAINTENANCE

Section I. GENERAL

3-1. Scope of Direct Support Maintenance

Scope of Direct Support Maintenance is detailed on the Maintenance Allocation chart Refer to TM 11-6125-253-20.

3-2. Tools, Test Equipment, and Materials Required

a. The following chart lists the test equipment required for the DS support of the generators. Also listed are the associated technical manual and the assigned common names for the equipment.

b. Tools, Test Equipment, and Materials Required.

Tool or device	*Location*	*Use*
Multimeter, Electronic ME-26B/U	Bench test	Measure voltages and resistances.
Multimeter TS-352B/U	Bench test	Motor-generator test and brush neutral settings.
Power Supply PP-1104A/G	Bench test	Used in conjunction with test set.
Test Set AN/GSM-65	Bench test	Test Motor-generator.
Tool Kit TK-100/G	Work area	Repair of motor-generator.
Torque Wrench FSN 5120-541-3002	Work area	Torquing hardware at reassembly.

Section II. DIRECT SUPPORT TROUBLESHOOTING

WARNING

When servicing the motor-generator, be extremely careful to avoid contact with the ac output circuits.

3-3. General Instructions

The DS troubleshooting procedures in this chapter cove: the duties and responsibilities of DS Maintenance as indicated by the Maintenance Allocation Chart. The systematic troubleshooting procedure, which begins with the operational and sectionalization check that can be performed at an organizational level is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting are more advanced.

3-4. Organization of Troubleshooting Procedures

a. General. The first step when servicing a defective motor-generator is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing brushes, burned electrical leads, and shorted stator windings can often be located by sight, smell, and hearing. Some faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. Listed below is a group of tests arranged to aid in tracing troubles in a defective motor-generator.

(1) Visual ***inspection.*** The purpose of visual inspection is to locate faults without testing or measuring circuits. Visual signs should be observed and an attempt made to sectionalize the fault to a particular component.

(2) Operational tests. Operational tests frequently indicate the general location of trouble. These tests will often help in determining the exact nature of the fault.

c. Localization. The tests listed will aid in isolating the trouble. First localize the trouble to either the rotating section, or the regulator section, and then isolate the trouble as follows:

(1) ***Voltage and frequency measurements.*** Voltage and frequency measurements by direct support level personnel are restricted. Make voltage and frequency measurements in this equipment only as specified. This equipment is transistorized. Observe all cautions given to prevent transistor damage use Electrical Power Test Set AN/GSM-65 to determine ac output voltage and frequency as ***specified*** for voltage and frequency measurements. Compare readings taken from AN/UPM-93A with those obtained from the aircraft voltage and frequency meters.

(2) Troubleshooting chart. The trouble symptoms listed in the chart will aid in localizing trouble to a component part.

(3) Intermittent troubles. In making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the external and internal wiring connections to the motor-generator.

CAUTION

Do not attempt removal or replacement of parts before reading paragraphs 3-5 and 3-6.

3-5. Operational Test

a. ***General.*** If the motor-generator output is determined to be out of limits localize the trouble as outlined in paragraph 3-7. If no fault is indicated, the fault may be in the wiring of the aircraft. Refer to the applicable aircraft manual for the interconnecting wiring diagram.

b. Power Requirements. The power supply must be capable of supplying 24 amperes at 28 volts dc.

CAUTION

Use a fine tipped screwdriver to adjust variable resistor to prevent damage to slots in the resistors. Loosen the outer lock nut on voltage adjustment resistor R7 before attempting to adjust. Tighten again at completion of test.

c. Test Procedure,

(1) Turn on the aircraft ac components o at a time until the motor-generator is fully load ed. The voltage variation between no load and full load must be less than 2 1/2-volt.

(2) If any abnormal indications (3) through (6) are noted, remove the motor-generator fro the aircraft and test using Test Set AN/UPM-93A.

(3) Turn off main power switch at completion of test and remove multimeter loads.

3-6. localizing Troubles

a. Use of Troubleshooting Chart. The trouble shooting chart will aid in localizing troubles to the components of the motor-generator. The troubleshooting chart supplements the equipment performance checklist in TM 11-6125-253-20. When no operational symptoms are know perform the operational test, and then proceed to the troubleshooting chart until trouble is locate If the localizing procedures in the troubleshooting ing chart do not correct the fault, remove the motor-generator from the aircraft for bench test ing and repair.

b. Conditions for Tests. All checks in the troubleshooting chart are to be conducted with the motor-generator connected for normal use.

3-7. Direct Support Troubleshooting Chart

Item No.	*Trouble symptoms*	*Probable trouble*	*Checks and corrective measures*
1	Motor-generator fails to start	a. No dc power supply	a. Check dc fuse or circuit breaker. (1) Clean and tighten fuse contacts, if applicable. Replace blown fuse. (2) Reset controls.
		b. Dc input circuit open.	*b.* Check test set wiring and connection to the motor-generator for an open circuit. Repair or replace defective test set wiring or connection.
		c. Dc brushes not making contact with commutator.	*c.* If visual inspection indicates this condition or worn or broken brushes, replace brushes.
		d. Armature jammed	*d.* Refer the motor-generator to the next higher category of maintenance for repair.
		e. Defective relay	*e.* Replace relay.
	Motor-generator virbrates	*a.* Loose or missing hardware.	*a.* Tighten or replace missing hardware.

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
		b. Motor-generator improperly seated.	*b.* See that mounting surface is clean and free of foreign objects.
		c. Unbalanced armature	c. Refer to higher category of maintenance.
3	Motor-generator runs but fails to deliver ac voltage or frequency.	a. Ac circuit open	a. Connect Multimeter TS-352/U to each of the ac terminals connections and ground in turn. Turn on necessary aircraft switches to start motor-generator. If multimeter indicates between 109 and 121 volts ac, check exterior wiring and connections for an open circuit. Repair or replace defective wiring. If multimeter does not indicate between 109- and 121-volt ac, refer to paragraph 3-11 *and* adjust voltage and frequency. If readings are still out of limits refer the motor-generator to a higher category for repair.
		b. Defective relay	*b.* Replace relay.
		c. Regulator failure	c. Refer motor-generator to next higher category of maintenance for repair.
4	Frequency is outside range of 395 *to 405* cps or ac voltage outside range of 108 to 123 volts.	a. Dc input voltage high or low.	*a.* Check dc voltage at power supply.
		b. Regulator out of adjustment.	*b.* Refer to paragraph 3-11 and adjust voltage and frequency. If still out of limits refer motor-generator to next higher maintenance category.
		c. Failure of motor-generator or regulator.	c. Refer Motor-generator to a higher category of maintenance for repair.
5	Output voltage unstable	a. Loose connections	*a.* Check for loose connections and tighten.
		b. Poor commutation	*b.* Refer motor-generator to next higher category of maintenance for repair.
		c. Worn or broken brushes.	c. Replace.
6	Motor-generator is noisy	a. Motor-generator not firmly mounted, or parts are loose.	a. Check mounting bolts and other bolts and screws. Tighten if loose.
		b. Worn bearings	*b.* Remove dc end fan cover and turn armature by hand; feel and listen for roughness in bearings. If bearings are worn refer motor-generator to higher maintenance category.
		c. Armature dragging	c. Remove dc *end* fan *cover* and rotate armature by hand; feel and listen for indications of interference. If interference is evident refer motor-generator to higher maintenance category.
		d. Brushes sparking	*d.* Replace brushes.

3-B. Bench Testing Motor-Generator

a. When to Bench Test. **Bench** test **the motor-**generator when any of the following conditions apply:

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

(2) When abnormal symptoms reported from operational tests (para 3-5) indicate the need for higher category repair.

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

(1) Mount the motor-generator on a test bench.

(2) Interconnect the motor-generator and the bench test set (para 3-10).

3-9. Test Equipment Required for Bench Testing

The following equipment is required for bench testing **the** motor-generator :

a. Test Set, Motor-Generator AN/GSM-65 (bench test set).

b. Power Supply PP-1104A/G.

3-10. Test Setup

Bench tests of the motor-generator require connection to the bench test set and to a 26- to 29-volt, SO-ampere dc power source. Prepare the bench test set for testing the motor-generator as outlined in a through j below.

a. All of the test will be performed with the motor-generator mounted on a test bench.

NOTE

Testing will be simplified if connections and tester control settings are made initially and modifications are made as required for the individual tests.

b. Use cable CX-12083/GSM-65 (cable No. 2) of AN/GSM-65 test set. See figure 3-l for motor-generator test hook-up.

CAUTION

Remove all unused cable sets from the storage compartment in the cabinet top to prevent cable damage due to heat generated during testing.

c. Set the following test set AN/GSM-65 switches and controls.

Switch or *control*	*Setting/position*
AC AMP METER RANGE	10
Volt/AMP switch	A
LOAD switch	3 PHASE
LIVE CIRCUIT	OFF
DC POWER	OFF
LOAD CONTROL	100
DC AMP METER RANGE	100

d. Remove the terminal board cover and connect the cable to the terminal board of the motor-generator and to the test set. Connect the power supply to the test set.

WARNING

The lead with the insulated alligator clip (connected to DC ON-OFF switch) provides line (28 vdc) voltage when the LIVE CIRCUIT switch is in the on position regardless of the position of the dc POWER switch.

3-11. Test Procedure

a. Place the bench test set LIVE CIRCUIT and POWER ON switches to the ON position. The motor-generator should start.

b. Loosen the motor-generator voltage adjustment locknut, and turn voltage adjustment potentiometer through its full range. The minimum reading at the extreme low voltage setting must not exceed 109 volts, and the reading at the extreme maximum setting must not be less than 121 volts.

c. Adjust the bench test set LOAD CONTROL until the AC AMPS meter indicates 2.17 amperes and the AC VOLTS meter indicates 115 volts. Turn the voltage adjustment through its full range. No variation in the adjustment range (*b* above) is permitted. Place the LOAD CONTROL at 0, and set the motor-generator voltage adjustment to provide an output of 115 volts ac. Tighten the adjustment locknut.

d. With the bench test set LOAD CONTROL at 0, vary the input voltage from 26 to 29 volts. The motor-generator output voltage should not vary more than 2.3 volts. The frequency should not vary more than 10 Hz.

e. Adjust the bench test set LOAD CONTROL until the AC AMPS meter indicates 2.17 amperes and the AC VOLTS meter indicates 115 volts. Vary the input voltage from 26 to 29 volts. The output voltage should not vary more than 2 3 volts; the frequency should not vary more than 10 Hz.

f. Adjust the motor-generator input to 29 volts with the LOAD CONTROL set at 0. Using the LOAD CONTROL, apply and remove a 2.17 ampere ac load. Repeat this procedure with the input adjusted to 26 volts. Voltage and frequency variations must be within the limits specified in e above.

NOTE

Maximum allowable input current during performance tests given in *d*, *e*, and f above is 13 amperes at zero load, 24.8 amperes at full load, single-phase.

g. If the indications in b through f above are abnormal, refer to the troubleshooting chart.

h. When satisfactory operation is obtained, place the bench test set LIVE CIRCUIT and POWER ON switches at OFF. Turn off or place all switches in the lowest numbered or lettered positions. Disconnect the motor-generator and the power supply leads.

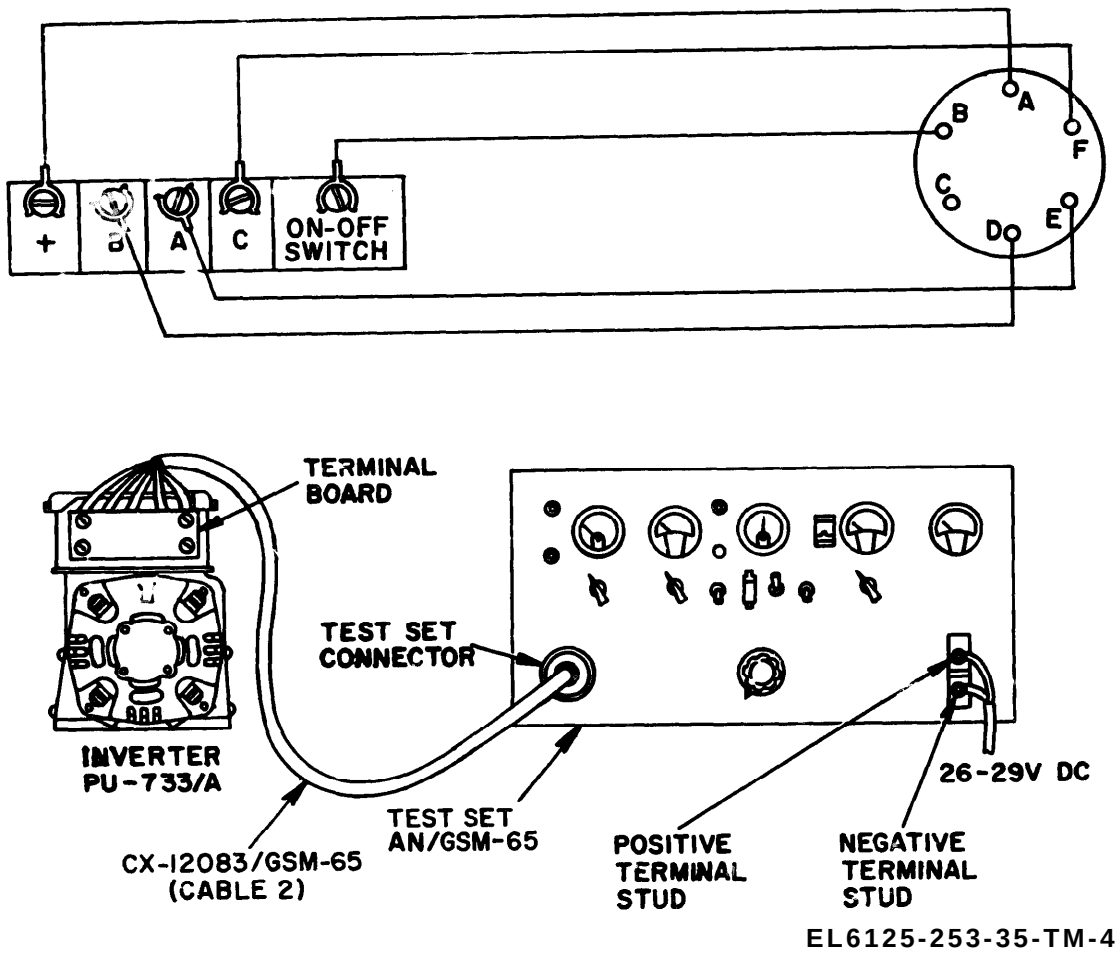


Figure 5-1. Motor-generator test hook-up.

Section III. ADJUSTMENT, ALIGNMENT, REPAIR, REMOVAL AND REPLACEMENT

3-12. Voltage and Frequency Adjustments

Adjustment of voltage and frequency is covered in paragraph 3-11.

3-13 Relay Testing and Replacement (fig. 3-2)

NOTE

Test relay before removing from the motor-generator.

a. Requirements and Test Procedure.

Operating Voltage	26-30 vdc
Contacts	3 PST-NO
Capacity	1 set, 30 amps @ 30 volts DC 2 sets, **3 amps @** 115 volts, 400Hz
Coil Current:	**500 ma** *max.*
Pick-up volts @ 125°C _____	19 or less
Drop out volts @ 125°C _____	**9 or less**

(1) See figure 3-3 for location of all components.

(2) Remove screws (1) lockwashers (2) flat washers (3) and lift cover (4) from motor-generator.

(3) Connect motor-generator to the test set as described in paragraph 3-10.

(4) LIVE CIRCUIT and DC POWER switches must be in the OFF position. All other switches and controls will not function during this test.

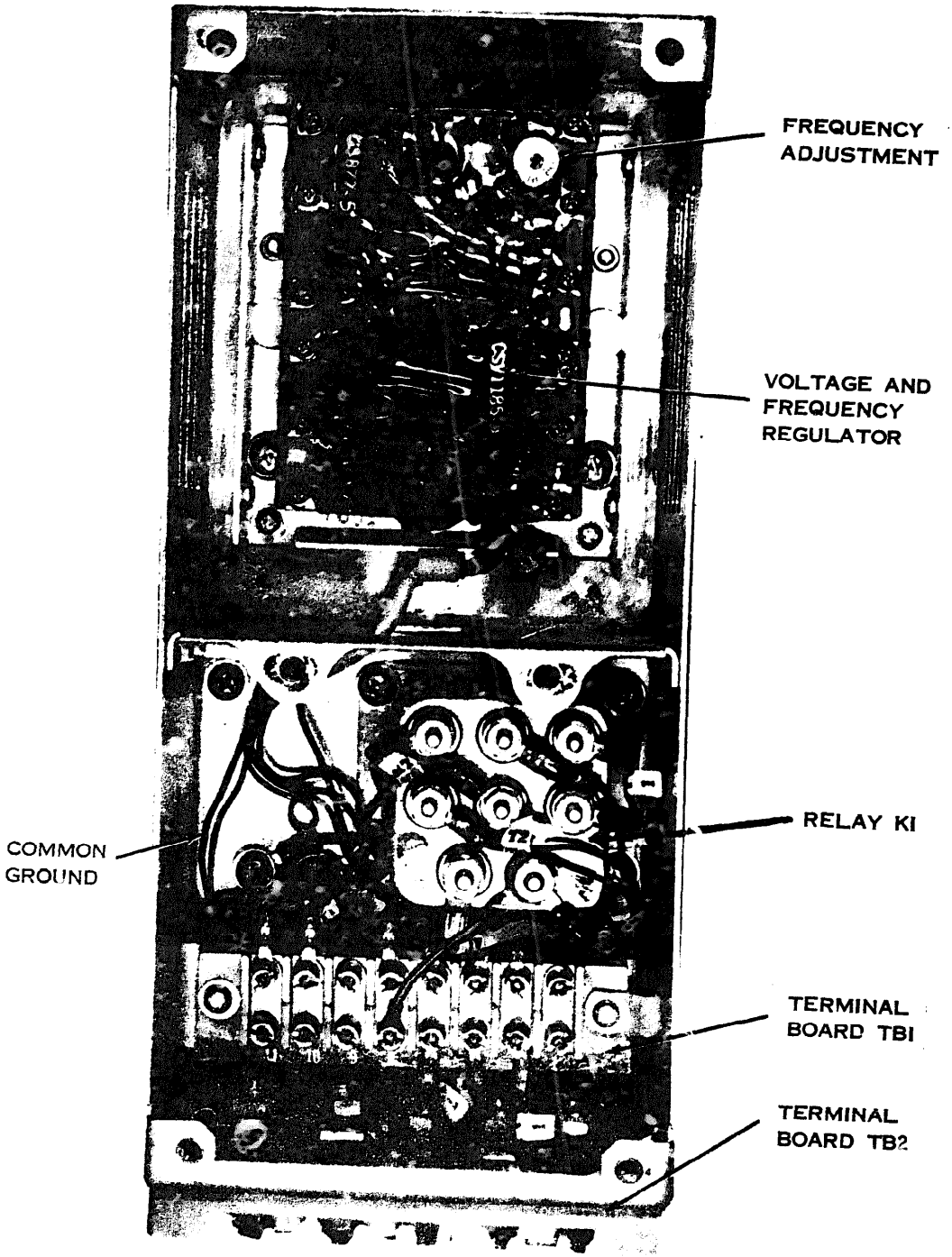


Figure 3-1. Location of components.

(5) Set POWER SUPPLY to 28 vdc and move LIVE CIRCUIT switch to the ON position.

(6) Use Multimeter TS-352B/U to check continuity on ac contacts (T1-L1, T2-L2).

(7) Move LIVE CIRCUIT switch to OFF. Place multimeter TS-352B/U leads across one of the three sets of contacts. Move LIVE CIRCUIT switch to ON and vary the dc input from approximately 8 vdc to 20 dvc and check the drop out and pick-up voltages.

(8) Move LIVE CIRCUIT switch to OFF and disconnect motor-generator from test set.

b. Removal and Replacement.

(1) If relay must be removed, disconnect leads attached to relays and remove screws (5), lockwashers (6), and flat washers (7). Lift relay (8) from motor-generator.

(2) Place new relay (8) in position and secure with screws (5) and washers (6 and 7).

(3) Connect leads as indicated by figures 2-2 and 3-4.

(4) Secure cover (4) in place using screws (1) and washers (2 and 3).

3-14. Ac Brush Replacement (fig. 3-3)

NOTE

Inspect brushes after each 500 hours of motor-generator operation.

a. Remove four caps (9, fig. 34). Pull brushes (10 and 11) from their respective brush holders.

NOTE

Always replace an entire set of four brushes. Replace brushes with authorized brushes only.

b. See figure 3-5 for brush dimensions and check brushes. Replace if worn beyond wear mark.

c. Slide brushes (10 and 11, fig. 3-3) into the brush holders and install caps (9).

d. Refer to paragraph 3-16 for brush run-in procedure.

3-15. Dc Brush Replacement (fig. 3-3)

NOTE

Do not attempt to remove end bell. If end bell is moved, brush neutral must be reset by next higher maintenance level.

a. Remove four screws (12) lock washers (13) and fan cover (14). Remove four screws (15), flat washers (16) and pull the brushes (17) from their respective brush holders.

NOTE

Always replace brushes as complete set using authorized brushes only.

b. See figure 3-5 for brush dimensions and check brushes. Replace brushes if worn beyond wear marks.

c. Slide brushes (17) into their brush holders and secure with flat washers (16) and screws (15).

d. Refer to paragraph 3-16 for brush run-in procedure.

3-16. Brush Run-In

After installing new brushes, run in the brushes so that the face of each commutator brush will contact its commutator 100 percent in the direction of rotation for at least 85 per cent of the brush width (dimension parallel with armature) (see fig. 3-6). The face of each slipring brush must contact its slipring surface at least 85 percent of the brush surface. There must be no evidence of grooving or other surface damage to the face of each brush. Run in brushes as follows :

a. Connect the motor-generator to bench Test Set AN/GSM-65. Connect the bench test set to 28-volt dc source power supply PP-1104A/G. Perform the bench test procedure (para 3-10).

b. At 28-volt input, no load, set the voltage adjustment at 115 volts at no load and the frequency adjustment at 400 Hz.

c. Adjust the bench test set LOAD CONTROL so that the A.C. AMPS meter reads 0.6 ampere. Run motor-generator approximately 2 hours or until there is visible evidence that the brushes contact the commutator and sliprings as specified.

d. After obtaining proper seating, set the LOAD CONTROL until the A.C. AMPS meter reads 1.3 amperes, and run the motor-generator until there is visible evidence of proper filming of the commutator (indicated by a visible darkening or discoloration of the commutator surface) (see fig. 3-6).

e. After completion of brush run-in, turn off dc power. Replace dc end fan cover.

f. Perform motor-generator bench test procedure given in paragraphs 3-10 and 3-11.

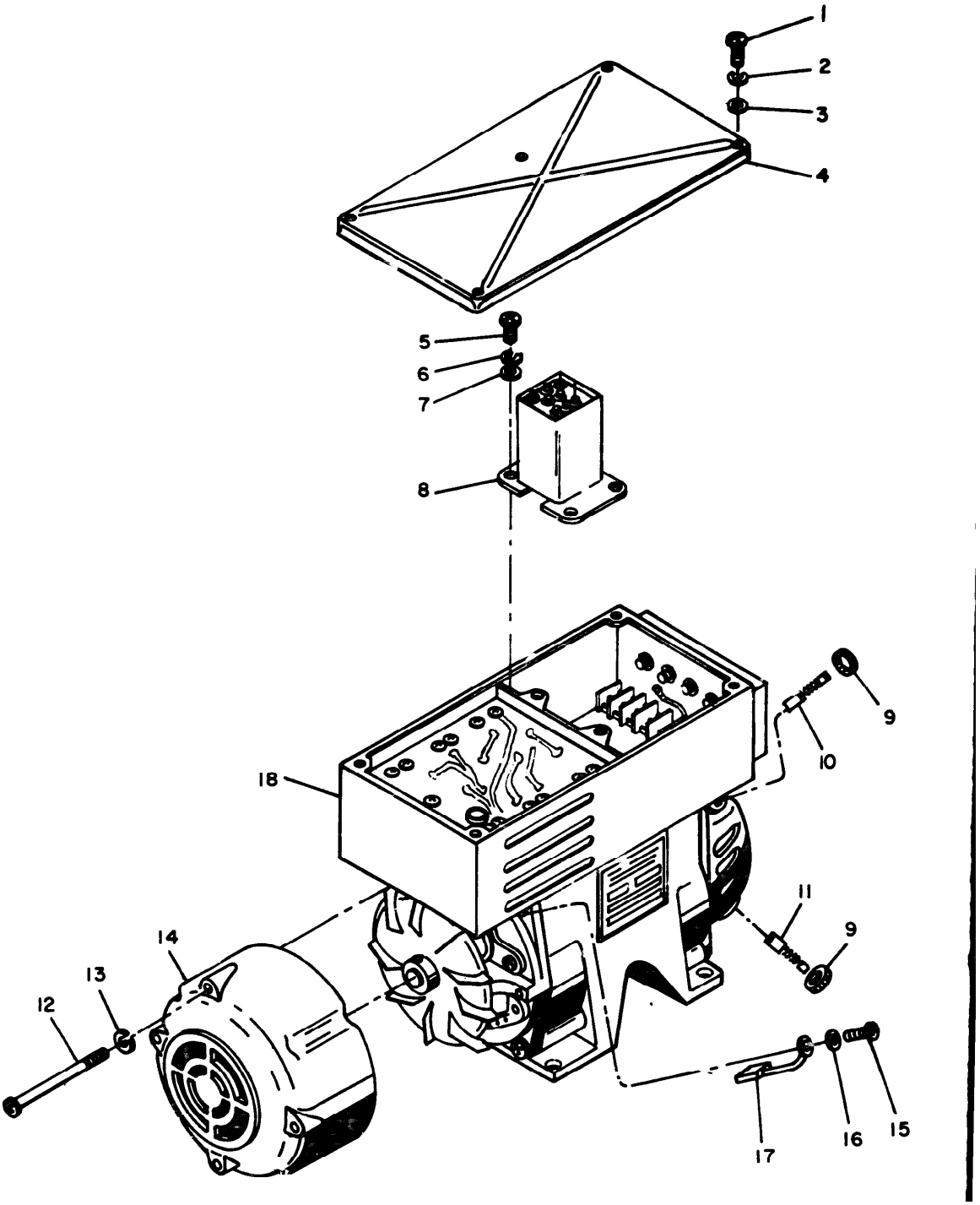


Figure 3-3. Replacement of relay and brushes.

1 Screw, machine-pan head, cross recessed 8-32 **by 3/8** inch
2 Washer, lock 3/8 (6 rqr)
3 Washer: flat 3/8 (6 rqr)
4 Cover, regulator, access
5 Screw, machine-pan, head cress recessed 10-32 by 1/2 inch (4 rqr)
6 Washer, lock l/2 (4 rqr)
7 Washer, flat l/2 (4 rqr)
8 Relay, armature
9 Cap, electrical (4 rqr)
10 Brush, electrical contact (2 rqr)
11 Brush, electric contact (2 rqr)
12 Screw, machine (special) (4 rqr)
13 Washer, lock No. 10 (4 rqr)
14 Cover, fan
15 Screw, assembled washer (special) (4 rqr)
16 Washer, flat No. 10 (4 rqr)
17 Brush, electric contact (4 rqr)
18 Motor-generator

Figure 3-3-Continued.

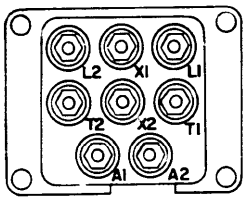


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Figure 3-4. Relay connections.

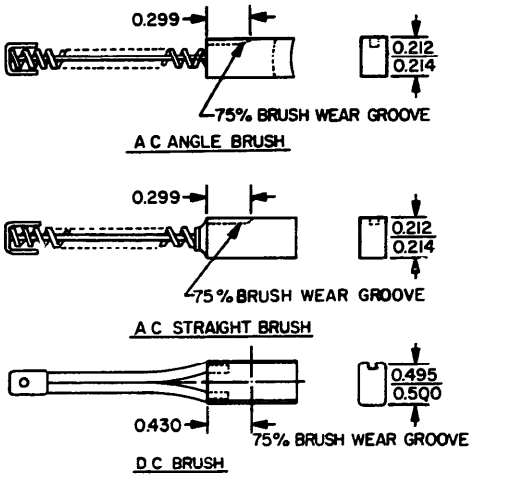

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Figure 3-5. Brush dimensions.

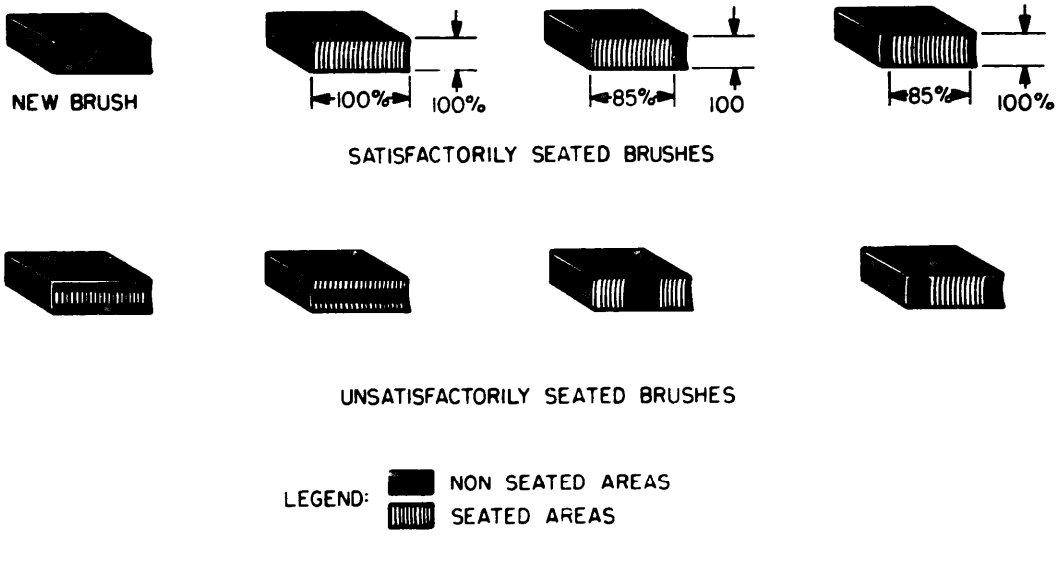

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Figure 3-6. Brush run-in.

Section IV. DIRECT SUPPORT TESTING PROCEDURES

3-17. Tests and Procedures

a. Tests are limited to those that can be performed with the tools, test equipments, and materials allocated to direct support maintenance by the maintenance allocation chart.

b. Refer to paragraphs 3-8 through 3-11 for correct test procedures.

3-18. Performance Standards

a. The criterion for performance standards is whether repaired equipment meeting the standards will perform its mission when returned to the users. Performance standards are not based on the original design specifications for the equipment; performance standards shall never exceed, and should rarely equal, the depot overhaul standards.

b. Direct support performance standards provide a direct go-no-go basis on which the tester can reject or pass the repaired equipment.

c. Refer to paragraph 3-8 through 3-11 for performance standards.

CHAPTER 4

GENERAL SUPPORT MAINTENANCE

Section I. GENERAL

4-1. Scope of General Support Maintenance

Scope of- General Support Maintenance is detailed in the Maintenance Assignment Chart. Refer to TM 11-6125-253-20.

4-2. Tools, Test Equipment, and Materials Required

a. The following chart lists the test equipment required for the GS support of the motor-generator and the assigned common names for the equipment.

b. Tools, Test Equipment, and Materials Required.

Tool or device	Location	Use
High Voltage Tester, Model 106	Bench test	Test motor-generator dielectric
Mechanical Puller	Work area	Remove bearings
Multimeter, Electronic ME-26B/U	Bench test	Motor-generator test
Multimeter TS-352B/U	Bench test	Motor-generator test and brush neutral settings
Test Set AN/GSM-65	Bench test	Test motor-generator (3 phase).
Tool Kit TK-100G	Work area	Repair of motor-generator
Torque Wrench FSN 5120-541-3002	Work area	Torquing hardware at reassembly
Oscilloscope AN/USM-281	Work area	Neutral settings

Section II. GENERAL SUPPORT TROUBLESHOOTING

WARNING

When servicing the motor-generator, be extremely careful to avoid contact with the ac output circuits.

4-3. General Instructions

The GS troubleshooting procedures in this chapter cover the duties and responsibilities of GS maintenance as indicated by the Maintenance Allocation Chart. The systematic troubleshooting procedure, which begins with the operational and sectionalization check that can be performed at an organizational level is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the Troubleshooting are more advanced.

4-4. Organization of Troubleshooting Procedures

a. The first step when servicing a defective motor-generator is to sectionalize the faults. The next step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing brushes, burned electrical leads and shorted stator windings can often be located by sight, smell, and hearing. Some faults, however, must be isolated by checking voltages and resistances.

b. The tests listed will aid in isolating the trouble. First localize the trouble to either the rotating section, or the regulator section, and then isolate the trouble as follows:

(1) Make voltage and frequency measurements in this equipment only as specified. This equipment is transistorized. Observe all cautions given to prevent transistor damage. Use Multimeter TS-352B/U.

(2) The trouble symptoms listed in the troubleshooting chart will aid in localizing trouble to a component part.

(3) In making any test, do not overlook the possibility of intermittent troubles. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the

external and internal wiring connections to the motor-generator.

CAUTION

Do not attempt removal or replacement of parts before reading paragraphs 4-S and 4-6.

4-5. Operational Test

a. General. If the motor-generator is determined to be faulty, localize the trouble as outlined in paragraph 3-6. Make continuity checks to determine if an open or broken connection exists.

b. Bench Test. Bench test motor generator in accordance with paragraphs 3-8 through 3-11.

c. Troubleshooting Chart. When use of the troubleshooting chart results in the discovery of trouble in the regulator section of the motor-generator, follow the isolating procedure given in paragraph 4-6.

4-6. Regulator Voltage Measurements

CAUTION

The regulator portion of this equipment is transistorized. To prevent transistor damage, make only those measurements specified.

a. Conditions for Measurement.

(1) Interconnect the equipment as described in paragraph 3-10.

(2) Operate the motor-generator as described in paragraph 3-11.

(3) Set the multimeter to read dc voltage and to the scale appropriate for the voltages given in the voltage charts ***(b*** and c below). Take voltage measurements at the regulator test points given in the voltage chart and as shown in figure 2-2.

(4) Set the power supply to provide a 26-volt dc input and set the bench test set to supply a full load on the motor-generator. Make the measurements given in the voltage measurements charts. If all readings agree with those in the voltage charts, increase the dc input to 28 volts dc and measure the voltages at the same test points. Remove and load from the motor-generator, adjust the input voltage to 29 volts dc, and repeat the measurements.

b. Chart.

Regulator terminals		*Input voltages*		
Negative probe	*Positive probe*	*26 VDC (full load)*	*28 VDC (full load)*	*29 VDC (no load)*
2	to 33	9.3±0.5	9.3±0.5	9.3±0.5
2	to 10	15.4±0.5	16.0±0.5	14.4±0.5
2	to 8	24.5±0.5	26.4±0.5	27.5±0.5
2	to 13	9.9±0.5	9.9±0.5	9.9±0.5
2	to 11	8.0±0.5	9.7±0.5	14.7±0.5
8	to 10	9.1±0.5	10.4±0.5	13.1±0.5
8	to 11	16.5±0.5	16.7±0.5	12.8±0.5
2	to 14	9.9±0.5	9.9±0.5	9.9±0.5
2	to 34	9.3±0.5	9.3±0.5	9.3±0.5

4-7. GS Troubleshooting Chart, Rotating Section

NOTE

Neutral setting must be checked and reset whenever there is a change of rotor, DC end bell, DC stator or repair of the rotor. If rotor or bearings are removed new bearings must be installed upon reinstallation of rotor.

Item NO.	*Trouble symptom*	*Probable trouble*	*Checks and corrective measures*
1	Motor-generator vibrates	a. Unbalanced rotor	a. Refer unit to higher echelon of maintenance.
2	Motor-generator fails to start	a. No power supply	a Check DC power supply.
		b. Loose or blown fuse in test.	b. Check dc fuse or test set. (1) Clean and tighten fuse contacts, if applicable. Replace blown fuse. (2) Reset controls.
		c. Dc input circuit open	c. Check wiring and terminal boards for broken connections. Replace defective wiring or terminal board.
		d. Dc brushes not making contact with commutator.	*d.* Check for weak or broken brush holder spring. Replace brush holder assembly if springs are broken. Replace brushes if necessary.

Item No.	Trouble symptom	Probable trouble	Checks and corrective measures
		e. Rotor jammed	e. Remove fan cover and try to rotate rotor by hand. If rotor is jammed, refer to higher echelon of maintenance.
		f. Defective relay	f. Replace relay. Refer to relay test procedure paragraph 3-13.
3	Motor-generator runs but fails to deliver ac voltage or frequency.	a. AC circuit open	a. Check wiring and connections for open circuit. Repair or replace defective wiring,
		b. AC brushes not making contact with sliprings.	b. Check for broken brushes and springs. Replace brushes if broken or worn. Check for sticking brushes. Clean brush holders.
		c. AC rotor windings open	c. Check for continuity between sliprings. If open, replace rotor.
		d. Regulator failure	d. Refer to paragraphs 4-6 and 4-8.
4	AC output voltage is low	a. Regulator out adjustment	a. Readjust voltage adjustment resistor, paragraphs 3-12 and 3-13.
		b. Regulator defective	b. Refer to regulator troubleshooting chart.
5	AC output voltage is high	a. Voltage regulator out of adjustment.	a. Readjust voltage adjustment resistor, paragraphs 3-12 and 3-13.
		b. Regulator failure	b. refer to regulator voltage measurement paragraph 4-6, troubleshooting chart paragraph 4-7, and regulator troubleshooting paragraph 4-8.
		c. Generator field grounded (regulator side)	c. Disassemble generator: see paragraph 4-17. Perform dielectric test on stator. If grounded, refer to higher echelon maintenance.
		d. Defective capacitor C6 or C7 *(26, 27, fig. 4-4) on* ac endbell.	d. Replace defective component.
6	Frequency is above or below normal.	a. Frequency adjustment resistor out of adjustment.	a. Adjust frequency to 400 cps.
		b. Open or short circuit in shunt field.	b. See paragraph 4-17. Check for continuity, resistance and perform dielectric test. If defective refer unit to higher echelon maintenance.
7	Voltage unstable	a. Loose or dirty connections.	a. Check for presence of loose or dirty connections in the motor-generator; clean and tighten.
		b. Poor ac brush contact at sliprings.	h. Check condition of sliprings. Check brushes and brush holders. Replace brushes; clean sliprings. If sliprings require refinishing refer to higher echelon of maintenance.
		c. Regulator defective	c. Refer to regulator voltage measurement, paragraph 4-6, troubleshooting chart, paragraph 4-

Item No.	*Trouble symptom*	*Probable trouble*	*Checks and corrective measures*
			7, and regulator troubleshooting paragraph 4-8.
		d. Defective relay	***d.*** Replace relay. Refer to relay test procedure paragraph 3-13.
8	Excessive sparking at brushes	a. Brushes stuck in holder or broken.	***a.*** Check brushes and brush holders. Replace faulty brushes. Clean brush holders.
		b. Commutator or sliprings dirty or pitted. High commutator bar.	***b.*** Check condition of commutator or sliprings. If too dirty or pitted, refer to higher echelon maintenance.
		c. Grounded generator field ; see paragraph 4-17.	c. Check ac rotor for open, shorts or grounded. If defective, discard and replace with a new armature.
		d. Grounded motor armature; see paragraph 4-17.	***d.*** Check armature for open, shorts or grounded. If defective, replace with a new armature.
9	Motor-generator overheats	a. Poor external ventilation.	a. Check for adequate air circulation around motor-generator. Provide ample circulation.
		b. Poor internal ventilation	***b.*** Check to see that air passages are free of obstructions. Clean air passages.
		c. Faulty bearings	c. Feel bearing housings in endbells. If hot to the touch, replace the bearings.

4-8. Regulator Troubleshooting

a. Conditions.

(1) If any of the measurements taken vary from those given in the regulator chart, make the measurements given in the regulator troubleshooting chart. Set the multimeter to measure dc voltage as specified in the chart, and make the measurements as indicated.

(2) The abnormal conditions listed in the troubleshooting charts refer to the motor-generator output as indicated on the bench test set. The peak voltage measurements are made between ground and the terminals indicated in the chart headings (see fig. ***2-2).*** All measurements specified for each item must be made. Make only the voltage measurements listed. Any variation from the readings indicated for each item will indicate the defective circuit board. Follow the instructions given in the remedy column of the charts.

b. Regulator Troubleshooting Chart.

Abnormal **condition**	*From*	*To*	*Voltage*	*Remedy*
High voltage	- 2	+13	More than 10.5v	Replace U3.
High voltage	- 2	+11	Less than 2v	Replace U3.
High voltage	-12	+13	Less than 10.2v	Replace U2.
Low voltage	- 2	+13	Less than 8.5v	Replace U2.
Low voltage	- 2	+11	More than 20v	Replace U3.
High frequency	- 2	+33	Less than 8.5v	Replace U1.
High frequency	- 2	+10	More than 20v	Replace U1.
Low frequency	- 2	+33	More than l0.5v	Replace U1.
Low frequency	- 2	+10	Less than 7.0v	Replace U1.
Low frequency	-32	+33	Less than 10.5v	Replace U2.

4-9. Bench Testing

Refer to paragraphs 3-8 through, 3-11 for all bench test procedures.

END

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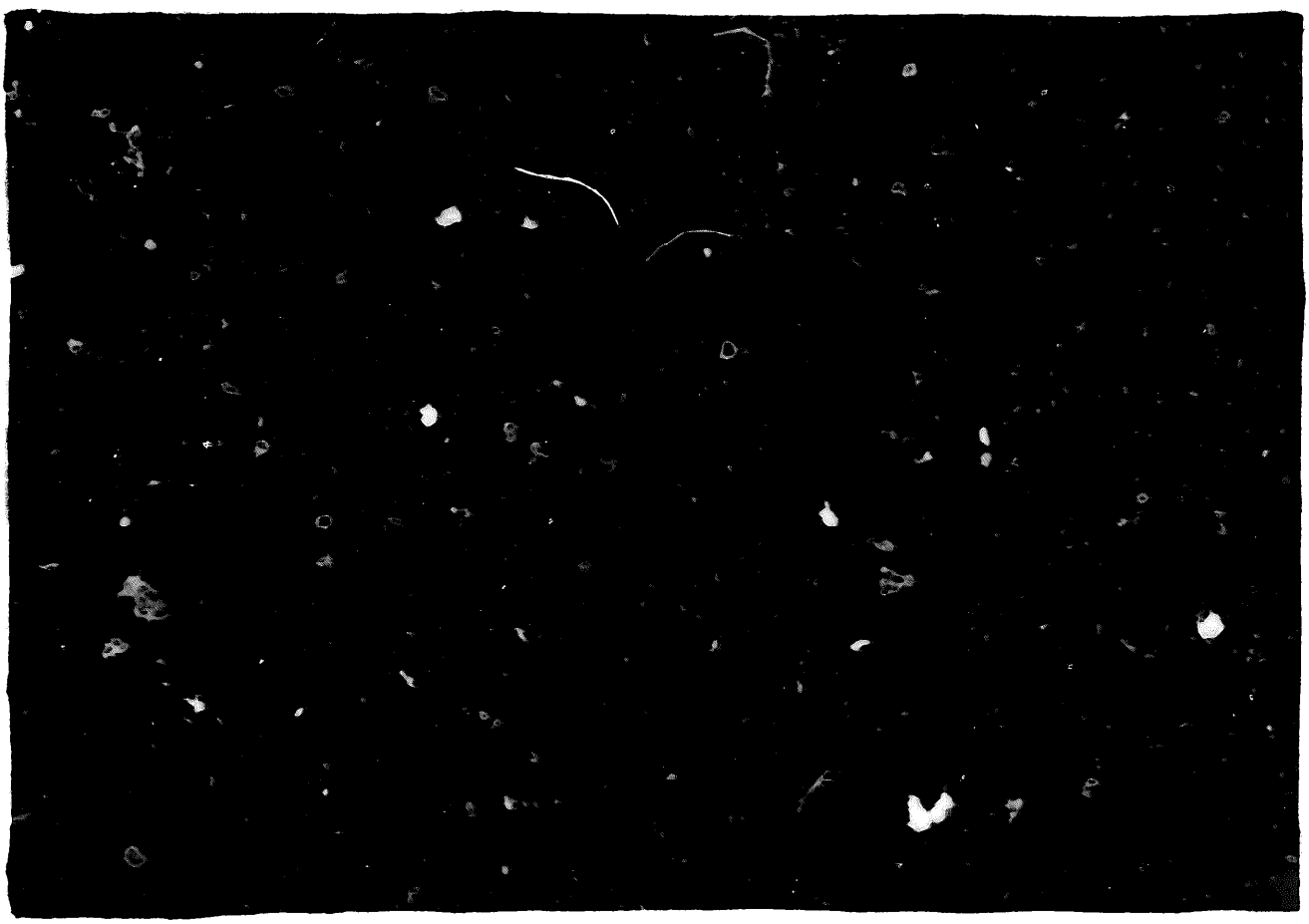

MICROFORM
TEST TARGET